Economics & the History of Money

First edition | 10 units | 50 lessons + exams | A video for every lesson

FIRST EDITION

Course guide

This is a full high-school course in economics, built around the history of money. Ten units cover economic thinking, markets and prices, market structures, the story of money from barter to the gold standard, fiat money and central banking, labor and capital, government and the economy, the whole economy and the wealth of nations. Each of the fifty lessons begins with a real moment in history: William Bradford changing the rules of Plymouth Colony in 1623, the oil boom at Titusville, Croesus striking gold and silver coins, the debasement of the Roman denarius, the silver mountain of Potosí, the goldsmiths of London, the Panic of 1907 and the meeting on Jekyll Island, the Bretton Woods conference of 1944, August 15, 1971, the Triangle fire, the Corn Laws and the first container ship.

Every lesson follows the same path. First comes **the story**. Then **how they figured it out**: what problem stood in the way, what people tried, what failed and what they measured. Then **the big idea**, the economic principle underneath, worked out with real numbers, graphs and formulas: opportunity cost, marginal analysis, comparative advantage, supply and demand, elasticity, profit maximization, the money multiplier, the quantity equation, real and nominal values, GDP and the rule of 70. Then **in business today**: how the idea is used now by families, firms, banks and central banks. Each lesson has worked examples, a practice set, a project with real measurements and records, a ledger-notebook page and a picture study.

Businesses and economic rules are weighed honestly by what they meant for **six stakeholders**: the financiers, the risk-takers, the builders, the workers, the customers and the community. The units on labor, capital and government are taught as settled history: what problem a rule or a custom fixed, how it worked, what it cost, and where rules went wrong. The year ends with a research paper on an episode of economic history of the student's choice.

> Most videos come from the Federal Reserve banks, Khan Academy, MRU, the economics teaching channel founded by two university economists (its explanatory videos only), museums, archives and a few careful history channels, chosen lesson by lesson. Every video was checked for content and accuracy, and none comes from a channel that takes sides in present-day public debates. A few end with an invitation to subscribe or a short sponsor message; stop the video when the teaching ends. Where a video touches on a policy question, the lesson notes say where to stop.

Start with Lesson 1.1 →

Who it is for

Written for students in grades 9–12 (about ages 14–18) who have finished Algebra I: they can solve linear equations, read and draw graphs, and work with percents and exponents. No earlier economics is needed. A parent or teacher reads along, discusses the stories and checks the practice sets. Nothing needs to be bought: a calculator, a notebook and free spreadsheet software are enough.

How to use this course

1. **The weekly rhythm.** The course has 50 lessons in 10 units. Each lesson takes three sessions of about 50 minutes: (1) the warm-up, video, teaching and worked examples; (2) the project and the ledger notebook; (3) the practice set and corrections. A unit test follows each unit, a midterm follows Unit 5 and a final follows Unit 10. At five sessions a week the course fills a school year of about 33 weeks.
2. **Story, then the big idea.** The core ideas are written to be read carefully, with a pencil. *The story* and *How they figured it out* tell what happened; *The big idea* states the principle; *In business today* shows how people use it now. After each paragraph, the student should be able to say the main point in one sentence.
3. **Worked examples and practice.** Study each worked example by covering the steps and trying them first. The practice set runs from easy to challenge. Do every problem, check the answers, and redo any you missed on a fresh page with a note about what went wrong. That correction habit is worth more than a high score.
4. **Picture study.** Each lesson has one public-domain painting, print, map, coin or historic photograph. Look at it quietly for two minutes, then work through the

"look for" items and questions, which tie the picture to the lesson's economics.

5. **The ledger notebook.** Keep one notebook for the year. Every project ends with something measured and written down: a price survey, a demand schedule, a payoff table, a coin-weight table, a balance sheet, an index of prices, a stakeholder scorecard. Date every page, label every column with units, and write one sentence about what the numbers mean.
6. **The six stakeholders.** Whenever the course looks at a business, a market or a rule, ask what it meant for the financiers, the risk-takers, the builders, the workers, the customers and the community. A business or a rule is good when it serves all six over a long time.
7. **Spreadsheets.** Many projects ask for a free spreadsheet (Google Sheets or LibreOffice Calc) to build tables and graphs. Learning to set one up is part of the course.
8. **Optional books and games.** Some units list free classics such as Adam Smith's *Wealth of Nations*, Leonard Read's essay "I, Pencil" and Walter Bagehot's *Lombard Street*, and free teaching sites such as Federal Reserve History. They are extras; every lesson can be completed without them.
9. **Tests and exams.** Each unit test, the midterm and the final are worth 100 points. Calculators are allowed and work must be shown. The tests are in each unit; the exams are at the end of the course outline.
10. **Money and safety.** Projects that involve stores, interviews or surveys are done with a parent. Never give out personal information online. Any investing in this course is practice with pretend money, and nothing here is advice to buy or sell anything.
11. **The capstone.** Unit 10 ends with a research paper of 1,500–2,500 words on an episode in economic history, using primary sources and the tools of the whole year.

Scope and sequence

UNIT 1 · WEEKS 1–4

Economic Thinking

Scarcity and opportunity cost, incentives, marginal thinking, specialization and comparative advantage, and work as a calling and a stewardship.

1.1 Scarcity and Opportunity Cost: Bastiat's Broken Window

1.2 Incentives: Plymouth Colony Changes the Rules, 1623

1.3 Thinking at the Margin: The Diamond-Water Paradox

1.4 Specialization and Comparative Advantage: Smith and Ricardo

1.5 Work, Vocation and Stewardship: Human Capital and "The Use of Money"

UNIT 2 · WEEKS 4–7

Markets and Prices

Demand, supply and equilibrium with schedules, graphs and equations; elasticity; and prices as information, with price ceilings and floors as history.

2.1 Demand: Henry Ford Cuts the Price of the Model T

2.2 Supply: The Oil Boom at Titusville, 1859

2.3 Equilibrium: Marshall's Scissors

2.4 Elasticity: King's Law of Harvests

2.5 Prices as Information: "I, Pencil," Hayek's Tin, and Price Controls

UNIT 3 · WEEKS 7–10

Market Structures

Perfect competition, monopolistic competition, oligopoly and simple game theory, monopoly pricing, and natural monopoly, regulation and antitrust from Standard Oil to AT&T.

3.1 Perfect Competition: Grading Wheat at the Chicago Board of Trade

3.2 Monopolistic Competition: Henry Heinz and the Clear Glass Bottle

3.3 Oligopoly and Game Theory: Railroad Pools and the Prisoner's Dilemma

3.4 Monopoly: Charles Martin Hall and Aluminum

3.5 Natural Monopoly, Regulation and Antitrust: Standard Oil (1911) and AT&T (1984)

UNIT 4 · WEEKS 10–13

The Story of Money I: Commodity Money

Barter and the functions of money; Lydia's coins and the gold trade; the debasement of the Roman denarius; the florin and the Medici; and Spanish silver and the great rise in prices that followed.

4.1 Barter and the Functions of Money: The Stone Money of Yap

4.2 Lydia's Coins and the Gold Trade

4.3 Rome's Denarius and Its Debasement

4.4 The Florentine Florin and the Medici Bank

4.5 Spanish Silver and the Great Rise in Prices

UNIT 5 · WEEKS 13–17

The Story of Money II: Banks and the Gold Standard

Goldsmiths and fractional-reserve banking; the Bank of England; American banking from Hamilton to the Panic of 1907; the Federal Reserve; and how the classical gold standard worked.

5.1 The Goldsmiths of London and Fractional-Reserve Banking

5.2 The Bank of England, 1694, and the Lender of Last Resort

5.3 American Banking from Hamilton's Bank to the Panic of 1907

5.4 Jekyll Island and the Federal Reserve, 1913

5.5 How the Classical Gold Standard Worked

UNIT 6 · WEEKS 17–20

Fiat Money and Central Banking

The gold measures of 1933–34, Bretton Woods, August 15, 1971, how the Fed sets interest rates today, and inflation, deflation and hyperinflation.

6.1 1933: Gold Is Called In and Repriced at $35

6.2 Bretton Woods, 1944

6.3 August 15, 1971: The Gold Window Closes

6.4 How the Fed Sets Interest Rates and the Money Supply

6.5 Inflation, Deflation and Hyperinflation: Weimar Germany and Zimbabwe

UNIT 7 · WEEKS 20–23

Labor, Capital and Fair Rules

The gains and costs of the first factories; wages and productivity; the Factory Acts, unions and the FLSA; workplace safety and workers' compensation; and rules that backfired.

7.1 The First Factories: Gains and Costs

7.2 Wages, Productivity and Labor Markets: Ford's $5 Day

7.3 The Factory Acts, Unions and the Fair Labor Standards Act

7.4 Workplace Safety and Workers' Compensation: After the Triangle Fire

7.5 When Rules Backfire: Diocletian's Price Edict and Price Controls

UNIT 8 · WEEKS 23–26

Government and the Economy

Property, contracts and the rule of law; public goods and spillovers; the principles of taxation; consumer and investor protection; and government failure and the limits of planning.

8.1 Property, Contracts and the Rule of Law: The Land Ordinance of 1785

8.2 Public Goods and Spillovers: Lighthouses and London's Great Stink

8.3 Taxes as Principle: Adam Smith's Maxims and the Window Tax

8.4 Consumer and Investor Protection: Pure Food (1906), the SEC (1934) and the FDIC (1933)

8.5 Government Failure and the Limits of Planning

UNIT 9 · WEEKS 27–30

The Whole Economy

Measuring GDP, unemployment and the business cycle; the Great Depression; and why some nations grow rich.

9.1 Measuring the Whole Economy: Simon Kuznets and GDP

9.2 Unemployment: Counting the Jobless

9.3 The Business Cycle: Seven Fat Years and Seven Lean

9.4 The Great Depression

9.5 Why Some Nations Grow Rich

UNIT 10 · WEEKS 30–33

Trade and the Wealth of Nations

Trade from the Silk Road to the container ship; exchange rates; the Corn Laws and the case for trade; capital, innovation and growth; and a capstone research paper.

10.1 Trade Through History: From the Silk Road to the Container Ship

10.2 Exchange Rates and Purchasing Power Parity

10.3 The Corn Laws and the Case for Trade

10.4 Capital, Innovation and Growth: Norman Borlaug's Wheat

10.5 Capstone: Writing Economic History, with John Law's Mississippi Bubble as a Model

Weekly pacing calendar

WEEK	PLAN
1	• Day 1: Lesson 1.1 Scarcity and Opportunity Cost: Bastiat's Broken Window: video, teaching and worked examples • Day 2: Lesson 1.1: project and notebook • Day 3: Lesson 1.1: practice set and corrections • Day 4: Lesson 1.2 Incentives: Plymouth Colony Changes the Rules, 1623: video, teaching and worked examples • Day 5: Lesson 1.2: project and notebook *Five sessions a week of about 50 minutes. Families on a four-day week can combine the practice day of one lesson with the teaching day of the next.*
2	• Day 1: Lesson 1.2: practice set and corrections • Day 2: Lesson 1.3 Thinking at the Margin: The Diamond-Water Paradox: video, teaching and worked examples • Day 3: Lesson 1.3: project and notebook • Day 4: Lesson 1.3: practice set and corrections • Day 5: Lesson 1.4 Specialization and Comparative Advantage: Smith and Ricardo: video, teaching and worked examples
3	• Day 1: Lesson 1.4: project and notebook • Day 2: Lesson 1.4: practice set and corrections • Day 3: Lesson 1.5 Work, Vocation and Stewardship: Human Capital and "The Use of Money": video, teaching and worked examples • Day 4: Lesson 1.5: project and notebook • Day 5: Lesson 1.5: practice set and corrections
4	• Day 1: Unit 1 test • Day 2: Lesson 2.1 Demand: Henry Ford Cuts the Price of the Model T: video, teaching and worked examples • Day 3: Lesson 2.1: project and notebook • Day 4: Lesson 2.1: practice set and corrections • Day 5: Lesson 2.2 Supply: The Oil Boom at Titusville, 1859: video, teaching and worked examples
5	• Day 1: Lesson 2.2: project and notebook • Day 2: Lesson 2.2: practice set and corrections • Day 3: Lesson 2.3 Equilibrium: Marshall's Scissors: video, teaching and worked examples

WEEK	PLAN
	• Day 4: Lesson 2.3: project and notebook • Day 5: Lesson 2.3: practice set and corrections
6	• Day 1: Lesson 2.4 Elasticity: King's Law of Harvests: video, teaching and worked examples • Day 2: Lesson 2.4: project and notebook • Day 3: Lesson 2.4: practice set and corrections • Day 4: Lesson 2.5 Prices as Information: "I, Pencil," Hayek's Tin, and Price Controls: video, teaching and worked examples • Day 5: Lesson 2.5: project and notebook
7	• Day 1: Lesson 2.5: practice set and corrections • Day 2: Unit 2 test • Day 3: Lesson 3.1 Perfect Competition: Grading Wheat at the Chicago Board of Trade: video, teaching and worked examples • Day 4: Lesson 3.1: project and notebook • Day 5: Lesson 3.1: practice set and corrections
8	• Day 1: Lesson 3.2 Monopolistic Competition: Henry Heinz and the Clear Glass Bottle: video, teaching and worked examples • Day 2: Lesson 3.2: project and notebook • Day 3: Lesson 3.2: practice set and corrections • Day 4: Lesson 3.3 Oligopoly and Game Theory: Railroad Pools and the Prisoner's Dilemma: video, teaching and worked examples • Day 5: Lesson 3.3: project and notebook
9	• Day 1: Lesson 3.3: practice set and corrections • Day 2: Lesson 3.4 Monopoly: Charles Martin Hall and Aluminum: video, teaching and worked examples • Day 3: Lesson 3.4: project and notebook • Day 4: Lesson 3.4: practice set and corrections • Day 5: Lesson 3.5 Natural Monopoly, Regulation and Antitrust: Standard Oil (1911) and AT&T (1984): video, teaching and worked examples
10	• Day 1: Lesson 3.5: project and notebook • Day 2: Lesson 3.5: practice set and corrections • Day 3: Unit 3 test

WEEK	PLAN
	• Day 4: Lesson 4.1 Barter and the Functions of Money: The Stone Money of Yap: video, teaching and worked examples • Day 5: Lesson 4.1: project and notebook
11	• Day 1: Lesson 4.1: practice set and corrections • Day 2: Lesson 4.2 Lydia's Coins and the Gold Trade: video, teaching and worked examples • Day 3: Lesson 4.2: project and notebook • Day 4: Lesson 4.2: practice set and corrections • Day 5: Lesson 4.3 Rome's Denarius and Its Debasement: video, teaching and worked examples
12	• Day 1: Lesson 4.3: project and notebook • Day 2: Lesson 4.3: practice set and corrections • Day 3: Lesson 4.4 The Florentine Florin and the Medici Bank: video, teaching and worked examples • Day 4: Lesson 4.4: project and notebook • Day 5: Lesson 4.4: practice set and corrections
13	• Day 1: Lesson 4.5 Spanish Silver and the Great Rise in Prices: video, teaching and worked examples • Day 2: Lesson 4.5: project and notebook • Day 3: Lesson 4.5: practice set and corrections • Day 4: Unit 4 test • Day 5: Lesson 5.1 The Goldsmiths of London and Fractional-Reserve Banking: video, teaching and worked examples
14	• Day 1: Lesson 5.1: project and notebook • Day 2: Lesson 5.1: practice set and corrections • Day 3: Lesson 5.2 The Bank of England, 1694, and the Lender of Last Resort: video, teaching and worked examples • Day 4: Lesson 5.2: project and notebook • Day 5: Lesson 5.2: practice set and corrections
15	• Day 1: Lesson 5.3 American Banking from Hamilton's Bank to the Panic of 1907: video, teaching and worked examples • Day 2: Lesson 5.3: project and notebook • Day 3: Lesson 5.3: practice set and corrections

WEEK	PLAN
	• Day 4: Lesson 5.4 Jekyll Island and the Federal Reserve, 1913: video, teaching and worked examples • Day 5: Lesson 5.4: project and notebook
16	• Day 1: Lesson 5.4: practice set and corrections • Day 2: Lesson 5.5 How the Classical Gold Standard Worked: video, teaching and worked examples • Day 3: Lesson 5.5: project and notebook • Day 4: Lesson 5.5: practice set and corrections • Day 5: Unit 5 test
17	• Day 1: Review day for the midterm • Day 2: Midterm exam • Day 3: Lesson 6.1 1933: Gold Is Called In and Repriced at $35: video, teaching and worked examples • Day 4: Lesson 6.1: project and notebook • Day 5: Lesson 6.1: practice set and corrections
18	• Day 1: Lesson 6.2 Bretton Woods, 1944: video, teaching and worked examples • Day 2: Lesson 6.2: project and notebook • Day 3: Lesson 6.2: practice set and corrections • Day 4: Lesson 6.3 August 15, 1971: The Gold Window Closes: video, teaching and worked examples • Day 5: Lesson 6.3: project and notebook
19	• Day 1: Lesson 6.3: practice set and corrections • Day 2: Lesson 6.4 How the Fed Sets Interest Rates and the Money Supply: video, teaching and worked examples • Day 3: Lesson 6.4: project and notebook • Day 4: Lesson 6.4: practice set and corrections • Day 5: Lesson 6.5 Inflation, Deflation and Hyperinflation: Weimar Germany and Zimbabwe: video, teaching and worked examples
20	• Day 1: Lesson 6.5: project and notebook • Day 2: Lesson 6.5: practice set and corrections • Day 3: Unit 6 test • Day 4: Lesson 7.1 The First Factories: Gains and Costs: video, teaching and worked examples

WEEK	PLAN
	• Day 5: Lesson 7.1: project and notebook
21	• Day 1: Lesson 7.1: practice set and corrections • Day 2: Lesson 7.2 Wages, Productivity and Labor Markets: Ford's $5 Day: video, teaching and worked examples • Day 3: Lesson 7.2: project and notebook • Day 4: Lesson 7.2: practice set and corrections • Day 5: Lesson 7.3 The Factory Acts, Unions and the Fair Labor Standards Act: video, teaching and worked examples
22	• Day 1: Lesson 7.3: project and notebook • Day 2: Lesson 7.3: practice set and corrections • Day 3: Lesson 7.4 Workplace Safety and Workers' Compensation: After the Triangle Fire: video, teaching and worked examples • Day 4: Lesson 7.4: project and notebook • Day 5: Lesson 7.4: practice set and corrections
23	• Day 1: Lesson 7.5 When Rules Backfire: Diocletian's Price Edict and Price Controls: video, teaching and worked examples • Day 2: Lesson 7.5: project and notebook • Day 3: Lesson 7.5: practice set and corrections • Day 4: Unit 7 test • Day 5: Lesson 8.1 Property, Contracts and the Rule of Law: The Land Ordinance of 1785: video, teaching and worked examples
24	• Day 1: Lesson 8.1: project and notebook • Day 2: Lesson 8.1: practice set and corrections • Day 3: Lesson 8.2 Public Goods and Spillovers: Lighthouses and London's Great Stink: video, teaching and worked examples • Day 4: Lesson 8.2: project and notebook • Day 5: Lesson 8.2: practice set and corrections
25	• Day 1: Lesson 8.3 Taxes as Principle: Adam Smith's Maxims and the Window Tax: video, teaching and worked examples • Day 2: Lesson 8.3: project and notebook • Day 3: Lesson 8.3: practice set and corrections • Day 4: Lesson 8.4 Consumer and Investor Protection: Pure Food (1906), the SEC (1934) and the FDIC (1933): video, teaching and worked examples

WEEK	PLAN
	• Day 5: Lesson 8.4: project and notebook
26	• Day 1: Lesson 8.4: practice set and corrections • Day 2: Lesson 8.5 Government Failure and the Limits of Planning: video, teaching and worked examples • Day 3: Lesson 8.5: project and notebook • Day 4: Lesson 8.5: practice set and corrections • Day 5: Unit 8 test
27	• Day 1: Lesson 9.1 Measuring the Whole Economy: Simon Kuznets and GDP: video, teaching and worked examples • Day 2: Lesson 9.1: project and notebook • Day 3: Lesson 9.1: practice set and corrections • Day 4: Lesson 9.2 Unemployment: Counting the Jobless: video, teaching and worked examples • Day 5: Lesson 9.2: project and notebook
28	• Day 1: Lesson 9.2: practice set and corrections • Day 2: Lesson 9.3 The Business Cycle: Seven Fat Years and Seven Lean: video, teaching and worked examples • Day 3: Lesson 9.3: project and notebook • Day 4: Lesson 9.3: practice set and corrections • Day 5: Lesson 9.4 The Great Depression: video, teaching and worked examples
29	• Day 1: Lesson 9.4: project and notebook • Day 2: Lesson 9.4: practice set and corrections • Day 3: Lesson 9.5 Why Some Nations Grow Rich: video, teaching and worked examples • Day 4: Lesson 9.5: project and notebook • Day 5: Lesson 9.5: practice set and corrections
30	• Day 1: Unit 9 test • Day 2: Lesson 10.1 Trade Through History: From the Silk Road to the Container Ship: video, teaching and worked examples • Day 3: Lesson 10.1: project and notebook • Day 4: Lesson 10.1: practice set and corrections • Day 5: Lesson 10.2 Exchange Rates and Purchasing Power Parity: video, teaching and worked examples

WEEK	PLAN
31	• Day 1: Lesson 10.2: project and notebook • Day 2: Lesson 10.2: practice set and corrections • Day 3: Lesson 10.3 The Corn Laws and the Case for Trade: video, teaching and worked examples • Day 4: Lesson 10.3: project and notebook • Day 5: Lesson 10.3: practice set and corrections
32	• Day 1: Lesson 10.4 Capital, Innovation and Growth: Norman Borlaug's Wheat: video, teaching and worked examples • Day 2: Lesson 10.4: project and notebook • Day 3: Lesson 10.4: practice set and corrections • Day 4: Lesson 10.5 Capstone: Writing Economic History, with John Law's Mississippi Bubble as a Model: video, teaching and worked examples • Day 5: Lesson 10.5: project and notebook
33	• Day 1: Lesson 10.5: practice set and corrections • Day 2: Unit 10 test • Day 3: Review day for the final • Day 4: Final exam

Materials

A calculator

A scientific calculator is enough. A financial calculator is optional.

A notebook (graph paper is best) for the ledger notebook

One for the whole year: tables, graphs, schedules and scorecards.

Free spreadsheet software (Google Sheets or LibreOffice Calc)

For building tables and graphs in the projects.

A ruler, colored pencils and graph paper

For drawing supply and demand graphs by hand.

Household items for small projects

Coins, a kitchen scale that reads in grams, receipts and store flyers, index cards.

Optional: one of the books listed in a unit

Never required. Most are free online.

Grading

Grades come from the practice sets, projects, notebook, unit tests and the two exams. Practice and projects are graded for effort, accuracy and corrections; tests and exams are graded for correct reasoning, with partial credit for clear work.

PART	%
Practice sets (completed and corrected)	**15**
Projects	**25**
Ledger notebook	**10**
Unit tests	**30**
Midterm exam	**10**
Final exam (including the capstone paper's defense)	**10**

Scale: A 90–100, B 80–89, C 70–79, D 60–69. Below 60: review the unit with help and retake the test.

- A practice set earns full credit when every problem is attempted, checked against the answers and corrected in writing.
- A project earns full credit when the data are real, honestly recorded and clearly explained, even if the numbers did not come out as predicted.
- On tests, show the formula, the numbers substituted and the units. A correct method with an arithmetic slip earns most of the points.
- The capstone research paper (Lesson 10.5) may be graded as part of the Unit 10 project weight; a parent may add a short oral defense.

A NOTE TO PARENTS

You do not need to be an economist to teach this course. Read the stories with your student, watch the videos together when you can, and ask three questions as often as possible: “What did it cost?” (including what was given up), “Who gains, and who pays?” and “How do you know? Show me the numbers.”

Economics touches public life, so this course is careful. It teaches principles and settled history: what happened, why, what it cost and what was learned. It names past presidents, laws and central bankers plainly where history requires, but it never asks you or your student to take a side in present-day debates, and it never names living officeholders. Where economists still disagree about the past, the course says so and gives the main explanations fairly.

Beneath the arithmetic is a Christian view of work and wealth: the earth is the Lord’s, work is a calling, honest weights and honest money are a matter of justice, and wealth is held in trust for God and neighbor. *Fabricando fit faber*: by making, one becomes a maker.

UNIT 1

Economic Thinking

Economics begins with a simple fact: we cannot have everything. Time, land, materials and skilled hands are limited, so every choice gives something up. In this unit you will learn the economist's basic tools for thinking about choices: opportunity cost and the production possibilities frontier, incentives, marginal thinking, and specialization and comparative advantage.

Each tool comes with a story: Bastiat's broken window, the Pilgrims at Plymouth changing their rules in 1623, Adam Smith's puzzle about diamonds and water, his pin factory, and Ricardo's two countries trading. The unit ends with work itself: vocation, stewardship and the human capital built by diligence, with John Wesley's three rules for the use of money.

PREREQUISITES

- Algebra I: solving linear equations and computing slopes
- Reading and drawing simple graphs
- Percents and ratios

MASTERY CHECKLIST

- ☐ I can define scarcity and opportunity cost and compute opportunity cost from a table or a frontier.
- ☐ I can explain what Bastiat meant by "what is not seen."
- ☐ I can explain how incentives changed behavior at Plymouth in 1623 and predict unintended consequences of a rule.
- ☐ I can use marginal benefit and marginal cost to make a decision and explain the diamond-water paradox.
- ☐ I can compute absolute and comparative advantage and show with numbers that both sides gain from trade.
- ☐ I can explain vocation, stewardship and human capital, and calculate a simple payback period.

OPTIONAL BOOKS AND GAMES FOR THIS UNIT

- ***The Wealth of Nations*, by Adam Smith (1776), Book I, chapters 1–3**: Free. The pin factory and the limits of the market, in Smith's own words. Read Book I, chapter 1, with Lesson 1.4 and the paradox of value in chapter 4 with Lesson 1.3. Ages 14+.
- **"What Is Seen and What Is Not Seen," by Frédéric Bastiat (1850)**: Free on Econlib, in *Selected Essays*. The broken-window parable is the first section and takes ten minutes to read. Use with Lesson 1.1.
- ***Of Plymouth Plantation*, by William Bradford**: Free. Bradford's account of the year 1623 tells the story of Lesson 1.2 in the governor's own words. Ages 14+.
- **"The Use of Money," sermon by John Wesley (1760)**: Free, from the Wesley Center Online. About twenty minutes to read aloud. Use with Lesson 1.5.

Not required. Every project in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

1.1 Scarcity and Opportunity Cost: Bastiat's Broken Window 3 sessions of 50 minutes

1.2 Incentives: Plymouth Colony Changes the Rules, 1623 3 sessions of 50 minutes

1.3 Thinking at the Margin: The Diamond-Water Paradox 3 sessions of 50 minutes

1.4 Specialization and Comparative Advantage: Smith and Ricardo
3 sessions of 50 minutes

1.5 Work, Vocation and Stewardship: Human Capital and "The Use of Money"
3 sessions of 50 minutes

Unit 1 Test

Calculators are allowed. Show your work for every calculation: write the formula, substitute the numbers with units, and give the answer. Answer the concept questions in complete sentences. The test is worth 100 points.

1. **6 pts**

   Define opportunity cost. Your best alternatives to a Saturday job paying $90 are (a) a hike with friends, which you value most, and (b) sleeping in. What is the opportunity cost of taking the job?

2. **8 pts**

   A country's PPF passes through (computers, tons of corn): (0, 500), (100, 450), (200, 350), (300, 200), (400, 0). Find the opportunity cost per computer of each 100-computer step. What shape is the curve?

3. **6 pts**

   Explain Bastiat's broken-window parable and what it teaches about "what is not seen."

4. **6 pts**

   What changed at Plymouth in 1623, and what did Bradford say were the results?

5. **6 pts**

   In a group of 25 workers who split output equally, one worker's extra effort produces 50 units. How many does he keep? How does this explain the free-rider problem?

6. **6 pts**

   Give an example of an incentive that backfired, and explain why.

7. **8 pts**

   Total utility from cups of coffee: 1 cup 20, 2 cups 32, 3 cups 38, 4 cups 40. Find each cup's marginal utility. If each cup costs 5 units of utility in money, how many cups should be bought?

8. **6 pts**

   Explain the diamond-water paradox and how economists of the 1870s resolved it.

9. **6 pts**

   A firm has spent $500,000 on a project. Finishing costs $300,000 more and will bring $350,000. Should it finish? Why?

10. **6 pts**

    Describe Smith's pin factory and give his three reasons for the gains from the division of labor.

11. **10 pts**

    Maria can make 6 shirts or 3 coats a day; Tom can make 4 shirts or 1 coat. (a) Who has the absolute advantage in each? (b) Find each person's opportunity cost of a coat. (c) Who should specialize in what? (d) Give a term of trade (shirts per coat) that benefits both.

12. **6 pts**

    Why do economists say both sides gain from voluntary trade? Use comparative advantage in your answer.

13. **8 pts**

    A two-year program costs $8,000 in tuition and $20,000 a year in lost wages. It raises earnings by $9,000 a year. Find the total cost and the payback period.

14. **6 pts**

    State Wesley's three rules and explain why he thought the third was necessary.

15. **6 pts**

    Short essay (one paragraph): Choose one idea from this unit and show how it applies to a decision your family or a local business has made.

ANSWER KEY

1. The value of the best alternative given up. The opportunity cost is the hike with friends.
2. 0.5, 1, 1.5 and 2 tons per computer. Rising opportunity cost: the curve bows outward.
3. A broken window creates work for the glazier (seen), but the owner loses what he would have bought instead, such as shoes (not seen). The town is poorer by one pair of shoes. Destruction does not create wealth.
4. The colony moved from a common store to family plots for each household's own use. Bradford wrote that it had very good success: more corn was planted and more people worked willingly.
5. $50/25 = 2$ units. He bears the full cost of the effort but receives a small share, so each person has little reason to work extra and a reason to let others carry the load.
6. Sample: a bounty on rat tails led people to breed rats; the reward was tied to tails, not to fewer rats. Rewarding a measure that can be manufactured invites gaming.
7. MU: 20, 12, 6, 2. Buy 3 cups (6 ≥ 5; the 4th's 2 is less than 5).
8. Water is more useful than diamonds but much cheaper. Price depends on marginal utility: water is plentiful, so the last unit has little value; diamonds are scarce, so the last one is valued highly. Jevons, Menger and Walras explained this in the 1870s.
9. Yes. The $500,000 is sunk. Future benefit $350,000 exceeds future cost $300,000, so finishing adds $50,000.
10. Ten men splitting about 18 operations made upward of 48,000 pins a day, versus perhaps 1–20 each working alone. Reasons: skill from repetition, no time lost switching, and invention of specialized tools.
11. (a) Maria in both. (b) Maria: 2 shirts per coat; Tom: 4 shirts per coat. (c) Maria makes coats, Tom makes shirts. (d) Any rate between 2 and 4 shirts per coat, such as 3.
12. Each side specializes where its opportunity cost is lower, so total output rises, and trade at terms between their opportunity costs gives each more than it could make alone. Neither would trade voluntarily if it expected to lose.
13. Cost: $\$8{,}000 + \$40{,}000 = \$48{,}000$. Payback: $48{,}000/9{,}000 \approx 5.3$ years.

14. Gain all you can, save all you can, give all you can. Without giving, gain and saving lead to love of money and arrogance; the Christian is a steward who gains in order to serve and give.
15. Answers vary. A strong answer names the idea correctly (for example, opportunity cost or comparative advantage), describes the real decision, uses at least one number, and identifies what was given up or gained.

PORTFOLIO PIECE: AN ECONOMIST'S NOTEBOOK OF EVERYDAY CHOICES

Keep a two-week log of at least ten real decisions made by you, your family or a local business. For each, record the choice, the opportunity cost, the incentives at work, and the marginal benefit and cost if you can estimate them. Then choose the three most interesting decisions and write a two-page essay analyzing them with the tools of this unit, including at least one graph or table (a frontier, a marginal table or a comparative-advantage table) built from real numbers.

LOOK FOR	WHAT IT MEANS
Accuracy	Opportunity cost, incentives, marginal reasoning and comparative advantage are used correctly.
Evidence	The log is dated and specific, with real numbers where possible; the graph or table is labeled and correct.
Insight	The essay identifies effects that are "not seen" and explains why people chose as they did.
Writing	Clear, organized and free of careless errors; each paragraph makes one point.

1.1 Scarcity and Opportunity Cost: Bastiat's Broken Window

OBJECTIVES

- Define scarcity and explain why every choice has an opportunity cost.
- Use Bastiat's parable of the broken window to separate what is seen from what is not seen.
- Draw a production possibilities frontier and calculate opportunity cost from it.

> **Warm-up.** List five things you did yesterday that took more than half an hour. For each one, write the next-best thing you could have done with that time instead. Which trade-off would you make differently today?

WATCH

(1/3) The Production Possibilities Frontier – Economic Lowdown

Federal Reserve Bank of St. Louis · 5:14

https://www.youtube.com/watch?v=nsQi2ipSP2c

> **WHEN TO WATCH**
> After the big idea, before the worked examples. Pause when the frontier is first drawn and label its axes in your notebook.

BACKUP VIDEO

Production possibilities frontier | Microeconomics | Khan Academy

Khan Academy · 10:58

https://www.youtube.com/watch?v=_7VHfuWV-Qg

During the worked examples, to see another frontier drawn step by step.

KEY TERMS

scarcity

The condition that our wants are greater than the time, resources and goods available to satisfy them, so we must choose.

opportunity cost

The value of the next-best alternative given up when a choice is made.

trade-off

Giving up some of one thing to get more of another.

production possibilities frontier (PPF)

A graph of the largest combinations of two goods an economy (or a person) can produce with given resources and technology.

efficient

Producing on the frontier: no more of one good can be made without making less of another.

CORE IDEAS

The story. In 1850 the French economist and legislator Frédéric Bastiat wrote a short essay called "What Is Seen and What Is Not Seen." It opens with a shopkeeper whose careless son breaks a pane of glass. The neighbors gather and console him: at least the glazier will have work. Replacing the window costs six francs, and the glazier earns them. Some people, Bastiat wrote, go on to conclude that broken windows are good for trade, because they keep money moving.

How they figured it out. Bastiat asked what the shopkeeper would have done with his six francs if the window had not broken. He might have bought a pair of shoes or a book. The glazier's gain is *seen*; the shoemaker's lost sale is *not seen*. When the window is fixed, the town has exactly one window, as before, and one fewer pair of shoes. The shopkeeper has spent his six francs to get back what he already had. Bastiat concluded that a good economist follows every effect of a choice, including the ones that never happen because something else was chosen.

The big idea. We live with **scarcity**: time, land, materials and skilled hands are limited, and our wants are not. So every choice has an **opportunity cost**, the value of the best alternative given up. Opportunity cost is not always money. The true cost of a college course includes the wages you could have earned in those hours. A **production possibilities frontier** pictures scarcity for a whole economy: with given resources it can make only so much of two goods. Points on the curve are efficient; points inside it waste resources; points outside cannot be reached today. The slope of the frontier is the opportunity cost of one good measured in the other. It usually bows outward, because resources are not equally good at everything: the first acres

turned from wheat to cotton are the ones best suited to cotton, so each extra bale costs more wheat than the last.

In business today. Firms weigh opportunity cost every day. A farmer who grows corn on a field cannot grow soybeans there; a bakery that gives its best oven hours to bread has fewer for cakes; a company that puts its money into a new building cannot put the same money into research. Accountants record what was spent, but managers must also ask what was given up. The broken-window error still appears whenever someone counts the jobs a disaster or a wasteful project "creates" without asking what those resources would otherwise have made.

Think it through. Jesus asked, "Which of you, intending to build a tower, sitteth not down first, and counteth the cost?" Counting the cost is the habit of the whole course: before you choose, list what you give up, and look for the effects that are not seen.

PICTURE STUDY



The Gleaners, Jean-François Millet, 1857 · Oil on canvas · Musée d'Orsay, Paris

Image: Wikimedia Commons, public domain

Millet painted three poor women gleaning: gathering the few grains of wheat left on the ground after the harvest, a right the law of Moses gave the poor (Leviticus 19:9–10; Ruth 2). In the distance the farm's harvest is huge. In the foreground every single stalk matters. The painting is a study of scarcity: the same wheat is worth very different amounts of effort to different people.

Look closely

- Find the three women. What is each one doing with her hands?
- Look at the haystacks and the cart in the distance. How much grain is there compared with what the gleaners hold?
- Find the man on horseback at the far right. What might his job be?
- Look at the empty ground around the women. What does it tell you about how much is left to gather?

Talk about it

1. What is the opportunity cost of a day of gleaning for these women? What else could they do with the day?
2. Why might a stalk of wheat be worth more to a gleaner than to the farmer who owns the field?

3. How does this picture show scarcity even in a time of harvest?

PROJECT

Your Own Production Possibilities Frontier

You will measure your own production possibilities for two simple tasks, draw your frontier, and compute your opportunity costs from real data. Then you will look for a broken-window error in a news story or advertisement from history.

You will need

- A timer
- Scrap paper, a pencil and a ruler
- Graph paper or a spreadsheet
- Your ledger notebook

Steps

1. Choose two simple tasks you can repeat: for example, folding paper airplanes and writing out multiplication facts, or folding towels and sorting coins.
2. Time yourself for 5 minutes doing only Task X. Count the units finished. Rest, then do only Task Y for 5 minutes and count.
3. Now split 5 minutes three ways: 1 minute X and 4 minutes Y; 2.5 and 2.5; 4 and 1. Count both tasks each time.
4. Record all five combinations in a table with columns: minutes on X, units of X, minutes on Y, units of Y.
5. Plot the five points with X on the horizontal axis and Y on the vertical. Connect them to draw your frontier.
6. Calculate the opportunity cost of X between each pair of neighboring points. Is it constant or rising? Explain why (fatigue, warming up, switching time).
7. Mark a point inside your frontier and a point outside it. Write what each one means for you.
8. Read the opening of Bastiat's essay (or the summary in this lesson). Write one paragraph describing a modern example of the broken-window error and what is not seen in it.

Tips

- Switching between tasks costs time. If your mixed rounds fall inside the straight line between the endpoints, that is a real finding: write it down.
- Keep the same materials and the same place for every round so the comparison is fair.

Check your work

- ☐ I can draw a frontier from real data and label efficient, inefficient and unreachable points.
- ☐ I can calculate opportunity cost from two points on a frontier.
- ☐ I can explain what is not seen in the broken-window story.

LEDGER NOTEBOOK

1. Copy your data table and frontier graph. Write one sentence on the shape of your curve and what caused it.
2. Draw a T-chart labeled “Seen” and “Not seen” for the broken window, and a second one for a choice you made this week.
3. List three big choices your family makes (where to live, how to travel, how to use Saturdays). For each, name the opportunity cost.

KEY FORMULAS

$$\text{Opportunity cost of 1 unit of X} = \frac{\text{units of Y given up}}{\text{units of X gained}}$$

$$\text{Slope of PPF} = \frac{\Delta Y}{\Delta X}$$

From history. Bastiat (1801–1850) wrote the essay in the last months of his life, while ill with tuberculosis, and is said to have rewritten it after losing the first draft. He served in France’s National Assembly and was famous for short, witty essays, including a mock petition from candle makers asking the government to block out the sun.

WORKED EXAMPLES

Example 1. A small farm can grow either 600 bushels of wheat or 200 bales of hay in a season, or any combination along a straight line between them. What is the opportunity cost of one bale of hay? Of one bushel of wheat?

Show solution

1. Giving up all the wheat (600 bushels) gains all the hay (200 bales).
2. Opportunity cost of 1 bale of hay: $600/200 = 3$ bushels of wheat.
3. Opportunity cost of 1 bushel of wheat: $200/600 = \frac{1}{3}$ bale of hay.
4. Notice that the two opportunity costs are reciprocals.

Answer: One bale of hay costs 3 bushels of wheat; one bushel of wheat costs ⅓ of a bale of hay.

Example 2. An economy's frontier passes through these points (tractors, bushels of wheat in millions): A (0, 100), B (10, 90), C (20, 70), D (30, 40), E (40, 0). Find the opportunity cost of each group of 10 tractors, and explain the pattern.

Show solution

1. A to B: 10 tractors cost $100 - 90 = 10$ million bushels, or 1 million per tractor.
2. B to C: 10 tractors cost 20 million bushels (2 million per tractor).
3. C to D: 10 tractors cost 30 million bushels (3 million per tractor).
4. D to E: 10 tractors cost 40 million bushels (4 million per tractor).
5. The cost rises because the workers and land shifted last are the ones best suited to wheat and worst suited to building tractors.

Answer: The opportunity cost rises from 1 to 2 to 3 to 4 million bushels per tractor: increasing opportunity cost, which makes the frontier bow outward.

Example 3. A student can work a summer job paying $15 an hour for 300 hours, or take a 300-hour summer course that charges $1,200 in tuition. What is the full opportunity cost of the course?

Show solution

1. Money paid: $1,200.
2. Wages given up: $300 \times \$15 = \$4{,}500$.
3. Full cost: $\$1{,}200 + \$4{,}500 = \$5{,}700$.

Answer: The course really costs about $5,700, not $1,200. Whether it is worth it depends on what it adds to the student's skill and future work.

PRACTICE

1. Easy Define scarcity in one sentence, and explain why even a very rich person faces it.

   Show answer

   Scarcity means wants exceed the resources and time available. Even a rich person has only 24 hours in a day and must choose how to use them.

2. Easy You choose to spend an evening studying instead of working a shift that pays $60 or watching a game with friends. Your next-best choice was the game. What is your opportunity cost?

   Show answer

   The evening with friends at the game (the next-best alternative). The $60 shift was a third choice, so it is not the opportunity cost unless it was the next best.

3. Easy On a PPF, what does a point inside the curve mean? A point outside it?

   Show answer

   Inside: resources are unused or wasted (inefficient). Outside: unreachable with today's resources and technology.

4. Medium A town can build 50 houses or 10 bridges in a year, along a straight-line frontier. What is the opportunity cost of one bridge?

   Show answer

   $50/10 = 5$ houses per bridge.

5. Medium Use the table in Worked Example 2. What is the opportunity cost of moving from point B to point D?

Show answer

It gains 20 tractors and gives up $90 - 40 = 50$ million bushels, an average of 2.5 million bushels per tractor.

6. Medium In Bastiat's story, list who gains and who loses when the window breaks, compared with the window not breaking.

Show answer

The glazier gains six francs of work. The shoemaker (or whoever would have been paid) loses a sale. The shopkeeper loses the shoes he would have had. The town as a whole is poorer by one pair of shoes.

7. Medium Explain why most production possibilities frontiers bow outward.

Show answer

Resources are specialized. As production shifts toward one good, the resources moved are less and less suited to it, so each extra unit costs more of the other good (increasing opportunity cost).

8. Hard A storm wrecks a factory, and rebuilding employs 200 workers for a year. A writer says, "The storm was good for the economy." Use Bastiat to answer him in three or four sentences.

Show answer

The rebuilding is seen; what is not seen is everything those 200 workers and the money spent would otherwise have produced. After rebuilding, the town has the factory it already had, not a factory plus new goods. The storm destroyed wealth; the rebuilding only restores it, at the cost of other things never made.

9. Hard Name two events that would shift a nation's PPF outward and one that would shift it inward. Explain each.

Show answer

Outward: better technology (a new seed or machine) or more resources (more trained workers, new capital). Inward: a disaster that destroys capital or land, or the loss of many workers.

10. **Challenge** A family business has 40 hours a week. Making a chair takes 8 hours and earns $240; making a table takes 20 hours and earns $500. Find the opportunity cost of one table in chairs, and which product earns more per hour.

    Show answer

    A table uses the time of $20/8 = 2.5$ chairs, worth $2.5 \times \$240 = \$600$. So a table costs 2.5 chairs. Per hour: chairs earn $30, tables $25. Chairs earn more per hour, so the table's opportunity cost ($600) is greater than its revenue ($500).

COMMON MISTAKES

- Adding up every alternative given up. Opportunity cost is only the single next-best alternative.
- Counting only money. Time, effort and the wages you could have earned are real costs.
- Thinking that activity is the same as wealth. Repairing a loss keeps people busy but only restores what was there; it does not add to it.

Make it a game · Seen and Unseen Sketch. Draw a production possibilities frontier for your next eight hours, choosing two goods such as study and exercise. Mark one efficient point and one inside the curve. Then your parent retells Bastiat's broken window while you call out what is seen and what is unseen, naming the opportunity cost in each case. Score a point for each unseen cost found.

Scripture. "For which of you, intending to build a tower, sitteth not down first, and counteth the cost, whether he have sufficient to finish it?" (Luke 14:28, KJV)

Counting the cost is the first habit of economic thinking: before any choice, ask what it will truly take and what you will give up.

1.2 Incentives: Plymouth Colony Changes the Rules, 1623

OBJECTIVES

- Explain what an incentive is and distinguish positive from negative incentives.
- Tell how William Bradford's change from a common store to family plots in 1623 changed the Pilgrims' work.
- Predict how people respond when rules change, including unintended consequences.

> **Warm-up.** Think of three rules at home, school or work that change how people act: a grade, a fine, a reward, a deadline. For each, write what the rule is meant to do and one way someone might "game" it.

WATCH

What are Incentives?

Marginal Revolution University · 2:02

https://www.youtube.com/watch?v=U3z0Rxummxc

> **WHEN TO WATCH**
> Before the story, as an introduction to the word incentive.

Note: Short. Watch it twice: once straight through, then pausing after each example to write it down.

KEY TERMS

incentive

A reward or penalty that changes the benefit or cost of a choice and so changes how people act.

positive incentive

A reward that encourages an action, such as a wage, a profit or a prize.

negative incentive

A penalty that discourages an action, such as a fine, a loss or a lower grade.

free rider

Someone who enjoys the benefit of others' work or payment without contributing his share.

unintended consequence

A result of a rule or choice that its makers did not expect or want.

CORE IDEAS

The story. The Pilgrims who landed at Plymouth in 1620 had borrowed their passage from a group of London investors. Their agreement required that for seven years the colony's produce go into a **common store**, from which everyone would be fed, with the profits divided at the end. After two hungry years, Governor William Bradford and the colony's leaders decided in the spring of 1623 to try something different. Each family was given a parcel of land for its own use, sized to the number of people in it, and told to raise its own corn.

How they figured it out. Bradford wrote in his history, *Of Plymouth Plantation*, that the change "had very good success." Much more corn was planted than before, and people went to the fields who had earlier pleaded weakness. Under the common store, the young men had resented working for other men's families without any return, and the strong and skilled received no more than the weak and idle. Bradford, a devout Christian, did not blame his neighbors as worse than other men. He blamed the arrangement, writing that it bred confusion and discontent, and that God had wisely ordered things otherwise. The colony did not grow rich overnight, but it never again faced the hunger of its first years.

The big idea. An **incentive** is anything that changes the reward or penalty for a choice. People respond to incentives, not because they are greedy but because they are sensible: a person who will receive the fruit of his work has a reason to work harder and plan ahead. When rewards are pooled, each person bears the full cost of his own effort but receives only a small share of its fruit. A **free rider** problem appears. Good rules line up private incentives with the common good. Bad rules, however well meant, can produce **unintended consequences**.

Who gained? The six stakeholders help here too. The London financiers wanted a return on their loan and finally received it, though slowly. The Pilgrim families were the risk-takers and the workers. The new rule rewarded the builders and workers who planted more, and the whole community ate better. The incentive did not make the Pilgrims less generous: they still shared with the sick and the widows, now out of plenty rather than scarcity.

In business today. Firms design incentives with care: commissions for salespeople, bonuses for safety records, a share of the profits for workers. A poorly designed incentive can backfire. Pay a sales clerk only for the number of sales and he may push customers into things they do not need; pay a factory only by weight of output and it may make heavy, useless goods. Good managers ask, “What will people actually do if we reward this?” and they reward the honest result they want, not a number that can be gamed.

PICTURE STUDY



Embarkation of the Pilgrims, Robert Walter Weir, 1857 (a smaller version of the 1843 painting in the U.S. Capitol Rotunda) · Oil on canvas · Brooklyn Museum, New York

Image: Wikimedia Commons, public domain

Weir painted the Pilgrims at prayer on the deck of the *Speedwell* before they left Holland in 1620. The large version hangs in the Rotunda of the U.S. Capitol. These families were about to stake their savings, their health and their lives on a venture financed by London investors, under rules they would later change.

Look closely

- Find the open Bible in the center. Who is holding it, and how do the others respond?
- Look for the armor, the tools and the goods on deck. What did the Pilgrims bring to start their colony?
- Find the families with children. Who would be the workers of the new colony?
- Look at the rigging and sails. What did it cost to hire a ship like this, and who paid?

Talk about it

1. Which of the six stakeholders can you find in the painting? Which are missing, and where were they?

2. What risks were these families taking? What would they need to get in return to make the risk worth it?
3. How might the common-store rule have looked fair on this deck in 1620 and still failed in practice?

PROJECT

An Incentive Experiment at the Kitchen Table

You will run a small, friendly experiment with family members to see how a change in rules changes effort, then compare your results with Plymouth.

You will need

- A bag of dried beans or rice and two bowls per person
- A timer
- Small rewards (a few raisins, pennies or points)
- Your ledger notebook

Steps

1. Recruit three to five family members. Explain that you will play two short rounds of a sorting game and record what happens.
2. Mix two kinds of dried beans (or beans and rice) in a bowl. The task is to sort them into two bowls.
3. Round 1 (common store): everyone sorts for 3 minutes. Count the total sorted, then share the rewards equally no matter who sorted how much. Record each person's count privately.
4. Round 2 (own plot): everyone sorts for 3 minutes, and each person receives rewards in proportion to what he or she sorted. Record each count.
5. Make a table: person, round 1 count, round 2 count, change. Find the totals and the average change.
6. Interview each player: Did you try harder in one round? Why?
7. Write one paragraph comparing your result with Plymouth in 1623. Note anything that might have biased your test (practice, tiredness, a competitive cousin).
8. Suggest one rule that would keep the effort of Round 2 and still take care of a player who cannot sort quickly (a small child, for instance).

Tips

- Keep it friendly. The point is to observe, not to win.

- Round 2 benefits from practice in Round 1. If you can, run it again on another day in the opposite order.

Check your work

- ☐ I can explain what an incentive is and give examples of positive and negative incentives.
- ☐ I can describe what changed at Plymouth in 1623 and why it mattered.
- ☐ I can name one weakness of my experiment.

LEDGER NOTEBOOK

1. Copy your results table and compute the percent change in total sorting from Round 1 to Round 2.
2. Make a two-column chart: “Common store” and “Own plot.” List the incentives each one gives to a strong worker, a weak worker and a lazy one.
3. Write down one incentive that shapes your own week and one unintended consequence it causes.

KEY FORMULAS

$$\text{Share of the reward from extra effort} = \frac{1}{N} \quad \text{(when output is split equally among } N \text{ people)}$$

From history. Bradford’s manuscript history was lost for many years and turned up in the library of the Bishop of London in the 1850s. It was returned to Massachusetts in 1897 and is kept in the State Library in Boston. The London investors (the Merchant Adventurers) were finally bought out by eight Plymouth leaders, who took on the colony’s debt in 1627.

Example 1. A colony of 50 families pools its harvest and divides it equally. One family considers working an extra 100 hours to raise 20 more bushels of corn. How many of those 20 bushels does the family itself receive? What if it keeps its own harvest?

Show solution

1. Pooled: the 20 bushels are split among 50 families, so the family receives $20/50 = 0.4$ bushel.
2. Its own plot: the family keeps all 20 bushels.
3. The extra 100 hours cost the family the same in both cases; only the reward changes.

Answer: Pooled, the family gets 0.4 bushel for 100 hours of work; with its own plot it gets 20 bushels. The reward is 50 times greater, so far more extra work is worth doing.

Example 2. A shop pays its clerk \$12 an hour plus a 5% commission on sales. On Saturday the clerk works 8 hours and sells \$2,400 of goods. Find the day's pay and the share that comes from the incentive.

Show solution

1. Hourly pay: $8 \times \$12 = \$96$.
2. Commission: $0.05 \times \$2{,}400 = \$120$.
3. Total: \$216. Incentive share: $120/216 \approx 56\%$.

Answer: \$216, of which about 56% is commission. A wise owner also checks that the clerk's sales are honest and that customers come back, not just the day's total.

Example 3. Using the six stakeholders, evaluate the 1623 change at Plymouth.

Show solution

1. Financiers (the London investors): more food and surplus made it more likely the colony would eventually repay its debt.
2. Risk-takers (the Pilgrim leaders and families): their risk on a new rule paid off in a fuller harvest.
3. Builders and workers: each family now kept the fruit of its labor, so effort and skill were rewarded.
4. Customers: there were few yet, but surplus corn later became the colony's main trading good with neighbors.
5. Community: less hunger and less resentment; charity to the sick continued.

Answer: The change served all six better than the common store, which is why Bradford judged it a success.

PRACTICE

1. Easy Give one positive and one negative incentive a store might use to get customers to return shopping carts.

   Show answer

   Positive: a coin deposit returned when the cart is returned. Negative: a fee or a lost deposit.

2. Easy What was the common store at Plymouth, and why did the colony start with it?

   Show answer

   All produce went into a shared supply and everyone was fed from it. The agreement with the London investors required it for seven years.

3. Easy What is a free rider? Give an example from a group project.

   Show answer

   Someone who gets the benefit without doing his share, such as a student who does no work but receives the group grade.

4. **Medium** In a pooled harvest of 40 families, how much of 30 extra bushels does the family that grew them receive?

Show answer

$30/40 = 0.75$ bushel.

5. **Medium** Bradford blamed the arrangement rather than the people. Why is that an important distinction for an economist?

Show answer

It means the problem can be fixed by changing the rules, without assuming people are wicked. People of ordinary character respond to the rewards in front of them.

6. **Medium** A city pays trash collectors by the hour. Another city pays them by the route completed, letting them go home when done. Predict one good and one bad effect of the second rule.

Show answer

Good: faster work and fewer wasted hours. Bad: workers may rush, skip cans or work less safely. Inspections can guard against that.

7. **Medium** A salesman earns 10% commission on a $900 sale and 6% on a $1,400 sale. Which pays him more?

Show answer

$90 versus $84; the first.

8. **Hard** A government once paid a bounty for every rat tail turned in, hoping to reduce rats. Explain how this incentive could backfire.

Show answer

People could breed rats or release tailless rats to keep earning bounties; the reward was tied to tails, not to fewer rats. Rewarding a number that can be manufactured invites gaming.

9. Hard Using the six stakeholders, explain why a business that rewards salespeople only for the day's sales might harm customers and, in the end, the financiers.

Show answer

Salespeople might pressure or mislead customers, who then stop returning and warn others. Lost trust lowers future sales and profits, which hurts the owners and investors.

10. Challenge Design an incentive plan for a small family bakery with three workers that rewards both output and honesty and quality. Name at least two measures and explain how each could be gamed and how you would prevent it.

Show answer

Sample: a bonus for loaves sold (gamed by over-baking; prevent by tying the bonus to sales, not loaves made) and a bonus for low waste and good customer reviews (gamed by hiding waste; prevent with a simple count by the owner). Strong answers tie rewards to the real goal and add a check.

COMMON MISTAKES

- Thinking incentives are only about money. Praise, time, grades, honor and safety are incentives too.
- Assuming that people who respond to incentives are selfish. Ordinary, decent people respond to the rewards in front of them.
- Judging a rule by its intentions instead of its results. Ask what people will actually do.

Make it a game · Common Store Experiment. Choose a one-minute task, such as sorting buttons by color. Round one: each of you works, but the total is split equally by rule. Round two: each keeps what you personally finish. Compare output. Then explain, as William Bradford might, how the 1623 change at Plymouth changed incentives, and where a free rider appeared in round one.

Scripture. "For even when we were with you, this we commanded you, that if any would not work, neither should he eat." (2 Thessalonians 3:10, KJV)

Paul joined work and reward plainly. Bradford quoted this principle in spirit when he gave each family the fruit of its own labor, while the colony still cared for those who could not work.

1.3 Thinking at the Margin: The Diamond-Water Paradox

OBJECTIVES

- State Adam Smith's diamond-water paradox and explain how marginal utility resolves it.
- Distinguish total from marginal benefit and cost, and decide by comparing marginal benefit with marginal cost.
- Explain why sunk costs should not drive decisions.

> **Warm-up.** Imagine you are very thirsty and someone offers you glasses of water one at a time. Rate how much you would want the 1st, 2nd, 3rd, 4th and 5th glass on a scale of 1 to 10. What happens to your numbers, and why?

WATCH

What Is Thinking on the Margin, and How Does It Solve the Sunk Cost Fallacy?

Marginal Revolution University · 6:18

https://www.youtube.com/watch?v=B9MPklfyRHI

> **WHEN TO WATCH**
> After the big idea, before the worked examples.

BACKUP VIDEO

The paradox of value - Akshita Agarwal

TED-Ed · 3:45

https://www.youtube.com/watch?v=e7S8jWh6AEs

After reading the story of the paradox.

KEY TERMS

utility

The satisfaction or benefit a person gets from a good or service.

marginal

Additional or extra: the change from one more (or one less) unit.

marginal utility

The extra benefit from consuming one more unit of a good.

diminishing marginal utility

The principle that each additional unit of a good usually adds less benefit than the one before.

sunk cost

A cost already paid that cannot be recovered, whatever you decide next.

CORE IDEAS

The story. In *The Wealth of Nations* (1776), Adam Smith posed a puzzle. Nothing is more useful than water, yet it will buy scarcely anything. A diamond has scarcely any use, yet a great quantity of other goods can be had in exchange for it. Smith separated "value in use" from "value in exchange," but he could not fully explain why the two should differ so much. For nearly a century the question stood as the **diamond-water paradox**.

How they figured it out. In the early 1870s three economists, working separately, found the answer at almost the same time: William Stanley Jevons in England (1871), Carl Menger in Austria (1871) and Léon Walras in Switzerland (1874). Their insight was that people never choose between "all the water in the world" and "all the diamonds." They choose about *one more* glass or *one more* stone. Because water is plentiful, the last glass a person uses is spent on something minor, like washing the car, so its extra value is tiny. Diamonds are so rare that even the last one has a high extra value. Price follows **marginal utility**, not total utility. Historians count this discovery as the beginning of modern economics.

The big idea. Economists think **at the margin**. The question is rarely "Is this good?" but "Is one more worth what it costs?" A rational choice keeps doing something as long as its marginal benefit is at least its marginal cost, and stops where they meet. Most goods show **diminishing marginal utility**: the first glass of water to a thirsty man is priceless, the fifth is nearly worthless. Thinking at the margin also means ignoring **sunk costs**. Money already spent is gone whatever you do; only future benefits and costs should guide the next choice.

In business today. A bakery decides whether to bake one more batch tonight by comparing the extra revenue with the extra flour, energy and labor, not by looking at

the average cost of all its bread. An airline will sell a last-minute seat cheaply because the plane is flying anyway and the marginal cost of one more passenger is small. A wise manager does not keep pouring money into a failing project just because so much has already been spent on it. Water utilities price the first gallons for drinking and cooking cheaply and charge more for heavy use, because the value of water at the margin is low but rising use is costly to supply.

Think it through. The diamond-water paradox teaches humility about price. A low price does not mean a thing is unimportant. Water, air and sunlight are gifts of immense total value. Their low price at the margin is a sign of God's abundance, not of their worth.

PICTURE STUDY



Woman Holding a Balance, Johannes Vermeer, about 1664 · Oil on canvas · National Gallery of Art, Washington, D.C.

Image: Wikimedia Commons, public domain

In a quiet Delft room, a woman holds a jeweler's balance perfectly level. On the table lie pearls, a string of beads and a few coins. The pans of her balance are empty: she seems to be waiting for them to settle before she weighs. On the wall behind her hangs a painting of the Last Judgment, a reminder that every life will be weighed. Vermeer turns a small act of measuring into a picture of careful, honest judgment.

Look closely

- Look closely at the balance. Is anything in the pans? Is it level?
- Find the pearls and the coins on the table. Why would someone need a fine balance to deal in them?
- Look at the light from the window. Where does it fall most brightly?
- Find the painting on the back wall. Why might Vermeer have placed it there?

Talk about it

1. Pearls and gold are tiny but costly; water is heavy and cheap. How does marginal utility explain why she weighs pearls with such care?
2. What does the empty, balanced scale suggest about weighing choices before acting?

3. How is weighing marginal benefit against marginal cost like what she is doing?

PROJECT

The Marginal Benefit Survey

You will measure diminishing marginal utility in real people and use your data to find where marginal benefit meets marginal cost.

You will need

- A plate of small snacks (crackers or apple slices)
- Three or more willing family members
- A spreadsheet or graph paper
- Your ledger notebook

Steps

1. Ask each person, before eating, to state the most he or she would "pay" in pretend cents for the 1st snack, then the 2nd, 3rd, 4th, 5th and 6th, eating each one before rating the next.
2. Record each person's bids in a table: unit number down the side, one column per person.
3. Calculate each person's total value (the running sum of bids). Graph marginal value and total value for one person.
4. Set a "price" of 10¢ per snack. For each person, find how many he or she would buy (the last unit with a bid of at least 10¢).
5. Repeat for prices of 5¢ and 20¢. Add the quantities across people at each price. You have just built a small demand schedule.
6. Write a short paragraph answering: Did everyone's bids fall? Where did your data break the pattern, and why might that be?
7. Connect your results to the diamond-water paradox in two or three sentences.

Tips

- Real snacks make honest bids. Use small portions so people do not tire of the game.
- Keep the bids in pretend money; nothing needs to be paid.

Check your work

- ☐ I can compute marginal values from a list of total values (or the reverse).
- ☐ I can find the quantity where marginal benefit equals the price.
- ☐ I can explain how diminishing marginal utility resolves the diamond-water paradox.

LEDGER NOTEBOOK

1. Copy your bid table, totals and the graph for one person. Label the falling marginal value line.
2. Write the paradox in Smith's words as best you can, and then write the resolution in your own words.
3. Describe one sunk cost you have faced (a non-refundable ticket, a half-finished project) and whether you made the right next choice.

KEY FORMULAS

$$MU = \frac{\Delta \text{Total utility}}{\Delta Q}$$

$$\text{Do one more unit if } MB \geq MC$$

$$MC = \frac{\Delta \text{Total cost}}{\Delta Q}$$

From history. Jevons, Menger and Walras did not coordinate their work and wrote in three languages. Menger's book (1871) founded the Austrian school of economics; Walras's *Elements of Pure Economics* (1874) built the first full mathematical model of many markets clearing at once.

WORKED EXAMPLES

Example 1. A thirsty hiker rates glasses of water by total utility: 1 glass 50, 2 glasses 80, 3 glasses 95, 4 glasses 100, 5 glasses 100. Find the marginal utility of each glass.

Show solution

1. 1st: $50 - 0 = 50$.
2. 2nd: $80 - 50 = 30$.
3. 3rd: $95 - 80 = 15$.
4. 4th: $100 - 95 = 5$.
5. 5th: $100 - 100 = 0$.

Answer: Marginal utility falls 50, 30, 15, 5, 0: diminishing marginal utility. Total utility is high, but the last glass is worth almost nothing.

Example 2. A bakery's total cost of baking batches of bread tonight is: 1 batch $40, 2 batches $70, 3 batches $105, 4 batches $150. Each batch sells for $45. How many batches should it bake?

Show solution

1. Marginal cost: batch 1 $40, batch 2 $30, batch 3 $35, batch 4 $45.
2. Marginal benefit of each batch: $45.
3. Batches 1–3 have $MB > MC$. Batch 4 has $MB = MC$, so it adds nothing to profit.
4. Profit at 3 batches: $3 \times 45 - 105 = \$30$. At 4: $4 \times 45 - 150 = \$30$.

Answer: Bake 3 batches (or 4; profit is the same, $30). A fifth batch with higher marginal cost would lose money.

Example 3. A company has spent $2 million developing a product. Finishing it will cost another $1 million, and it is now expected to bring in $800,000. Should it finish?

Show solution

1. The $2 million is sunk: it is gone whether the company finishes or not.
2. Compare only the future: benefit $0.8 million versus cost $1 million.
3. Finishing loses $200,000 more than stopping.

Answer: Stop the project (unless some other future benefit is missing from the numbers). Past spending is not a reason to keep spending.

PRACTICE

1. Easy What does “marginal” mean in economics?

   Show answer

   Additional: the change from one more or one less unit.

2. Easy Who first stated the diamond-water paradox, and in what book?

   Show answer

   Adam Smith, in *The Wealth of Nations* (1776).

3. Easy Name the three economists of the early 1870s credited with marginal utility.

   Show answer

   Jevons, Menger and Walras.

4. Medium Total utility from pizza slices is 30, 50, 62, 68, 70. Find the marginal utility of the 3rd and 5th slices.

   Show answer

   3rd: 12; 5th: 2.

5. Medium A student values extra hours of study for a test at 20, 14, 9, 5 and 2 points of benefit. Each hour costs 6 points of other activities. How many hours should she study?

   Show answer

   3 hours (benefits 20, 14, 9 all exceed 6; the 4th hour’s 5 is less than 6).

6. Medium Explain in two sentences why water is cheap even though it is essential.

Show answer

Water is plentiful, so people use so much that the last unit goes to a minor use with low marginal utility. Price reflects that low marginal value, not water's huge total value.

7. Medium You paid \$30 for a concert ticket. On the night, you feel ill and would rather rest at home. Does the \$30 matter to your choice?

Show answer

No. It is a sunk cost, spent either way. Decide by comparing the benefit of going tonight with the cost of going ill.

8. Hard A factory's marginal cost of the 101st unit is \$8 and its average cost is \$12. A buyer offers \$10 for one extra unit. Should the factory accept, if this sale does not affect its other prices?

Show answer

Yes: $\$10 > \$8$, so profit rises by \$2. The average cost includes fixed costs already being paid.

9. Hard An airline flight has 15 empty seats an hour before takeoff. Explain, using marginal cost, why it might sell them for far less than the usual fare.

Show answer

The plane flies anyway; the marginal cost of one more passenger (a snack, a bit of fuel) is small. Any fare above that marginal cost adds to profit, as long as it does not teach regular customers to wait for cheap seats.

10. Challenge Total benefit of hours of piano practice is $TB = 40h - 4h^2$ and each hour has an opportunity cost of 8. How many hours maximize net benefit? (Hint: marginal benefit is $40 - 8h$.)

Show answer

Set $40 - 8h = 8$, so $h = 4$. Net benefit: $40(4) - 4(16) - 8(4) = 64$.

COMMON MISTAKES

- Confusing total utility with marginal utility. A good can have huge total value and tiny marginal value.

- Using average cost to decide on one more unit. Compare the extra benefit with the extra cost.
- Letting sunk costs drive decisions (“We have spent too much to quit now”).

> **Make it a game · Marginal Cracker Table.** Eat crackers one at a time, rating each from one to ten for satisfaction. Build a table of total and marginal benefit. Assign each cracker a cost of three points and decide where to stop by comparing marginal benefit with marginal cost. Then explain the diamond-water paradox to your parent, and which crackers count as sunk cost.

1.4 Specialization and Comparative Advantage: Smith and Ricardo

OBJECTIVES

- Explain how the division of labor raises output, using Adam Smith's pin factory.
- Distinguish absolute from comparative advantage and calculate each from a table.
- Show with numbers why two parties can both gain from trade, using Ricardo's example.

> **Warm-up.** Your family must make 20 sandwiches. Plan two ways: each person makes whole sandwiches, or each person does one step (bread, spread, filling, wrap). Which would be faster, and why?

WATCH

Comparative Advantage

Marginal Revolution University · 7:15

https://www.youtube.com/watch?v=4rUfoU04QJM

> **WHEN TO WATCH**
> After the big idea, before the worked examples.

BACKUP VIDEO

Comparative advantage specialization and gains from trade | Microeconomics | Khan Academy

Khan Academy · 8:56

https://www.youtube.com/watch?v=xx9xNJlPOJo

During the worked examples: pause and check your own table against his.

KEY TERMS

division of labor
Splitting a job into separate tasks done by different workers, each specializing in one.

specialization
Concentrating on producing the goods or tasks one does best, and trading for the rest.

absolute advantage

The ability to produce more of a good than another producer with the same resources.

comparative advantage

The ability to produce a good at a lower opportunity cost than another producer.

terms of trade

The rate at which one good is exchanged for another.

CORE IDEAS

The story. Adam Smith opened *The Wealth of Nations* (1776) with a small pin factory. One untrained man working alone, he wrote, could perhaps make one pin a day, and certainly not twenty. In the factory he had seen, the work was split into about eighteen operations: one man drew out the wire, another straightened it, a third cut it, a fourth pointed it. Ten men working this way made upward of 48,000 pins a day, about 4,800 each. Forty years later, in 1817, the English stockbroker and economist Ricardo asked a harder question. What if one country is better at making *everything*? Should it still trade?

How they figured it out. Smith gave three reasons the division of labor works: workers grow more skillful by repeating one task; no time is lost switching between tasks; and specialized workers invent better tools for their one job. He also saw its limit: it depends on "the extent of the market." A village cannot keep a full-time pin maker busy; a great trading city can. Ricardo built a famous example with two countries, England and Portugal, and two goods. Portugal needed fewer hours of labor for both goods, yet Ricardo showed that both countries gained if each specialized in the good where its *relative* advantage was greater and traded for the other.

The big idea. A producer has an **absolute advantage** when he can make more of a good with the same resources. He has a **comparative advantage** when he can make it at a lower *opportunity cost*. Everyone has a comparative advantage in something, even a person with no absolute advantage at all, because opportunity costs are ratios: if you are much better at A and only a little better at B, your opportunity cost of B is high. When each party specializes where its opportunity cost is lowest and they trade at terms between their two opportunity costs, total output rises and

both gain. Trade is not a contest with a winner and a loser; it is a cooperation that creates wealth.

In business today. A skilled surgeon may type faster than her assistant, but she hires the assistant anyway, because an hour of her time in surgery is worth far more. A small firm buys accounting services rather than training its builders to do the books. Whole regions specialize: Iowa in corn, Washington State in apples and airplanes, Taiwan in computer chips. Specialization also has costs: workers whose skills are tied to one product can be hurt when demand moves, which is why wise workers keep learning and wise communities do not depend on a single trade.

Think it through. Paul describes the church as one body with many members, each with a different gift (1 Corinthians 12). Specialization and trade are an economic picture of the same truth: people are made different, and they serve one another best by using their different gifts and exchanging the fruit.

PICTURE STUDY



Portrait of the Merchant Georg Gisze, Hans Holbein the Younger, 1532 · Oil on oak panel · Gemäldegalerie, Berlin

Image: Wikimedia Commons, public domain

Georg Gisze was a merchant from Danzig working in the Steelyard, the London trading base of the Hanseatic League. Holbein filled the portrait with the tools of long-distance trade: letters from partners, seals to sign contracts, a small balance for coins, and a clock. Gisze bought English cloth and sold goods from the Baltic. He lived by specialization and trade between distant places.

Look closely

- Find the letter in his hands and the other letters tucked into the walls. Why would a merchant need so many?
- Look for the small brass balance on the shelf. What would he weigh with it?
- Find the seals and the pen holder. What do they tell you about contracts in trade?
- Look at the clock and the vase of flowers. What might they say about time and the shortness of life?

Talk about it

1. Gisze lived far from home to buy and sell goods. Which countries gained from his trade, and how?
2. Why does long-distance trade depend on trust, letters and contracts?

3. Which of Smith's or Ricardo's ideas does this picture illustrate best? Explain.

PROJECT

The Comparative-Advantage Workshop

You will measure two people's output on two tasks, find who has the comparative advantage in each, and prove with your own numbers that specializing and trading raises total output.

You will need

- A partner (a sibling or parent)
- A timer
- Paper and envelopes (or towels and socks)
- A spreadsheet or graph paper
- Your ledger notebook

Steps

1. Choose two tasks, such as folding letters and stuffing envelopes, or folding towels and pairing socks.
2. Each person spends 5 minutes on Task A alone, then 5 minutes on Task B alone. Record the counts.
3. Compute each person's opportunity cost of one unit of A and of one unit of B.
4. Decide who has the absolute advantage and who has the comparative advantage in each task.
5. Without specializing: each person spends 5 minutes on each task. Predict the totals from your counts.
6. With specializing: each person spends 10 minutes on his or her comparative-advantage task. Run it and count.
7. Compare the totals. Then propose terms of trade that leave both people with more of both tasks done than without specializing.
8. Write a paragraph: Did your results match the theory? What got in the way (fatigue, learning, a mismatched pair of tasks)?

Tips

- Choose tasks that do not take long to learn, so practice does not swamp the comparison.
- If one person has the absolute advantage in both tasks, that is the most interesting case.

Check your work

- ☐ I can tell absolute from comparative advantage using real data.
- ☐ I can show that specialization raised total output.
- ☐ I can find terms of trade that benefit both partners.

LEDGER NOTEBOOK

1. Copy your output table, opportunity-cost table and the before-and-after totals.
2. Sketch Smith's pin factory as a flow chart of at least six steps, with a worker for each.
3. Write two sentences explaining to a younger student why a country that is better at everything still gains from trade.

KEY FORMULAS

$$\text{Opportunity cost of X} = \frac{\text{output of Y given up}}{\text{output of X gained}}$$

Mutually beneficial terms lie between the two producers' opportunity costs

From history. Ricardo (1772–1823) made a fortune as a stockbroker in London before turning to economics after reading *The Wealth of Nations* on holiday in Bath. His *Principles* (1817) set out comparative advantage in a few pages. He later sat in Parliament.

WORKED EXAMPLES

Example 1. Ricardo's numbers: in England, a year's output of cloth takes 100 workers and a year's output of a second good (call it grain) takes 120 workers. In Portugal, the same cloth takes 90 workers and the same grain takes 80. Who has the absolute advantage in each good? Who has the comparative advantage in each?

Show solution

1. Absolute advantage: Portugal needs fewer workers for both goods (90 < 100 and 80 < 120), so Portugal has the absolute advantage in both.
2. Opportunity cost of cloth in England: $100/120 \approx 0.83$ units of grain. In Portugal: $90/80 = 1.125$ units of grain.
3. Opportunity cost of grain in England: $120/100 = 1.2$ units of cloth. In Portugal: $80/90 \approx 0.89$ units of cloth.
4. England gives up less grain for cloth; Portugal gives up less cloth for grain.

Answer: Portugal has the absolute advantage in both goods, but England has the comparative advantage in cloth and Portugal in grain.

Example 2. Continuing: England has 220 workers and Portugal 170. Without trade, each makes one unit of each good. Show the gain if each specializes.

Show solution

1. Without trade: England makes 1 cloth + 1 grain (100 + 120 workers). Portugal makes 1 cloth + 1 grain (90 + 80 workers). World total: 2 cloth, 2 grain.
2. England specializes in cloth: $220/100 = 2.2$ units of cloth.
3. Portugal specializes in grain: $170/80 = 2.125$ units of grain.
4. World total: 2.2 cloth and 2.125 grain, more of both goods than before.
5. If they trade 1 cloth for 1 grain, England has 1.2 cloth and 1 grain, and Portugal has 1 cloth and 1.125 grain. Each is better off.

Answer: With the same workers, specialization adds 0.2 units of cloth and 0.125 units of grain to world output, and trade lets both countries share the gain.

Example 3. Anna can paint 4 fences or bake 20 pies in a day. Ben can paint 2 fences or bake 16 pies. Who should paint and who should bake? Give terms of trade that help both.

Show solution

1. Anna's opportunity cost of 1 fence: $20/4 = 5$ pies. Ben's: $16/2 = 8$ pies.
2. Anna paints fences (lower cost). Ben bakes pies: his cost per pie is $2/16 = 0.125$ fence, Anna's is $4/20 = 0.2$ fence.
3. Any price between 5 and 8 pies per fence helps both, for example 6 pies per fence.

Answer: Anna paints and Ben bakes, trading at about 6 pies per fence (any rate strictly between 5 and 8).

PRACTICE

1. Easy According to Smith, how many pins a day did his ten-man factory make, and about how many per worker?

   Show answer

   Upward of 48,000 a day, about 4,800 per worker.

2. Easy Name Smith's three reasons the division of labor raises output.

   Show answer

   Greater skill (dexterity) from repetition, time saved from not switching tasks, and the invention of specialized tools and machines.

3. Easy What is the difference between absolute and comparative advantage?

   Show answer

   Absolute: producing more with the same resources. Comparative: producing at a lower opportunity cost.

4. Medium Country A can make 10 cars or 40 tons of wheat per worker-year; Country B can make 4 cars or 32 tons. Find each country's opportunity cost of a car.

   Show answer

   A: $40/10 = 4$ tons per car. B: $32/4 = 8$ tons per car. A has the comparative advantage in cars.

5. Medium In problem 4, who has the comparative advantage in wheat? Give a term of trade that helps both.

Show answer

B (its cost per ton is 1/8 car versus A's 1/4 car). Any rate between 4 and 8 tons per car, such as 6.

6. Medium Explain Smith's phrase that the division of labor is limited by "the extent of the market."

Show answer

Specialists need enough customers to keep them busy. A small market cannot support many specialists; growing trade and transport make more specialization possible.

7. Medium A lawyer types 100 words a minute; her secretary types 60. The lawyer earns $200 an hour; the secretary $25. Who should do the typing? Why?

Show answer

The secretary. The lawyer's opportunity cost of an hour of typing is $200 of legal work; the secretary's is much lower.

8. Hard Using the six stakeholders, name one way specialization helps workers and one way it can hurt them.

Show answer

Helps: higher productivity tends to raise wages and builds valuable skill. Hurts: narrow, repetitive work can be dull, and workers tied to one product can lose their jobs if demand moves.

9. Hard In Ricardo's example (Worked Example 2), what range of terms of trade (grain per cloth) benefits both countries?

Show answer

Between England's opportunity cost of cloth (0.83 grain) and Portugal's (1.125 grain): any rate between about 0.83 and 1.125 grain per cloth.

10. **Challenge** Two workers each have 12 hours. Kate makes a chair in 3 hours or a table in 6; Luis makes a chair in 4 hours or a table in 4. (a) Who has the comparative advantage in each? (b) If both specialize fully, how many chairs and tables are made? (c) Compare with each splitting time equally.

    Show answer

    (a) Kate's table costs 2 chairs; Luis's costs 1 chair. Luis has it in tables, Kate in chairs. (b) Kate: 4 chairs; Luis: 3 tables. (c) Equal split: Kate 2 chairs + 1 table, Luis 1.5 chairs + 1.5 tables, total 3.5 chairs and 2.5 tables. Specializing gives 4 chairs and 3 tables, more of both.

COMMON MISTAKES

- Thinking a country that is better at everything has nothing to gain from trade. Comparative advantage depends on opportunity cost, not on absolute skill.
- Dividing the wrong way when computing opportunity cost. Put the good given up on top and the good gained on the bottom.
- Picking terms of trade outside the two opportunity costs. Only terms between them help both sides.

> **Make it a game · Pin Factory Assembly Line.** Make paper chains with ten links each. Round one: each person builds a whole chain alone. Round two: split the job into steps, such as cutting and linking. Compare chains per minute, as in Adam Smith's pin factory. Then compute each person's opportunity cost from your own output numbers and decide who has the comparative advantage in which step.

1.5 Work, Vocation and Stewardship: Human Capital and "The Use of Money"

OBJECTIVES

- Explain the Christian idea of vocation and stewardship and how it shaped thinking about work and wealth.
- Summarize John Wesley's three rules in "The Use of Money" (1760).
- Define human capital and calculate a simple return on an investment in skill.

> **Warm-up.** Write down three skills you have that took real time to learn. For each, estimate how many hours you spent learning it and what it now lets you do that you could not do before.

WATCH

Human capital | Finance & Capital Markets | Khan Academy

Khan Academy · 5:56

https://www.youtube.com/watch?v=ivy1QmWUtQI

> **WHEN TO WATCH**
> After the big idea, before Worked Example 2.

BACKUP VIDEO

Human Capital

Council for Economic Education · 2:37

https://www.youtube.com/watch?v=QEpkJoD21Qw

After the big idea.

KEY TERMS

vocation

A calling: the work and station in life to which God calls a person, in which he serves God and neighbor.

stewardship

Managing what belongs to someone else, as God's servants managing time, talents and wealth for Him.

human capital

The knowledge, skill, health and habits that make a person productive.

return on investment

The gain from an investment compared with its cost, often written as a percent.

capital

Goods made to produce other goods, such as tools, machines and buildings; human capital is skill built in people.

CORE IDEAS

The story. In 1760 John Wesley, the Anglican preacher whose followers became the Methodists, published a sermon called "The Use of Money" on the text "Make to yourselves friends of the mammon of unrighteousness" (Luke 16:9). Most of his hearers were coal miners, weavers, shopkeepers and servants. He gave them three plain rules: **gain all you can**, by honest and diligent work that harms neither your body, your soul nor your neighbor; **save all you can**, by cutting waste and needless luxury; and **give all you can**, because you are not the owner but the steward of what God has entrusted to you.

How they figured it out. Wesley watched what happened to his followers. Sober, hardworking and thrifty, many of them rose out of poverty, learned trades and started small businesses. Late in life he worried that wealth was making some of them proud and careless, and he pressed the third rule harder: the first two without the third would ruin them. Two centuries earlier the Reformers had taught that ordinary work, the farmer's, the smith's, the mother's, is a holy **vocation**, not a second-best to the monastery. Benjamin Franklin's *The Way to Wealth* (1758) gave the same habits in proverbs: "Early to bed, and early to rise." Economists later gave a name to what these habits built inside people.

The big idea. In 1960 the economist Theodore Schultz, and in 1964 Gary Becker, used the term **human capital** for the skill, knowledge, health and habits that make a person productive. Like a machine, human capital is built by giving something up now (time, effort, tuition) for a stream of benefits later. It is the largest source of wealth in most modern economies. Unlike a machine, it cannot be sold or taken away; it is part of the person. The parable of the talents (Matthew 25:14–30) is a

parable of stewardship: the master gives each servant something to work with and expects it to grow.

In business today. Firms invest in human capital through apprenticeships, training and mentoring; families invest through education and good habits. A skilled tradesman, a nurse or an engineer earns more because each hour of work produces more. Economists measure the return on schooling and training just as they measure the return on a machine. But human capital is not only about pay. Wesley's rules remind us why we gain: to provide for our families, to be useful, and to have something to give (Ephesians 4:28).

Think it through. "Whatsoever ye do, do it heartily, as to the Lord" (Colossians 3:23). The economist sees diligence as productivity; the Christian sees it first as faithfulness. Both are true, and the second gives the first its purpose.

PICTURE STUDY



The Angelus, Jean-François Millet, 1857–1859 · Oil on canvas · Musée d'Orsay, Paris

Image: Wikimedia Commons, public domain

As the church bell rings the evening Angelus, a farm couple stop digging potatoes and pray. Millet said the picture came from memories of his grandmother, who never failed to stop work and pray when the bell rang. Work and worship stand side by side: the fork in the ground, the full basket, the bowed heads.

Look closely

- Find the tools: the pitchfork, the basket and the wheelbarrow. What work have they been doing?
- Look at the horizon. What building can you see, and why does it matter to the scene?
- Look at how the two figures stand. What does their posture say?
- Notice the light. What time of day is it, and what does that tell you about their workday?

Talk about it

1. How does this picture show the idea of vocation: ordinary work done before God?
2. What human capital do these farmers have? How did they get it?

3. How might Wesley's three rules apply to a farm family like this one?

Safety first. A parent arranges and attends the interview.

PROJECT

A Human-Capital Plan

You will interview a skilled worker about how he or she learned a trade, calculate the cost and payback of that training, and write a short stewardship plan for one skill of your own.

You will need

- A parent to arrange and join an interview
- A calculator or spreadsheet
- Your ledger notebook

Steps

1. With a parent, choose a skilled worker you know: an electrician, nurse, mechanic, farmer, baker, accountant or teacher.
2. Ask: How did you learn your work? How long did it take? What did it cost (tuition, tools, lower pay as an apprentice)?
3. Ask: What can you do now that you could not do before? How has your pay or responsibility changed over the years?
4. Ask: What do you find meaningful in your work? How does it serve other people?
5. Estimate the training cost (money plus income given up) and the extra yearly income. Calculate the payback period.
6. Choose one skill you want to build in the next year. List its cost in hours and money and its expected benefits, in money and otherwise.
7. Write a one-page plan using Wesley's three rules: how you will gain (learn and work), save (cut waste of time and money) and give (use the skill to serve).

Tips

- Ask for estimates, not exact pay figures, and do not record anything the person would prefer to keep private.
- Thank your interviewee in writing.

Check your work

- ☐ I can explain vocation and stewardship in my own words.
- ☐ I can calculate a payback period and a simple return for an investment in skill.
- ☐ I can state Wesley's three rules and apply them.

LEDGER NOTEBOOK

1. Record your interview notes and the payback calculation in a neat table.
2. Copy Wesley's three rules and, under each, write one way you will practice it this month.
3. Draw a timeline of your own learning so far: the main skills you have built and roughly when.

KEY FORMULAS

$$\text{Return on investment} = \frac{\text{Gain} - \text{Cost}}{\text{Cost}} \times 100\%$$

$$\text{Payback period} = \frac{\text{Cost}}{\text{Extra income per year}}$$

From history. Wesley practiced his own rules. He earned large sums from his books, and he gave most of it away. He wrote that if he left more than ten pounds when he died, people could call him a robber; his estate at his death in 1791 was very small.

WORKED EXAMPLES

Example 1. A young man can take a one-year welding course costing $6,000 in tuition. During the course he earns nothing instead of $24,000 at his current job. After it, he expects to earn $12,000 a year more than he would have. Find the total cost and the payback period (ignoring interest).

Show solution

1. Total cost: tuition plus wages given up: $\$6{,}000 + \$24{,}000 = \$30{,}000$.
2. Payback period: $\dfrac{\$30{,}000}{\$12{,}000 \text{ per year}} = 2.5$ years.

Answer: The course costs $30,000 and pays for itself in about 2.5 years; after that, the extra income is gain.

Example 2. Over 10 working years, the welder in Example 1 earns an extra $12,000 a year. Find his simple return on investment.

Show solution

1. Total gain: $10 \times \$12{,}000 = \$120{,}000$.
2. Return: $\dfrac{120{,}000 - 30{,}000}{30{,}000} \times 100\% = 300\%$.

Answer: A simple return of 300% over ten years. (A more careful estimate would discount future dollars, which you will learn later.)

Example 3. Apply Wesley's three rules to a worker who earns $3,000 a month and spends $2,400 on living costs. If she trims $200 of waste and gives 10% of her income, how much does she save each month?

Show solution

1. Gain all you can: income $3,000.
2. Save all you can: spending falls to $\$2{,}400 - \$200 = \$2{,}200$.
3. Give all you can: $0.10 \times \$3{,}000 = \$300$.
4. Saved: $\$3{,}000 - \$2{,}200 - \$300 = \$500$.

Answer: She saves $500 a month while giving $300, compared with saving $600 and giving nothing before.

PRACTICE

1. Easy State Wesley's three rules for the use of money.

   Show answer

   Gain all you can, save all you can, give all you can.

2. Easy What is human capital? Give two examples.

   Show answer

   The skill, knowledge, health and habits that make a person productive, such as knowing how to weld or the habit of punctuality.

3. Easy What is the main teaching of the parable of the talents about stewardship?

Show answer

God entrusts gifts to us and expects us to use them faithfully and make them grow; the servant who buried his talent was rebuked.

4. Medium A nursing program costs $20,000 and two years of lost earnings of $18,000 a year. It raises income by $16,000 a year. Find the payback period.

Show answer

Cost: $\$20{,}000 + \$36{,}000 = \$56{,}000$. Payback: $56{,}000 / 16{,}000 = 3.5$ years.

5. Medium Wesley said to gain all you can, but not at the expense of your body, soul or neighbor. Give one example of gain he would forbid.

Show answer

Work that ruins one's health, cheating customers, selling something harmful, or gaining by a neighbor's loss.

6. Medium Why is human capital different from physical capital?

Show answer

It is part of the person, cannot be sold or seized, goes wherever the person goes, and depreciates if not used and renewed.

7. Medium An apprentice earns $14 an hour; a journeyman in the same trade earns $30. At 2,000 hours a year, how much more does the journeyman earn per year?

Show answer

$2{,}000 \times (30 - 14) = \$32{,}000$.

8. Hard Explain how Wesley's first two rules, without the third, could harm a person, and why he worried about it.

Show answer

Gaining and saving without giving can make a person proud, greedy and attached to riches (1 Timothy 6:10). Wesley saw prosperous followers growing cold and pressed giving as the remedy.

9. Hard A training course costs $5,000 and raises income by $2,000 a year for 8 years. Find the simple return on investment.

   Show answer

   Gain $16,000; return $(16{,}000 - 5{,}000)/5{,}000 = 220\%$.

10. Challenge Some argue schooling raises income partly because it builds skill and partly because it signals to employers that a student is diligent. Explain why this difference matters for a student deciding how to spend a year.

    Show answer

    If skill is the main reason, the student should choose the training that builds the most useful skill. If signaling matters, a credential may help even when skill gains are small. A wise student seeks both real skill and honest proof of it, and does not pay heavily for a credential that teaches little.

COMMON MISTAKES

- Counting only tuition as the cost of education. Lost wages are usually the larger part.
- Thinking stewardship means poverty. Wesley urged his hearers to gain all they could, honestly, in order to give.
- Treating human capital as permanent. Skills fade without use and must be renewed.

Make it a game · Return on Investment Duel. Your parent names a pretend investment in yourself, such as a 300-dollar course that raises yearly pay by 150 dollars. Compute the return on investment and the payback time in fifteen seconds. Rate five different investments. Then recite Wesley's three rules from memory and give one example of vocation and one of stewardship. Beat your previous score.

Scripture. “And whatsoever ye do, do it heartily, as to the Lord, and not unto men;” (Colossians 3:23, KJV)

Paul wrote this to servants doing ordinary work. Diligence is first faithfulness to God; the productivity economists measure follows from it.

UNIT 1

Economic Thinking

Economics begins with a simple fact: we cannot have everything. Time, land, materials and skilled hands are limited, so every choice gives something up. In this unit you will learn the economist's basic tools for thinking about choices: opportunity cost and the production possibilities frontier, incentives, marginal thinking, and specialization and comparative advantage.

Each tool comes with a story: Bastiat's broken window, the Pilgrims at Plymouth changing their rules in 1623, Adam Smith's puzzle about diamonds and water, his pin factory, and Ricardo's two countries trading. The unit ends with work itself: vocation, stewardship and the human capital built by diligence, with John Wesley's three rules for the use of money.

PREREQUISITES

- Algebra I: solving linear equations and computing slopes
- Reading and drawing simple graphs
- Percents and ratios

MASTERY CHECKLIST

- ☐ I can define scarcity and opportunity cost and compute opportunity cost from a table or a frontier.
- ☐ I can explain what Bastiat meant by "what is not seen."
- ☐ I can explain how incentives changed behavior at Plymouth in 1623 and predict unintended consequences of a rule.
- ☐ I can use marginal benefit and marginal cost to make a decision and explain the diamond-water paradox.
- ☐ I can compute absolute and comparative advantage and show with numbers that both sides gain from trade.
- ☐ I can explain vocation, stewardship and human capital, and calculate a simple payback period.

OPTIONAL BOOKS AND GAMES FOR THIS UNIT

- ***The Wealth of Nations*, by Adam Smith (1776), Book I, chapters 1–3**: Free. The pin factory and the limits of the market, in Smith's own words. Read Book I, chapter 1, with Lesson 1.4 and the paradox of value in chapter 4 with Lesson 1.3. Ages 14+.
- **"What Is Seen and What Is Not Seen," by Frédéric Bastiat (1850)**: Free on Econlib, in *Selected Essays*. The broken-window parable is the first section and takes ten minutes to read. Use with Lesson 1.1.
- ***Of Plymouth Plantation*, by William Bradford**: Free. Bradford's account of the year 1623 tells the story of Lesson 1.2 in the governor's own words. Ages 14+.
- **"The Use of Money," sermon by John Wesley (1760)**: Free, from the Wesley Center Online. About twenty minutes to read aloud. Use with Lesson 1.5.

Not required. Every project in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

1.1	**Scarcity and Opportunity Cost: Bastiat's Broken Window**	3 sessions of 50 minutes
1.2	**Incentives: Plymouth Colony Changes the Rules, 1623**	3 sessions of 50 minutes
1.3	**Thinking at the Margin: The Diamond-Water Paradox**	3 sessions of 50 minutes
1.4	**Specialization and Comparative Advantage: Smith and Ricardo**	3 sessions of 50 minutes
1.5	**Work, Vocation and Stewardship: Human Capital and "The Use of Money"**	3 sessions of 50 minutes

Unit 1 Test

Calculators are allowed. Show your work for every calculation: write the formula, substitute the numbers with units, and give the answer. Answer the concept questions in complete sentences. The test is worth 100 points.

1. **6 pts**

   Define opportunity cost. Your best alternatives to a Saturday job paying $90 are (a) a hike with friends, which you value most, and (b) sleeping in. What is the opportunity cost of taking the job?

2. **8 pts**

   A country's PPF passes through (computers, tons of corn): (0, 500), (100, 450), (200, 350), (300, 200), (400, 0). Find the opportunity cost per computer of each 100-computer step. What shape is the curve?

3. **6 pts**

   Explain Bastiat's broken-window parable and what it teaches about "what is not seen."

4. **6 pts**

   What changed at Plymouth in 1623, and what did Bradford say were the results?

5. **6 pts**

   In a group of 25 workers who split output equally, one worker's extra effort produces 50 units. How many does he keep? How does this explain the free-rider problem?

6. **6 pts**

   Give an example of an incentive that backfired, and explain why.

7. **8 pts**

   Total utility from cups of coffee: 1 cup 20, 2 cups 32, 3 cups 38, 4 cups 40. Find each cup's marginal utility. If each cup costs 5 units of utility in money, how many cups should be bought?

8. **6 pts**

   Explain the diamond-water paradox and how economists of the 1870s resolved it.

9. **6 pts**

   A firm has spent $500,000 on a project. Finishing costs $300,000 more and will bring $350,000. Should it finish? Why?

10. **6 pts**

    Describe Smith's pin factory and give his three reasons for the gains from the division of labor.

11. **10 pts**

    Maria can make 6 shirts or 3 coats a day; Tom can make 4 shirts or 1 coat. (a) Who has the absolute advantage in each? (b) Find each person's opportunity cost of a coat. (c) Who should specialize in what? (d) Give a term of trade (shirts per coat) that benefits both.

12. **6 pts**

    Why do economists say both sides gain from voluntary trade? Use comparative advantage in your answer.

13. **8 pts**

    A two-year program costs $8,000 in tuition and $20,000 a year in lost wages. It raises earnings by $9,000 a year. Find the total cost and the payback period.

14. **6 pts**

    State Wesley's three rules and explain why he thought the third was necessary.

15. **6 pts**

    Short essay (one paragraph): Choose one idea from this unit and show how it applies to a decision your family or a local business has made.

ANSWER KEY

1. The value of the best alternative given up. The opportunity cost is the hike with friends.
2. 0.5, 1, 1.5 and 2 tons per computer. Rising opportunity cost: the curve bows outward.
3. A broken window creates work for the glazier (seen), but the owner loses what he would have bought instead, such as shoes (not seen). The town is poorer by one pair of shoes. Destruction does not create wealth.
4. The colony moved from a common store to family plots for each household's own use. Bradford wrote that it had very good success: more corn was planted and more people worked willingly.
5. $50/25 = 2$ units. He bears the full cost of the effort but receives a small share, so each person has little reason to work extra and a reason to let others carry the load.
6. Sample: a bounty on rat tails led people to breed rats; the reward was tied to tails, not to fewer rats. Rewarding a measure that can be manufactured invites gaming.
7. MU: 20, 12, 6, 2. Buy 3 cups (6 ≥ 5; the 4th's 2 is less than 5).
8. Water is more useful than diamonds but much cheaper. Price depends on marginal utility: water is plentiful, so the last unit has little value; diamonds are scarce, so the last one is valued highly. Jevons, Menger and Walras explained this in the 1870s.
9. Yes. The $500,000 is sunk. Future benefit $350,000 exceeds future cost $300,000, so finishing adds $50,000.
10. Ten men splitting about 18 operations made upward of 48,000 pins a day, versus perhaps 1–20 each working alone. Reasons: skill from repetition, no time lost switching, and invention of specialized tools.
11. (a) Maria in both. (b) Maria: 2 shirts per coat; Tom: 4 shirts per coat. (c) Maria makes coats, Tom makes shirts. (d) Any rate between 2 and 4 shirts per coat, such as 3.
12. Each side specializes where its opportunity cost is lower, so total output rises, and trade at terms between their opportunity costs gives each more than it could make alone. Neither would trade voluntarily if it expected to lose.
13. Cost: $\$8{,}000 + \$40{,}000 = \$48{,}000$. Payback: $48{,}000/9{,}000 \approx 5.3$ years.

14. Gain all you can, save all you can, give all you can. Without giving, gain and saving lead to love of money and arrogance; the Christian is a steward who gains in order to serve and give.
15. Answers vary. A strong answer names the idea correctly (for example, opportunity cost or comparative advantage), describes the real decision, uses at least one number, and identifies what was given up or gained.

PORTFOLIO PIECE: AN ECONOMIST'S NOTEBOOK OF EVERYDAY CHOICES

Keep a two-week log of at least ten real decisions made by you, your family or a local business. For each, record the choice, the opportunity cost, the incentives at work, and the marginal benefit and cost if you can estimate them. Then choose the three most interesting decisions and write a two-page essay analyzing them with the tools of this unit, including at least one graph or table (a frontier, a marginal table or a comparative-advantage table) built from real numbers.

LOOK FOR	WHAT IT MEANS
Accuracy	Opportunity cost, incentives, marginal reasoning and comparative advantage are used correctly.
Evidence	The log is dated and specific, with real numbers where possible; the graph or table is labeled and correct.
Insight	The essay identifies effects that are "not seen" and explains why people chose as they did.
Writing	Clear, organized and free of careless errors; each paragraph makes one point.

UNIT 2

Markets and Prices

A market is any place, or any arrangement, where buyers and sellers meet. In this unit you will build the most useful model in economics: supply and demand. You will see how Henry Ford's price cuts moved buyers down a demand curve, how Drake's oil well at Titusville shifted supply so far that the price of oil fell to pennies, how Alfred Marshall put the two curves together like the blades of a pair of scissors, and how the statistician King discovered that a short harvest could bring farmers more money than a large one.

The unit ends with one of the most important ideas in all of economics: prices carry information. Leonard Read's pencil and Friedrich Hayek's tin show how millions of people cooperate without knowing one another, and the gasoline lines of the 1970s and the cheese stored by the government in the 1980s show what happens when prices are not allowed to tell the truth. You will solve for equilibrium with equations, calculate elasticities and run market experiments at the dinner table.

PREREQUISITES

- Unit 1 (opportunity cost, marginal thinking)
- Solving two linear equations in two unknowns
- Graphing lines and reading slopes
- Percent change

MASTERY CHECKLIST

- ☐ I can draw and interpret demand and supply curves and tell shifts from movements along a curve.
- ☐ I can find equilibrium price and quantity from schedules, graphs and equations.
- ☐ I can predict the effects of shifts in demand and supply, including double shifts.
- ☐ I can compute price elasticity of demand with the midpoint method and apply the total-revenue test.
- ☐ I can explain how prices carry information, using "I, Pencil" and Hayek's tin example.
- ☐ I can calculate the shortage from a price ceiling and the surplus from a price floor and explain their history.

OPTIONAL BOOKS AND GAMES FOR THIS UNIT

- **"I, Pencil," by Leonard E. Read (1958)**: Free on Econlib. A short essay, about fifteen minutes to read aloud. Use with Lesson 2.5. Ages 12+.
- **"The Use of Knowledge in Society," by F. A. Hayek (1945)**: Free on Econlib. A harder essay; read the section with the tin example (about two pages) with Lesson 2.5. Ages 15+.
- **Econ Lowdown, from the Federal Reserve Bank of St. Louis**: Free lessons and short videos on supply, demand and elasticity, written for high-school students. Parents can browse without an account.

Not required. Every project in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

2.1	**Demand: Henry Ford Cuts the Price of the Model T**	3 sessions of 50 minutes
2.2	**Supply: The Oil Boom at Titusville, 1859**	3 sessions of 50 minutes
2.3	**Equilibrium: Marshall's Scissors**	3 sessions of 50 minutes
2.4	**Elasticity: King's Law of Harvests**	3 sessions of 50 minutes
2.5	**Prices as Information: "I, Pencil," Hayek's Tin, and Price Controls**	3 sessions of 50 minutes

Unit 2 test

Calculators are allowed. Show your work for every calculation: write the equation, substitute and solve, and label the units. Draw and label graphs where asked. Answer the concept questions in complete sentences. The test is worth 100 points.

1. **5 pts**
   State the law of demand and the law of supply.

2. **6 pts**
   For each, say whether demand or supply for new cars shifts, and which way: (a) incomes rise; (b) steel becomes more expensive; (c) car loans become cheaper; (d) a new robot cuts assembly costs.

3. **6 pts**
   Explain the difference between a change in demand and a change in quantity demanded, using the Model T.

4. **6 pts**
   How did Drake's method of drilling and the oil rush of 1860–61 affect the supply and price of oil?

5. **10 pts**

   Demand: $Q_d = 150 - 5P$. Supply: $Q_s = 30 + 7P$. (a) Find the equilibrium. (b) Find the shortage or surplus at $P = \$8$.

6. **6 pts**

   In problem 5, demand rises to $Q_d = 174 - 5P$. Find the new equilibrium.

7. **6 pts**

   Supply rises and demand falls at the same time. What happens to price? To quantity?

8. **6 pts**

   What did Alfred Marshall mean by comparing supply and demand to the blades of a pair of scissors?

9. **8 pts**

   The price of a good rises from \$4 to \$6, and quantity demanded falls from 120 to 80. Find the midpoint elasticity, classify it and say what happens to revenue.

10. **6 pts**

    Explain King's Law and why a short harvest could raise farmers' total income.

11. **5 pts**

    Rank from most to least elastic demand, and explain: insulin, a particular brand of cola, gasoline.

12. **6 pts**

    Summarize Hayek's tin example in three or four sentences.

13. **10 pts**

    Demand: $Q_d = 80 - 4P$; supply: $Q_s = 4P$. (a) Find the equilibrium. (b) A ceiling of \$6 is imposed. Find the shortage. (c) A floor of \$12 is imposed instead. Find the surplus.

14. **6 pts**

    Describe the gasoline lines of the 1970s and explain them with a graph.

15. **8 pts**

Short essay (one or two paragraphs): Read's pencil says that "not a single person" knows how to make it. Explain what he meant and what this suggests about the role of prices in a large economy.

ANSWER KEY

1. Demand: other things equal, a lower price raises the quantity demanded. Supply: other things equal, a higher price raises the quantity supplied.
2. (a) demand right; (b) supply left; (c) demand right; (d) supply right.
3. Ford's price cuts changed the quantity demanded (movement along the curve). Rising incomes and better roads changed demand (shifted the curve right).
4. Drake's drive pipe made drilling practical, and the rush of new wells shifted supply far to the right. The price fell from about $10 a barrel at the start of 1861 to as low as 10 cents by the end of the year.
5. (a) $150 - 5P = 30 + 7P$, $P^* = 10$, $Q^* = 100$. (b) At $8: $Q_d = 110$, $Q_s = 86$; shortage of 24.
6. $174 - 5P = 30 + 7P$, $P^* = 12$, $Q^* = 114$.
7. Price falls for certain. The change in quantity is uncertain; it depends on which shift is larger.
8. Price is set by both sides together: the buyers' utility (demand) and the sellers' cost (supply). Asking which one sets the price is like asking which blade cuts.
9. $\%\Delta Q = -40/100 = -40\%$; $\%\Delta P = 2/5 = 40\%$; $E_d = 1$, unit elastic. Revenue: $480 both times; unchanged.
10. King found that a small shortfall in the grain harvest raised the price by much more than in proportion, because demand for bread is very inelastic. So when the harvest falls, price rises by a larger percentage and total revenue rises.
11. Most elastic: a brand of cola (many substitutes); then gasoline (few substitutes, though some adjustment over time); least: insulin (a necessity with no substitute).
12. If tin becomes scarcer for any reason, its price rises. Users who know nothing of the cause cut back and seek substitutes, and their actions ripple through the economy. Millions adjust as if they knew the facts. The price system communicates dispersed knowledge no planner could gather.
13. (a) $P^* = 10$, $Q^* = 40$. (b) At $6: $Q_d = 56$, $Q_s = 24$; shortage 32. (c) At $12: $Q_d = 32$, $Q_s = 48$; surplus 16.
14. Price controls held gasoline below its market price while oil supplies were disrupted in 1973 and 1979. At the controlled price, quantity demanded exceeded quantity supplied, so drivers waited in long lines and some states used

odd-even days. The graph shows a ceiling below equilibrium and the gap between demand and supply.

15. A strong answer explains the many materials and occupations involved, that each person knows only a tiny part, and that prices coordinate their work by signaling scarcity and rewarding response. It may note that this is cooperation without central direction and connect it to Hayek's point about dispersed knowledge.

PORTFOLIO PIECE: A MARKET STUDY

Choose one product sold in your town (eggs, gasoline, a kind of fruit, used bicycles). Collect its price at three stores or sellers on at least four dates over the unit, and estimate a demand schedule by survey. Graph your survey demand curve, mark the prices you observed, and write a three-page report explaining what shifts demand and supply for your product, how elastic you think its demand is and why, and one historical example of what happened when the price of a similar good was controlled.

LOOK FOR	WHAT IT MEANS
Data	Prices are recorded with dates and sources; the survey has at least eight respondents and is summarized in a clear table.
Analysis	Graphs are labeled and correct; demand and supply shifters, elasticity and equilibrium are explained accurately.
History	The price-control example is accurate and connected to the product.
Writing	Clear, organized and honest about the limits of the data.

2.1 Demand: Henry Ford Cuts the Price of the Model T

OBJECTIVES

- State the law of demand and draw a demand curve from a demand schedule.
- Distinguish a change in quantity demanded (a movement along the curve) from a change in demand (a shift).
- Use the Model T story to explain how lower prices and rising incomes together sold millions of cars.

> **Warm-up.** Your favorite snack costs $2. Write how many you would buy in a month at $4, $2, $1 and 50¢. Then write what would change your answers even if the price stayed at $2.

WATCH

What Shifts the Demand Curve?

Marginal Revolution University · 9:54

https://www.youtube.com/watch?v=XYr8natwhuY

> **WHEN TO WATCH**
> After the big idea, before the worked examples.

BACKUP VIDEO

Demand - Economic Lowdown

Federal Reserve Bank of St. Louis · 6:53

https://www.youtube.com/watch?v=LqOzRAVOV9o

Before the project, as a review.

KEY TERMS

demand

The quantities of a good buyers are willing and able to buy at each possible price, other things being equal.

law of demand

Other things equal, when the price of a good falls, the quantity demanded rises, and when the price rises, the quantity demanded falls.

quantity demanded

The amount buyers will purchase at one particular price.

demand shifter

A change other than the good's own price (income, tastes, the prices of related goods, the number of buyers, expectations) that moves the whole demand curve.

substitute and complement

A substitute is used instead of a good (a horse instead of a car); a complement is used with it (gasoline with a car).

CORE IDEAS

The story. When Henry Ford introduced the Model T in October 1908, the touring car cost $850, more than a year's pay for most workers. Ford wanted to build "a motor car for the great multitude." Year after year he cut the price: to about $360 by 1916 and to about $260 for the basic model by the mid-1920s. Sales rose from about ten thousand in the first full year to well over a million a year in the early 1920s. By 1927, when production ended, about fifteen million Model Ts had been made.

How they figured it out. Ford's managers did not have an economics textbook, but they watched the order books. Every price cut brought in buyers who could not afford the car before: farmers, doctors on country rounds, salesmen, and in time the factory workers themselves. Ford reasoned that a lower price and a small profit on each of a great many cars would earn more than a high price on a few. The moving assembly line of 1913 cut the hours needed to build each car, which made the lower prices possible. At the same time, Americans' incomes were rising, roads were improving and gasoline stations were spreading, so more people wanted cars at every price.

The big idea. Demand is a whole schedule: how much buyers will purchase at each price. The **law of demand** says that, other things equal, a lower price raises the quantity demanded, for two reasons: the good becomes cheaper compared with substitutes, and a buyer's income stretches further. On a graph with price on the vertical axis, the demand curve slopes downward. A change in the good's own price is a *movement along* the curve. A change in anything else that matters to buyers (income, tastes, the prices of substitutes and complements, the number of buyers,

expectations about the future) *shifts* the whole curve. The Model T story had both: Ford's price cuts moved buyers down the curve, while rising incomes, better roads and cheaper gasoline shifted the curve to the right.

In business today. Firms estimate demand constantly. A grocery chain tests prices in a few stores and watches sales; an airline raises fares for dates with heavy demand; a car maker watches incomes, gasoline prices and interest rates on car loans, all of which shift demand. A good seller keeps both questions in mind: "How many will buy at this price?" and "What is changing in my customers' lives?"

Who gained? Ford's customers gained a reliable car at a price that kept falling. Ford's workers gained steady jobs and, from 1914, the famous $5 day. Ford and his early investors, the financiers and risk-takers, became very rich. The country gained mobility, rural doctors and mail routes, and a new industry of roads, garages and suppliers. You will return to Ford's workers in Unit 7.

PICTURE STUDY



1910 Model T Ford, Salt Lake City, Harry Shipler, Shipler Commercial Photographers, 1910 · Photograph · Salt Lake City, Utah

Image: Wikimedia Commons, public domain

The Model T was simple, high off the ground for rough country roads, and easy to repair with a few tools. Ford famously offered it in a single basic design for years so that his factory could make it faster and cheaper. Each price cut brought it within reach of new buyers.

Look closely

- Look at the height of the car and the size of the wheels. Why would that matter on the roads of 1910?
- Find the headlamps and the folding top. What did a buyer get for the price?
- Look for anything that shows how the car was started or fueled.
- Count the seats. Who might buy a car like this: a family, a doctor, a salesman, a farmer?

Talk about it

1. Why did each price cut sell more cars? Use the law of demand.
2. Name two changes in American life between 1908 and 1925 that shifted the demand for cars to the right.
3. How did Ford's lower costs make the lower prices possible?

> **Safety first.** A parent helps choose whom to survey. Do not collect names, addresses or other personal information.

PROJECT

Estimate a Real Demand Curve

You will survey people about how much of a familiar item they would buy at several prices, build a market demand schedule, fit a straight line to it and test a demand shifter.

You will need

- A survey sheet
- At least eight respondents (family, friends, a church group), with a parent's help
- A spreadsheet
- Your ledger notebook

Steps

1. Choose an item people buy regularly, such as a loaf of fresh bread or a bag of apples, and five prices around its usual price.
2. Write a survey: "How many would you buy in a month at each of these prices?" Ask at least eight people.
3. Add the answers at each price to make a market demand schedule.
4. Enter the schedule in a spreadsheet and graph it with price on the vertical axis.
5. Add a straight-line trendline and write its equation. Rewrite it in the form $Q_d = a - bP$.
6. Ask the same people one follow-up: "Suppose your income rose by 10%. Would your answers change?" Record the new totals.
7. Graph the new schedule on the same axes. Did the curve shift? By how much at the usual price?
8. Write a paragraph explaining what your curve shows and two reasons survey answers might differ from real buying.

Tips

- Ask about an item where people really do buy different amounts at different prices.

- People often say they would buy more than they really would. Note that in your write-up.

Check your work

- ☐ I can build a market demand schedule by adding individual demands.
- ☐ I can graph a demand curve and write its equation.
- ☐ I can tell a movement along the curve from a shift of the curve.

LEDGER NOTEBOOK

1. Copy your demand schedule and both curves. Label the shift and the movement along the curve.
2. List the five kinds of demand shifters and give a Model T example for each.
3. Draw a timeline of Model T prices from 1908 to the mid-1920s with the main events (the assembly line in 1913, the $5 day in 1914).

KEY FORMULAS

$$Q_d = a - bP \quad (b > 0)$$

$$\text{Slope of the demand curve on a } (Q, P) \text{ graph} = -\frac{1}{b}$$

From history. Ford sold the Model T for nineteen years with few changes. When buyers began to want variety and style, General Motors, under Alfred Sloan, offered "a car for every purse and purpose," in several colors and with yearly models. Ford's sales fell, and in 1927 he stopped the Model T and closed his plants for months to retool for the Model A.

WORKED EXAMPLES

Example 1. A town's demand for bicycles is $Q_d = 500 - 2P$, where P is the price in dollars and Q_d is bicycles per year. Make a demand schedule for prices of \$50, \$100, \$150 and \$200.

Show solution

1. At \$50: $500 - 2(50) = 400$.
2. At \$100: $500 - 200 = 300$.
3. At \$150: $500 - 300 = 200$.
4. At \$200: $500 - 400 = 100$.

Answer: 400, 300, 200 and 100 bicycles. Each \$50 increase in price lowers the quantity demanded by 100.

Example 2. Incomes in the town rise, and demand becomes $Q_d = 600 - 2P$. At a price of \$150, how many more bicycles are demanded? Is this a movement along the curve or a shift?

Show solution

1. Old: $500 - 2(150) = 200$.
2. New: $600 - 2(150) = 300$.
3. Difference: 100 more bicycles at the same price.

Answer: Demand shifted right by 100 at every price. This is a change in demand, not a change in quantity demanded.

Example 3. For each event, say whether the demand for Model Ts shifts right, shifts left, or neither (a movement along the curve): (a) Ford cuts the price; (b) farm incomes rise; (c) gasoline becomes cheaper; (d) railroads cut passenger fares.

Show solution

1. (a) A change in the car's own price: a movement down along the curve, not a shift.
2. (b) Higher income: demand shifts right (a car is a normal good).
3. (c) Gasoline is a complement: cheaper gasoline shifts demand right.
4. (d) Train travel is a substitute: cheaper train fares shift demand for cars left.

Answer: (a) movement along; (b) right; (c) right; (d) left.

PRACTICE

1. Easy State the law of demand.

   Show answer

   Other things equal, a lower price raises the quantity demanded and a higher price lowers it.

2. Easy What was the price of the Model T touring car in 1908, and about what did the basic model cost by the mid-1920s?

   Show answer

   About $850 in 1908; about $260 by the mid-1920s.

3. Easy Name the five kinds of demand shifters.

   Show answer

   Income, tastes, prices of related goods (substitutes and complements), number of buyers, and expectations.

4. Medium Demand is $Q_d = 120 - 4P$. Find the quantity demanded at $P = \$10$ and the price at which no one buys.

   Show answer

   $120 - 40 = 80$; $Q_d = 0$ when $P = \$30$.

5. Medium The price of gasoline doubles. What happens to the demand for large cars? For bicycles?

Show answer

Demand for large cars (a complement of gasoline) shifts left; demand for bicycles (a substitute for driving) shifts right.

6. Medium A newspaper writes, “The price of apples rose, so demand fell.” Correct the sentence.

Show answer

“The price of apples rose, so the quantity demanded fell.” Demand (the whole curve) did not change; buyers moved along it.

7. Medium Three buyers want these quantities at \$4: 2, 5 and 3. At \$2: 4, 8 and 6. Find the market quantity demanded at each price.

Show answer

At \$4: 10. At \$2: 18.

8. Hard Demand is $Q_d = 300 - 5P$. A rise in incomes adds 50 units at every price. Write the new equation and find the new quantity demanded at $P = \$20$.

Show answer

$Q_d = 350 - 5P$; at \$20, $350 - 100 = 250$.

9. Hard Ford cut prices and sales rose, but incomes and roads were improving at the same time. Why does this make it hard to measure how much the price cuts alone raised sales?

Show answer

Both a movement along the curve (price cuts) and a rightward shift (incomes, roads) happened together. The rise in sales mixes the two effects; to separate them, you must hold the other factors constant or estimate them separately.

10. Challenge A seller faces $Q_d = 1{,}000 - 10P$. Find total revenue ($P \times Q$) at prices of \$30, \$50 and \$70. Which price gives the most revenue?

Show answer

At \$30: $30 \times 700 = \$21{,}000$. At \$50: $50 \times 500 = \$25{,}000$. At \$70: $70 \times 300 = \$21{,}000$. \$50 gives the most revenue (you will see why in Lesson 2.4).

COMMON MISTAKES

- Saying “demand fell” when the price rose. The price changes the quantity demanded; demand is the whole curve.
- Putting price on the horizontal axis. Economists put price on the vertical axis and quantity on the horizontal.
- Forgetting “other things equal.” The law of demand describes the effect of price alone.

> **Make it a game · Shift or Slide Calls.** Ask your parent how many cookies they would buy at prices of 1, 2, 3 and 4 dollars. Draw the demand curve from the schedule. Then your parent calls events, such as Ford cutting the Model T price, a rival good getting cheaper, or incomes rising. Say whether it is a movement along the curve or a shift of demand, and in which direction.

2.2 Supply: The Oil Boom at Titusville, 1859

OBJECTIVES

- State the law of supply and draw a supply curve from a supply schedule.
- Name the main supply shifters and distinguish a change in supply from a change in quantity supplied.
- Use the Pennsylvania oil boom of the 1860s to explain how new supply lowers prices.

> **Warm-up.** You can mow lawns on Saturday. How many would you mow if each paid $10? $25? $50? Write your answers, then explain why your number rises with the pay.

WATCH

What Shifts the Supply Curve?

Marginal Revolution University · 9:49

https://www.youtube.com/watch?v=TvBHJERKto0

> **WHEN TO WATCH**
> After the big idea, before the worked examples.

BACKUP VIDEO

Drake Well Museum: Drilling the Drake Well

Pennsylvania Historical and Museum Commission · 4:29

https://www.youtube.com/watch?v=jBKEnZRWm1E

With the story, to see how Drake's well was drilled.

KEY TERMS

supply
The quantities of a good sellers are willing and able to offer at each possible price, other things being equal.

law of supply
Other things equal, when the price of a good rises, the quantity supplied rises.

quantity supplied

The amount sellers will offer at one particular price.

supply shifter

A change other than the good's own price (input costs, technology, the number of sellers, expectations, taxes or subsidies, weather) that moves the whole supply curve.

kerosene

A lamp oil refined from crude petroleum; in the 1860s it replaced whale oil and other costlier lighting fuels.

CORE IDEAS

The story. In the 1850s Americans lit their homes with whale oil, candles and costly coal oils, and whale oil was growing scarce and expensive. A group of investors hoped that the oil that seeped from the ground in western Pennsylvania could be refined into a cheaper lamp fuel. They hired Edwin Drake, a former railroad conductor, to find a way to get it out in quantity. Drillers laughed at him, but on August 27, 1859, near Titusville, his well struck oil at about 69 feet. It was the first well drilled for oil in the United States, and within months the valley of Oil Creek was crowded with derricks.

How they figured it out. Drake's great idea was to drive an iron pipe down through the loose gravel so that the hole would not cave in, then drill inside it. Others copied the method at once. The quantity of oil soared, far faster than refineries, barrels and wagons could handle it. According to the historian Daniel Yergin, the price of a barrel fell from about $10 at the start of 1861 to as little as 10 cents by the end of that year. Many producers were ruined; the survivors learned to build pipelines, to refine in bulk, and to store oil until prices recovered. Cheap kerosene soon lit homes across America and Europe, and the demand for whale oil collapsed.

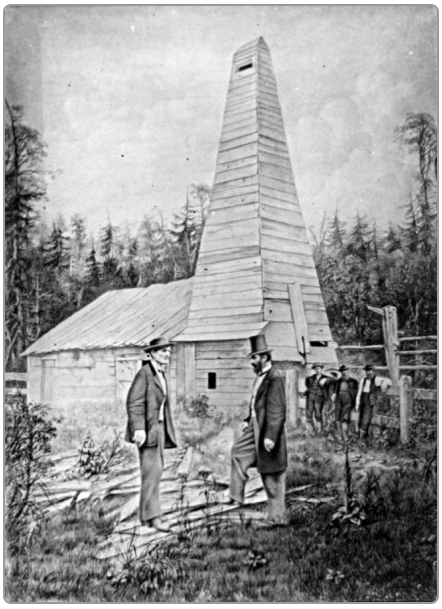
The big idea. Supply is a schedule of how much sellers will offer at each price. The **law of supply** says that, other things equal, a higher price brings a larger quantity supplied, because it covers the higher cost of producing more (extra wells, overtime, less productive land) and draws in new producers. On a graph the supply curve slopes upward. A change in the good's own price moves sellers along the curve. A

change in anything else that affects the cost or ability to produce (technology, input prices, the number of sellers, expectations, taxes, weather) shifts the whole curve. Drake's drilling method and the rush of new wells shifted the supply of oil far to the right, and the price fell.

In business today. Producers watch input costs and technology closely. When a farmer's fertilizer costs rise, his supply curve shifts left; when a better seed arrives, it shifts right. New drilling methods have repeatedly shifted the supply of oil and natural gas, with large effects on prices. A business plans for supply shocks by keeping inventories, signing long contracts and finding more than one supplier.

Who gained? Customers gained cheap, bright light. The risk-takers and financiers of the early boom often lost everything when prices crashed; a few, such as a young bookkeeper in Cleveland named John D. Rockefeller, built fortunes by bringing order to refining. Workers found good wages but dangerous work. The community saw boomtowns rise and fall within a few years, and the whales, at last, were spared.

PICTURE STUDY



The Drake Well, Unknown photographer, photograph from the early 1860s; this retouched print 1890 · Photograph · Drake Well Museum, Titusville, Pennsylvania

Image: Wikimedia Commons, public domain

This retouched print of an early photograph shows Drake's wooden derrick and engine house at Titusville, with Edwin Drake himself standing at the right. Within two years, hundreds of derricks like this one crowded the valley, and the price of oil collapsed.

Look closely

- Find the derrick. What do you think it was for?
- Look at the engine house. What powered the drill?
- Look at the ground around the well. What does it tell you about the work?
- Find the people in the picture. What can you guess about them from their clothes?

Talk about it

1. How did Drake's idea of driving a pipe change the supply of oil?
2. Why did the price of oil fall so far in 1861?
3. Which stakeholders gained from the boom and which lost?

PROJECT

Build a Supply Schedule from Real Costs

You will estimate the cost of making increasing batches of a simple product (cookies, bread or lemonade) and build a supply schedule showing how much you would offer at each price.

You will need

- Recipe and current prices of ingredients from a store flyer or receipt
- A calculator or spreadsheet
- Your ledger notebook

Steps

1. Choose a product and write its recipe for one batch. Price each ingredient using a receipt or flyer.
2. Estimate your time per batch. Decide what an hour of your time is worth (your opportunity cost).
3. Assume each extra batch takes a little longer as you tire or must buy ingredients at a farther store. Write the cost of the 1st, 2nd, 3rd, 4th and 5th batch.
4. For each price per batch ($8, $12, $16, $20, $24), decide how many batches you would make: keep adding batches while the price covers the cost of the next one.
5. Record the supply schedule and graph it with price on the vertical axis.
6. Now suppose flour doubles in price. Recalculate the costs and draw the new supply curve on the same graph.
7. Write a paragraph explaining why your curve slopes upward and why it shifted.

Tips

- Use real prices. The point is to see how costs shape supply.
- Count your time. A product that seems profitable may not be once your hours are valued.

Check your work

- ☐ I can build a supply schedule from rising marginal costs.
- ☐ I can show a shift in supply caused by an input price.
- ☐ I can explain the law of supply.

LEDGER NOTEBOOK

1. Copy your cost table, supply schedule and both supply curves.
2. List the six kinds of supply shifters with an oil-industry example for each.
3. Draw a quick graph of the oil market in 1861: show the supply curve shifting right and the price falling.

KEY FORMULAS

$$Q_s = c + dP \quad (d > 0)$$

From history. Drake himself never grew rich. He did not patent his drive-pipe method, lost his savings in oil speculation, and lived his later years in poverty until the Pennsylvania legislature granted him a small pension in 1873.

WORKED EXAMPLES

Example 1. Supply of a crop is $Q_s = -20 + 4P$ (bushels in thousands, price in dollars). Find the quantity supplied at \$10, \$15 and \$20, and the lowest price at which anything is supplied.

Show solution

1. At \$10: $-20 + 40 = 20$.
2. At \$15: $-20 + 60 = 40$.
3. At \$20: $-20 + 80 = 60$.
4. Set $Q_s = 0$: $P = 5$.

Answer: 20, 40 and 60 thousand bushels; no supply below \$5 a bushel.

Example 2. A new pump lowers costs so that oil producers will offer 30 more thousand barrels at every price. The old supply was $Q_s = 10 + 5P$. Write the new supply and find the quantity at $P = \$4$ before and after.

Show solution

1. New supply: $Q_s = 40 + 5P$.
2. Before: $10 + 20 = 30$ thousand barrels.
3. After: $40 + 20 = 60$ thousand barrels.

Answer: Supply shifts right; at \$4, the quantity supplied doubles from 30 to 60 thousand barrels.

Example 3. For each event, does the supply of whale oil in the 1860s shift right, shift left or neither? (a) Whales grow scarcer and voyages longer; (b) the price of whale oil falls as kerosene spreads; (c) the cost of ship timber rises.

Show solution

1. (a) Higher cost of catching whales: supply shifts left.
2. (b) A change in whale oil's own price: a movement along the supply curve (and the falling price came from falling demand).
3. (c) A higher input cost: supply shifts left.

Answer: (a) left; (b) neither (a movement along the curve); (c) left.

PRACTICE

1. Easy State the law of supply.

   Show answer

   Other things equal, a higher price raises the quantity supplied.

2. Easy When and where did Drake find oil?

   Show answer

   August 27, 1859, near Titusville, Pennsylvania.

3. Easy What was Drake's key technical idea?

Show answer

Driving an iron pipe through the loose ground to keep the hole from caving in, and drilling inside it.

4. Medium Supply is $Q_s = 5P - 10$. Find the quantity supplied at $P = \$6$ and $P = \$10$.

Show answer

20 and 40.

5. Medium Name the shifter in each case and the direction: (a) a drought; (b) a new machine; (c) a tax on each unit produced.

Show answer

(a) weather, left; (b) technology, right; (c) tax, left.

6. Medium Why does the supply curve usually slope upward?

Show answer

Producing more usually costs more per extra unit (less suitable land, overtime, extra equipment), so a higher price is needed to cover it; higher prices also draw in new producers.

7. Medium By how many times did the price of a barrel of oil fall in 1861, from \$10 to 10 cents?

Show answer

By a factor of 100 (to one-hundredth of its earlier price).

8. Hard Explain why the oil boom lowered the price of whale oil even though nothing happened to whaling ships.

Show answer

Kerosene became a cheap substitute, so the demand for whale oil shifted left, lowering its price. The change came through demand, not supply.

9. Hard Supply is $Q_s = 2P$ for each of 50 identical farms. Write the market supply equation.

Show answer

$Q_s = 100P$.

10. **Challenge** A producer's cost of each extra barrel is $MC = 2 + 0.5Q$. Assuming it supplies barrels as long as the price covers marginal cost, write its supply curve Q_s as a function of P and find the quantity supplied at $P = \$7$.

    Show answer

    Set $P = 2 + 0.5Q$, so $Q_s = 2P - 4$. At \$7: $Q_s = 10$ barrels.

COMMON MISTAKES

- Saying "supply rose" when only the price rose. A higher price raises the quantity supplied; supply is the whole curve.
- Confusing a change in a substitute's supply with a change in this good's supply.
- Forgetting that the cost of the producer's own time and equipment belongs in the cost of supply.

> **Make it a game · Wildcat Driller Costs.** Roll a die six times to assign a per-barrel cost to six pretend oil drillers at Titusville. Your parent calls prices. At each price, count how many drillers would produce at a profit. Build the supply schedule and plot the supply curve. Then your parent names a supply shifter, and you shift the curve the right way.

2.3 Equilibrium: Marshall's Scissors

OBJECTIVES

- Find the equilibrium price and quantity from schedules, a graph and equations.
- Explain how shortages and surpluses push a market toward equilibrium.
- Predict the effect of shifts in supply and demand on price and quantity, including double shifts.

> **Warm-up.** A school bake sale prices cookies at $3, and by noon half are left. A second sale prices them at 50¢, and they are gone in ten minutes with a line still waiting. What should each sale have done, and why?

WATCH

The Equilibrium Price and Quantity

Marginal Revolution University · 4:50

https://www.youtube.com/watch?v=7eZcPs9z9OA

> **WHEN TO WATCH**
> After the story, before the big idea.

BACKUP VIDEO

Market equilibrium | Supply, demand, and market equilibrium | Microeconomics | Khan Academy

Khan Academy · 10:16

https://www.youtube.com/watch?v=PEMkfgrifDw

During the worked examples.

KEY TERMS

equilibrium

The price and quantity at which the quantity demanded equals the quantity supplied.

shortage

A situation in which quantity demanded is greater than quantity supplied at the current price (excess demand).

surplus

A situation in which quantity supplied is greater than quantity demanded at the current price (excess supply).

market-clearing price

Another name for the equilibrium price: the price at which every buyer who wants to buy at that price can, and every seller who wants to sell can.

CORE IDEAS

The story. For a century after Adam Smith, economists argued about what sets a price. One school said cost of production: a thing is worth what it takes to make. The marginal economists of the 1870s answered that value depends on utility, on how much buyers want one more unit. In 1890 the Cambridge economist Alfred Marshall settled the dispute with an image in his *Principles of Economics*. Arguing whether utility or cost governs value, he wrote, is like arguing whether the upper or the under blade of a pair of scissors cuts a piece of paper.

How they figured it out. Marshall drew demand and supply as two curves on one graph, with price on the vertical axis. Demand carries the buyers' side (utility); supply carries the sellers' side (cost). The price settles where the two curves cross. Marshall also distinguished time periods: on a single market day, supply is fixed and demand rules the price; over months and years, producers adjust and cost matters more. His diagrams, drawn by hand in his books and lectures, became the standard picture of a market in every economics classroom.

The big idea. At the **equilibrium** price, buyers want exactly as much as sellers offer. Above it there is a **surplus**: unsold goods pile up and sellers cut prices. Below it there is a **shortage**: buyers compete, shelves empty, and prices rise. No one has to calculate the equilibrium; the actions of many buyers and sellers push the price there. When demand rises, both price and quantity rise. When supply rises, price falls and quantity rises. When both shift at once, one of the two (price or quantity) moves in a direction you can predict, and the other depends on which shift is larger.

In business today. A farmers' market vendor who sells out by nine in the morning has learned that her price was below equilibrium; one who carries most of her tomatoes home has learned the opposite. Concert sellers whose tickets resell for three times their price set them below the market-clearing price. Merchants watch inventories as a signal: stock that piles up says "lower the price," and empty shelves say "order more, or raise the price."

Think it through. Proverbs 20:14 describes bargaining honestly: “It is naught, it is naught, saith the buyer: but when he is gone his way, then he boasteth.” A market price is the meeting of many such bargains. Honest dealing on both sides keeps it a fair meeting.

PICTURE STUDY



Nihonbashi: Morning View (Station 1 of The Fifty-three Stations of the Tōkaidō), Utagawa Hiroshige, about 1833–1834 · Woodblock print, ink and color on paper · The Metropolitan Museum of Art, New York
Image: Wikimedia Commons, public domain

Nihonbashi, the "bridge of Japan," was the starting point of the great Tōkaidō road in Edo (now Tokyo) and the site of the city's fish market. Hiroshige shows dawn: a lord's procession sets out across the bridge, while fishmongers with baskets on poles hurry off to sell the morning's catch before it spoils.

Look closely

- Find the fish sellers in the front. How are they carrying their goods?
- Look at the procession on the bridge. Who are these people, and where are they going?
- Look at the color of the sky. What time is it, and why would fish sellers start so early?
- Look at the gates and buildings. What tells you this is a busy place of trade?

Talk about it

1. Fresh fish spoils by evening. How would that affect the seller's price late in the day?
2. If a large catch came in one morning, what would happen to the price of fish at Nihonbashi? Use supply and demand.

3. What does a market like this need in order to work well: honest weights, a meeting place, trust?

PROJECT

A Dinner-Table Market

You will run a small classroom-style market with family members, record the prices of trades, and see whether they move toward the equilibrium predicted by the buyers' and sellers' cards.

You will need

- Index cards
- Play money or slips of paper
- A whiteboard or large paper to post trades
- At least four players (two buyers, two sellers; more is better)
- Your ledger notebook

Steps

1. Make buyer cards with a "value" (the most the buyer will pay) and seller cards with a "cost" (the least the seller will accept). Use values $10, $9, $8, $7, $6, $5 and costs $3, $4, $5, $6, $7, $8.
2. Before playing, draw the demand and supply schedules from the cards and predict the equilibrium price and quantity.
3. Hand out the cards privately. Buyers earn value minus price; sellers earn price minus cost. No one may trade at a loss.
4. Run a 3-minute round: buyers and sellers call out offers; when a buyer and seller agree, post the price.
5. Run three or four rounds, shuffling the cards each time. Record every trade price.
6. Compute the average price each round. Did prices move toward your prediction?
7. Change the game: add two more buyer cards ($9 and $8). Predict the new equilibrium, play a round and compare.
8. Write a paragraph explaining what you saw and how it matches Marshall's scissors.

Tips

- Shuffle the cards between rounds so no one keeps the same advantage.
- Keep the rounds short so that offers come fast.

Check your work

- ☐ I can find equilibrium from schedules and equations.
- ☐ I can explain why shortages and surpluses push the price toward equilibrium.
- ☐ I can predict how a shift in demand or supply changes price and quantity.

LEDGER NOTEBOOK

1. Copy the schedules from your cards, your predicted equilibrium and the table of trade prices by round.
2. Draw four small graphs: demand up, demand down, supply up, supply down. Label the changes in price and quantity.
3. Draw Marshall's scissors with one blade labeled "demand (utility)" and one labeled "supply (cost)."

KEY FORMULAS

$$\text{Equilibrium: } Q_d = Q_s$$

$$a - bP = c + dP \;\Rightarrow\; P^* = \frac{a - c}{b + d}$$

From history. Marshall (1842–1924) first studied mathematics and kept his equations in footnotes and appendices, so that his books could be read by businessmen. He was a professor at Cambridge for over twenty years and taught John Maynard Keynes, whom you will meet at Bretton Woods in Unit 6.

WORKED EXAMPLES

Example 1. Demand is $Q_d = 100 - 2P$ and supply is $Q_s = 20 + 3P$. Find the equilibrium price and quantity.

Show solution

1. Set them equal: $100 - 2P = 20 + 3P$.
2. Solve: $80 = 5P$, so $P^* = 16$.
3. Quantity: $Q^* = 100 - 2(16) = 68$. Check: $20 + 3(16) = 68$.

Answer: $P^* = \$16$, $Q^* = 68$ units.

Example 2. In the same market, the price is held at \$10. Is there a shortage or a surplus, and how large?

Show solution

1. Quantity demanded: $100 - 20 = 80$.
2. Quantity supplied: $20 + 30 = 50$.
3. Demand exceeds supply by $80 - 50 = 30$.

Answer: A shortage of 30 units. Buyers would bid the price up toward \$16.

Example 3. A good harvest raises supply to $Q_s = 40 + 3P$. Find the new equilibrium and describe the change.

Show solution

1. Set $100 - 2P = 40 + 3P$: $60 = 5P$, $P^* = 12$.
2. Quantity: $100 - 24 = 76$.

Answer: Price falls from \$16 to \$12 and quantity rises from 68 to 76: the result of a rightward supply shift.

Example 4. At the same time, more buyers move to town and demand rises. Supply also rises because of a new road. What happens to price and quantity?

Show solution

1. Demand rising alone: price up, quantity up.
2. Supply rising alone: price down, quantity up.
3. Both: quantity rises for certain. Price could go either way, depending on which shift is larger.

Answer: Quantity rises; the effect on price is uncertain without numbers.

PRACTICE

1. Easy What is equilibrium in a market?

   Show answer

   The price and quantity where quantity demanded equals quantity supplied.

2. Easy What did Marshall compare demand and supply to?

Show answer

The two blades of a pair of scissors.

3. Easy At a price above equilibrium, is there a shortage or a surplus?

Show answer

A surplus.

4. Medium Demand: $Q_d = 60 - P$; supply: $Q_s = 2P$. Find the equilibrium.

Show answer

$60 - P = 2P$, $P^* = 20$, $Q^* = 40$.

5. Medium In problem 4, what happens if the price is set at \$25?

Show answer

Quantity demanded 35, supplied 50: a surplus of 15.

6. Medium A frost destroys part of the orange crop. Predict the effect on the price and quantity of oranges and on the price of apple juice.

Show answer

Orange supply shifts left: price up, quantity down. Apple juice is a substitute, so its demand rises and its price rises.

7. Medium Demand for a good rises while its supply falls. What happens to price? To quantity?

Show answer

Price rises for certain; the change in quantity depends on which shift is larger.

8. Hard Demand: $Q_d = 200 - 4P$; supply: $Q_s = -40 + 4P$. Find the equilibrium, then the new equilibrium after demand rises to $Q_d = 240 - 4P$.

Show answer

Original: $P^* = 30$, $Q^* = 80$. New: $P^* = 35$, $Q^* = 100$.

9. Hard Explain Marshall's point that on a single market day demand governs price, but over years cost matters more.

Show answer

On one day supply is fixed (what is in the market), so buyers' demand sets the price. Over time producers can enter, leave and expand, so price tends toward the cost of production.

10. Challenge Find the general formula for equilibrium quantity when $Q_d = a - bP$ and $Q_s = c + dP$. Check it on Worked Example 1.

Show answer

$Q^* = \dfrac{ad + bc}{b + d}$. Check: $\dfrac{100(3) + 2(20)}{5} = 68$.

11. Challenge Ticket resellers often charge far more than the face price of concert tickets. What does this tell you about the face price, and who gains from the difference?

Show answer

The face price is below the market-clearing price, creating a shortage at that price. Resellers capture the difference between buyers' willingness to pay and the face price; the performer and original seller do not.

COMMON MISTAKES

- Shifting a curve when only the price changed. Price changes cause movements along curves; only other factors shift them.
- Assuming both price and quantity are always predictable when both curves shift. One of them is uncertain.
- Solving the equations but forgetting to plug back in and check that both sides give the same quantity.

> **Make it a game · Marshall's Double Auction.** Write five buyer values and five seller costs on slips. Without showing them, auction trades by calling out offers using paper chips. Find the equilibrium price and quantity from the slips, then check it against what actually happened. Name the shortage or surplus at a price one dollar too high or too low. Explain Marshall's scissors.

> **Scripture.** “It is naught, it is naught, saith the buyer: but when he is gone his way, then he boasteth.” (Proverbs 20:14, KJV)
>
> The buyer runs down the goods to lower the price and boasts afterward of his bargain. Markets are full of such haggling; honesty keeps it fair to both sides.

2.4 Elasticity: King's Law of Harvests

OBJECTIVES

- Calculate the price elasticity of demand with the midpoint method and classify demand as elastic, inelastic or unit elastic.
- Use the total-revenue test to explain why a smaller harvest can bring farmers more money.
- Name the factors that make demand more or less elastic.

> **Warm-up.** If the price of each item below doubled tomorrow, would your family buy much less, a little less or about the same? Salt, movie tickets, gasoline, a favorite brand of cereal, electricity.

WATCH

Total revenue and elasticity | Elasticity | Microeconomics | Khan Academy

Khan Academy · 11:40

https://www.youtube.com/watch?v=Udltkvm9HLc

> **WHEN TO WATCH**
> After the big idea, before Worked Example 2.

BACKUP VIDEO

Price Elasticity of Demand: What Is Elasticity? | Part 1

Federal Reserve Bank of St. Louis · 6:01

https://www.youtube.com/watch?v=Fc4KIRKM-tQ

Before the big idea, as an introduction.

KEY TERMS

price elasticity of demand
The percentage change in quantity demanded divided by the percentage change in price; it measures how strongly buyers respond to price.

elastic
Demand with elasticity greater than 1 in absolute value: quantity responds more than in proportion to price.

inelastic

Demand with elasticity less than 1 in absolute value: quantity responds less than in proportion to price.

midpoint method

Computing percentage changes using the average of the starting and ending values, so the answer is the same in either direction.

total revenue

Price times quantity sold: the total money sellers receive and buyers spend.

CORE IDEAS

The story. G. King (1648–1712) was an English herald, mapmaker and pioneer of statistics who tried to count the whole population and income of England in the 1690s. His friend Charles Davenant published one of King's findings in 1699: a table of how the price of grain rose when the harvest fell short. By King's estimate, a harvest one-tenth short would raise the price by three-tenths; two-tenths short, by eight-tenths; three-tenths short, by 1.6 times; four-tenths short, by 2.8 times; and half short, by 4.5 times. Economists still call this pattern King's Law.

How they figured it out. King noticed something the farmers knew in their bones. People must eat bread whether it is cheap or dear, so when grain is scarce they cut back only a little and bid the price up a lot. When the harvest is plentiful, they eat only a little more, and the price collapses. His table means that in a poor year farmers as a group could receive *more* money for *less* grain, and in a bumper year less money for more. This "paradox of the farmer" is a matter of **elasticity**.

The big idea. The **price elasticity of demand** measures how much quantity responds to price, in percentages. If a 10% rise in price cuts quantity by 20%, elasticity is 2: demand is **elastic**. If it cuts quantity by 5%, elasticity is 0.5: demand is **inelastic**. (Economists usually report the absolute value.) Demand is more elastic when there are close substitutes, when the good takes a large share of income, when it is a luxury rather than a necessity, and when buyers have more time to adjust. The **total-revenue test** follows: when demand is inelastic, raising the price raises total revenue; when it is elastic, raising the price lowers total revenue. Revenue is greatest where elasticity equals 1.

In business today. Firms study elasticity before changing prices. A brand of soap with many rivals faces elastic demand and must be careful raising prices; a hospital emergency room or a gasoline station on a lonely highway faces inelastic demand. Governments that want to raise money from a tax look at elasticity, too, because a tax on a good with elastic demand shrinks its own base. Farmers, facing King's Law, have long used storage, cooperatives and futures contracts to smooth out the swings in their incomes.

Think it through. Joseph stored grain in Egypt's seven good years for the seven years of famine (Genesis 41). Storage is the oldest answer to King's Law: by buying when grain is cheap and selling when it is dear, a wise steward makes prices steadier for everyone.

PICTURE STUDY



The Harvesters, Pieter Bruegel the Elder, 1565 · Oil on wood · The Metropolitan Museum of Art, New York

Image: Wikimedia Commons, public domain

Bruegel painted this harvest as one of a series of six pictures of the seasons for an Antwerp merchant's house. It shows the whole work of the grain year: cutting, binding, carrying, and the midday meal under a tree. A good harvest like this one fed a village through the winter. A poor one could double or triple the price of bread.

Look closely

- Find the workers cutting wheat with scythes and those binding sheaves. How many different jobs can you see?
- Look at the group eating under the tree. What are they eating?
- Find the cart carrying sheaves and the path to the village. Where is the grain going?
- Look far into the distance for the harbor and ships. Why might grain be shipped?

Talk about it

1. According to King's Law, what would have happened to the price of this grain if the harvest were half as large?
2. Why is the demand for bread inelastic? What would these villagers do if it doubled in price?

3. How do storage and shipping help steady the price of grain?

PROJECT

Measure Elasticity at Home

You will estimate the price elasticity of demand for three goods using a survey of your household and a real price change from receipts or flyers, and test the total-revenue rule.

You will need

- Store flyers or receipts from two dates
- A calculator or spreadsheet
- Your ledger notebook

Steps

1. Choose three goods your family buys: one necessity (milk or bread), one with many substitutes (a brand of cereal) and one treat.
2. Ask your family how many of each they buy in a month at the usual price, and how many they would buy if the price rose by 25%.
3. Compute the midpoint elasticity for each good from the two answers.
4. Rank the three goods from most to least elastic. Write which factors (substitutes, share of budget, necessity) explain the ranking.
5. Compute your family's spending on each good at the old and new prices. Check the total-revenue rule.
6. Find one item in store flyers whose price changed between two weeks. Estimate how sales might have changed, and explain your guess.
7. Write a paragraph comparing your results with King's Law for grain.

Tips

- Ask people to answer for a real month, not an imagined one.
- A good with an elasticity near zero is not an error: salt and electricity often look like that.

Check your work

☐ I can compute an elasticity with the midpoint method.

☐ I can classify demand as elastic or inelastic and apply the total-revenue test.

- [ ] I can explain King's Law and the farmer's paradox.

LEDGER NOTEBOOK

1. Copy your survey results, elasticity calculations and spending table.
2. Copy King's table and add a column for farmers' total revenue at each harvest size.
3. Draw two demand curves on one graph, one steep (inelastic) and one flat (elastic), and label a good of each kind.

KEY FORMULAS

$$E_d = \frac{\%\Delta Q}{\%\Delta P}$$

$$\%\Delta Q = \frac{Q_2 - Q_1}{(Q_1 + Q_2)/2} \times 100\%, \qquad \%\Delta P = \frac{P_2 - P_1}{(P_1 + P_2)/2} \times 100\%$$

$$TR = P \times Q$$

From history. King's estimates of England's population and income in 1688 were so careful that historians still use them. He sorted every family by rank and trade, from lords to laborers, and estimated each group's income and spending. His work was not published in full until 1802, ninety years after his death.

WORKED EXAMPLES

Example 1. The price of a bus ticket rises from \$2.00 to \$2.50, and daily riders fall from 10,000 to 9,000. Find the elasticity with the midpoint method. Is demand elastic or inelastic? What happens to revenue?

Show solution

1. Percent change in quantity: $\dfrac{9{,}000 - 10{,}000}{9{,}500} = -10.5\%$.
2. Percent change in price: $\dfrac{2.50 - 2.00}{2.25} = 22.2\%$.
3. Elasticity: $10.5 / 22.2 \approx 0.47$ (in absolute value).
4. Revenue before: \$20,000; after: $2.50 \times 9{,}000 = \$22{,}500$.

Answer: Elasticity ≈ 0.47: inelastic. Revenue rises from \$20,000 to \$22,500.

Example 2. Use King's table. In a normal year, the harvest is 100 units at price 1. In a year one-tenth short, the harvest is 90 at price 1.3. In a year three-tenths short, it is 70 at price 2.6. Find farmers' total revenue in each year, and the elasticity between the normal year and the one-tenth-short year.

Show solution

1. Normal: $100 \times 1 = 100$.
2. One-tenth short: $90 \times 1.3 = 117$.
3. Three-tenths short: $70 \times 2.6 = 182$.
4. Elasticity: $\%\Delta Q = -10/95 = -10.5\%$; $\%\Delta P = 0.3/1.15 = 26.1\%$; $E_d \approx 0.40$.

Answer: Revenue rises from 100 to 117 to 182 as the harvest shrinks. Demand for grain is very inelastic (about 0.4), so scarcity raises the price more than in proportion.

Example 3. A bakery sells 400 loaves a week at \$5. It estimates its elasticity of demand at 2.5. If it cuts the price by 10%, about how many loaves will it sell, and what happens to revenue?

Show solution

1. Quantity rises by about $2.5 \times 10\% = 25\%$, to about 500 loaves.
2. New price: \$4.50. Revenue: $4.50 \times 500 = \$2{,}250$ versus $5 \times 400 = \$2{,}000$.

Answer: About 500 loaves; revenue rises by about \$250, because demand is elastic. (Whether profit rises depends on the cost of baking 100 more loaves.)

PRACTICE

1. Easy What does an elasticity of 3 mean?

   Show answer

   A one percent change in price causes a three percent change in quantity demanded in the opposite direction: elastic demand.

2. Easy Name three things that make demand more elastic.

   Show answer

   Close substitutes, a large share of income, being a luxury, and more time to adjust (any three).

3. Easy According to King, how much did a harvest one-tenth short raise the price of grain?

Show answer

By three-tenths (30%).

4. Medium The price of a magazine falls from $5 to $4, and sales rise from 1,000 to 1,400. Find the midpoint elasticity.

Show answer

$\%\Delta Q = 400/1{,}200 = 33.3\%$; $\%\Delta P = 1/4.5 = 22.2\%$; $E_d \approx 1.5$ (elastic).

5. Medium In problem 4, did revenue rise or fall? Is that consistent with the total-revenue test?

Show answer

Revenue rose from $5,000 to $5,600. Yes: with elastic demand, a lower price raises revenue.

6. Medium Why is the demand for a particular brand of gasoline more elastic than the demand for gasoline in general?

Show answer

Other brands are close substitutes for one brand, but there are few substitutes for gasoline as a whole.

7. Medium A city raises bridge tolls by 20%, and traffic falls by 4%. What is the elasticity? Does toll revenue rise?

Show answer

0.2; inelastic, so revenue rises.

8. Hard Using King's table, find farmers' revenue when the harvest is half short (50 units at price 5.5).

Show answer

$50 \times 5.5 = 275$, nearly three times the revenue of a normal year.

9. Hard If grain farmers all gain from a short harvest, why would a single farmer still want a large harvest on his own farm?

Show answer

One farmer's crop is too small to change the market price, so for him more grain at the going price means more revenue. The paradox applies only to farmers as a group.

10. Hard Demand is $Q = 100 - 2P$. Find total revenue at $P = 20$, $P = 25$ and $P = 30$. Where is demand unit elastic?

Show answer

TR: 1,200, 1,250, 1,200. Revenue peaks at $25, where demand is unit elastic.

11. Challenge Show that on the linear demand curve $Q = a - bP$, the point elasticity $E = bP/Q$ equals 1 at $P = a/(2b)$. Find that price for $Q = 100 - 2P$.

Show answer

At $P = a/(2b)$, $Q = a/2$, so $E = b \cdot \frac{a}{2b} / \frac{a}{2} = 1$. For the example, $P = 100/4 = \$25$.

COMMON MISTAKES

- Using the slope of the demand curve as its elasticity. Elasticity uses percentages and changes along a straight-line curve.
- Computing percentage changes from different starting points in each direction. Use the midpoint method.
- Assuming a price rise always raises revenue. It does so only when demand is inelastic.

> **Make it a game · Elasticity Prediction Duel.** Your parent names a good, such as salt or concert tickets, and a price change. Before calculating, predict whether demand is elastic or inelastic and whether total revenue rises or falls. Then use the midpoint method with numbers your parent supplies. The closer prediction wins. Explain why King noticed a smaller harvest could bring farmers more money.

2.5 Prices as Information: "I, Pencil," Hayek's Tin, and Price Controls

OBJECTIVES

- Explain how prices carry information and incentives to millions of people who never meet.
- Summarize Leonard Read's "I, Pencil" (1958) and Friedrich Hayek's tin example (1945).
- Analyze price ceilings and floors with a graph, using the American gasoline lines of the 1970s and dairy surpluses as history.

> **Warm-up.** Pick up a pencil and list every material in it. Next to each, write where you think it came from and who might have made it. How many people can you count?

WATCH

A Price Is a Signal Wrapped Up in an Incentive

Marginal Revolution University · 4:47

https://www.youtube.com/watch?v=aBYzvPbIFNw

> **WHEN TO WATCH**
> After the story of the pencil and the tin, before the big idea.

BACKUP VIDEO

Price Ceilings: The US Economy Flounders in the 1970s

Marginal Revolution University · 3:50

https://www.youtube.com/watch?v=sq1zIj8s8R0

With the section on price ceilings.

KEY TERMS

price signal

A change in price that tells buyers and sellers that something has become more or less scarce.

dispersed knowledge

Information about local conditions, needs and opportunities spread among millions of people, which no single planner can gather.

price ceiling

A legal maximum price; if set below equilibrium, it causes a shortage.

price floor

A legal minimum price; if set above equilibrium, it causes a surplus.

non-price rationing

Ways of deciding who gets a scarce good when price is not allowed to do it: lines, coupons, favoritism or first come, first served.

CORE IDEAS

The story. In 1958 the American writer Leonard Read published a short essay told by an ordinary pencil. "Not a single person on the face of this earth knows how to make me," it says. The cedar comes from Oregon and California, cut by loggers using saws and trucks; the graphite from Ceylon (now Sri Lanka), mixed with clay from Mississippi; the brass ferrule from mines and mills; the eraser from rapeseed oil from the East Indies and pumice from Italy; the lacquer, the glue, the paint, the ships and the railroads from thousands more. Millions of people cooperate to make a pencil, and almost none of them know they are doing it.

How they figured it out. Thirteen years earlier, in 1945, the economist Friedrich Hayek had explained how such cooperation is possible in an essay called "The Use of Knowledge in Society." Suppose, he wrote, that somewhere in the world a new use for tin is found, or a source of tin is lost. It does not matter which. Users of tin do not need to know the reason. They need only to know that tin has become scarcer, and the rising price tells them. They cut back, look for substitutes, and their actions ripple outward, until millions of people adjust as if they all knew the facts, though only a handful do. The price system, Hayek wrote, is a machine for communicating information.

The big idea. A price is a signal wrapped in an incentive. It tells people what has become scarce and rewards them for responding. When law fixes a price, the signal is muffled. A **price ceiling** below equilibrium creates a shortage: in 1971 the United States froze wages and prices, and controls on oil and gasoline continued through the 1970s. When oil supplies were disrupted in 1973 and 1979, gasoline could not rise to its market price, and drivers waited in lines that stretched for blocks, some stations allowing purchases only on odd or even days by license plate. A **price floor**

above equilibrium creates a surplus: price supports for milk led the U.S. government, by the early 1980s, to store hundreds of millions of pounds of surplus butter, cheese and dried milk, much of which it finally gave away.

In business today. Every business reads price signals. A furniture maker who sees lumber prices rise uses less, switches species, or raises its own prices; a farmer who sees soybean prices rise plants more. Shortage and surplus are also signals inside a firm: goods that pile up in a warehouse and goods that sell out tell managers what to make. The lesson of history is not that prices are always pleasant, but that a price allowed to tell the truth puts goods where they are most wanted far better than lines or favoritism.

Think it through. The pencil essay closes with a note of wonder: no human mind directs this cooperation. A Christian may see in it the wisdom of the Creator, who made people able to serve one another freely across the whole world. A price that tells the truth is part of honest dealing.

PICTURE STUDY



Line at a gas station, June 15, 1979, W. K. Leffler, U.S. News & World Report, June 15, 1979 · Photograph · Library of Congress, Washington, D.C.

Image: Wikimedia Commons, public domain

This photograph was taken in Maryland. In the summer of 1979, when oil supplies were disrupted and price controls kept gasoline from rising to its market price, lines like this one formed across the United States. Drivers spent hours waiting; some states allowed purchases only on odd or even days according to the last number on a license plate.

Look closely

- Count the cars you can see in line. How far back does the line go?
- Look at the gas station. Can you see a sign or any notice about price or limits?
- What are the drivers doing while they wait?
- Look at the cars themselves. What do they tell you about how much gasoline Americans used?

Talk about it

1. What is the real cost of a gallon of gasoline for a driver who waits an hour in this line?
2. How does this picture show a shortage? Draw the graph that goes with it.
3. Who gained and who lost from keeping the price low?

PROJECT

The Pencil Trail and a Price-Control Simulation

You will trace the materials of an everyday object as far back as you can, then run a short simulation showing how a price ceiling changes who gets a scarce good.

You will need

- An ordinary wooden pencil (or another simple object)
- Internet access with a parent, or an encyclopedia
- Index cards and play money
- Your ledger notebook

Steps

1. List every material in your pencil. For each, find where it usually comes from and what tools are needed to get it.
2. Draw a map or flow chart showing at least ten steps and five countries or states involved.
3. Estimate how many different occupations are involved. Explain why no single person could make a pencil from scratch.
4. Simulation: make 8 buyer cards with values of $10, $9, $8, $7, $6, $5, $4 and $3 for one “gallon,” and offer only 4 gallons.
5. Round 1: sell the 4 gallons by auction. Record who buys and the price.
6. Round 2: impose a ceiling of $4. Allow sales only to those who are first in a line (draw places at random). Record who buys.
7. Compare: In which round did the gallons go to the buyers who valued them most? What did buyers in Round 2 have to do instead of paying?
8. Write a paragraph connecting your simulation to the gasoline lines of 1979 and to Hayek’s point about information.

Tips

- Most pencil makers describe their materials on their websites; use those as one source.

- In the simulation, let buyers in line "trade" places for money if they want. What happens?

Check your work

- ☐ I can explain how prices carry information, using the pencil or the tin.
- ☐ I can calculate a shortage or surplus from equations.
- ☐ I can explain why a price ceiling below equilibrium leads to lines and other rationing.

LEDGER NOTEBOOK

1. Copy your pencil flow chart and your simulation results table.
2. Draw a price-ceiling graph and a price-floor graph. Label the shortage and the surplus.
3. Write Hayek's tin example in five steps of your own.

KEY FORMULAS

$$\text{Shortage} = Q_d(P_{\max}) - Q_s(P_{\max}) \quad \text{when } P_{\max} < P^*$$

$$\text{Surplus} = Q_s(P_{\min}) - Q_d(P_{\min}) \quad \text{when } P_{\min} > P^*$$

From history. Hayek (1899–1992) was an Austrian economist who taught in London and Chicago and received the Nobel Prize in economics in 1974. "The Use of Knowledge in Society" appeared in the *American Economic Review* in 1945 and remains one of the most cited articles in economics.

WORKED EXAMPLES

Example 1. In a city's gasoline market, $Q_d = 200 - 50P$ and $Q_s = -40 + 70P$ (thousands of gallons a day, price in dollars). Find the equilibrium. Then a ceiling of \$1.50 is imposed. Find the shortage.

Show solution

1. Equilibrium: $200 - 50P = -40 + 70P$, $240 = 120P$, $P^* = \$2.00$, $Q^* = 100$.
2. At \$1.50: $Q_d = 200 - 75 = 125$; $Q_s = -40 + 105 = 65$.
3. Shortage: $125 - 65 = 60$ thousand gallons a day.

Answer: Equilibrium is \$2.00 and 100 thousand gallons. The ceiling creates a shortage of 60 thousand gallons a day, and less gasoline is sold (65 instead of 100).

Example 2. In a milk market, $Q_d = 100 - 20P$ and $Q_s = 20 + 20P$ (millions of gallons, dollars). The government guarantees farmers \$2.50 a gallon and buys any surplus. Find the surplus and the government's cost.

Show solution

1. Equilibrium: $100 - 20P = 20 + 20P$, $P^* = \$2$, $Q^* = 60$.
2. At \$2.50: $Q_s = 70$, $Q_d = 50$.
3. Surplus: 20 million gallons. Cost: $20 \times \$2.50 = \$50$ million.

Answer: A surplus of 20 million gallons, costing the government \$50 million, which it must then store or give away.

Example 3. Trace Hayek's tin example. A tin mine closes. Explain step by step how a canning company far away responds without knowing the cause.

Show solution

1. The closure reduces the supply of tin; its price rises.
2. Tin dealers raise their prices to manufacturers of tin plate, who raise their prices to canners.
3. The canner sees only that tin plate costs more. It uses thinner coatings, switches some products to glass, or raises prices slightly.
4. Its customers buy a little less canned food. Tin flows to the uses where it is valued most.

Answer: The price carries the information; every user economizes on tin without knowing why, which is exactly what the situation requires.

PRACTICE

1. Easy Who wrote "I, Pencil," and when?

   Show answer

   Leonard Read, in 1958.

2. Easy What is a price ceiling? What does it cause if set below equilibrium?

   Show answer

   A legal maximum price; it causes a shortage.

3. Easy What is a price floor? What does it cause if set above equilibrium?

   Show answer

   A legal minimum price; it causes a surplus.

4. Medium In Hayek's example, why does it not matter whether tin became scarce because of a new use or a lost mine?

   Show answer

   Either way, users need only to economize on tin. The price tells them it is scarcer; the reason is irrelevant to the right response.

5. **Medium** Demand $Q_d = 90 - 3P$, supply $Q_s = 6P$. Find the equilibrium and the shortage at a ceiling of $P = 8$.

Show answer

Equilibrium $P^* = 10$, $Q^* = 60$. At 8: $Q_d = 66$, $Q_s = 48$; shortage 18.

6. **Medium** In problem 5, what happens with a ceiling of $P = 12$?

Show answer

Nothing: a ceiling above equilibrium does not bind, and the market stays at $10 and 60.

7. **Medium** Name three forms of non-price rationing that appear during shortages.

Show answer

Waiting in lines, ration coupons, favoritism or bribes, odd-even days, limits per customer (any three).

8. **Hard** During the 1979 gasoline lines, some people said the stations were cheating customers if they charged more. Explain, using supply and demand, what would have happened if prices had been allowed to rise.

Show answer

Higher prices would have reduced the quantity demanded (less driving, carpooling) and drawn more gasoline into the market, eliminating the shortage and the lines, though at a higher price. Buyers would pay in money instead of in hours of waiting.

9. **Hard** Why did dairy price supports lead the government to store huge amounts of cheese and butter?

Show answer

The support price was above equilibrium, so farmers produced more than consumers would buy at that price, and the government had to buy and store the surplus to keep the price up.

10. Hard Using the six stakeholders, evaluate a price ceiling on bread during a poor harvest.

Show answer

Customers who get bread pay less, but many find none; producers (risk-takers and workers) earn less and supply less; the community gets lines, black markets and less bread next season; financiers are less willing to lend to bakers.

11. Challenge In Worked Example 1, the ceiling of \$1.50 reduced sales from 100 to 65 thousand gallons. Drivers who want gasoline most are willing to pay up to $P = (200 - 65)/50 = \$2.70$ for the 65th thousand gallon. Explain what this number means and what it suggests about the cost of waiting in line.

Show answer

At a quantity of 65, buyers value the last gallon at \$2.70. The ceiling price is \$1.50, so drivers would be willing to bear up to about \$1.20 per gallon in other costs, such as time in line, to get it. The waiting can use up much of the savings from the low price.

COMMON MISTAKES

- Thinking a price ceiling makes a good cheaper for everyone. It is cheaper for those who get it; others get none, and everyone pays in time or trouble.
- Placing a ceiling above equilibrium and calling it binding. Only a ceiling below equilibrium (or a floor above it) changes the market.
- Treating high prices as the cause of scarcity. A high price is the signal of scarcity, not its cause.

> **Make it a game · Pencil Trail Draw and Guess.** Draw one input of the pencil, such as graphite, cedar or the metal band, without writing words. Your parent guesses it and adds a worker upstream. Keep going until the chain runs out. Then your parent announces that tin has become scarce, and you explain how people far away change their behavior, knowing nothing but the price, as Hayek argued.

UNIT 2

Markets and Prices

A market is any place, or any arrangement, where buyers and sellers meet. In this unit you will build the most useful model in economics: supply and demand. You will see how Henry Ford's price cuts moved buyers down a demand curve, how Drake's oil well at Titusville shifted supply so far that the price of oil fell to pennies, how Alfred Marshall put the two curves together like the blades of a pair of scissors, and how the statistician King discovered that a short harvest could bring farmers more money than a large one.

The unit ends with one of the most important ideas in all of economics: prices carry information. Leonard Read's pencil and Friedrich Hayek's tin show how millions of people cooperate without knowing one another, and the gasoline lines of the 1970s and the cheese stored by the government in the 1980s show what happens when prices are not allowed to tell the truth. You will solve for equilibrium with equations, calculate elasticities and run market experiments at the dinner table.

PREREQUISITES

- Unit 1 (opportunity cost, marginal thinking)
- Solving two linear equations in two unknowns
- Graphing lines and reading slopes
- Percent change

MASTERY CHECKLIST

- ☐ I can draw and interpret demand and supply curves and tell shifts from movements along a curve.
- ☐ I can find equilibrium price and quantity from schedules, graphs and equations.
- ☐ I can predict the effects of shifts in demand and supply, including double shifts.
- ☐ I can compute price elasticity of demand with the midpoint method and apply the total-revenue test.
- ☐ I can explain how prices carry information, using "I, Pencil" and Hayek's tin example.
- ☐ I can calculate the shortage from a price ceiling and the surplus from a price floor and explain their history.

OPTIONAL BOOKS AND GAMES FOR THIS UNIT

- **"I, Pencil," by Leonard E. Read (1958)**: Free on Econlib. A short essay, about fifteen minutes to read aloud. Use with Lesson 2.5. Ages 12+.
- **"The Use of Knowledge in Society," by F. A. Hayek (1945)**: Free on Econlib. A harder essay; read the section with the tin example (about two pages) with Lesson 2.5. Ages 15+.
- **Econ Lowdown, from the Federal Reserve Bank of St. Louis**: Free lessons and short videos on supply, demand and elasticity, written for high-school students. Parents can browse without an account.

Not required. Every project in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

2.1	**Demand: Henry Ford Cuts the Price of the Model T**	3 sessions of 50 minutes
2.2	**Supply: The Oil Boom at Titusville, 1859**	3 sessions of 50 minutes
2.3	**Equilibrium: Marshall's Scissors**	3 sessions of 50 minutes
2.4	**Elasticity: King's Law of Harvests**	3 sessions of 50 minutes
2.5	**Prices as Information: "I, Pencil," Hayek's Tin, and Price Controls**	3 sessions of 50 minutes

Unit 2 test

Calculators are allowed. Show your work for every calculation: write the equation, substitute and solve, and label the units. Draw and label graphs where asked. Answer the concept questions in complete sentences. The test is worth 100 points.

1. **5 pts**
   State the law of demand and the law of supply.

2. **6 pts**
   For each, say whether demand or supply for new cars shifts, and which way: (a) incomes rise; (b) steel becomes more expensive; (c) car loans become cheaper; (d) a new robot cuts assembly costs.

3. **6 pts**
   Explain the difference between a change in demand and a change in quantity demanded, using the Model T.

4. **6 pts**
   How did Drake's method of drilling and the oil rush of 1860–61 affect the supply and price of oil?

5. **10 pts**

   Demand: $Q_d = 150 - 5P$. Supply: $Q_s = 30 + 7P$. (a) Find the equilibrium. (b) Find the shortage or surplus at $P = \$8$.

6. **6 pts**

   In problem 5, demand rises to $Q_d = 174 - 5P$. Find the new equilibrium.

7. **6 pts**

   Supply rises and demand falls at the same time. What happens to price? To quantity?

8. **6 pts**

   What did Alfred Marshall mean by comparing supply and demand to the blades of a pair of scissors?

9. **8 pts**

   The price of a good rises from \$4 to \$6, and quantity demanded falls from 120 to 80. Find the midpoint elasticity, classify it and say what happens to revenue.

10. **6 pts**

    Explain King's Law and why a short harvest could raise farmers' total income.

11. **5 pts**

    Rank from most to least elastic demand, and explain: insulin, a particular brand of cola, gasoline.

12. **6 pts**

    Summarize Hayek's tin example in three or four sentences.

13. **10 pts**

    Demand: $Q_d = 80 - 4P$; supply: $Q_s = 4P$. (a) Find the equilibrium. (b) A ceiling of \$6 is imposed. Find the shortage. (c) A floor of \$12 is imposed instead. Find the surplus.

14. **6 pts**

    Describe the gasoline lines of the 1970s and explain them with a graph.

15. **8 pts**

Short essay (one or two paragraphs): Read's pencil says that "not a single person" knows how to make it. Explain what he meant and what this suggests about the role of prices in a large economy.

ANSWER KEY

1. Demand: other things equal, a lower price raises the quantity demanded. Supply: other things equal, a higher price raises the quantity supplied.
2. (a) demand right; (b) supply left; (c) demand right; (d) supply right.
3. Ford's price cuts changed the quantity demanded (movement along the curve). Rising incomes and better roads changed demand (shifted the curve right).
4. Drake's drive pipe made drilling practical, and the rush of new wells shifted supply far to the right. The price fell from about $10 a barrel at the start of 1861 to as low as 10 cents by the end of the year.
5. (a) $150 - 5P = 30 + 7P$, $P^* = 10$, $Q^* = 100$. (b) At $8: $Q_d = 110$, $Q_s = 86$; shortage of 24.
6. $174 - 5P = 30 + 7P$, $P^* = 12$, $Q^* = 114$.
7. Price falls for certain. The change in quantity is uncertain; it depends on which shift is larger.
8. Price is set by both sides together: the buyers' utility (demand) and the sellers' cost (supply). Asking which one sets the price is like asking which blade cuts.
9. $\%\Delta Q = -40/100 = -40\%$; $\%\Delta P = 2/5 = 40\%$; $E_d = 1$, unit elastic. Revenue: $480 both times; unchanged.
10. King found that a small shortfall in the grain harvest raised the price by much more than in proportion, because demand for bread is very inelastic. So when the harvest falls, price rises by a larger percentage and total revenue rises.
11. Most elastic: a brand of cola (many substitutes); then gasoline (few substitutes, though some adjustment over time); least: insulin (a necessity with no substitute).
12. If tin becomes scarcer for any reason, its price rises. Users who know nothing of the cause cut back and seek substitutes, and their actions ripple through the economy. Millions adjust as if they knew the facts. The price system communicates dispersed knowledge no planner could gather.
13. (a) $P^* = 10$, $Q^* = 40$. (b) At $6: $Q_d = 56$, $Q_s = 24$; shortage 32. (c) At $12: $Q_d = 32$, $Q_s = 48$; surplus 16.
14. Price controls held gasoline below its market price while oil supplies were disrupted in 1973 and 1979. At the controlled price, quantity demanded exceeded quantity supplied, so drivers waited in long lines and some states used

odd-even days. The graph shows a ceiling below equilibrium and the gap between demand and supply.

15. A strong answer explains the many materials and occupations involved, that each person knows only a tiny part, and that prices coordinate their work by signaling scarcity and rewarding response. It may note that this is cooperation without central direction and connect it to Hayek's point about dispersed knowledge.

PORTFOLIO PIECE: A MARKET STUDY

Choose one product sold in your town (eggs, gasoline, a kind of fruit, used bicycles). Collect its price at three stores or sellers on at least four dates over the unit, and estimate a demand schedule by survey. Graph your survey demand curve, mark the prices you observed, and write a three-page report explaining what shifts demand and supply for your product, how elastic you think its demand is and why, and one historical example of what happened when the price of a similar good was controlled.

LOOK FOR	WHAT IT MEANS
Data	Prices are recorded with dates and sources; the survey has at least eight respondents and is summarized in a clear table.
Analysis	Graphs are labeled and correct; demand and supply shifters, elasticity and equilibrium are explained accurately.
History	The price-control example is accurate and connected to the product.
Writing	Clear, organized and honest about the limits of the data.

UNIT 3

Market Structures

Markets differ in how many sellers they have and how alike their products are, and those differences shape prices, profits and the choices customers get. In this unit you will study the four main market structures: perfect competition (graded wheat at the Chicago Board of Trade), monopolistic competition (Henry Heinz and his clear glass bottles), oligopoly (the railroad pools of the 1870s and the prisoner's dilemma), and monopoly (Charles Martin Hall and the aluminum industry).

The unit ends with the hardest case: what should be done about monopoly? You will learn why some industries are natural monopolies and are regulated, and how the antitrust laws were used to break up Standard Oil in 1911 and the Bell System in 1984. You will calculate profits, find the profit-maximizing output in each structure, measure deadweight loss and play a pricing game that shows why cartels tend to fail.

PREREQUISITES

- Unit 2 (supply, demand and elasticity)
- Reading cost tables; average and marginal values
- Solving linear and simple quadratic equations

MASTERY CHECKLIST

- ☐ I can describe the four market structures and give a real example of each.
- ☐ I can find the profit-maximizing output and profit for a competitive firm and a monopolist.
- ☐ I can explain why economic profit tends to zero in the long run under competition and monopolistic competition.
- ☐ I can use a payoff matrix to find dominant strategies and a Nash equilibrium, and explain why cartels break down.
- ☐ I can compute deadweight loss and explain the case for and against patents.
- ☐ I can explain natural monopoly and average-cost regulation, and tell the history of Standard Oil and AT&T.

OPTIONAL BOOKS AND GAMES FOR THIS UNIT

- *The History of the Standard Oil Company*, by Ida M. Tarbell (1904): Free on Project Gutenberg. Read the chapter on the railroad rebates with Lesson 3.5. A classic of careful investigative writing. Ages 15+.
- Federal Reserve History (federalreservehistory.org): Free. Short, reliable essays on American economic history. Useful all year; in this unit, search for the essays on antitrust and on the railroads.
- *Ticket to Ride* (Days of Wonder): A family board game about building railroad routes and blocking rivals. Ages 8+. A fun picture of competing for limited routes, to play after Lesson 3.3.

Not required. Every project in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

3.1 Perfect Competition: Grading Wheat at the Chicago Board of Trade

3 sessions of 50 minutes

3.2 Monopolistic Competition: Henry Heinz and the Clear Glass Bottle

3 sessions of 50 minutes

3.3 Oligopoly and Game Theory: Railroad Pools and the Prisoner's Dilemma

3 sessions of 50 minutes

3.4 Monopoly: Charles Martin Hall and Aluminum 3 sessions of 50 minutes

3.5 Natural Monopoly, Regulation and Antitrust: Standard Oil (1911) and AT&T (1984)

3 sessions of 50 minutes

Unit 3 test

Calculators are allowed. Show your work for every calculation: write the formula, substitute and solve. Draw and label diagrams where asked. Answer the concept questions in complete sentences. The test is worth 100 points.

1. **6 pts**

   Complete the comparison for perfect competition, monopolistic competition, oligopoly and monopoly: number of sellers, type of product, ease of entry.

2. **5 pts**

   Explain how grading wheat at the Chicago Board of Trade made the grain market more competitive.

3. **8 pts**

   A competitive firm sells at $15. Its MC for units 1–6 is $5, $7, $10, $13, $15, $19, and its ATC at 5 units is $11. Find its profit-maximizing output and profit.

4. **6 pts**

   Explain why economic profit tends toward zero in the long run in perfect competition.

5. **6 pts**

   Why did Heinz use clear bottles, and what does his story teach about brands?

6. **6 pts**

   A monopolistically competitive firm faces $P = 24 - 0.5Q$ (so $MR = 24 - Q$) with MC = $8. Find its output and price.

7. **8 pts**

   Payoffs (A, B) for two airlines choosing High or Low fares: both High (40, 40); A Low, B High (55, 15); A High, B Low (15, 55); both Low (25, 25). Find each firm's dominant strategy and the Nash equilibrium. Why is this a prisoner's dilemma?

8. **6 pts**

   Why did the railroad pools of the 1870s keep breaking down?

9. **10 pts**

   A monopolist faces $P = 80 - 2Q$ with MC = $16 and no fixed cost. (a) Find its output, price and profit. (b) Find the competitive output and the deadweight loss.

10. **5 pts**

    Explain why a monopolist's marginal revenue is less than its price.

11. **6 pts**

How did Alcoa gain its monopoly, how did it keep it after 1909, and what happened in 1945?

12. **6 pts**

What is a natural monopoly, and why do regulators usually require average-cost pricing rather than marginal-cost pricing?

13. **8 pts**

A utility has fixed cost $400,000 and MC $5 per unit. It sells 80,000 units. (a) What price covers its costs? (b) With 10,000 customers, what fixed monthly fee plus a per-unit price of $5 would cover costs for a year?

14. **6 pts**

Describe the breakup of Standard Oil and of the Bell System. How were the reasons different?

15. **8 pts**

Short essay: Using the six stakeholders, was Standard Oil a great business? Give a balanced answer in one or two paragraphs.

ANSWER KEY

1. Perfect competition: many, identical, easy. Monopolistic competition: many, differentiated, easy. Oligopoly: few, identical or differentiated, difficult. Monopoly: one, unique, blocked.
2. Standard grades made wheat interchangeable, so it could be traded by receipt among many buyers and sellers without inspection, turning it into a commodity sold at one market price.
3. 5 units (MC = \$15 = P). Profit $(15 - 11)(5) = \$20$.
4. Profit attracts new firms, which raise market supply and lower the price until it equals minimum average total cost, leaving only a normal return.
5. To show customers that his horseradish was pure when rivals hid fillers. A brand carries a reputation, and a firm that protects it has a strong reason to be honest.
6. $24 - Q = 8$, $Q = 16$, $P = \$16$.
7. Low is dominant for both (55 > 40 and 25 > 15). The Nash equilibrium is both Low (25, 25), though both High (40, 40) would be better for both: individual incentives lead to a worse joint result.
8. Each railroad could gain by secretly cutting rates (rebates) while others held to the pool rate, so cheating was each member's best move and the agreements collapsed.
9. (a) $MR = 80 - 4Q = 16$, $Q = 16$, $P = \$48$, profit $(48 - 16)(16) = \$512$. (b) $Q_c = 32$; DWL $\frac{1}{2}(48 - 16)(16) = \$256$.
10. To sell one more unit it must lower the price on all units, so the extra revenue equals the new price minus the revenue lost on the earlier units.
11. Hall's patent gave it the sole right to the process; afterward it controlled bauxite and power sources and expanded ahead of demand. In 1945 the appeals court ruled it an illegal monopoly; after the war new firms (Reynolds and Kaiser) entered.
12. An industry in which one firm can serve the market at lowest average cost. Marginal-cost pricing would not cover fixed costs and the firm would lose money; average-cost pricing covers costs with a fair return.
13. (a) $ATC = 400{,}000/80{,}000 + 5 = \$10$. (b) $400{,}000/(10{,}000 \times 12) \approx \$3.33$ a month.
14. Standard Oil (1911) was split into 34 companies because it had monopolized the industry by restraining trade. The Bell System (1984) was split into seven

regional companies plus AT&T after new technology made parts of telephone service competitive and an antitrust suit was settled.

15. A strong answer credits real value (lower costs and prices for kerosene, efficient refining, returns to financiers, Rockefeller's giving) and real wrongs (secret rebates, ruin of rivals and their workers, harm to fair competition), and reaches a reasoned judgment using several stakeholders.

PORTFOLIO PIECE: MARKET STRUCTURES IN MY TOWN

Find one real business in your town or region for each of the four market structures (for example, a farm selling at a grain elevator, a restaurant, a cell-phone carrier, and the water utility). For each, describe the number of rivals, how the product is differentiated, the barriers to entry and how prices are set, with at least one real price. Then write a stakeholder scorecard for one of them. Present your work as a four-page illustrated report with a summary table.

LOOK FOR	WHAT IT MEANS
Classification	Each business is correctly placed in a market structure, with clear reasons.
Evidence	Real prices and facts are gathered and sourced; the summary table is accurate.
Analysis	The report explains how structure affects price, profit and customer choice, and the scorecard is thoughtful and fair.
Presentation	Clear, neat and well organized, with labeled diagrams or photographs.

3.1 Perfect Competition: Grading Wheat at the Chicago Board of Trade

OBJECTIVES

- List the conditions of perfect competition and explain why a competitive firm is a price taker.
- Find a competitive firm's profit-maximizing output where price equals marginal cost, and compute its profit.
- Explain why entry and exit drive long-run economic profit toward zero.

> **Warm-up.** Name three things you buy where you do not care at all which seller made them (a gallon of milk, a pound of nails, a bag of sugar). Then name three where the brand matters a great deal. What makes the difference?

WATCH

Introduction to Perfect Competition | Economics Explained

Federal Reserve Bank of St. Louis · 6:18

https://www.youtube.com/watch?v=J9OO9lSQnG8

> **WHEN TO WATCH**
> After the big idea, before the worked examples.

BACKUP VIDEO

Midwest Grain Trade: History of Futures Exchanges

CME Group · 3:01

https://www.youtube.com/watch?v=GUYAoueXqKE

With the story of the Board of Trade.

KEY TERMS

perfect competition

A market with many buyers and sellers of an identical product, free entry and exit, and good information, so that no one can affect the price.

price taker

A seller too small to influence the market price; it can sell all it wants at that price and nothing above it.

commodity

A standardized good, such as graded wheat, whose units are interchangeable whoever produced them.

economic profit

Revenue minus all costs, including the opportunity cost of the owner's time and money; zero economic profit means the owner earns a normal return.

marginal revenue

The extra revenue from selling one more unit; for a price taker it equals the price.

CORE IDEAS

The story. In the 1840s, a farmer bringing wheat to Chicago sold it sack by sack. Every buyer had to open the sacks and judge the grain, and every lot was a separate bargain. Then railroads and steam-powered grain elevators changed the scale. In 1848 a group of merchants founded the Chicago Board of Trade, and in 1856 it did something that seemed small and changed the world's grain trade: it set standard grades of wheat, such as "No. 1 Spring" and "No. 2 Spring," checked by official inspectors.

How they figured it out. Once grain was graded, wheat from a thousand farms could be poured together in one elevator. The farmer received a receipt for so many bushels of No. 2 wheat, not for his own sacks. Buyers and sellers no longer needed to see the grain at all; they could trade receipts and, soon, contracts for future delivery. Wheat had become a **commodity**: every bushel of a grade was as good as every other. With many thousands of farmers selling the same thing to many buyers, no farmer could charge a cent more than the price posted on the Board, and none needed to charge less.

The big idea. Perfect competition has four marks: many small sellers and buyers, an identical product, free entry and exit, and good information. Each firm is a **price taker**: its demand curve is flat at the market price, so its marginal revenue equals the price. It maximizes profit by producing where **price equals marginal cost.** If the price is above average total cost, firms earn economic profit, which draws new firms in, raising supply and lowering the price. If the price is below average cost, firms lose money and some leave. In the long run, the price is driven to the minimum of

average total cost, and **economic profit is zero**: owners earn just enough to keep them in the business. This is the market structure that delivers goods at the lowest possible cost.

In business today. Farm products, metals, crude oil and many raw materials still trade in near-perfect competition on exchanges, where standard grades let buyers and sellers deal across the world. For a wheat farmer, the lesson is plain: he cannot raise his price, so his profit depends on lowering his costs, choosing the right crop and managing risk. Many farmers sell part of next year's crop ahead with futures contracts, a tool invented on the Chicago Board of Trade.

Who gained? Customers gained cheap bread, because standard grades and competition cut the cost of moving grain from farm to table. Farmers gained a market for everything they grew, but also faced prices they could not control. Financiers and merchants gained new ways to manage risk, though speculation also brought scandals and calls for rules. The community of Chicago grew from a small town into one of the world's great cities.

PICTURE STUDY



In the wheat pit of the Board of Trade of the city of Chicago, Unknown photographer, about 1900 · Photograph · Library of Congress

Image: Wikimedia Commons, public domain

By 1900 the Chicago Board of Trade was the world's busiest grain market. Traders stood in octagonal "pits" and shouted bids and offers for wheat, corn and oats, and the prices they set were telegraphed around the world. None of them ever needed to see the grain: the grades did that work.

Look closely

- Find the groups of traders. How are they standing, and why might they gather in circles?
- Look for chalkboards or posted prices. Why would everyone need to see the same price?
- Look at the windows and the size of the room. What does it tell you about the importance of this market?
- Can you find any grain in the picture? Why not?

Talk about it

1. Why does grading wheat make it possible for thousands of farmers to sell at one price?
2. Could any single trader here charge more than the posted price? Why not?

3. How does this market show the four marks of perfect competition?

PROJECT

A Competitive Market in the Kitchen

You will build cost tables for a small "firm," find its best output at different prices, and show how entry pushes profit toward zero.

You will need

- A spreadsheet or graph paper
- A calculator
- Store prices for a commodity your family buys (eggs, flour or sugar)
- Your ledger notebook

Steps

1. Choose a commodity, such as eggs, and record its price at three stores. How close are the prices? Why?
2. Imagine a small egg farm. Make a cost table with fixed cost $40 a week and total costs for 0 to 8 dozen eggs a day that rise faster and faster (for example $40, $52, $60, $70, $84, $102, $124, $150, $180).
3. Compute marginal cost, average total cost and average variable cost for each output.
4. At prices of $10, $18, $22 and $26 a dozen, find the profit-maximizing output (where P is as close as possible to MC without falling below it) and the profit.
5. Graph MC, ATC and AVC. Mark the shutdown point (minimum AVC) and the break-even point (minimum ATC).
6. Suppose the market price starts at $26 and new farms enter. Explain step by step what happens to the price and to your firm's profit.
7. Write a paragraph comparing your egg farm with a wheat farmer selling at the Chicago Board of Trade.

Tips

- Build the table in a spreadsheet so you can change the price easily.
- If two outputs give the same profit, either is correct; choose the one where price first equals marginal cost.

Check your work

- ☐ I can find the profit-maximizing output of a price taker.
- ☐ I can find the break-even and shutdown prices on a cost table.
- ☐ I can explain long-run equilibrium in perfect competition.

LEDGER NOTEBOOK

1. Copy your cost table and graph with MC, ATC and AVC labeled.
2. Record the egg prices from three stores and one sentence on why they are close.
3. Draw the two-panel diagram: the market (supply and demand) and one firm (flat demand at the market price, MC and ATC).

KEY FORMULAS

$$TR = P \times Q, \qquad MR = P \text{ (price taker)}$$

$$\text{Profit-maximizing output: } P = MC$$

$$\text{Profit} = (P - ATC) \times Q$$

From history. Futures contracts, agreements to deliver grain at a set price on a later date, grew up on the Chicago Board of Trade in the 1860s. They let farmers and millers lock in prices before the harvest, and they remain a basic tool for managing risk in farming.

WORKED EXAMPLES

Example 1. A wheat farm's costs for different outputs (thousands of bushels): Q = 1, TC = $6,000; Q = 2, TC = $9,000; Q = 3, TC = $13,000; Q = 4, TC = $19,000; Q = 5, TC = $27,000. Fixed cost is $2,000. The market price is $6 a bushel ($6,000 per thousand). How much should it grow, and what is its profit?

Show solution

1. Marginal cost per thousand bushels: 2nd $3,000, 3rd $4,000, 4th $6,000, 5th $8,000.
2. Produce while $P \geq MC$: the 4th thousand has $MC = \$6{,}000 = P$, the 5th has $MC = \$8{,}000 > P$.
3. At $Q = 4$: revenue $4 \times 6{,}000 = \$24{,}000$; cost $19,000; profit $5,000.

Answer: Grow 4,000 bushels for a profit of $5,000 (3,000 bushels gives the same $5,000; 5,000 bushels would cut profit to $3,000).

Example 2. In Worked Example 1, average total cost at Q = 4 is $19{,}000/4 = \$4{,}750$ per thousand bushels. What will happen to the price in the long run, and why?

Show solution

1. The price ($6,000 per thousand) is above average total cost, so farms earn economic profit.
2. Profit attracts new farmers and draws land into wheat, shifting market supply right.
3. The price falls until it equals the minimum average total cost, where economic profit is zero.

Answer: The price will fall toward the minimum of average total cost, and economic profit will disappear.

Example 3. At a price of $3 a bushel, should the farm in Example 1 keep growing wheat this season, given that its fixed cost of $2,000 is already committed?

Show solution

1. Average variable cost: at Q = 2, $(9{,}000 - 2{,}000)/2 = \$3{,}500$ per thousand; at Q = 1, $4,000.
2. The lowest average variable cost is about $3,500 per thousand, above the price of $3,000 per thousand.
3. If it produces, it fails to cover even its variable costs; if it shuts down, it loses only the $2,000 fixed cost.

Answer: It should shut down this season: at $3 a bushel the price is below average variable cost, so producing loses more than stopping.

PRACTICE

1. Easy List the four conditions of perfect competition.

   Show answer

   Many buyers and sellers, identical products, free entry and exit, and good information.

2. Easy Why is a competitive firm's marginal revenue equal to the price?

   Show answer

   It can sell any amount at the market price, so each extra unit brings in exactly the price.

3. Easy In what year did the Chicago Board of Trade begin grading wheat?

   Show answer

   1856.

4. Medium A firm sells at $12. Its MC for units 1–5 is $6, $8, $10, $12, $15. How many units should it produce?

   Show answer

   4 units (MC = P at the 4th; the 5th costs more than it brings in).

5. Medium A firm produces 500 units at a price of $20, with ATC $16. Find its profit.

Show answer

$(20 - 16) \times 500 = \$2{,}000.$

6. Medium What is the difference between accounting profit and economic profit? Why can a firm with zero economic profit still be worth running?

Show answer

Economic profit subtracts the owner's opportunity costs as well. Zero economic profit means the owner earns as much as in his next-best use of time and money, so he is content to stay.

7. Medium Explain how grading made wheat a commodity.

Show answer

Graded wheat of one class was interchangeable, so it could be pooled and traded by receipt without inspection, making each bushel the same as any other.

8. Hard Price falls below a firm's ATC but stays above its AVC. Should it keep producing in the short run? Explain.

Show answer

Yes. It covers its variable costs and part of its fixed costs, losing less than if it shut down (when it would lose all its fixed cost).

9. Hard In long-run equilibrium, a competitive industry has price $8. What must be true of each firm's minimum ATC and its economic profit?

Show answer

Minimum ATC equals $8, and economic profit is zero.

10. **Challenge** A firm's cost is $TC = 100 + 2Q + 0.5Q^2$, so $MC = 2 + Q$. At a price of \$14, find its output, revenue, cost and profit. Then find the long-run price if all firms have this cost.

    Show answer

    Set $14 = 2 + Q$: $Q = 12$. TR = \$168; TC = $100 + 24 + 72 = \$196$; profit −\$28 (a loss). Minimum ATC: $ATC = 100/Q + 2 + 0.5Q$ is lowest at $Q = \sqrt{200} \approx 14.1$, where $ATC \approx \$16.14$. The long-run price is about \$16.14; at \$14, firms will leave until the price rises.

COMMON MISTAKES

- Thinking a competitive firm should produce as much as possible. It stops where marginal cost reaches the price.
- Confusing zero economic profit with going broke. It means a normal return, enough to stay in business.
- Shutting down whenever there is a loss. In the short run, keep producing if the price covers average variable cost.

> **Make it a game · Wheat Pit Profit Sprint.** Your parent gives a market price of 10 and a marginal cost table for a wheat farm. Find the output where price equals marginal cost and compute the profit. Four rounds, each with a new price; beat the clock. Then explain why the farmer is a price taker and how grading wheat at the Chicago Board of Trade made grain tradeable.

3.2 Monopolistic Competition: Henry Heinz and the Clear Glass Bottle

OBJECTIVES

- Describe monopolistic competition and how it differs from perfect competition and monopoly.
- Explain how product differentiation and brands give a firm some control over price, and why entry erodes long-run profit.
- Evaluate the honest and dishonest uses of branding and advertising, using the Heinz story.

> **Warm-up.** Look in your kitchen for three brands of the same kind of product (ketchup, cereal, peanut butter). Write what makes each one different and why someone might pay more for one of them.

WATCH

Monopolistic Competition | Economics Explained

Federal Reserve Bank of St. Louis · 4:09

https://www.youtube.com/watch?v=m7p5g868MzE

> **WHEN TO WATCH**
> After the big idea, before the worked examples.

BACKUP VIDEO

Monopolistic competition and economic profit | Microeconomics | Khan Academy

Khan Academy · 8:50

https://www.youtube.com/watch?v=RUVsEovktGU

During the worked examples.

KEY TERMS

monopolistic competition

A market with many sellers of differentiated products and free entry, so each firm has a little control over its own price.

product differentiation

Making a product distinct from rivals in quality, design, location, service or reputation.

brand

A name or mark that identifies a seller's product and carries its reputation.

excess capacity

Producing less than the output at which average total cost is lowest, as monopolistically competitive firms do in the long run.

adulteration

Making a product impure by adding cheaper or harmful substances.

CORE IDEAS

The story. In 1869 a young man named Henry John Heinz began selling bottled horseradish near Pittsburgh. Horseradish was a common product sold by many grocers, and many sellers stretched it with turnip, wood fibers or leaves, then sold it in green or brown bottles that hid what was inside. Heinz used **clear glass**, so that every buyer could see the purity of what he was buying. His first company failed in the financial panic of 1873 and went bankrupt in 1875, but Heinz started again, kept a notebook of his personal debts and later paid them back. By 1896 his growing line of pickles, sauces and condiments carried the slogan "57 Varieties."

How they figured it out. Heinz understood that customers could not test every jar, so they relied on reputation. He built his on purity: clean factories that he opened to public tours, quality checks on suppliers, and honest labels. He was also a devoted Sunday-school worker and treated his employees well for the time, with lunchrooms, medical care and classes. When Congress debated the Pure Food and Drug Act of 1906, Heinz supported it, unlike many food makers, because honest rules protected the honest firms. His ketchup was not the only ketchup, but buyers knew what they were getting, and many would pay a little more for it.

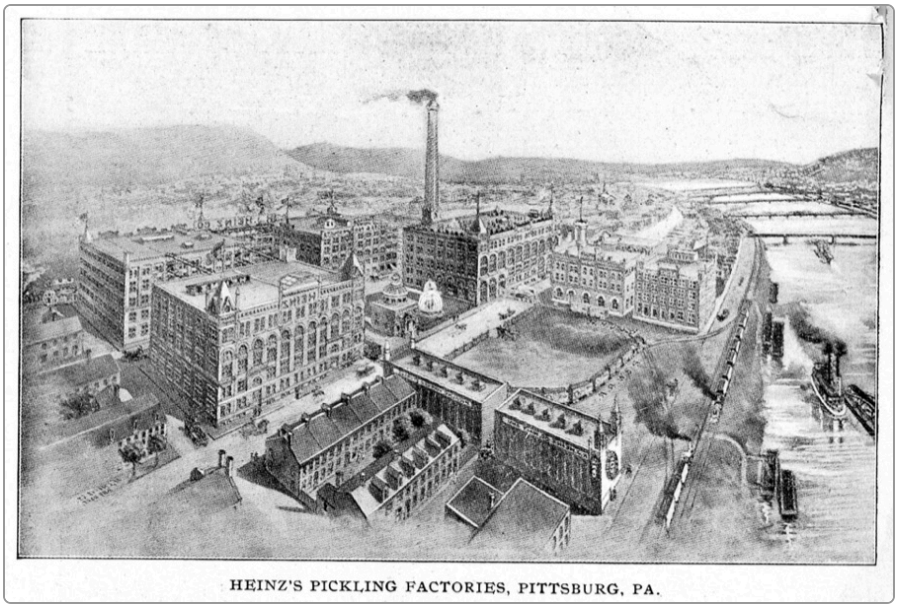
The big idea. Monopolistic competition lies between perfect competition and monopoly. There are many sellers and free entry, but each sells a **differentiated** product: different in quality, location, style, service or reputation. So each firm faces a downward-sloping demand curve and has a little power over its own price. In the short run, a firm with a popular product earns profit by producing where marginal revenue equals marginal cost. But profit draws in imitators who offer close substitutes, pulling each firm's demand down until price equals average total cost

and economic profit is zero. Firms end up with some **excess capacity**, a slightly higher cost than perfect competition, which is the price of variety.

In business today. Restaurants, clothing shops, hair salons, bakeries and most consumer brands live in monopolistic competition. Each must keep earning its customers' loyalty, because a rival can open next door. Brands serve customers when they carry real information: a known name promises consistent quality and gives the maker a strong reason not to cheat, because one scandal can destroy a reputation built over decades. Advertising can inform, or it can mislead. The honest seller, like Heinz with his clear bottle, lets the customer see.

Who gained? Customers gained pure, safe food and honest labels. Heinz's workers gained steady work in unusually clean conditions. The financiers who lent to Heinz after his bankruptcy were repaid. The community of Pittsburgh gained a major employer, and the whole country gained, in part, from the food-safety law Heinz helped pass.

PICTURE STUDY



Heinz's Pickling Factories, Pittsburg, Unknown artist, 1901 · Printed illustration · Published in 1901

Image: Wikimedia Commons, public domain

By the early 1900s Heinz's Pittsburgh works was one of the largest food factories in the world, with thousands of workers. Heinz invited the public to tour it, so that customers could see how their food was made. The open factory, like the clear bottle, was part of the brand.

Look closely

- Find the caption. Why would a company publish a picture of its factories?
- Count the floors and windows. What does the size of the factory tell you about how much Heinz sold?
- Find the railroad tracks and the river. How did goods get in and out?
- What would a visitor on a factory tour want to see?

Talk about it

1. Why did Heinz open his factory to public tours? What was he selling besides ketchup?
2. How does a well-known brand protect customers who cannot test every product?
3. Why might Heinz have supported a law that his competitors opposed?

> **Safety first.** Check every taster for food allergies before the taste test, and handle food with clean hands and utensils.

PROJECT

A Brand Study and a Blind Taste Test

You will compare three brands of one product on price, ingredients and label claims, run a blind taste test with your family, and calculate how much more people pay for a brand they trust.

You will need

- Three brands of one product (ketchup, peanut butter or crackers), including a store brand
- Small cups or plates and labels
- At least four tasters
- Your ledger notebook

Steps

1. Record each brand's price, size and price per ounce. Copy the ingredients and every claim on the label.
2. Compute how much more (in percent) the most expensive brand costs per ounce than the cheapest.
3. Set up a blind test: a parent labels samples A, B and C so tasters do not know which is which.
4. Each taster rates each sample from 1 to 10 and says which he or she would buy.
5. Reveal the brands. Compare the ratings with the prices and with what the tasters said before the test.
6. Write which label claims are informative (ingredients, weight, origin) and which are mere persuasion.
7. Write a paragraph: Is the price difference worth it? What is a brand really selling: taste, safety, consistency, a feeling?

Tips

- Use plain samples (on a cracker, for example) so tasters judge the product, not the package.
- Check for food allergies before the test.

Check your work

- ☐ I can explain how differentiation gives a firm some control over its price.
- ☐ I can compute price per ounce and the premium for a brand.
- ☐ I can tell informative claims from mere persuasion.

LEDGER NOTEBOOK

1. Copy your brand comparison table and taste-test results.
2. Draw the short-run and long-run diagrams for a monopolistically competitive firm, labeling demand, MR, MC and ATC.
3. Write three ways a small business in your town differentiates itself from its rivals.

KEY FORMULAS

$$\text{Short run: produce where } MR = MC, \text{ charge the price on the demand curve}$$

$$\text{Long run: } P = ATC, \text{ economic profit} = 0$$

From history. Heinz counted well over sixty products when he chose the slogan "57 Varieties" in 1896. He later said he liked the sound of the number. He was a lifelong Sunday-school teacher and leader, and in his will he left a statement of his faith in Christ.

WORKED EXAMPLES

Example 1. A bakery's weekly demand for its special bread is $P = 10 - 0.02Q$, so $MR = 10 - 0.04Q$. Its marginal cost is a constant \$2 a loaf and its fixed cost is \$400 a week. Find its best price, output and profit.

Show solution

1. Set $MR = MC$: $10 - 0.04Q = 2$, so $Q = 200$ loaves.
2. Price from demand: $P = 10 - 0.02(200) = \$6$.
3. Profit: $(6 - 2)(200) - 400 = \$400$ a week.

Answer: Sell 200 loaves at \$6 for a profit of \$400 a week.

Example 2. A rival bakery opens nearby, and the first bakery's demand falls to $P = 8 - 0.02Q$. Find its new best output and profit. Is the industry in long-run equilibrium?

Show solution

1. New MR: $8 - 0.04Q = 2$, so $Q = 150$.
2. Price: $8 - 3 = \$5$.
3. Profit: $(5 - 2)(150) - 400 = \$50$.
4. Profit is still positive, so more rivals may enter until it reaches zero.

Answer: Sell 150 loaves at $5 for a profit of $50 a week; not yet at long-run equilibrium, since some profit remains.

Example 3. Using the six stakeholders, evaluate Heinz's decision to sell horseradish in clear glass bottles.

Show solution

1. Customers: could see that the product was pure, so they were dealt with honestly.
2. Risk-takers: Heinz staked his reputation on quality and was rewarded with loyal buyers.
3. Builders and workers: had to meet higher standards, and the firm's clean factories became a selling point.
4. Financiers: a trusted brand made the business a better risk to lend to.
5. Community: honest competition pushed rivals toward purity and helped build support for food-safety laws.

Answer: A choice that served all six: honesty became a competitive advantage.

PRACTICE

1. Easy Name the two features that monopolistic competition shares with perfect competition and the one it shares with monopoly.

   Show answer

   Shares many sellers and free entry with perfect competition; shares a downward-sloping demand curve (some price control) with monopoly.

2. Easy Why did Heinz use clear glass bottles?

Show answer

So customers could see the horseradish was pure, when many rivals hid fillers in colored glass.

3. Easy What is product differentiation? Give two examples.

Show answer

Making a product distinct from rivals, for example by quality, location, service, style or brand.

4. Medium Demand is $P = 20 - Q$ and $MR = 20 - 2Q$. MC is \$4. Find the best output and price.

Show answer

$20 - 2Q = 4$, $Q = 8$, $P = \$12$.

5. Medium In problem 4, fixed cost is \$40. Find the profit.

Show answer

$(12 - 4)(8) - 40 = \$24$.

6. Medium Why does economic profit tend to vanish in the long run under monopolistic competition?

Show answer

Profit attracts new firms with close substitutes, which takes customers away and shifts each firm's demand down until price equals average total cost.

7. Medium What is excess capacity, and why is it called the cost of variety?

Show answer

Firms produce below the output that minimizes ATC, so costs are a bit higher than in perfect competition. Customers accept this in exchange for many different products.

8. Hard Explain how a brand can give a firm an incentive to be honest.

Show answer

A brand's value rests on reputation built over years. Cheating might gain a little once but could destroy the brand's value, so the firm has a strong reason to keep quality high.

9. Hard Why might an honest food maker like Heinz support a pure-food law?

Show answer

Rules against adulteration stop dishonest rivals from undercutting him with cheap, impure goods, and they raise customers' trust in packaged food generally.

10. Challenge A restaurant faces $P = 30 - 0.1Q$ (so $MR = 30 - 0.2Q$) with MC = \$10 and fixed cost \$800 a week. (a) Find its profit. (b) New rivals enter. What demand intercept (replacing 30) would leave it with zero profit, assuming the slope stays 0.1?

Show answer

(a) $30 - 0.2Q = 10$, $Q = 100$, $P = \$20$, profit $(20 - 10)(100) - 800 = \$200$. (b) With intercept a: $Q = 5(a - 10)$, profit $0.1Q^2 - 800 = 0$, so $Q \approx 89.4$, $a \approx 27.9$.

COMMON MISTAKES

- Thinking any firm with a brand is a monopoly. Close substitutes and free entry make it monopolistic competition.
- Assuming advertising is always wasteful. It can inform buyers and back a promise of quality.
- Forgetting that the price comes from the demand curve after finding the quantity where MR = MC.

> **Make it a game · Blind Brand Taste Test.** Close your eyes while your parent offers two similar foods, such as brands of crackers or peanut butter. Guess which is which. Then list differences brand and packaging make. Explain how Henry Heinz used a clear glass bottle to differentiate his product, and why new entrants erode profit over time in monopolistic competition. Trade roles and repeat.

3.3 Oligopoly and Game Theory: Railroad Pools and the Prisoner's Dilemma

OBJECTIVES

- Describe oligopoly and explain why firms in it are interdependent.
- Use a payoff matrix to find dominant strategies and a Nash equilibrium.
- Explain why cartels such as the railroad pools of the 1870s and OPEC tend to break down.

> **Warm-up.** Two gas stations face each other on a corner. Each can charge $3.50 or $3.20 a gallon. Write what you think each owner will do, and why. What would happen if they agreed to keep the high price?

WATCH

Prisoners' dilemma and Nash equilibrium | Microeconomics | Khan Academy

Khan Academy · 9:21

https://www.youtube.com/watch?v=UkXI-zPcDIM

> **WHEN TO WATCH**
> After the story, before the worked examples.

BACKUP VIDEO

Oligopolies, duopolies, collusion, and cartels | Microeconomics | Khan Academy

Khan Academy · 8:26

https://www.youtube.com/watch?v=N0L00FZnhtg

After the big idea, for the section on cartels.

KEY TERMS

oligopoly

A market dominated by a few large sellers, each of whose choices affect the others.

cartel

A group of firms that agree to fix prices or limit output, acting together like a monopoly.

game theory

The study of strategic choices in which each player's best move depends on what others do.

dominant strategy

A choice that is best for a player no matter what the other players do.

Nash equilibrium

A set of choices in which no player can do better by changing his choice alone, given what the others are doing.

CORE IDEAS

The story. In the 1870s a handful of railroads competed for the freight running between Chicago and the East Coast. Rate wars broke out again and again: one line cut its rates to win traffic, the others cut too, and soon all were hauling grain and cattle at a loss. To stop the wars, the railroads formed **pools**: agreements to keep rates up and divide the traffic or the revenue by fixed shares. In 1877 the eastern trunk lines hired a respected engineer, Albert Fink, as commissioner to run their pool. Yet again and again it broke down. Each railroad found that it could quietly offer secret rebates to big shippers and win extra traffic, as long as the others kept their rates high.

How they figured it out. The railroads' problem was later given a precise form by mathematicians. In 1950, at the RAND Corporation, Merrill Flood and Melvin Dresher studied a simple game, and the Princeton mathematician Albert Tucker told it as a story about two prisoners questioned separately. Each can stay silent or confess. Whatever the other does, each is better off confessing, so both confess, and both end up worse off than if they had kept quiet. The same year John Nash defined the equilibrium of such games: a situation in which no player can gain by changing his choice alone. The railroad pool was a prisoner's dilemma: cheating was each line's best move, and so the pool collapsed.

The big idea. In an **oligopoly**, a few firms dominate a market, and each must think about how the others will respond. Firms gain together by limiting output and keeping prices high, as a monopoly would. But each firm gains even more by cheating while the others hold back, so **cartels** are unstable. Game theory analyzes this with a **payoff matrix**. Look for each player's **dominant strategy**; if both have one, the result is a **Nash equilibrium**, which may be worse for both than cooperation.

Cooperation can last when the game is repeated many times, when cheating is easy to detect, and when it can be punished. In the United States, price-fixing agreements were banned outright by the Sherman Antitrust Act of 1890; the Interstate Commerce Act of 1887 had already outlawed railroad pooling.

In business today. Many important industries are oligopolies: airlines, large jet engines, soft drinks, mobile phone networks. Firms compete hard on price at times, and at other times on service, advertising and new products. Agreements among competitors to fix prices are illegal in most countries, and executives have gone to prison for them. The oil cartel OPEC, formed in 1960, shows the pattern on a world scale: it raised prices sharply in the 1970s, but in the 1980s many members produced above their quotas and prices fell.

Think it through. Game theory shows why trust matters so much in business. People who keep their word, even when breaking it would pay, make cooperation possible. A good name, Proverbs says, is rather to be chosen than great riches (Proverbs 22:1).

PICTURE STUDY



The "Lightning Express" Trains Leaving the Junction, Frances F. Palmer, published by Currier & Ives, 1863 · Hand-colored lithograph · Library of Congress

Image: Wikimedia Commons, public domain

Currier & Ives sold cheap, colorful prints to American households, and railroads were among their favorite subjects. This one shows two express trains leaving a junction side by side, a picture of speed and of competition: two lines heading the same way, each hoping for the passengers and the freight.

Look closely

- Find the two trains. Which way is each one going?
- Look at the station and the people. What are they doing?
- Look at the smoke and the crowd on the platform. How did the artist show speed and excitement?
- Look at the river and hills. Where do you think the tracks lead?

Talk about it

1. If two railroads served the same route, what would each be tempted to do to its rates?
2. Why would railroads form a pool, and why would it be hard to keep?
3. How is this picture a good image of an oligopoly?

PROJECT

The Pricing Game

You will play a repeated pricing game with a partner, record the results and compare them with the predictions of game theory.

You will need

- A partner
- Index cards marked High and Low for each player
- A score sheet
- Your ledger notebook

Steps

1. Use the payoff matrix from Worked Example 1. Each round, both players choose a card secretly and reveal at the same time.
2. Play 5 rounds without talking. Record each choice and payoff.
3. Play 10 more rounds, now allowed to talk before each round but not to make binding promises. Record the results.
4. Play 10 final rounds, but agree in advance that the game will end after exactly 10. Watch what happens near the end.
5. Compute each player’s total and average payoff in each stage.
6. Compare: When did cooperation (both High) happen most? When did it break down?
7. Write a paragraph connecting your results to the railroad pools and to the conditions that help cooperation last (repetition, detection, punishment, trust).

Tips

- Keep the game friendly: this is an experiment in incentives, not a test of character.
- If you have more players, run a three-firm version and see whether cooperation becomes harder.

Check your work

- ☐ I can read a payoff matrix and find dominant strategies.
- ☐ I can find a Nash equilibrium.
- ☐ I can explain why cartels tend to break down and when cooperation can last.

LEDGER NOTEBOOK

1. Copy your score sheet and the averages for each stage of the game.
2. Draw the payoff matrix for the railroad pool and circle the Nash equilibrium.
3. List four industries you think are oligopolies and name the main firms in each.

KEY FORMULAS

Nash equilibrium: each player's choice is a best response to the others' choices

From history. Albert Fink, the pool commissioner, was a German-born engineer who designed the Fink truss bridge. He kept careful statistics of railroad costs and argued that rate wars harmed shippers as well as railroads, but even his skill could not keep the pool together for long.

WORKED EXAMPLES

Example 1. Two railroads, A and B, each choose a High rate or a Low rate. Monthly profits (A, B) in thousands: both High (50, 50); A Low, B High (70, 20); A High, B Low (20, 70); both Low (30, 30). Find each line's dominant strategy and the Nash equilibrium.

Show solution

1. If B charges High, A earns 50 with High or 70 with Low: Low is better.
2. If B charges Low, A earns 20 with High or 30 with Low: Low is better.
3. So Low is A's dominant strategy. By symmetry, it is also B's.
4. Nash equilibrium: both Low, earning 30 each, although both High would give 50 each.

Answer: Both choose Low; the Nash equilibrium (30, 30) is worse for both than cooperating at (50, 50).

Example 2. The railroads in Example 1 deal with each other every month for years. A's manager says: "We will charge High as long as you do; if you ever cut, we will charge Low forever." Compare A's total profit over 12 months from cooperating with B's gain from cheating once.

Show solution

1. If B cooperates for 12 months: $12 \times 50 = 600$ thousand.
2. If B cheats in month 1, it earns 70, then 30 for 11 months: $70 + 11 \times 30 = 400$ thousand.
3. Cheating gains 20 once but costs 20 every month after.

Answer: Cooperating earns B \$600,000 versus \$400,000 from cheating, so the threat makes cooperation worthwhile, as long as cheating can be detected.

Example 3. A two-firm cartel agrees that each will sell 40 units, keeping the price at \$10. Each firm's cost is \$4 a unit. If one firm secretly sells 50, the price falls to \$9. Find each firm's profit before and after the cheating.

Show solution

1. Before: each earns $(10 - 4)(40) = \$240$.
2. After: the cheater earns $(9 - 4)(50) = \$250$; the honest firm earns $(9 - 4)(40) = \$200$.

Answer: The cheater gains \$10 and the honest firm loses \$40: cheating pays the cheater and hurts the group, which is why cartels break down.

PRACTICE

1. Easy What is an oligopoly?

   Show answer

   A market dominated by a few large sellers whose choices affect one another.

2. Easy What was a railroad pool?

   Show answer

   An agreement among railroads to keep rates up and share traffic or revenue.

3. Easy Which law of 1887 outlawed railroad pooling?

Show answer

The Interstate Commerce Act.

4. Medium Define a dominant strategy and a Nash equilibrium.

Show answer

A dominant strategy is best whatever others do. A Nash equilibrium is a set of choices where no one can gain by changing alone.

5. Medium Payoffs (A, B): both Advertise (10, 10); A Advertises, B Not (18, 6); A Not, B Advertises (6, 18); neither (14, 14). Find the Nash equilibrium.

Show answer

Advertising is dominant for both (18 > 14, 10 > 6), so both Advertise (10, 10), though neither advertising (14, 14) is better for both.

6. Medium Why did railroads give secret rebates to large shippers even while belonging to a pool?

Show answer

Each line could win extra traffic and profit by undercutting the pool rate quietly, as long as the others did not, so each had an incentive to cheat.

7. Medium Name three conditions that help a cartel hold together.

Show answer

Few members, repeated dealings, easy detection of cheating, and the ability to punish cheaters (any three).

8. Hard In 1950, who first studied the prisoner's dilemma game and who gave it its name and story?

Show answer

Merrill Flood and Melvin Dresher at RAND studied it; Albert Tucker told it as the story of two prisoners.

9. Hard OPEC raised oil prices sharply in the 1970s, but prices fell in the 1980s. Use game theory to explain one reason.

Show answer

Members had an incentive to produce above their quotas to earn more at the high price; widespread cheating raised supply and pushed prices down.

10. Hard Why do economists say oligopoly outcomes can lie anywhere between competition and monopoly?

Show answer

If firms compete fiercely, prices approach cost, as in competition; if they cooperate, prices approach the monopoly level. The result depends on the strategies they choose.

11. Challenge In the repeated game of Worked Example 2, suppose future profits matter less, so that a month's profit next year is worth only half as much as this month. Is cooperation still worth it for B over 12 months? Assume months 2–12 each count at half value.

Show answer

Cooperate: $50 + 11(25) = 325$. Cheat: $70 + 11(15) = 235$. Cooperation still pays, but the gap is smaller; the less the future matters, the more tempting cheating becomes.

COMMON MISTAKES

- Assuming the Nash equilibrium is always the best outcome for the players. In the prisoner's dilemma it is worse for both.
- Reading payoffs from the wrong player's side of the matrix. Fix the other player's choice, then compare your own payoffs.
- Thinking cartels are stable because members agree. Agreement is easy; keeping it is hard.

> **Make it a game · Pricing Game Matrix.** Two railroads each secretly choose to hold the price or cut it by placing a coin heads or tails. Using a payoff matrix you draw, hold-hold pays 3 each, cut-cut pays 1 each, and a lone cutter earns 5 against 0. Play ten rounds, then find the dominant strategy and Nash equilibrium. Explain why a cartel is hard to hold.

3.4 Monopoly: Charles Martin Hall and Aluminum

OBJECTIVES

- Explain the sources of monopoly power: patents, control of resources, economies of scale and law.
- Find a monopolist's profit-maximizing output and price using MR = MC, and compute its profit.
- Measure the deadweight loss of monopoly and evaluate the Alcoa case of 1945.

> **Warm-up.** List three products or services in your town that have only one seller. For each, write what keeps a competitor from starting up.

WATCH

Maximizing Profit Under Monopoly

Marginal Revolution University · 11:11

https://www.youtube.com/watch?v=IEjcTLPtTIY

> **WHEN TO WATCH**
> After the big idea, before the worked examples.

BACKUP VIDEO

What is a Monopoly? | Economics Explained

Federal Reserve Bank of St. Louis · 7:18

https://www.youtube.com/watch?v=146O2tCFBWs

Before the big idea, as an introduction.

KEY TERMS

monopoly
A market with a single seller of a good with no close substitutes, protected by barriers to entry.

barrier to entry
Anything that keeps new firms from entering a market: a patent, control of a key resource, large economies of scale, or a legal license.

patent

A government grant giving an inventor the exclusive right to make and sell an invention for a limited time (now 20 years in the United States).

deadweight loss

The value of trades that would benefit both buyers and sellers but do not happen because the price is above marginal cost.

price maker

A seller that can choose its price, because it faces the whole downward-sloping market demand curve.

CORE IDEAS

The story. In the 1850s aluminum was a precious metal. It is the most common metal in the earth's crust, but it is locked tightly in ores, and refining it chemically was so costly that France's emperor Napoleon III is said to have served his most honored guests with aluminum spoons. In 1886 Charles Martin Hall, a 22-year-old graduate of Oberlin College working in a woodshed behind his family's house in Ohio, found a way to refine aluminum with electricity. A Frenchman, Paul Héroult, found the same process the same year. With backing from Pittsburgh investors, Hall founded the Pittsburgh Reduction Company in 1888, later renamed the Aluminum Company of America, or Alcoa.

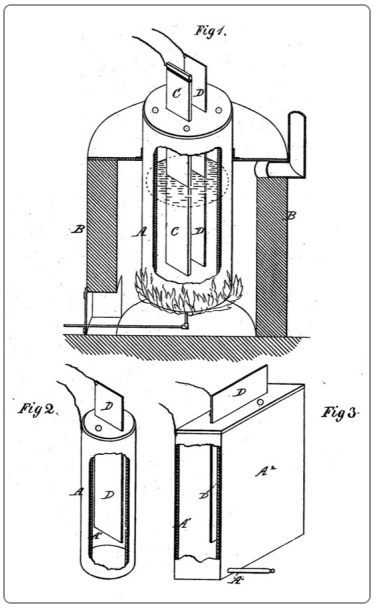
How they figured it out. Hall's patent, together with a related patent the company bought, gave it the sole right to make aluminum by electrolysis in the United States until 1909. The price of aluminum fell dramatically as production grew, from several dollars a pound to a small fraction of that, and the metal went into cooking pots, wire, and later airplanes. When the patent expired, Alcoa kept its position by controlling sources of bauxite ore and cheap electric power and by expanding ahead of demand. For decades it was the only producer of new aluminum in the country. In 1937 the government sued, and in 1945 the federal appeals court, in an opinion by Judge Learned Hand, ruled that Alcoa held an illegal monopoly of the market for new aluminum. After the Second World War, aluminum plants that the government had built for the war were sold to new competitors, Reynolds and Kaiser, and the industry became an oligopoly.

The big idea. A **monopoly** is a single seller protected by **barriers to entry**. Because it faces the whole market demand curve, it is a **price maker**: to sell more, it must lower the price on every unit, so its marginal revenue is less than the price. It maximizes profit by producing where **MR = MC** and charging the highest price buyers will pay for that quantity. Compared with competition, a monopoly produces less and charges more, and some trades worth making never happen: this is the **deadweight loss**. Yet some monopolies are temporary rewards for invention. Patents trade a limited monopoly for the public benefit of new ideas, as the Constitution intends, "to promote the progress of science and useful arts."

In business today. Pure monopolies are rare, and most are limited: a drug under patent, a local utility, a firm with a unique resource. Monopoly power can come from real excellence or from shutting out rivals; the law treats the two very differently. A firm that wins a market by making a better product at a lower price, as Alcoa did at first, serves its customers. A firm that keeps its position by blocking rivals, rather than by serving customers, invites the antitrust laws.

Who gained? Hall and his financiers became rich; Hall left much of his fortune to Oberlin College. Customers gained a light, strong, cheap metal that had once been a luxury. Builders found new uses for it in everything from kitchens to airplanes. But customers also paid more than they would have under competition, which is why the 1945 decision and the entry of new firms after the war mattered.

PICTURE STUDY



Charles Martin Hall's patent drawing for refining aluminum, Charles Martin Hall (inventor), U.S. Patent Office, Patented April 2, 1889 · Patent drawing, ink on paper · United States Patent and Trademark Office

Image: Wikimedia Commons, public domain

This drawing accompanied one of Hall's patents for refining aluminum by passing electricity through a molten bath. A patent is a public bargain: the inventor publishes exactly how his invention works, and in return the law grants him the sole right to use it for a limited time. When Hall's patents expired, anyone could use his process, but Alcoa had by then built an enormous head start.

Look closely

- Find the container and the bath inside it. What is happening in it?
- Find the electrodes and the wires. Where does the electricity enter and leave?
- Look for the small letters that label each part. Why does a patent drawing need them?
- Find the flame beneath the container. Why does the process need heat as well as electricity?

Talk about it

1. What did Hall gain by patenting his process, and what did the public gain?
2. Why does a patent create a temporary monopoly?

3. After the patent ran out, what kept rivals from competing with Alcoa?

Safety first. A parent helps choose whom to survey. Any real selling is done with a parent.

PROJECT

Pricing Like a Monopolist

You will build a demand schedule for a product only you sell (a craft, a baked good or a service) by surveying willingness to pay, then find the profit-maximizing price and compare it with the competitive price.

You will need

- A survey sheet
- At least eight respondents, with a parent's help
- A spreadsheet
- Your ledger notebook

Steps

1. Choose something you could make or do that no one else nearby offers, and estimate its marginal cost per unit (materials plus a fair value for your time).
2. Ask at least eight people the most they would pay for one unit. Sort the answers from highest to lowest.
3. Build a demand schedule: at each price equal to one of the answers, how many people would buy?
4. Compute total revenue and marginal revenue for each quantity.
5. Find the quantity where MR is closest to MC without going below it, and the price that goes with it. Compute profit.
6. Find the "competitive" quantity, where price equals marginal cost. Compare quantities and prices.
7. Calculate the deadweight loss approximately (the total value to buyers left out, minus their cost). Write a paragraph on what you would actually charge and why.

Tips

- Ask people to answer honestly as if they were really buying.
- You may decide to charge less than the monopoly price for good reasons: goodwill, fairness, or attracting future customers. Explain your choice.

Check your work

- ☐ I can build demand and marginal revenue from survey data.
- ☐ I can find the monopoly price and quantity with MR = MC.
- ☐ I can explain deadweight loss.

LEDGER NOTEBOOK

1. Copy your survey, demand schedule and revenue table.
2. Draw the monopoly diagram: demand, MR, MC, the monopoly price and quantity, the competitive quantity and the deadweight-loss triangle.
3. Write a timeline of aluminum: 1850s (precious metal), 1886, 1888, 1909, 1945, after the war.

KEY FORMULAS

$$\text{Linear demand } P = a - bQ \;\Rightarrow\; MR = a - 2bQ$$

$$\text{Profit-maximizing output: } MR = MC$$

$$\text{Deadweight loss} = \tfrac{1}{2}(P_m - MC)(Q_c - Q_m) \quad (\text{constant } MC)$$

From history. Hall's sister Julia, who had also studied chemistry at Oberlin, helped him with his experiments and kept careful records of them. Hall never married, and at his death in 1914 he left a large part of his estate to Oberlin College, where a statue of him cast in aluminum still stands.

WORKED EXAMPLES

Example 1. A monopolist faces demand $P = 100 - 2Q$ and has a constant marginal cost of \$20 (no fixed cost). Find its output, price and profit.

Show solution

1. Marginal revenue: $MR = 100 - 4Q$.
2. Set $MR = MC$: $100 - 4Q = 20$, so $Q_m = 20$.
3. Price from demand: $P_m = 100 - 40 = \$60$.
4. Profit: $(60 - 20)(20) = \$800$.

Answer: The monopolist sells 20 units at \$60 for a profit of \$800.

Example 2. Compare with a competitive industry with the same costs. Find the competitive output and price, and the deadweight loss of monopoly.

Show solution

1. Competition: $P = MC = 20$, so $100 - 2Q = 20$ and $Q_c = 40$.
2. Monopoly sells 20 units at \$60; competition sells 40 at \$20.
3. Deadweight loss: $\frac{1}{2}(60 - 20)(40 - 20) = \$400$.

Answer: Competition gives 40 units at \$20. Monopoly halves the quantity, triples the price and causes a deadweight loss of \$400.

Example 3. Why is a monopolist's marginal revenue below its price? Show it with the demand in Example 1 by moving from 10 units to 11.

Show solution

1. At Q = 10: $P = 80$, $TR = 800$.
2. At Q = 11: $P = 78$, $TR = 858$.
3. Marginal revenue: $858 - 800 = \$58$, less than the new price of \$78.
4. The 11th unit brings in \$78, but the price falls by \$2 on the 10 units that were already selling, losing \$20.

Answer: MR (\$58) is less than P (\$78), because a monopolist must cut the price on all its units to sell one more.

PRACTICE

1. Easy Name four barriers to entry.

   Show answer

   Patents, control of a key resource, large economies of scale, government licenses (or high start-up costs).

2. Easy Who discovered the electrolytic process for aluminum in the United States, and when?

   Show answer

   Charles Martin Hall, in 1886.

3. Easy Why does a monopolist produce where MR = MC rather than where P = MC?

Show answer

Because to sell one more unit it must lower the price on all units, so its extra revenue (MR) is less than the price; profit is greatest where MR equals MC.

4. Medium Demand $P = 50 - Q$, MC = \$10. Find the monopoly quantity, price and profit.

Show answer

$MR = 50 - 2Q = 10$, $Q = 20$, $P = \$30$, profit \$400.

5. Medium In problem 4, find the competitive quantity and the deadweight loss.

Show answer

$Q_c = 40$; DWL $\tfrac{1}{2}(30 - 10)(20) = \$200$.

6. Medium How long does a U.S. patent last today? What is the public's side of the bargain?

Show answer

Generally 20 years from filing. The inventor must publish the invention, and afterward anyone may use it.

7. Medium What did the 1945 Alcoa decision find, and what happened to the industry after the war?

Show answer

The court found that Alcoa illegally monopolized the market for new aluminum. Government-built plants were sold to Reynolds and Kaiser, creating competition.

8. Hard Show that MR is below price at every quantity greater than zero for demand $P = a - bQ$.

Show answer

$MR = a - 2bQ = P - bQ$, which is less than P for any $Q > 0$.

9. Hard Explain how a patent can both create a monopoly and serve the public.

Show answer

It gives the inventor a temporary monopoly, raising prices for a time, but that reward encourages invention and requires the inventor to publish it. Afterward the public has the invention forever.

10. Hard A monopolist has demand $P = 120 - 3Q$ and MC = \$30 plus a fixed cost of \$300. Find its profit.

Show answer

$120 - 6Q = 30$, $Q = 15$, $P = \$75$, profit $(75 - 30)(15) - 300 = \$375$.

11. Challenge A monopolist with demand $P = 100 - 2Q$ and MC = \$20 is told by regulators to charge no more than \$40. Find its output, profit and the remaining deadweight loss.

Show answer

At a \$40 ceiling it can sell up to $Q = 30$ (from demand), and MR = \$40 > MC for those units, so it sells 30. Profit $(40 - 20)(30) = \$600$. DWL $\frac{1}{2}(40 - 20)(40 - 30) = \$100$, down from \$400.

COMMON MISTAKES

- Thinking a monopolist can charge any price it likes. It is limited by demand: a higher price means fewer sales.
- Setting the monopoly price equal to MR. Find the quantity where MR = MC, then read the price from the demand curve.
- Assuming every large firm is a monopoly. A monopoly has no close substitutes and is protected by barriers to entry.

> **Make it a game · Price Maker Table Challenge.** Your parent writes a demand schedule for aluminum. Build columns for total revenue and marginal revenue, add a constant marginal cost, and find the output where marginal revenue equals marginal cost. Guess the profit-maximizing price before finishing, then compute profit and deadweight loss. Explain how Charles Martin Hall's patent created monopoly power.

> **Scripture.** “He that withholdeth corn, the people shall curse him: but blessing shall be upon the head of him that selleth it.” (Proverbs 11:26, KJV)
>
> A seller who holds back supply to raise the price harms his neighbors. The monopolist’s temptation is ancient, and so is the blessing of the one who brings goods to market.

3.5 Natural Monopoly, Regulation and Antitrust: Standard Oil (1911) and AT&T (1984)

OBJECTIVES

- Explain natural monopoly and why it is often regulated rather than broken up.
- Calculate the regulated price under average-cost pricing and compare it with monopoly and marginal-cost pricing.
- Tell the history of the Sherman Act, the breakup of Standard Oil in 1911 and the breakup of the Bell System in 1984, and weigh their results.

> **Warm-up.** Your home probably has one company for water, one for electric power lines and one for sewer. Why does no town have three competing water mains under every street?

WATCH

Natural Monopoly and the need for Government Regulation

Jason Welker · 15:14

https://www.youtube.com/watch?v=LhiyJlI5xa0

> **WHEN TO WATCH**
> After the big idea, before Worked Example 2.

BACKUP VIDEO

The Sherman Anti-Trust Act Explained: US History Review

Hip Hughes (HipHughes) · 6:12

https://www.youtube.com/watch?v=_DSN0uUNLOw

With the history of the Sherman Act and Standard Oil.

KEY TERMS

natural monopoly

An industry in which one firm can serve the whole market at a lower average cost than two or more firms could, usually because of very large fixed costs.

economies of scale

Falling average cost as output grows.

rate regulation

Government setting of the prices a utility may charge, usually to cover its costs plus a fair return.

antitrust law

Laws that forbid agreements to restrain trade and attempts to monopolize, such as the Sherman Act of 1890.

divestiture

A court-ordered breakup of a company into separate firms.

CORE IDEAS

The story. By 1880 John D. Rockefeller's Standard Oil refined about nine-tenths of America's oil. It had cut costs brilliantly, through large refineries, careful accounting and its own pipelines and barrels, and the price of kerosene fell. But it had also won secret rebates from the railroads, so that it paid less to ship oil than its rivals did, and it sometimes cut prices in one town until a competitor sold out. The journalist Ida Tarbell, whose father had been a small oil producer, laid out the record in a series in *McClure's Magazine* from 1902 to 1904. In 1911 the U.S. Supreme Court ruled that Standard Oil had illegally monopolized the industry under the Sherman Antitrust Act of 1890, and ordered it split into 34 separate companies.

How they figured it out. The telephone posed a different problem. Once wires reach every house, adding another customer costs little, while building a second set of wires down every street would double the cost. Many economists concluded that local telephone service was a **natural monopoly**: one network could serve everyone more cheaply than two. In 1913 the Bell System, run by AT&T, agreed with the government to operate as a regulated monopoly, and for seventy years state and federal commissions set its rates. But new technology, especially microwave radio for long-distance calls, made competition possible in parts of the business. After a long antitrust suit, AT&T agreed to break up, and on January 1, 1984, its local telephone companies were split into seven regional firms. Long-distance prices fell sharply in the following years as rivals competed.

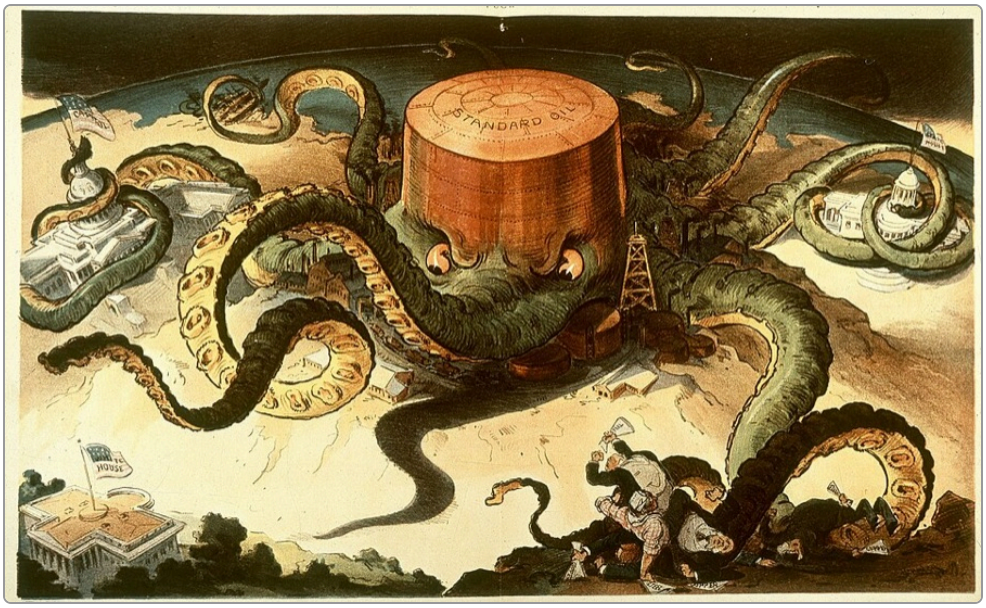
The big idea. In a **natural monopoly**, average cost keeps falling as output grows, so breaking the firm up would raise costs. Left alone, it would charge the monopoly price. Regulators often require **average-cost pricing**, setting the price where it just covers the firm's costs, including a fair return to investors. Marginal-cost pricing

would be ideal for efficiency but would leave the firm losing money, because its marginal cost is below its average cost. **Antitrust** law addresses a different problem: firms that gain or keep monopoly power not by serving customers better but by restraining trade, such as through secret rebates, price-fixing or driving rivals out unfairly. Good antitrust acts like a referee: it does not punish size or success, but it keeps the game fair.

In business today. Water, sewer, electric power lines and gas pipelines are still usually regulated monopolies, with rates set by public commissions after hearings. Where technology opens a business to competition, as it did for long-distance calling and, later, for generating electricity, regulators have often allowed rivals in. Antitrust agencies still review large mergers and prosecute price-fixing. Both tools try to keep the benefits of large-scale production while protecting customers from abuse.

Who gained? Using the six stakeholders on Standard Oil: customers gained cheap kerosene but paid for the rebates' unfairness in the end; rivals and their workers were often ruined; Rockefeller and his investors gained enormously and, interestingly, grew richer still after the breakup as the separate companies' shares rose. Rockefeller, a devout Baptist, gave away a large share of his fortune, founding the University of Chicago and Rockefeller University and funding medical research. The community gained a lesson that efficiency and fair dealing must go together.

PICTURE STUDY



Next!, Udo J. Keppler, in *Puck* magazine, September 7, 1904 · Color lithograph (magazine cartoon) · Library of Congress

Image: Wikimedia Commons, public domain

This famous cartoon appeared while Ida Tarbell's history of Standard Oil was running in *McClure's*. It shows the company as an octopus whose tentacles grip other industries, a state house and the Capitol, and reach for the White House. Cartoons like this one shaped public opinion in the years before the 1911 breakup. Look at it as a historical document: what did its readers fear?

Look closely

- Find the octopus's body. What is it made of?
- Follow each tentacle. What has it grabbed?
- Look at the buildings labeled with the names of government. Why did the artist include them?
- Find the title. What does "Next!" suggest?

Talk about it

1. What does the cartoonist think Standard Oil was doing besides selling oil?
2. Is the cartoon fair? What does it leave out about what Standard Oil did for its customers?
3. Which of the six stakeholders did readers of 1904 worry about most?

> **Safety first.** Use a bill only with a parent's permission, and cover account numbers and personal details before taking notes.

PROJECT

Your Town's Utilities and a Rate Case

You will study a real utility that serves your home, find how its rates are set, and work through a simple rate case of your own.

You will need

- A recent water, electric or gas bill (with a parent's permission)
- The utility's or state commission's website, with a parent
- A spreadsheet
- Your ledger notebook

Steps

1. From the bill, record the fixed monthly charge, the price per unit (per gallon, kilowatt-hour or therm) and your household's use. Cover or remove any account numbers.
2. Find out who regulates this utility (a state public utility commission, a city council or a water board).
3. Find out when its rates were last changed and what reason was given (new pipes, higher fuel costs, a new plant).
4. Explain why this business is a natural monopoly in your area.
5. Work a rate case: suppose the utility has fixed costs of $5 million a year, marginal cost of $3 per unit and sells 1 million units. What price per unit covers its costs? What happens if it charges a fixed monthly fee of $20 to 20,000 customers instead and a per-unit price of $3?
6. Compare the two pricing methods. Which is closer to marginal-cost pricing? Which is fairer to small users?
7. Write a one-page memo to the commission recommending one pricing method, using the six stakeholders.

Tips

- A two-part price (a fixed fee plus a per-unit charge) lets a utility cover fixed costs while charging close to marginal cost for each unit.
- Do not share account numbers or the address on the bill.

Check your work

- ☐ I can explain why some industries are natural monopolies.
- ☐ I can compute an average-cost price and a two-part price.
- ☐ I can tell the story of Standard Oil and AT&T and weigh the results.

LEDGER NOTEBOOK

1. Copy your bill data (without personal details) and your rate-case calculations.
2. Draw the natural-monopoly diagram: falling ATC, MC below it, demand, and the monopoly, average-cost and marginal-cost prices.
3. Write a stakeholder scorecard (1–5 for each of the six, with a reason) for Standard Oil before 1911.

KEY FORMULAS

$$ATC = \frac{FC}{Q} + AVC$$

$$\text{Average-cost pricing: } P = ATC \text{ where the demand curve meets } ATC$$

$$\text{Marginal-cost pricing: } P = MC \;\Rightarrow\; \text{loss} = (ATC - MC) \times Q$$

From history. Rockefeller was the largest shareholder of the 34 companies created in 1911, and their combined shares rose in value after the breakup. Several of the successor firms are still among the largest oil companies in the world. Senator John Sherman of Ohio, who gave his name to the 1890 act, was the brother of the Civil War general William Tecumseh Sherman.

WORKED EXAMPLES

Example 1. A water company has fixed costs of $1,200,000 a year and a constant marginal cost of $2 per thousand gallons. Demand is $P = 14 - 0.01Q$ (Q in thousands of thousand-gallon units). Find the unregulated monopoly price and profit.

Show solution

1. MR: $14 - 0.02Q$. Set $14 - 0.02Q = 2$: $Q = 600$ (600,000 thousand-gallon units).
2. Price: $P = 14 - 6 = \$8$.
3. Profit: $(8 - 2)(600{,}000) - 1{,}200{,}000 = \$2{,}400{,}000$.

Answer: Unregulated, it would sell 600,000 units at $8, earning $2.4 million a year above all costs.

Example 2. The commission requires average-cost pricing. Find the regulated price and quantity. (Hint: ATC = 1,200,000/Q + 2, with Q in units.)

Show solution

1. Let q = quantity in thousands of units. Demand: $P = 14 - 0.01q$; ATC: $P = 1{,}200/q + 2$.
2. Set equal: $14 - 0.01q = 1{,}200/q + 2$. Multiply by q: $0.01q^2 - 12q + 1{,}200 = 0$.
3. Solve: $q = \dfrac{12 \pm \sqrt{144 - 48}}{0.02} = \dfrac{12 \pm 9.80}{0.02}$, so $q \approx 1{,}090$ (the larger root).
4. Price: $P \approx 14 - 10.90 = \$3.10$.

Answer: About 1,090,000 units at about $3.10, with zero economic profit. Customers get far more water at a much lower price than under the unregulated monopoly.

Example 3. If the commission instead required marginal-cost pricing ($2), how much water would be sold and what would the company lose?

Show solution

1. Quantity: $14 - 0.01q = 2$, $q = 1{,}200$ (1,200,000 units).
2. Revenue: $\$2 \times 1{,}200{,}000 = \$2{,}400{,}000$; variable cost the same, so the company loses its whole fixed cost of $1,200,000.

Answer: 1,200,000 units, with a loss of $1.2 million a year, which would have to be covered by a subsidy or a fixed fee. This is why regulators usually choose average-cost pricing.

PRACTICE

1. Easy What is a natural monopoly? Give two examples.

   Show answer

   An industry where one firm can serve the market at lower average cost than several, such as local water mains and electric power lines.

2. Easy In what year did the Supreme Court order Standard Oil broken up, and into how many companies?

   Show answer

   1911, into 34 companies.

3. Easy When did the Bell System's breakup take effect?

   Show answer

   January 1, 1984.

4. Medium Who was Ida Tarbell and why does she matter to this story?

   Show answer

   A journalist whose history of Standard Oil in *McClure's* (1902–1904) documented its rebates and tactics and helped build the case for antitrust action.

5. Medium A utility has fixed cost $600,000 and MC $4. At 100,000 units, what is its ATC? What price covers its costs at that output?

Show answer

$6 + 4 = \$10$; $10.

6. Medium Why does marginal-cost pricing cause a natural monopoly to lose money?

Show answer

Its average cost is above its marginal cost because of large fixed costs, so charging marginal cost does not cover the fixed costs.

7. Medium What practices of Standard Oil did critics consider unfair?

Show answer

Secret railroad rebates, local price cutting to drive out rivals, and buying up competitors under pressure.

8. Hard Why did economists come to see long-distance telephone service as open to competition, while local wires remained a natural monopoly?

Show answer

Microwave and later fiber technology lowered the cost of building long-distance networks, so several firms could compete; local wires to every house still had huge fixed costs that one network could cover most cheaply.

9. Hard Standard Oil cut the price of kerosene. Why did the courts still find it guilty of monopolization?

Show answer

The law punished the means, not low prices: the company restrained trade through rebates and tactics aimed at excluding rivals, not only by being efficient.

10. Hard Explain the difference between regulating a natural monopoly and breaking up a monopoly under antitrust law.

Show answer

Regulation keeps a single efficient firm but controls its prices; antitrust breakup creates competition where one firm's dominance came from restraining trade rather than from natural cost advantages.

11. **Challenge** A utility has $TC = 900 + 3Q$ (thousands of dollars) and demand $P = 15 - 0.02Q$. Find the average-cost price and quantity.

Show answer

Set $15 - 0.02Q = 900/Q + 3$: $0.02Q^2 - 12Q + 900 = 0$,
$Q = \dfrac{12 \pm \sqrt{144 - 72}}{0.04} = \dfrac{12 \pm 8.49}{0.04}$. The larger root $Q \approx 512$,
$P \approx 15 - 10.24 = \$4.76$.

COMMON MISTAKES

- Thinking every big firm should be broken up. In a natural monopoly, one firm is the cheapest way to serve customers.
- Confusing the price that covers average cost with the monopoly price. Regulators aim for the first; an unregulated monopolist charges the second.
- Treating antitrust as a punishment for success. It targets agreements and tactics that restrain trade.

> **Make it a game · The Rate Case Hearing.** Your parent plays the regulator in a rate case; you are the water utility. Using costs your parent supplies, argue for the monopoly price, then compute the average-cost price and the marginal-cost price. Explain which one the regulator should choose and why the firm might lose money at marginal-cost pricing. Add one fact about Standard Oil or AT&T.

UNIT 3

Market Structures

Markets differ in how many sellers they have and how alike their products are, and those differences shape prices, profits and the choices customers get. In this unit you will study the four main market structures: perfect competition (graded wheat at the Chicago Board of Trade), monopolistic competition (Henry Heinz and his clear glass bottles), oligopoly (the railroad pools of the 1870s and the prisoner's dilemma), and monopoly (Charles Martin Hall and the aluminum industry).

The unit ends with the hardest case: what should be done about monopoly? You will learn why some industries are natural monopolies and are regulated, and how the antitrust laws were used to break up Standard Oil in 1911 and the Bell System in 1984. You will calculate profits, find the profit-maximizing output in each structure, measure deadweight loss and play a pricing game that shows why cartels tend to fail.

PREREQUISITES

- Unit 2 (supply, demand and elasticity)
- Reading cost tables; average and marginal values
- Solving linear and simple quadratic equations

MASTERY CHECKLIST

- ☐ I can describe the four market structures and give a real example of each.
- ☐ I can find the profit-maximizing output and profit for a competitive firm and a monopolist.
- ☐ I can explain why economic profit tends to zero in the long run under competition and monopolistic competition.
- ☐ I can use a payoff matrix to find dominant strategies and a Nash equilibrium, and explain why cartels break down.
- ☐ I can compute deadweight loss and explain the case for and against patents.
- ☐ I can explain natural monopoly and average-cost regulation, and tell the history of Standard Oil and AT&T.

OPTIONAL BOOKS AND GAMES FOR THIS UNIT

- *The History of the Standard Oil Company*, by Ida M. Tarbell (1904): Free on Project Gutenberg. Read the chapter on the railroad rebates with Lesson 3.5. A classic of careful investigative writing. Ages 15+.
- Federal Reserve History (federalreservehistory.org): Free. Short, reliable essays on American economic history. Useful all year; in this unit, search for the essays on antitrust and on the railroads.
- *Ticket to Ride* (Days of Wonder): A family board game about building railroad routes and blocking rivals. Ages 8+. A fun picture of competing for limited routes, to play after Lesson 3.3.

Not required. Every project in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

3.1 Perfect Competition: Grading Wheat at the Chicago Board of Trade

3 sessions of 50 minutes

3.2 Monopolistic Competition: Henry Heinz and the Clear Glass Bottle

3 sessions of 50 minutes

3.3 Oligopoly and Game Theory: Railroad Pools and the Prisoner's Dilemma

3 sessions of 50 minutes

3.4 Monopoly: Charles Martin Hall and Aluminum 3 sessions of 50 minutes

3.5 Natural Monopoly, Regulation and Antitrust: Standard Oil (1911) and AT&T (1984)

3 sessions of 50 minutes

Unit 3 test

Calculators are allowed. Show your work for every calculation: write the formula, substitute and solve. Draw and label diagrams where asked. Answer the concept questions in complete sentences. The test is worth 100 points.

1. **6 pts**

   Complete the comparison for perfect competition, monopolistic competition, oligopoly and monopoly: number of sellers, type of product, ease of entry.

2. **5 pts**

   Explain how grading wheat at the Chicago Board of Trade made the grain market more competitive.

3. **8 pts**

   A competitive firm sells at $15. Its MC for units 1–6 is $5, $7, $10, $13, $15, $19, and its ATC at 5 units is $11. Find its profit-maximizing output and profit.

4. **6 pts**

   Explain why economic profit tends toward zero in the long run in perfect competition.

5. **6 pts**

   Why did Heinz use clear bottles, and what does his story teach about brands?

6. **6 pts**

   A monopolistically competitive firm faces $P = 24 - 0.5Q$ (so $MR = 24 - Q$) with MC = $8. Find its output and price.

7. **8 pts**

   Payoffs (A, B) for two airlines choosing High or Low fares: both High (40, 40); A Low, B High (55, 15); A High, B Low (15, 55); both Low (25, 25). Find each firm's dominant strategy and the Nash equilibrium. Why is this a prisoner's dilemma?

8. **6 pts**

   Why did the railroad pools of the 1870s keep breaking down?

9. **10 pts**

   A monopolist faces $P = 80 - 2Q$ with MC = $16 and no fixed cost. (a) Find its output, price and profit. (b) Find the competitive output and the deadweight loss.

10. **5 pts**

    Explain why a monopolist's marginal revenue is less than its price.

11. **6 pts**

How did Alcoa gain its monopoly, how did it keep it after 1909, and what happened in 1945?

12. **6 pts**

What is a natural monopoly, and why do regulators usually require average-cost pricing rather than marginal-cost pricing?

13. **8 pts**

A utility has fixed cost $400,000 and MC $5 per unit. It sells 80,000 units. (a) What price covers its costs? (b) With 10,000 customers, what fixed monthly fee plus a per-unit price of $5 would cover costs for a year?

14. **6 pts**

Describe the breakup of Standard Oil and of the Bell System. How were the reasons different?

15. **8 pts**

Short essay: Using the six stakeholders, was Standard Oil a great business? Give a balanced answer in one or two paragraphs.

ANSWER KEY

1. Perfect competition: many, identical, easy. Monopolistic competition: many, differentiated, easy. Oligopoly: few, identical or differentiated, difficult. Monopoly: one, unique, blocked.
2. Standard grades made wheat interchangeable, so it could be traded by receipt among many buyers and sellers without inspection, turning it into a commodity sold at one market price.
3. 5 units (MC = \$15 = P). Profit $(15 - 11)(5) = \$20$.
4. Profit attracts new firms, which raise market supply and lower the price until it equals minimum average total cost, leaving only a normal return.
5. To show customers that his horseradish was pure when rivals hid fillers. A brand carries a reputation, and a firm that protects it has a strong reason to be honest.
6. $24 - Q = 8$, $Q = 16$, $P = \$16$.
7. Low is dominant for both (55 > 40 and 25 > 15). The Nash equilibrium is both Low (25, 25), though both High (40, 40) would be better for both: individual incentives lead to a worse joint result.
8. Each railroad could gain by secretly cutting rates (rebates) while others held to the pool rate, so cheating was each member's best move and the agreements collapsed.
9. (a) $MR = 80 - 4Q = 16$, $Q = 16$, $P = \$48$, profit $(48 - 16)(16) = \$512$. (b) $Q_c = 32$; DWL $\frac{1}{2}(48 - 16)(16) = \$256$.
10. To sell one more unit it must lower the price on all units, so the extra revenue equals the new price minus the revenue lost on the earlier units.
11. Hall's patent gave it the sole right to the process; afterward it controlled bauxite and power sources and expanded ahead of demand. In 1945 the appeals court ruled it an illegal monopoly; after the war new firms (Reynolds and Kaiser) entered.
12. An industry in which one firm can serve the market at lowest average cost. Marginal-cost pricing would not cover fixed costs and the firm would lose money; average-cost pricing covers costs with a fair return.
13. (a) $ATC = 400{,}000/80{,}000 + 5 = \$10$. (b) $400{,}000/(10{,}000 \times 12) \approx \$3.33$ a month.
14. Standard Oil (1911) was split into 34 companies because it had monopolized the industry by restraining trade. The Bell System (1984) was split into seven

regional companies plus AT&T after new technology made parts of telephone service competitive and an antitrust suit was settled.

15. A strong answer credits real value (lower costs and prices for kerosene, efficient refining, returns to financiers, Rockefeller's giving) and real wrongs (secret rebates, ruin of rivals and their workers, harm to fair competition), and reaches a reasoned judgment using several stakeholders.

PORTFOLIO PIECE: MARKET STRUCTURES IN MY TOWN

Find one real business in your town or region for each of the four market structures (for example, a farm selling at a grain elevator, a restaurant, a cell-phone carrier, and the water utility). For each, describe the number of rivals, how the product is differentiated, the barriers to entry and how prices are set, with at least one real price. Then write a stakeholder scorecard for one of them. Present your work as a four-page illustrated report with a summary table.

LOOK FOR	WHAT IT MEANS
Classification	Each business is correctly placed in a market structure, with clear reasons.
Evidence	Real prices and facts are gathered and sourced; the summary table is accurate.
Analysis	The report explains how structure affects price, profit and customer choice, and the scorecard is thoughtful and fair.
Presentation	Clear, neat and well organized, with labeled diagrams or photographs.

UNIT 4

The Story of Money I: Commodity Money

This unit tells the first half of the story of money. You will begin on the island of Yap, where great stone disks served as money without ever moving, and use it to learn what money does. Then you will follow precious metal: the first coins of Lydia and the gold of Croesus and Mansa Musa; the Roman denarius, slowly emptied of its silver by emperors who needed to pay their armies; the gold florin of Florence, so steady that it became a measuring stick for all of Europe, and the Medici bankers who moved money with paper instead of gold; and the silver mountain of Potosí, whose treasure raised prices across Europe and gave the world its first global coin.

Along the way you will calculate the savings money brings over barter, the seigniorage that tempts every issuer, the hidden tax of debasement, the gains on a bill of exchange, and the quantity equation that ties money to prices. You will also see the human cost behind some of history's money, told plainly.

PREREQUISITES

- Units 1–3
- Percents, ratios and exponents
- Using a spreadsheet for simple tables

MASTERY CHECKLIST

- ☐ I can name and illustrate money's four functions and explain how money solves the problems of barter.
- ☐ I can explain why the first coins were struck in Lydia and calculate seigniorage.
- ☐ I can explain debasement as a hidden tax and state Gresham's law.
- ☐ I can explain bills of exchange and why the Medici Bank rose and fell.
- ☐ I can use the quantity equation MV = PY to explain the great rise in European prices after 1500.
- ☐ I can tell the history of the Spanish dollar and its link to the U.S. dollar.

OPTIONAL BOOKS AND GAMES FOR THIS UNIT

- ***The Wealth of Nations*, by Adam Smith, Book I, chapter 4, "Of the Origin and Use of Money"**: Free. Smith's short account of barter, commodity money, coins and debasement. Read it with Lessons 4.1–4.3. Ages 14+.
- ***The Island of Stone Money*, by William Henry Furness (1910)**: Free on the Internet Archive. The chapter on stone money tells the stories used in Lesson 4.1, with photographs. Ages 14+.
- **Federal Reserve History (federalreservehistory.org)**: Free. Reliable essays on the history of money and banking; useful throughout Units 4–6.

Not required. Every project in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

4.1	**Barter and the Functions of Money: The Stone Money of Yap**	3 sessions of 50 minutes
4.2	**Lydia's Coins and the Gold Trade**	3 sessions of 50 minutes
4.3	**Rome's Denarius and Its Debasement**	3 sessions of 50 minutes
4.4	**The Florentine Florin and the Medici Bank**	3 sessions of 50 minutes
4.5	**Spanish Silver and the Great Rise in Prices**	3 sessions of 50 minutes

Unit 4 Test

Calculators are allowed. Show your work for every calculation: write the formula, substitute and solve. Answer the concept questions in complete sentences. The test is worth 100 points.

1. **6 pts**

   Name money's four functions and give an example of each.

2. **6 pts**

   How many barter exchange rates are needed for 40 goods? How many prices with money?

3. **6 pts**

   Explain how ownership of Yap's stones changed without moving them, and how this resembles modern money.

4. **6 pts**

   Why were the first Lydian coins stamped, and what did Croesus add?

5. **8 pts**

   A coin costs 6 cents to make and has a face value of 10 cents. Find the seigniorage on 3 billion coins. Explain what seigniorage is.

6. **6 pts**

   What happened to the value of gold in Cairo after Mansa Musa's visit in 1324, and why?

7. **8 pts**

   A denarius of 3.9 g at 97% silver is replaced by one of 3.4 g at 80% silver. Find the silver in each and the percent loss.

8. **6 pts**

   State Gresham's law and explain it with the Roman antoninianus.

9. **6 pts**

   Why is debasement called a hidden tax?

10. **8 pts**

    A Florence merchant sends 500 florins to Bruges at 56 groats per florin; the return bill is at 60 groats per florin. How many florins would the round trip return, and what is the bank's gain in percent?

11. **6 pts**

    Give two reasons the florin became a standard of value across Europe, and one reason the Medici Bank failed.

12. **8 pts**

M = 800, V = 5, Y = 2,000. (a) Find P. (b) M rises to 1,200 with V and Y unchanged. Find the new P and the percent change.

13. **6 pts**

Prices doubled in 60 years. Find the average annual inflation rate.

14. **6 pts**

Who was Martín de Azpilcueta, and why does he matter to economics?

15. **8 pts**

Short essay: Spain received more silver than any nation in history. Explain why it did not become the richest nation in Europe, and what this teaches about wealth. Include the human cost of the silver.

ANSWER KEY

1. Medium of exchange (paying for groceries), unit of account (a price tag), store of value (savings), standard of deferred payment (a loan written in dollars).
2. $40 \times 39/2 = 780$; about 40 prices.
3. Ownership was recorded by common knowledge; the stone stayed put while everyone recognized its new owner. Modern money is mostly records in bank ledgers that change without anything physical moving.
4. The stamp guaranteed weight and fineness so coins could pass by count rather than being weighed and tested. Croesus struck separate pure gold and silver coins.
5. $0.04 \times 3 \times 10^9 = \$120$ million. Seigniorage is the issuer's profit from money's face value exceeding its cost of production.
6. It fell, because his caravan spent and gave away so much gold that the supply in Cairo rose suddenly; the effect lasted about twelve years by al-Umari's account.
7. 3.78 g and 2.72 g; $(2.72 - 3.78)/3.78 \approx -28\%$.
8. Bad money drives out good when both must be accepted at the same value. People spent the antoninianus (valued at two denarii but with less silver) and hoarded older, purer denarii.
9. The government gains purchasing power from issuing more coins, and holders of money lose it through rising prices, without any openly levied tax.
10. $500 \times 56 = 28{,}000$ groats; $28{,}000/60 \approx 466.7$ florins. The bank gains about 33.3 florins, about 6.7%.
11. Steady weight and purity for about two centuries; Florence's wide trading network. The bank failed after heavy, unwise lending to rulers who did not repay (and the family's expulsion in 1494).
12. (a) $P = 4{,}000/2{,}000 = 2$. (b) $P = 6{,}000/2{,}000 = 3$, a 50% rise.
13. $2^{1/60} - 1 \approx 1.16\%$ a year.
14. A Salamanca scholar who in 1556 observed that money is worth less where it is abundant, an early statement of the quantity theory of money.
15. A strong answer explains that the silver raised prices and paid for imports and wars rather than domestic production, that wealth is goods and services rather than money, and that the silver was mined largely by forced Andean labor under the mita, a grave injustice.

PORTFOLIO PIECE: A MUSEUM CASE OF COMMODITY MONEY

Design a museum case (a poster or a display box) of six objects that tell the story of commodity money, from barter to the piece of eight. For each object, make a label with its date, place, what it was made of, which functions of money it served well or poorly, and one calculation (a seigniorage, a silver content, a percent change or an exchange gain). Add a one-page essay that explains the quantity equation with a historical example, and a timeline from Yap and Lydia to Potosí.

LOOK FOR	WHAT IT MEANS
Accuracy	Dates, places and facts on every label are correct.
Calculations	Each label's calculation is correct, with units and a clear explanation.
Understanding	The essay uses MV = PY correctly and connects it to history.
Presentation	The case is clear, neat and readable from a few feet away.

4.1 Barter and the Functions of Money: The Stone Money of Yap

OBJECTIVES

- Explain the double coincidence of wants and calculate how money reduces the number of prices a market needs.
- Name and illustrate money's functions: medium of exchange, unit of account, store of value and standard of deferred payment.
- Use the stone money of Yap to show that money rests on trust and records, not on carrying metal from hand to hand.

> **Warm-up.** Imagine a town with no money. You have eggs and want shoes. Write the steps you would need to take to get the shoes. What could go wrong?

WATCH

Money: An Economist's Perspective - The Curious Case of the Yap Stones (Part 4)

Atlanta Fed · 7:39

https://www.youtube.com/watch?v=VbqW3A3PsXo

> **WHEN TO WATCH**
> After the story of the stones, before the big idea.

BACKUP VIDEO

Functions of money | Financial sector | AP Macroeconomics | Khan Academy

Khan Academy · 6:10

https://www.youtube.com/watch?v=ok2vtKnSZzY

After the big idea.

KEY TERMS

barter

Trading goods or services directly for other goods or services, without money.

double coincidence of wants

The barter requirement that each trader has what the other wants, at the same time.

medium of exchange

Something generally accepted in payment for goods and services.

unit of account

A common measure in which prices are stated and values compared.

store of value

A way of holding purchasing power from the present into the future.

standard of deferred payment

A unit in which debts to be paid later are written.

CORE IDEAS

The story. On the island of Yap, in the western Pacific, people used huge disks of carved limestone as money. The stones, called *rai*, were quarried on the islands of Palau, about 250 miles away, and brought home on rafts and canoes at great risk. Some were small enough to carry; the largest stood taller than a man. When the American anthropologist William Henry Furness visited Yap in 1903, he found that big stones were rarely moved at all. When one changed owners in a trade, it simply stayed where it was, and everyone knew whose it now was. Furness was told of a family whose great stone had sunk to the bottom of the sea while it was being brought home; because the crew had seen it and vouched for it, the family was still counted rich.

How they figured it out. Furness also recorded how the German government, which ruled Yap after 1899, got the islanders to repair their paths. Rather than seize stones, officials painted a black cross on some of them to mark them as taken by the government. The owners promptly fixed the roads, and the crosses were washed off. Nothing physical had moved; only the record of ownership had changed. The economist Milton Friedman later wrote an essay on Yap (1991) pointing out how much it resembled a modern central bank: in the 1930s, when France's central bank wanted its gold stored in New York to belong to France rather than the United States, the gold was simply moved from one compartment to another in the same vault, and newspapers spoke of a loss of American gold.

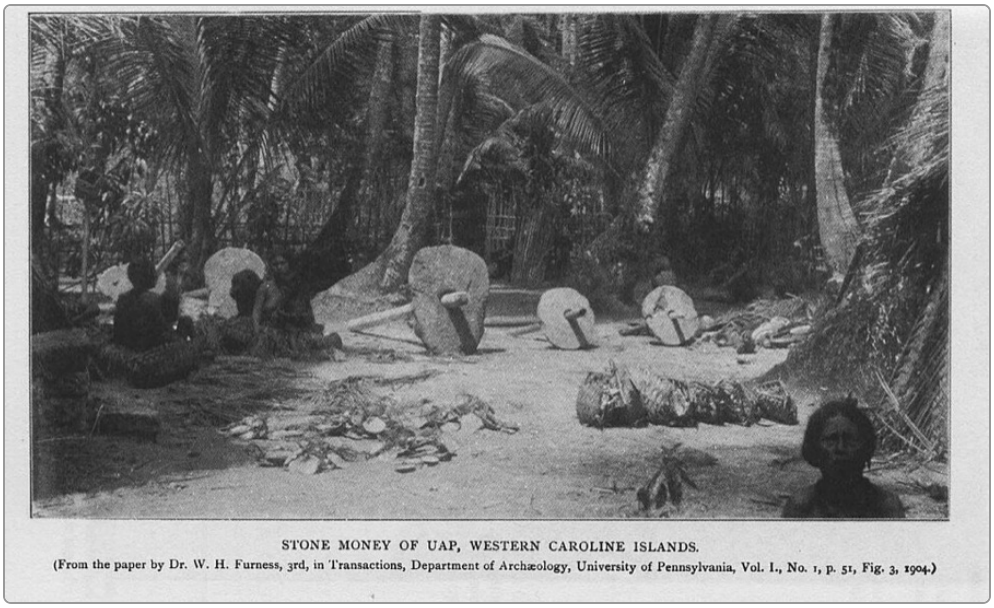
The big idea. Barter requires a **double coincidence of wants**: you must find someone who has what you want and wants what you have. Money removes that problem. It serves as a **medium of exchange** (accepted by everyone), a **unit of account** (a common measuring stick for prices), a **store of value** (it keeps purchasing power until you spend it) and a **standard of deferred payment** (debts are written in it).

Good money is durable, portable, divisible, uniform, limited in supply and widely accepted. The unit-of-account job alone saves enormous effort: in a barter economy of n goods, every pair needs its own exchange rate, $n(n-1)/2$ of them; with money, only n prices are needed. Yap shows that what matters is not the object but the shared trust and the shared record of who owns what.

In business today. Most of today's money is a record in a bank's books. When you pay with a card or a transfer, nothing physical moves; balances change in two accounts, just as ownership of a Yap stone changed without moving the stone. Businesses rely on money's functions every day: they price in dollars, take payment in dollars, borrow and lend in dollars, and keep reserves in dollars. When money fails at any of these jobs, as in a hyperinflation, businesses fall back on barter, foreign money or goods held as value, and trade slows sharply.

Think it through. Money is a social agreement built on trust. That is why honesty in keeping accounts, paying debts and weighing goods (Proverbs 11:1) is not a small matter: every lie in a ledger weakens the trust that makes money work.

PICTURE STUDY



Stone Money of Uap (Yap), Western Caroline Islands, William Henry Furness III, 1903 · Photograph · Published in Furness's writings on Yap

Image: Wikimedia Commons, public domain

Furness photographed these stones during his stay on Yap in 1903. Each disk has a hole in the center so that a pole could be passed through it for carrying. Many stood in front of houses or along paths, where everyone could see them, which was part of how the island kept track of who owned what.

Look closely

- Compare the stones with the people beside them. How big are the largest?
- Find the hole in the center of each stone. What was it for?
- Look at where the stones stand. Why might they be kept in such a public place?
- Are all the stones the same size? What might make one more valuable than another?

Talk about it

1. Which of money's functions did the rai stones serve? Which did they serve poorly?
2. How could a stone at the bottom of the sea still count as wealth?
3. How is a bank balance today like a Yap stone that never moves?

PROJECT

The Barter Market and the Money Market

You will run two short trading rounds with family members, one by barter and one with a simple money, and measure how many trades succeed and how long they take.

You will need

- Index cards
- A timer
- Play money or slips of paper
- At least four players
- Your ledger notebook

Steps

1. Make cards for eight goods (bread, eggs, shoes, cloth, a lamp, a chair, apples, a book). Give each player two random “have” cards and two secret “want” cards.
2. Round 1 (barter): for 5 minutes, players may trade only goods for goods. Record every trade and whether each player got what he wanted.
3. Round 2 (money): give each player $20 in play money. Set a price for each good by agreement. For 5 minutes, players buy and sell freely. Record every trade.
4. Compare: number of trades, number of players who got both wants, and time until the market went quiet.
5. Count how many barter exchange rates your eight goods would need and how many money prices you used.
6. Run a third round in which money is only a list on paper: the parent keeps the ledger of balances, and no play money changes hands. Did it work? What did it require?
7. Write a paragraph connecting your third round to the stones of Yap and to bank accounts today.

Tips

- Keep the wants secret so that players must search, as real traders do.
- The ledger round works only if everyone trusts the keeper. Notice that.

Check your work

- ☐ I can explain the double coincidence of wants.
- ☐ I can name and illustrate money's four functions.
- ☐ I can explain why Yap's money worked without moving the stones.

LEDGER NOTEBOOK

1. Copy your results table for the three rounds.
2. Make a chart of the qualities of good money (durable, portable, divisible, uniform, limited, accepted) and rate Yap stones, gold coins, cattle and a bank balance on each from 1 to 5.
3. Write the formula for barter exchange rates and compute it for 10, 100 and 1,000 goods.

KEY FORMULAS

$$\text{Exchange rates needed under barter} = \frac{n(n-1)}{2}$$

$$\text{Prices needed with money} = n$$

From history. Furness published his account in *The Island of Stone Money* (1910). Yap's stones are still used today for ceremonial exchanges such as marriages and land transfers, while everyday purchases on the island are made in U.S. dollars.

WORKED EXAMPLES

Example 1. A village trades 20 different goods. How many exchange rates are needed under barter? How many prices are needed if one good becomes money?

Show solution

1. Barter: $\frac{20 \times 19}{2} = 190$ exchange rates.
2. With money: each of the other 19 goods needs one price in money, plus money itself (price 1): about 20 prices.

Answer: 190 barter rates versus about 20 money prices, a reduction of nearly ten times. With 1,000 goods, barter needs 499,500 rates.

Example 2. A farmer with wheat wants a plow. The smith wants cloth, the weaver wants wheat. Show how the trade happens with barter and with money.

Show solution

1. Barter: the farmer trades wheat to the weaver for cloth, then cloth to the smith for the plow: two trades, and only because he found both partners.
2. With money: the farmer sells wheat to anyone for money and pays the smith in money. The smith uses the money to buy cloth when he likes.
3. Money separates the act of selling from the act of buying, in time and in partner.

Answer: Barter needs a chain of matching wants; money lets each person sell to one and buy from another.

Example 3. Classify each use of money by its function: (a) a menu lists a sandwich at $8; (b) you pay $8 for it; (c) you save $8 for next week; (d) a friend promises to repay you $8 next month.

Show solution

1. (a) Unit of account: the price is measured in dollars.
2. (b) Medium of exchange.
3. (c) Store of value.
4. (d) Standard of deferred payment.

Answer: (a) unit of account; (b) medium of exchange; (c) store of value; (d) standard of deferred payment.

PRACTICE

1. Easy What is the double coincidence of wants?

   Show answer

   In barter, each trader must have what the other wants at the same time.

2. Easy Name money's four functions.

   Show answer

   Medium of exchange, unit of account, store of value, standard of deferred payment.

3. Easy Where were Yap's stones quarried, and roughly how far from Yap?

   Show answer

   On Palau, about 250 miles away.

4. Medium How many barter exchange rates are needed for 50 goods?

   Show answer

   $50 \times 49/2 = 1{,}225$.

5. Medium Give one reason cattle make poor money and one reason they were used anyway.

   Show answer

   Poor: not divisible, uniform or portable. Used: durable, valuable, and they produce more value (milk, calves) while held.

6. Medium Why did the German officials' painted crosses get the paths repaired?

Show answer

The cross marked the stone as taken by the government, which the islanders treated as a real loss of wealth, so they did the work to have it removed.

7. Medium A store lists prices in dollars but accepts payment in gift cards and dollars. Which function is the gift card serving?

Show answer

Medium of exchange (the dollar still serves as the unit of account).

8. Hard Explain the comparison Friedman drew between Yap and the movement of gold in a New York vault.

Show answer

In both cases wealth changed hands by changing the record of ownership, not by moving the object. The French gold never left the vault; it was relabeled, yet people spoke of a loss of American gold.

9. Hard During a severe inflation, which function of money fails first, and why?

Show answer

Store of value: money loses purchasing power quickly, so people spend it at once or switch to goods or foreign money. Unit of account fails next as prices change too fast.

10. Challenge A barter economy has 30 goods; adding money cuts the number of prices to 30. If each exchange rate must be learned at a cost of 1 minute, how many hours of learning does money save? What does this suggest about why money appears in every complex economy?

Show answer

Barter: $30 \times 29/2 = 435$ rates; money: 30. Saved 405 minutes, about 6.75 hours, and the savings grow with the square of the number of goods. As trade grows, money's savings become enormous, so societies adopt it.

COMMON MISTAKES

- Thinking money must be made of something valuable. Yap's stones and modern bank balances work through trust and records.

- Mixing up the unit of account and the medium of exchange. A price tag is the first; handing over payment is the second.
- Forgetting that the number of barter exchange rates grows much faster than the number of goods.

> **Make it a game · Barter Price Count.** Write five goods on cards and give each of you a few. Try to trade without money and notice how rarely both sides want what the other holds. Compute how many prices exist with five goods without money and with one money good. Your parent names other numbers of goods, and you answer in ten seconds. Then name the four functions of money.

4.2 Lydia's Coins and the Gold Trade

OBJECTIVES

- Explain why the first coins were struck in Lydia and how a stamp solved the problem of weighing and testing metal.
- Define seigniorage and calculate it for a coin whose face value exceeds the value of its metal.
- Trace the gold trade from Lydia to the caravans of the Sahara and explain what Mansa Musa's spending did to the value of gold in Cairo.

> **Warm-up.** Look at a quarter. Write every word, number and picture on both sides. Which of them tell you that it is genuine and how much it is worth?

WATCH

Mansa Musa, one of the wealthiest people who ever lived - Jessica Smith

TED-Ed · 3:54

https://www.youtube.com/watch?v=O3YJMaL55TM

> **WHEN TO WATCH**
> After the story of the Saharan gold trade, before the big idea.

BACKUP VIDEO

The History of the West African Salt Trade

World History Encyclopedia · 6:19

https://www.youtube.com/watch?v=5h8P9OxcLoo

With the section on the caravans.

KEY TERMS

electrum

A natural alloy of gold and silver found in the rivers of Lydia; the first coins were made of it.

coin

A piece of metal of set weight and fineness, stamped by an authority that guarantees it.

fineness

The share of pure precious metal in a coin or bar, often given in parts per thousand or carats.

seigniorage

The profit an issuer of money makes from the difference between the money's face value and its cost of production.

bimetallism

A money system using both gold and silver coins at a fixed ratio of value.

CORE IDEAS

The story. Lydia was a kingdom in western Anatolia (modern Turkey) whose rivers, especially the Pactolus, carried flakes of electrum, a natural mix of gold and silver. Around 600 BC, or a little before, Lydian kings began melting electrum into lumps of fixed weight and stamping them with a lion's head. These were the first true coins; some of the earliest were found buried under the temple of Artemis at Ephesus. The last Lydian king, Croesus (about 560–546 BC), took the next step. His workshops at Sardis refined electrum into nearly pure gold and pure silver and struck separate coins of each, at a fixed ratio of value: an early bimetallic system.

How they figured it out. Natural electrum varies a great deal in its gold content, so a lump of it is hard to value. Modern tests of Lydian coins show that they were fairly uniform, at about 55 percent gold, less than much of the natural metal. That suggests the kings mixed in silver deliberately and stood behind the coins with their stamp, so that merchants accepted them by count rather than by weighing and testing. The difference between what a coin was accepted for and what its metal cost was the king's profit, called **seigniorage**. Croesus's pure gold and silver coins solved the remaining doubt. Trade grew, and the Greek cities and later Rome copied the idea.

The big idea. A coin is a promise: the issuer guarantees its weight and fineness. That saves every trader the cost of weighing and testing, and it lets money pass by count. But the promise is only as good as the issuer. Because a coin may be worth more than its metal, an issuer earns seigniorage, and the temptation to put in less metal is always present (as you will see with Rome in Lesson 4.3). Gold was prized because it is scarce, durable and does not tarnish. Yet even gold's value depends on supply. Across the Sahara, from about AD 800 to 1500, camel caravans carried salt south and brought gold north from the fields of West Africa. In 1324 Mansa Musa, ruler of the

empire of Mali, passed through Cairo on pilgrimage to Mecca with a vast caravan and spent and gave away so much gold that, according to the historian al-Umari, its value in Cairo was still depressed twelve years later.

In business today. Governments still earn seigniorage: a U.S. quarter costs the Mint much less than 25 cents to make, and the difference becomes revenue to the Treasury. Gold still trades worldwide, measured by fineness and weight, and refiners stamp bars with marks that guarantee them, much as the Lydians did. Assayers, inspectors and auditors carry on the same work of building trust that the king's stamp began.

Who gained? Merchants gained from coins they could trust; kings gained seigniorage and the power to pay soldiers and builders; customers gained lower costs of trade. In Mali, the gold trade made the empire rich and supported cities of learning such as Timbuktu, though Mansa Musa's spending in Cairo also showed how a flood of money can lower its value.

PICTURE STUDY



Gold stater of Lydia (a "Croeseid"), Mint of Sardis, Lydia, about 560–546 BC · Gold · The Metropolitan Museum of Art, New York

Image: Wikimedia Commons, public domain

Coins like this one are credited to the reign of Croesus. One side shows the foreparts of a lion and a bull facing each other; the other has only two square punch marks, made when the coin was struck. It is thick and small, about the size of a fingernail, but it is nearly pure gold.

Look closely

- Find the lion and the bull. Which way does each face?
- The other side (not shown) has only two square punch marks. How might they have been made?
- Look at the edges. Are they perfectly round? What does that tell you about how coins were made?
- Notice what is missing: no words, no date, no number. How did people know its value?

Talk about it

1. What did the stamp promise to a merchant who received this coin?
2. Why would a pure gold coin be easier to trust than an electrum one?

3. How could a king profit from issuing coins, and what might tempt him to cheat?

PROJECT

Weigh the Coins: Metal Value, Face Value and Seigniorage

You will weigh modern U.S. coins, look up their metal content, estimate their metal value at current metal prices and calculate the seigniorage on each.

You will need

- 20 each of pennies, nickels, dimes and quarters
- A kitchen scale that reads in grams
- The U.S. Mint's coin specifications (usmint.gov) and a current price of copper and nickel per pound
- A spreadsheet
- Your ledger notebook

Steps

1. Weigh 20 of each coin and divide by 20. Compare with the Mint's official weights.
2. From the Mint's specifications, record each coin's composition (for example, the nickel is 75% copper and 25% nickel).
3. Find today's prices of copper and nickel per pound and convert to dollars per gram (1 pound = 453.6 grams).
4. Compute each coin's metal value.
5. Find the Mint's most recent unit cost for each coin in its annual report (with a parent) and compute seigniorage per coin (face value minus unit cost).
6. Which coin costs more to make than it is worth? What would a business do with a product like that?
7. Write a paragraph comparing a modern quarter with a Lydian gold coin: what each promises, and why people accept it.

Tips

- Pennies made before 1982 are mostly copper and heavier; check dates if your average is off.
- Metal prices change daily; record the date and source.

Check your work

- ☐ I can compute a coin's metal value from weight, composition and metal prices.
- ☐ I can define and calculate seigniorage.
- ☐ I can explain what a coin's stamp promises.

LEDGER NOTEBOOK

1. Copy your coin table: weight, composition, metal value, unit cost, face value and seigniorage.
2. Draw a map of the gold and salt routes across the Sahara, marking Timbuktu, the Niger River, Cairo and Mecca.
3. Sketch both sides of the Croeseid and label the lion, the bull and the punch marks.

KEY FORMULAS

$$\text{Seigniorage per coin} = \text{face value} - \text{cost of metal} - \text{cost of minting}$$

$$\text{Metal value} = \text{weight} \times \text{fineness} \times \text{price per gram}$$

From history. Herodotus, writing about a century after Croesus, said that the Lydians were the first people to use gold and silver coins and the first retail traders. Archaeologists at Sardis have found the refinery where Lydian goldsmiths separated gold from silver by heating electrum with salt.

WORKED EXAMPLES

Example 1. A Lydian electrum coin weighs 4.7 g and is 55% gold and 45% silver. Suppose gold is worth 13 times as much as silver, by weight. Express the coin's metal value in grams of silver.

Show solution

1. Gold: $0.55 \times 4.7 = 2.585$ g, worth $2.585 \times 13 = 33.6$ g of silver.
2. Silver: $0.45 \times 4.7 = 2.115$ g.
3. Total: $33.6 + 2.1 = 35.7$ g of silver.

Answer: About 35.7 grams of silver. If natural electrum with more gold had been valued the same, the king would gain the difference.

Example 2. A modern quarter costs the Mint about 12 cents to make (metal plus minting). If the Mint ships 2 billion quarters to banks in a year, estimate the seigniorage.

Show solution

1. Seigniorage per coin: $25 - 12 = 13$ cents.
2. Total: $2 \times 10^9 \times \$0.13 = \$260$ million.

Answer: About \$260 million. (The cost figure is an estimate; the Mint reports its exact unit costs each year in its annual report.)

Example 3. Before Mansa Musa's visit, 1 mithqal of gold traded in Cairo for 25 silver dirhams; afterward, by al-Umari's report, it traded for about 22. By what percent did gold's value in silver fall?

Show solution

1. Change: $22 - 25 = -3$.
2. Percent: $-3/25 = -12\%$.

Answer: Gold lost about 12% of its value in silver in Cairo: a local inflation in gold prices caused by a sudden increase in the supply of gold.

PRACTICE

1. Easy What is electrum, and where was it found?

   Show answer

   A natural gold-silver alloy found in Lydia's rivers, such as the Pactolus.

2. Easy About when were the first coins struck, and by whom?

   Show answer

   About 600 BC or a little earlier, by the kings of Lydia.

3. Easy What did Croesus add to coinage?

   Show answer

   Separate coins of refined, nearly pure gold and silver, at a fixed ratio.

4. **Medium** A coin has face value \$1 and costs 30 cents to make. Find the seigniorage on 50 million coins.

   Show answer

   $0.70 \times 50{,}000{,}000 = \$35$ million.

5. **Medium** A 10-gram bar is 90% gold. Gold is \$70 a gram. Find its metal value.

   Show answer

   $10 \times 0.9 \times 70 = \$630$.

6. **Medium** Why were Lydian electrum coins valuable only because of the king's stamp, in a way pure gold was not?

   Show answer

   Their gold content was hard to judge by eye, so people relied on the king's guarantee rather than on their own test of the metal.

7. **Medium** What did the caravans carry across the Sahara in each direction?

   Show answer

   Salt went south; gold went north.

8. **Hard** Explain, using supply and demand, what Mansa Musa's spending did to gold in Cairo.

   Show answer

   A sudden large increase in the supply of gold in Cairo lowered its price in terms of silver and goods: each unit of gold bought less.

9. **Hard** If the price of copper and nickel rose so that a nickel's metal was worth 8 cents, what might people do, and why?

   Show answer

   Some might melt or hoard nickels, because the metal is worth more than the coin's face value. (The United States has made melting coins for profit illegal for this reason.)

10. **Challenge** A king strikes 10,000 electrum coins of 4.7 g each. If he uses 55% gold instead of a natural 70%, how many grams of gold does he save? At 13 g of silver per g of gold, what is that worth in silver?

    Show answer

    Gold saved per coin: $0.15 \times 4.7 = 0.705$ g; total 7,050 g, worth about 91,650 g of silver.

COMMON MISTAKES

- Thinking the first coins came from Greece or Rome. They came from Lydia; the Greeks and Romans copied the idea.
- Assuming gold always holds the same value. A flood of gold lowers its value, as in Cairo in 1324.
- Confusing a coin's face value with its metal value.

Make it a game · Seigniorage Mint Duel. Your parent names a coin with a face value and a metal value, such as face 10, metal 6. Compute the seigniorage per coin and for a run of 1,000 coins. Use a kitchen scale to compare real coins if you wish. Explain how Lydian coins solved the problem of weighing and testing metal, and what fineness and electrum mean.

Scripture. "And Abraham hearkened unto Ephron; and Abraham weighed to Ephron the silver, which he had named in the audience of the sons of Heth, four hundred shekels of silver, current money with the merchant." (Genesis 23:16, KJV)

Long before coins, Abraham paid by weighing silver of the standard "current with the merchant." Coins later did the weighing in advance, with a stamp to vouch for it.

4.3 Rome's Denarius and Its Debasement

OBJECTIVES

- Trace the silver content of the Roman denarius from Augustus to the third century.
- Explain debasement as a hidden tax and connect it to rising prices, using the quantity of money.
- State Gresham's law and explain why good coins disappear from circulation when bad ones are issued at the same value.

> **Warm-up.** Your allowance is $10 a week. Suppose a new rule quietly makes every dollar buy only 90 cents' worth of goods, and the next year 80 cents. Write how you would notice, and what you would do.

WATCH

How Inflation Ruined the Roman Economy

toldinstone · 13:53

https://www.youtube.com/watch?v=qrebO_9bhuM

> **WHEN TO WATCH**
> After the story, before the big idea.

Note: By a historian of ancient Rome. Skip the sponsor message from 4:25 to 5:18.

KEY TERMS

denarius

The standard silver coin of Rome for over four centuries; the "penny" of the King James New Testament.

debasement

Reducing the precious-metal content of coins while keeping their face value.

Gresham's law

The principle that when two kinds of money have the same legal value but different metal value, the better money is hoarded and the worse circulates: "bad money drives out good."

antoninianus

A Roman coin introduced about AD 215, officially worth two denarii but containing much less than twice the silver.

purchasing power

The quantity of goods and services a unit of money will buy.

CORE IDEAS

The story. Under the emperor Augustus (27 BC–AD 14), the silver denarius was nearly pure silver and weighed about 3.9 grams. It was a day's wage for a laborer in the parable of the vineyard, and it bore the emperor's image, as Jesus pointed out when asked about the tribute (Matthew 22:19–21). In AD 64 the emperor Nero lowered both its weight and its silver. Later emperors kept going. By the reign of Septimius Severus (193–211) the denarius was only about half silver. His son Caracalla introduced a new coin, the antoninianus, worth two denarii but containing only about one and a half times the silver. By the 260s and 270s, under emperors fighting invasions and rebellions, the coins were bronze with a thin silver wash, often only a few percent silver.

How they figured it out. The emperors had bills to pay: armies, officials, the free grain of the city of Rome. Taxes were hard to raise, and mines were not producing enough silver. Making more coins from the same silver seemed a quiet way to pay. Ordinary Romans soon noticed. People hoarded the older, purer coins and spent the new ones, so that the good coins vanished from circulation, an effect later called **Gresham's law** after the Elizabethan merchant Sir Thomas Gresham. As the quantity of coins grew faster than goods, prices rose. Surviving records from Roman Egypt show the price of wheat rising many times over during the third century, with the steepest rise after the 270s. Soldiers increasingly demanded pay in goods, and some taxes were collected in kind.

The big idea. Debasement is a hidden tax: the issuer gains real resources, and everyone holding coins loses purchasing power as prices rise. When the money supply grows much faster than the goods it buys, prices rise; this is **inflation**.

Because people can test coins, debased money also changes behavior: good coins are hoarded, melted or sent abroad, and trust in money declines. Debasement buys time for a government, but it damages the unit of account, discourages saving and lending, and in the end forces more painful reforms. Diocletian's attempt to stop rising prices by law (AD 301) is the subject of Lesson 7.5.

In business today. Modern money is not made of silver, but the same principle holds: when money is created much faster than goods and services, its purchasing power falls. Businesses track inflation carefully, because it changes costs, prices and the real value of debts and savings. A firm that signs a long contract in a currency losing value may be paid in money worth far less than it expected. The prophet's complaint, "Thy silver is become dross," has been heard in many centuries.

Think it through. Honest money is a form of honest weights and measures (Leviticus 19:35–36). A ruler who debases the coin takes from his people without their knowledge, which is why debasement has so often been treated in history as a betrayal of trust.

PICTURE STUDY



Christ and the Tribute Money, Domenico Fetti, about 1618–1622 · Oil on panel · The Walters Art Museum, Baltimore

Image: Wikimedia Commons, public domain

Fetti painted the moment in Matthew 22 when Jesus, asked whether it was lawful to pay tribute to Caesar, said, "Shew me the tribute money," and was handed a denarius. "Whose is this image and superscription?" he asked. The coin in the questioner's hand was the standard silver coin of the empire, nearly pure silver in that century.

Look closely

- Find the coin. Who is holding it, and how?
- Look at Christ's hand. What is he doing with it?
- Study the questioner's face. What is he thinking?
- Look at the clothes. How did the painter show the difference between Christ and the questioners?

Talk about it

1. Why did the coin bear the emperor's image, and what did that image promise?
2. What would happen to the meaning of that promise when later emperors debased the coin?

3. What does “Render therefore unto Caesar the things which are Caesar’s; and unto God the things that are God’s” teach about money and loyalty?

PROJECT

A Debasement Simulation

You will run a small coin economy with your family, debase the coins step by step and record what happens to prices and to what people choose to spend and keep.

You will need

- Pennies and dimes (or two colors of tokens)
- A kitchen scale
- Index cards for goods
- Three or more players
- Your ledger notebook

Steps

1. Round 1: each player gets 20 “good” coins (dimes). Set prices for five goods in coins, and trade for 5 minutes. Record prices and trades.
2. Round 2: the parent, as emperor, issues a new coin (a penny) and declares it equal to a dime. Give each player 10 pennies in addition. Trade again and record which coins players spend and which they keep.
3. Round 3: the emperor issues 20 more pennies to each player. Allow sellers to change prices. Record the new prices.
4. Compute the percent change in the price of each good from Round 1 to Round 3.
5. Count how many dimes stayed in players’ pockets in Rounds 2 and 3. Explain using Gresham’s law.
6. Weigh 10 dimes and 10 pennies. Compute grams per coin and compare with the emperor’s declared values.
7. Write a paragraph comparing your simulation with Rome in the third century.

Tips

- Let sellers change their prices freely; that is where the lesson shows.
- Keep the simulation short so that players stay engaged.

Check your work

- ☐ I can explain debasement as a hidden tax.
- ☐ I can state and illustrate Gresham's law.
- ☐ I can calculate percent changes in silver content and prices.

LEDGER NOTEBOOK

1. Copy your price table for the three rounds and the percent changes.
2. Draw a line graph of the denarius's silver content: about 3.8 g (Augustus), about 3.0 g (after Nero), about 1.6 g (about AD 200), and under 0.2 g (the 270s, using the antoninianus's silver per denarius of value).
3. Write Gresham's law in your own words and give a modern example.

KEY FORMULAS

$$\text{Silver content} = \text{weight} \times \text{fineness}$$

$$\text{Percent change} = \frac{\text{new} - \text{old}}{\text{old}} \times 100\%$$

From history. Sir Thomas Gresham (about 1519–1579) advised Queen Elizabeth I to restore England's coinage after her father Henry VIII had debased it. The phrase "Gresham's law" was coined much later, in 1858, by the economist Henry Dunning Macleod, though the idea was known long before, including to the astronomer Copernicus.

WORKED EXAMPLES

Example 1. Under Augustus a denarius weighed about 3.9 g at about 97% silver. By about AD 200 a denarius weighed about 3.2 g at about 50% silver. Find the silver content of each and the percent change.

Show solution

1. Augustus: $3.9 \times 0.97 = 3.78$ g.
2. About AD 200: $3.2 \times 0.50 = 1.60$ g.
3. Change: $\frac{1.60 - 3.78}{3.78} \approx -58\%$.

Answer: The denarius lost about 58% of its silver in two centuries.

Example 2. An antoninianus was valued at 2 denarii but contained about 1.5 times the silver of a denarius. If you had 100 denarii, how much silver would you gain by melting them and paying debts in antoniniani instead?

Show solution

1. 100 denarii pay a debt of 100 denarii. In antoniniani you need 50 coins.
2. Silver in 50 antoniniani: $50 \times 1.5 = 75$ denarius-units of silver.
3. You keep $100 - 75 = 25$ denarius-units of silver.

Answer: You save a quarter of the silver, which is exactly why people hoarded the older coins and paid in the newer ones: Gresham's law.

Example 3. Suppose a province's supply of coins rises from 10 million to 25 million while the quantity of goods traded stays the same and people spend coins just as often. By about how much would prices rise?

Show solution

1. With goods and spending speed unchanged, prices rise in proportion to the money supply.
2. Ratio: $25/10 = 2.5$.
3. Prices rise about 150%.

Answer: Prices about 2.5 times higher, an increase of about 150%. (You will meet the full quantity equation in Lesson 4.5.)

PRACTICE

1. Easy About how much did an Augustan denarius weigh, and how pure was it?

   Show answer

   About 3.9 g, nearly pure silver.

2. Easy Which emperor first reduced the denarius in AD 64?

   Show answer

   Nero.

3. Easy State Gresham's law.

Show answer

When two moneys have the same legal value but different metal value, the better one is hoarded and the worse one circulates.

4. Medium A coin of 3.4 g is 90% silver. Find its silver content.

Show answer

3.06 g.

5. Medium Silver content falls from 3.0 g to 1.5 g. If prices adjust fully to silver content, by what percent do prices rise?

Show answer

Each coin has half the silver, so prices about double: a 100% rise.

6. Medium Why did Roman emperors debase the coinage instead of raising taxes?

Show answer

Debasement was quieter and quicker: it let them pay armies and officials with more coins from the same silver, without passing new taxes.

7. Medium Explain why debasement is called a hidden tax.

Show answer

The government gains purchasing power by issuing more coins, and holders of money lose it through higher prices, without any tax being openly levied.

8. Hard An antoninianus in the 270s might weigh about 3.5 g and contain 2% silver, valued at 2 denarii. How much silver did it contain per denarius of value? Compare with Augustus.

Show answer

Silver: 0.07 g, so 0.035 g per denarius of value, about one percent of Augustus's 3.8 g.

9. Hard Why might soldiers in the third century prefer to be paid in food and clothing rather than coins?

Show answer

Coins were losing value quickly and prices were rising, so goods held their value better than money.

10. **Challenge** Prices of wheat in Roman Egypt rose many times over in the third century. Using the quantity theory, name two things besides more coins that could have pushed prices up, and explain how.

Show answer

Less output (war, plague, disrupted trade reduces goods, so more money chases fewer goods) and faster spending (people spend coins quickly as they lose trust, raising velocity). Either raises prices for a given quantity of coins.

COMMON MISTAKES

- Thinking Rome's money lost value all at once. The debasement took about two centuries, speeding up in the third.
- Treating debasement and inflation as unrelated. Debasement increased the number of coins relative to goods, which raised prices.
- Getting Gresham's law backward. Bad money drives out good, not the reverse, when both must be accepted at the same value.

Make it a game · The Emperor's Mint. You are the emperor with a pile of silver tokens, each worth 100 percent silver. Each round you mint more by lowering silver content, and your parent plays the merchant raising prices. Track the silver percentage, prices and purchasing power for six rounds. Your parent hoards the good coins to show Gresham's law. Explain how debasement is a hidden tax.

Scripture. "Thy silver is become dross," (Isaiah 1:22, KJV)

Isaiah used debased silver as a picture of a people who had lost their integrity. A debased coin looks the same but is worth less, and so does a debased character.

4.4 The Florentine Florin and the Medici Bank

OBJECTIVES

- Explain why the gold florin of 1252 became a standard of value across Europe.
- Describe how the Medici Bank used bills of exchange to move money and to earn returns, and why it collapsed.
- Calculate the gain on a bill of exchange from the difference between exchange rates in two cities.

> **Warm-up.** If you had to send $1,000 to a relative in another country without using a bank or the internet, how would you do it? List the dangers.

WATCH

How did Medieval Banking Work? (Short Animated Documentary)

History Matters · 3:17

https://www.youtube.com/watch?v=UE7nd36EpRU

> **WHEN TO WATCH**
> After the story, before the bill-of-exchange examples.

BACKUP VIDEO

The Gold Florin of Florence

Paolo Penko · 3:50

https://www.youtube.com/watch?v=tC78sn0U89s

With the picture study, to see how a florin was made.

KEY TERMS

florin

The gold coin of Florence, first struck in 1252, about 3.5 grams of nearly pure gold.

bill of exchange

A written order to pay a sum of money in another place and usually another currency at a future date.

usury

In medieval usage, charging interest on a loan; the Church forbade it, though lending by bills of exchange was permitted.

exchange rate

The price of one currency in terms of another.

branch

An office of a business in another city, managed under the main firm.

CORE IDEAS

The story. In 1252 the city of Florence began striking a gold coin, the *fiorino d'oro*, with the city's lily on one side and St. John the Baptist on the other. It contained about 3.5 grams of gold as pure as the minters could make it, and Florence kept that weight and purity essentially unchanged for about two centuries. Merchants across Europe came to trust it, and the florin became a common unit of account for great transactions from London to the Levant. Florentine merchant-bankers, using that trusted coin, built international firms. The greatest was the bank founded by Giovanni di Bicci de' Medici in 1397 and enlarged by his son Cosimo, with branches in Rome, Venice, Geneva (later Lyon), Bruges, London, Avignon, Milan and Pisa.

How they figured it out. The Church's rule against usury forbade charging interest on a simple loan. Bankers used the **bill of exchange** instead. A merchant in Florence paid florins to the Medici and received a bill ordering the Medici branch in Bruges to pay him a set amount in Flemish money weeks later, when he arrived. The bank set exchange rates so that a round trip of bills (Florence to Bruges and back) returned more florins than it started with, a gain earned through currency exchange and time. Merchants got safe transfers without carrying gold across Europe. The Medici also kept careful double-entry books, appointed branch managers as junior partners with a share of profits, and audited them each year.

The big idea. Money is most useful when it is stable: a coin whose value people trust becomes a **unit of account** across borders. The florin's stability made it the measuring stick for contracts far from Florence. Banking adds a second idea: credit can move value without moving metal. A bill of exchange is a promise, and a network of branches that honor each other's promises can serve as a payment system across a continent. But credit depends on judgment. In its later years, under

managers less careful than Cosimo, the Medici Bank lent heavily to princes, such as the kings of England during their wars, who were slow to repay or did not repay at all. Branches failed one by one, and when the Medici were driven from Florence in 1494, the bank collapsed.

In business today. International payments still work like a network of bills of exchange. When a company in Chicago pays a supplier in Germany, banks with accounts in each other's countries adjust balances in dollars and euros; little currency crosses the ocean. Exchange rates still determine whether such transfers gain or lose, and banks still fail when they lend too much to borrowers who cannot or will not repay.

Who gained? Stakeholder scorecard for the Medici Bank: financiers (the Medici partners) earned great fortunes for decades; risk-takers (branch managers) shared profits but also bore losses; builders (clerks and accountants) developed bookkeeping and banking skills that spread across Europe; customers gained safe, fast transfers; the community of Florence gained patronage of art and learning, though the bank's ties to the city's government also entangled the city in its troubles.

PICTURE STUDY



Portrait of Cosimo de' Medici the Elder, Jacopo Pontormo, about 1518–1520 · Oil on panel · Uffizi Gallery, Florence

Image: Wikimedia Commons, public domain

Cosimo de' Medici (1389–1464) led the family bank at its height and was Florence's leading citizen. Pontormo painted this portrait about fifty years after his death for the Medici family. The laurel branch beside him, with one cut stem and a living shoot, was a family emblem: the family goes on.

Look closely

- Look at Cosimo's clothing. Is it showy or plain? What might that say about how he wished to be seen?
- Find the laurel branch. Notice the cut stem and the new growth.
- Look at his hands and face. What mood did the painter give him?
- What objects of trade or wealth are missing from the picture? Why might the painter leave them out?

Talk about it

1. Cosimo kept careful books and audited his branches every year. Why would that matter to a bank spread across Europe?
2. How did the bill of exchange let the Medici earn returns while obeying the rule against usury?

3. What lesson does the bank’s later collapse teach about lending?

PROJECT

A Medici Branch Network

You will set up a small network of "branches" at home, send bills of exchange between them with different exchange rates, and keep a ledger showing the bank's gains and its risks.

You will need

- Index cards for bills of exchange
- Two kinds of play money for two "currencies"
- A notebook ledger for each branch
- Two or three players
- A spreadsheet

Steps

1. Set up two branches, Florence (florins) and Bruges (groats). Each branch starts with a cash reserve.
2. Post exchange rates: in Florence, the bank sells bills on Bruges at 54 groats per florin; in Bruges, it sells bills on Florence at 58 groats per florin.
3. Players act as merchants who want to move money between cities. Write and honor at least six bills in each direction.
4. Each branch records every bill in its ledger: date, merchant, amount, rate, and the amount owed by or to the other branch.
5. At the end, settle accounts between the branches and compute the bank's total gain.
6. Add a risk: one large borrower (a "prince") takes a loan from the Bruges branch and fails to repay. Recompute the bank's position.
7. Write a one-page report to Cosimo: how much the network earned, where the risk lay, and one rule you would make for branch managers.

Tips

- Use different colors of play money for the two currencies.
- Keep both branches' ledgers carefully; the final settlement must balance.

Check your work

- ☐ I can explain how a bill of exchange worked.
- ☐ I can compute a round-trip gain from two exchange rates.
- ☐ I can explain why the Medici Bank failed.

LEDGER NOTEBOOK

1. Copy both branch ledgers and the final settlement.
2. Draw a map of the Medici branches across Europe.
3. Write a stakeholder scorecard (1–5 with reasons) for the Medici Bank at its height and at its collapse.

KEY FORMULAS

$$\text{Amount received} = \text{amount sent} \times \text{exchange rate}$$

$$\text{Round-trip gain} = \frac{\text{florins returned} - \text{florins sent}}{\text{florins sent}} \times 100\%$$

From history. The Medici family later produced two popes and two queens of France. The bank's records survived in the Florentine archives and were studied in detail by the historian Raymond de Roover, whose book *The Rise and Decline of the Medici Bank* (1963) remains the standard account.

WORKED EXAMPLES

Example 1. A Florence merchant pays the Medici 100 florins for a bill payable in Bruges at 54 groats per florin. In Bruges, the Medici agent later buys a bill back to Florence at 58 groats per florin. How many florins does the round trip return?

Show solution

1. In Bruges: $100 \times 54 = 5{,}400$ groats.
2. Back to Florence: $5{,}400 / 58 \approx 93.1$ florins.
3. The rates are the other way round for the bank: it receives 5,400 groats' worth and later pays back fewer florins.

Answer: The merchant who sent 100 florins and brought them back would hold about 93.1 florins; the bank, on the other side of both bills, earned about 6.9 florins over the months the bills took, about 6.9%.

Example 2. A florin weighs 3.54 g of gold. If gold is worth $70 a gram today, what is a florin's gold worth? How many florins would a merchant need to carry to make a payment worth $50,000, and what would they weigh?

Show solution

1. Value: $3.54 \times 70 \approx \$248$.
2. Coins: $50{,}000 / 248 \approx 202$ florins.
3. Weight: $202 \times 3.54 \approx 715$ g (about 1.6 pounds of gold).

Answer: About 202 florins weighing about 715 g. A bill of exchange let the merchant carry a sheet of paper instead of a fortune in gold past robbers.

Example 3. Using the six stakeholders, explain why lending to kings hurt the Medici Bank.

Show solution

1. Financiers: royal borrowers often paid late or not at all, and could not be sued like merchants.
2. Risk-takers: branch managers in London and Bruges, eager for royal favor, lent beyond safe limits.
3. Customers: depositors' money was tied up in bad loans, so branches could not pay them.
4. Community: Florence suffered when the bank failed in 1494.

Answer: The bank broke its own rule of careful, diversified lending; concentrated loans to powerful borrowers turned profits into losses.

PRACTICE

1. Easy When was the gold florin first struck, and what did it show?

   Show answer

   1252; the lily of Florence and St. John the Baptist.

2. Easy Who founded the Medici Bank, and when?

   Show answer

   Giovanni di Bicci de' Medici, in 1397.

3. Easy What is a bill of exchange?

Show answer

A written order to pay a sum in another place, usually in another currency, at a later date.

4. Medium Why did merchants across Europe trust the florin?

Show answer

Florence kept its weight and gold purity nearly constant for about two centuries.

5. Medium A merchant sends 200 florins at 55 groats per florin. How many groats are paid in Bruges?

Show answer

11,000 groats.

6. Medium Name three cities where the Medici had branches.

Show answer

Any three of Rome, Venice, Geneva/Lyon, Bruges, London, Avignon, Milan, Pisa.

7. Medium How did the Medici manage branch managers to keep them honest and diligent?

Show answer

Managers were junior partners with a share of the profits, and branches were audited annually from Florence.

8. Hard A bank sells bills at 52 groats per florin in Florence and buys florins back at 56 groats per florin in Bruges. Find the round-trip return to the bank on 1,000 florins.

Show answer

$1{,}000 \times 52 = 52{,}000$ groats; returning at 56 costs $52{,}000/56 \approx 928.6$ florins, so the bank gains about 71.4 florins, a little over 7%.

9. Hard Why did lending to kings and princes prove dangerous for medieval banks?

Show answer

Rulers could delay or refuse repayment, could not easily be sued, and borrowed large sums for wars; one default could ruin a branch.

10. Challenge A round trip of bills took about six months and returned 7%. What is the approximate annual return if the bank could repeat it twice a year? Why might the Church have treated this differently from a loan at 14% a year?

Show answer

About $1.07^2 - 1 \approx 14.5\%$ a year. The bill involved exchange of currencies and real risk from changing rates, so it was treated as a trade rather than a loan, though critics argued it was disguised interest.

COMMON MISTAKES

- Thinking the florin was a paper note. It was a gold coin; the paper was the bill of exchange.
- Assuming the Medici simply charged interest. They earned returns mainly through exchange rates on bills.
- Forgetting that stable money and careful credit are separate virtues; the florin stayed sound while the bank failed.

Make it a game · Bill of Exchange Relay. Draw a map with Florence, Bruges and London. You are the Medici branch in Florence; your parent is a merchant in Bruges who needs funds in London. Write a bill of exchange, then convert the amounts using exchange rates you choose. Show how the bank earned a profit hidden in the rate. Explain why the florin was trusted and why the bank collapsed.

Scripture. “Wherefore then gavest not thou my money into the bank, that at my coming I might have required mine own with usury?” (Luke 19:23, KJV)

In the parable, the master expects even the timid servant to put the money where it would earn something. Stewardship means putting resources to work, with care.

4.5 Spanish Silver and the Great Rise in Prices

OBJECTIVES

- Tell the story of Potosí and the flow of American silver into Europe and Asia.
- State the quantity equation MV = PY and use it to explain the sixteenth-century rise in prices.
- Explain how the Spanish piece of eight became the first world currency and the model for the U.S. dollar.

> **Warm-up.** If everyone in your town suddenly had twice as much money, but the stores had the same goods on their shelves, what would happen to prices? Write your prediction and your reason.

WATCH

Potosi: The Silver Mine that Changed the World

The History Guy: History Deserves to Be Remembered · 13:43

https://www.youtube.com/watch?v=5BebknA0PeU

> **WHEN TO WATCH**
> After the story of Potosí, before the big idea.

BACKUP VIDEO

A Short History Of The Spanish Dollar: How It Impacted The World | Digging History '76

Digging History '76 · 11:57

https://www.youtube.com/watch?v=VKpkh0TMDGs

With the section on the piece of eight.

KEY TERMS

price revolution

The long rise in European prices from about 1500 to 1650, when the general price level rose several times over.

quantity equation

MV = PY: money times velocity equals the price level times real output.

velocity of money

The average number of times a unit of money is spent on final goods and services in a year.

piece of eight

The Spanish silver peso of 8 reales, struck in the Americas and used worldwide.

mita

A system of compulsory labor imposed by Spanish authorities on Andean villages to supply workers for the mines.

CORE IDEAS

The story. In 1545 Spanish prospectors found a mountain of silver ore in the high Andes, the Cerro Rico above Potosí, in what is now Bolivia. Within a few decades Potosí was one of the largest cities in the Americas. In the 1570s the viceroy Francisco de Toledo brought in a new process of refining silver with mercury, and organized a system of forced labor called the **mita**, which required Andean villages to send men to work the mines in rotation. The work was brutal and dangerous, and many died; it is a grave wrong in the history of money, and it should be remembered plainly. Silver from Potosí and from Mexico was minted into pieces of eight, carried to Spain in treasure fleets, and from 1571 shipped across the Pacific to Manila to buy Chinese silk and porcelain.

How they figured it out. Prices in Spain and then across Europe began to rise and kept rising. Over the sixteenth century, prices in Spain rose roughly fourfold. In 1556 a Spanish priest and scholar at the University of Salamanca, Martín de Azpilcueta, noticed the pattern: where money is scarce, goods and labor are cheap, and where it is abundant, as in Spain after the discovery of the Indies, they are dear. In 1568 the French writer Jean Bodin made the same argument. They had found what economists now call the quantity theory of money. Spain itself paid a price: rich in silver, it bought from abroad what it no longer made at home, and despite the treasure its crown defaulted on its debts several times.

The big idea. The **quantity equation** says $MV = PY$: the money spent in a year (money stock M times velocity V) equals the value of what is bought (price level P times real output Y). If velocity is steady and output grows slowly, then when the money supply grows faster than output, prices rise. In percentages, approximately:

money growth plus velocity growth equals inflation plus output growth. The silver of the Americas raised Europe's money supply far faster than its output for decades, and prices followed. Money does not make a nation richer by its quantity; wealth is goods and services, and more money chasing the same goods only raises their prices.

In business today. Central banks watch the growth of money and credit because of the same relationship, though velocity can change, sometimes suddenly. The Spanish dollar left a lasting mark: it was legal tender in the United States until 1857, it was the model for the U.S. dollar defined in the Mint Act of 1792, and its eight "bits" gave Americans the phrase "two bits" for a quarter. A trusted coin of steady weight became the first world currency, used from Boston to Canton.

Who gained? The Spanish crown and the financiers of its treasure fleets gained enormous revenues, though much of the silver flowed out to pay for wars and imports. Merchants in the Netherlands, England and China gained a flood of silver for their goods. The miners forced into the mita suffered terribly; people are made in God's image and are never mere tools of production. Ordinary Europeans on fixed incomes saw their wages buy less as prices rose.

PICTURE STUDY



Spanish silver 8 reales (piece of eight), Mexico City mint, Mexico City mint, 1739 · Silver · Photograph of a coin in a private collection

Image: Wikimedia Commons, public domain

This “pillar dollar” was struck in Mexico City in 1739. One side shows two hemispheres of the world under a crown between the Pillars of Hercules, with the Latin motto VTRAQUE VNUM (“both are one”). Coins like this, with machine-made round edges that were hard to clip, became the most trusted silver money in the world.

Look closely

- Find the two globes. What do they stand for?
- Find the two pillars with banners. Some think this design is the origin of the dollar sign ($). Can you see why?
- Look at the edges. Why would a well-made edge discourage people from shaving off silver?
- Find the date and the mint mark. Where was this coin made?

Talk about it

1. Why would merchants in China, Europe and America all accept this coin?
2. How did millions of coins like this one raise prices in Europe?
3. Who mined the silver, and at what cost to them?

PROJECT

The Quantity Theory in a Model Market

You will run a small market twice, once with a fixed supply of money and once after a "treasure fleet" arrives, and test the quantity equation with your data.

You will need

- Play money
- Index cards for goods (at least 10 goods)
- Three or more players
- A spreadsheet
- Your ledger notebook

Steps

1. Round 1: give each player $20 and put 10 goods on sale. Let sellers set prices and buyers bid for 5 minutes. Record every sale price.
2. Compute total spending ($M \times V$) as the sum of all sale prices, the number of goods sold (Y) and the average price (P).
3. Round 2: a treasure fleet arrives. Give each player $40 more. Offer the same 10 goods. Trade for 5 minutes and record prices.
4. Compute the same totals and compare. Did the average price change in proportion to the money?
5. Compute velocity in each round: total spending divided by the money stock.
6. Explain any difference from the theory (for example, players who hoarded money, changing velocity).
7. Write a paragraph applying your results to sixteenth-century Spain.

Tips

- Keep the number and kind of goods identical in both rounds.
- Record every price; the average is the key number.

Check your work

☐ I can state and use the quantity equation.

☐ I can calculate an average annual inflation rate over many years.

☐ I can explain the price revolution and its human cost.

LEDGER NOTEBOOK

1. Copy your two rounds of data: money stock, spending, goods sold, average price and velocity.
2. Draw a map of the silver routes: Potosí to the Pacific coast, across to Panama and Spain, and from Acapulco to Manila and China.
3. Write Azpilcueta's insight in one sentence of your own.

KEY FORMULAS

$$MV = PY$$

$$\%\Delta M + \%\Delta V \approx \%\Delta P + \%\Delta Y$$

$$\text{Average annual rate} = \left(\frac{\text{end}}{\text{start}}\right)^{1/n} - 1$$

From history. The Manila galleons sailed between Acapulco and Manila from 1565 to 1815, and for two and a half centuries much of the world's silver ended up in China, which was then switching its tax payments to silver. Historians sometimes date the beginning of a truly global economy to 1571, when Manila was founded as the meeting point of American silver and Chinese goods.

WORKED EXAMPLES

Example 1. In an economy, $M = 500$ million pesos, $V = 4$ and real output $Y = 1{,}000$ million units. Find the price level. If M doubles and V and Y stay the same, what happens to P?

Show solution

1. Price level: $P = \dfrac{MV}{Y} = \dfrac{500 \times 4}{1{,}000} = 2$ pesos per unit.
2. Doubling M: $P = \dfrac{1{,}000 \times 4}{1{,}000} = 4$.

Answer: P = 2 pesos per unit, and it doubles to 4 when M doubles with V and Y unchanged.

Example 2. Prices in Spain rose about fourfold between 1500 and 1600. What average annual inflation rate does that imply?

Show solution

1. Ratio: 4 over 100 years.
2. Annual rate: $4^{1/100} - 1 = e^{(\ln 4)/100} - 1 \approx 0.0140$.

Answer: About 1.4% a year: slow by modern standards, but compounded over a century it quadrupled prices and was called a revolution.

Example 3. Suppose Europe's money stock grew 2.5% a year, output grew 0.5% a year and velocity was steady. Estimate the inflation rate.

Show solution

1. Use $\%\Delta M + \%\Delta V \approx \%\Delta P + \%\Delta Y$.
2. So $2.5 + 0 \approx \%\Delta P + 0.5$, and $\%\Delta P \approx 2.0\%$.

Answer: About 2% a year.

PRACTICE

1. Easy When and where was the silver mountain of Potosí discovered?

   Show answer

   In 1545, in the Andes, in modern Bolivia.

2. Easy Write the quantity equation and name each letter.

   Show answer

   $MV = PY$: money stock, velocity, price level, real output.

3. Easy What was the mita?

   Show answer

   A Spanish system of forced labor requiring Andean villages to send workers to the mines.

4. Medium M = 200, V = 5, Y = 400. Find P.

   Show answer

   $P = 1{,}000/400 = 2.5$.

5. **Medium** Money grows 6%, velocity is steady and output grows 2%. Estimate inflation.

Show answer

About 4%.

6. **Medium** Who was Martín de Azpilcueta and what did he observe?

Show answer

A Salamanca scholar who in 1556 observed that goods are cheap where money is scarce and dear where it is abundant, as in Spain after the American treasure.

7. **Medium** How did the piece of eight influence the United States?

Show answer

It circulated widely in America, was legal tender until 1857, and was the model for the U.S. dollar in the Mint Act of 1792.

8. **Hard** Prices triple over 80 years. Find the average annual inflation rate.

Show answer

$3^{1/80} - 1 \approx 1.38\%$ a year.

9. **Hard** Spain received vast silver yet its crown defaulted several times. Explain how a country can receive treasure and still not grow rich.

Show answer

The silver raised prices and paid for imports and wars rather than building domestic production. Wealth is the ability to produce goods and services, not the quantity of money.

10. **Challenge** Use the quantity equation to explain why prices might not rise when money increases. Give two cases.

Show answer

If output Y rises as fast as money (a growing economy), or if velocity V falls (people hold money longer, or hoard it), then P need not rise.

COMMON MISTAKES

- Thinking more money makes a nation richer. More money with the same goods mainly raises prices.

- Forgetting velocity in the quantity equation. Prices depend on how fast money is spent as well as how much there is.
- Treating 1.4% a year as small. Compounded over a century it quadruples prices.

> **Make it a game · Quantity Equation Drill.** Write MV = PY. Your parent gives three of four numbers and you solve for the fourth within twenty seconds. Then your parent doubles the money supply, holds velocity and output fixed, and asks what happens to prices. Do six rounds. Finally, in sixty seconds, tell how Potosi silver flowed through Spain to Europe and Asia and raised prices.

UNIT 4

The Story of Money I: Commodity Money

This unit tells the first half of the story of money. You will begin on the island of Yap, where great stone disks served as money without ever moving, and use it to learn what money does. Then you will follow precious metal: the first coins of Lydia and the gold of Croesus and Mansa Musa; the Roman denarius, slowly emptied of its silver by emperors who needed to pay their armies; the gold florin of Florence, so steady that it became a measuring stick for all of Europe, and the Medici bankers who moved money with paper instead of gold; and the silver mountain of Potosí, whose treasure raised prices across Europe and gave the world its first global coin.

Along the way you will calculate the savings money brings over barter, the seigniorage that tempts every issuer, the hidden tax of debasement, the gains on a bill of exchange, and the quantity equation that ties money to prices. You will also see the human cost behind some of history's money, told plainly.

PREREQUISITES

- Units 1–3
- Percents, ratios and exponents
- Using a spreadsheet for simple tables

MASTERY CHECKLIST

- ☐ I can name and illustrate money's four functions and explain how money solves the problems of barter.
- ☐ I can explain why the first coins were struck in Lydia and calculate seigniorage.
- ☐ I can explain debasement as a hidden tax and state Gresham's law.
- ☐ I can explain bills of exchange and why the Medici Bank rose and fell.
- ☐ I can use the quantity equation MV = PY to explain the great rise in European prices after 1500.
- ☐ I can tell the history of the Spanish dollar and its link to the U.S. dollar.

OPTIONAL BOOKS AND GAMES FOR THIS UNIT

- ***The Wealth of Nations*, by Adam Smith, Book I, chapter 4, "Of the Origin and Use of Money"**: Free. Smith's short account of barter, commodity money, coins and debasement. Read it with Lessons 4.1–4.3. Ages 14+.
- ***The Island of Stone Money*, by William Henry Furness (1910)**: Free on the Internet Archive. The chapter on stone money tells the stories used in Lesson 4.1, with photographs. Ages 14+.
- **Federal Reserve History (federalreservehistory.org)**: Free. Reliable essays on the history of money and banking; useful throughout Units 4–6.

Not required. Every project in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

4.1	**Barter and the Functions of Money: The Stone Money of Yap**	3 sessions of 50 minutes
4.2	**Lydia's Coins and the Gold Trade**	3 sessions of 50 minutes
4.3	**Rome's Denarius and Its Debasement**	3 sessions of 50 minutes
4.4	**The Florentine Florin and the Medici Bank**	3 sessions of 50 minutes
4.5	**Spanish Silver and the Great Rise in Prices**	3 sessions of 50 minutes

Unit 4 Test

Calculators are allowed. Show your work for every calculation: write the formula, substitute and solve. Answer the concept questions in complete sentences. The test is worth 100 points.

1. **6 pts**

   Name money's four functions and give an example of each.

2. **6 pts**

   How many barter exchange rates are needed for 40 goods? How many prices with money?

3. **6 pts**

   Explain how ownership of Yap's stones changed without moving them, and how this resembles modern money.

4. **6 pts**

   Why were the first Lydian coins stamped, and what did Croesus add?

5. **8 pts**

   A coin costs 6 cents to make and has a face value of 10 cents. Find the seigniorage on 3 billion coins. Explain what seigniorage is.

6. **6 pts**

   What happened to the value of gold in Cairo after Mansa Musa's visit in 1324, and why?

7. **8 pts**

   A denarius of 3.9 g at 97% silver is replaced by one of 3.4 g at 80% silver. Find the silver in each and the percent loss.

8. **6 pts**

   State Gresham's law and explain it with the Roman antoninianus.

9. **6 pts**

   Why is debasement called a hidden tax?

10. **8 pts**

    A Florence merchant sends 500 florins to Bruges at 56 groats per florin; the return bill is at 60 groats per florin. How many florins would the round trip return, and what is the bank's gain in percent?

11. **6 pts**

    Give two reasons the florin became a standard of value across Europe, and one reason the Medici Bank failed.

12. **8 pts**

M = 800, V = 5, Y = 2,000. (a) Find P. (b) M rises to 1,200 with V and Y unchanged. Find the new P and the percent change.

13. **6 pts**

Prices doubled in 60 years. Find the average annual inflation rate.

14. **6 pts**

Who was Martín de Azpilcueta, and why does he matter to economics?

15. **8 pts**

Short essay: Spain received more silver than any nation in history. Explain why it did not become the richest nation in Europe, and what this teaches about wealth. Include the human cost of the silver.

ANSWER KEY

1. Medium of exchange (paying for groceries), unit of account (a price tag), store of value (savings), standard of deferred payment (a loan written in dollars).
2. $40 \times 39/2 = 780$; about 40 prices.
3. Ownership was recorded by common knowledge; the stone stayed put while everyone recognized its new owner. Modern money is mostly records in bank ledgers that change without anything physical moving.
4. The stamp guaranteed weight and fineness so coins could pass by count rather than being weighed and tested. Croesus struck separate pure gold and silver coins.
5. $0.04 \times 3 \times 10^9 = \$120$ million. Seigniorage is the issuer's profit from money's face value exceeding its cost of production.
6. It fell, because his caravan spent and gave away so much gold that the supply in Cairo rose suddenly; the effect lasted about twelve years by al-Umari's account.
7. 3.78 g and 2.72 g; $(2.72 - 3.78)/3.78 \approx -28\%$.
8. Bad money drives out good when both must be accepted at the same value. People spent the antoninianus (valued at two denarii but with less silver) and hoarded older, purer denarii.
9. The government gains purchasing power from issuing more coins, and holders of money lose it through rising prices, without any openly levied tax.
10. $500 \times 56 = 28{,}000$ groats; $28{,}000/60 \approx 466.7$ florins. The bank gains about 33.3 florins, about 6.7%.
11. Steady weight and purity for about two centuries; Florence's wide trading network. The bank failed after heavy, unwise lending to rulers who did not repay (and the family's expulsion in 1494).
12. (a) $P = 4{,}000/2{,}000 = 2$. (b) $P = 6{,}000/2{,}000 = 3$, a 50% rise.
13. $2^{1/60} - 1 \approx 1.16\%$ a year.
14. A Salamanca scholar who in 1556 observed that money is worth less where it is abundant, an early statement of the quantity theory of money.
15. A strong answer explains that the silver raised prices and paid for imports and wars rather than domestic production, that wealth is goods and services rather than money, and that the silver was mined largely by forced Andean labor under the mita, a grave injustice.

PORTFOLIO PIECE: A MUSEUM CASE OF COMMODITY MONEY

Design a museum case (a poster or a display box) of six objects that tell the story of commodity money, from barter to the piece of eight. For each object, make a label with its date, place, what it was made of, which functions of money it served well or poorly, and one calculation (a seigniorage, a silver content, a percent change or an exchange gain). Add a one-page essay that explains the quantity equation with a historical example, and a timeline from Yap and Lydia to Potosí.

LOOK FOR	WHAT IT MEANS
Accuracy	Dates, places and facts on every label are correct.
Calculations	Each label's calculation is correct, with units and a clear explanation.
Understanding	The essay uses MV = PY correctly and connects it to history.
Presentation	The case is clear, neat and readable from a few feet away.

UNIT 5

The Story of Money II: Banks and the Gold Standard

In this unit money becomes paper and ledger entries, and banks take center stage. You will meet the goldsmiths of London, who invented fractional-reserve banking and learned its danger when the king stopped paying in 1672; the Bank of England, founded in 1694 to lend to a government at war, which grew into the model of a central bank; and America's long struggle over banking, from Hamilton's bank and the free-banking era to the Panic of 1907, when J. P. Morgan rescued Wall Street from his library.

Then you will follow the secret meeting on Jekyll Island and the creation of the Federal Reserve in 1913, and see how the classical gold standard tied the world's money together until 1914. You will compute money multipliers, read central-bank balance sheets, value discounted banknotes and calculate mint parity, and you will stage your own bank run and rescue.

PREREQUISITES

- Unit 4 (functions of money, the quantity equation)
- Basic balance sheets (assets, liabilities, capital)
- Geometric series (helpful, not required)

MASTERY CHECKLIST

- ☐ I can explain fractional-reserve banking and compute the money multiplier.
- ☐ I can explain why banks are exposed to runs and what a lender of last resort does.
- ☐ I can tell the history of the Bank of England and state Bagehot's rule.
- ☐ I can trace American banking from 1791 to 1907 and value discounted banknotes.
- ☐ I can describe the founding and structure of the Federal Reserve and show how a discount loan changes balance sheets.
- ☐ I can compute mint parity and explain how the classical gold standard adjusted.

OPTIONAL BOOKS AND GAMES FOR THIS UNIT

- *Lombard Street*, by Walter Bagehot (1873): Free. The classic account of the London money market and the lender of last resort. Read chapter 7 with Lesson 5.2. Ages 15+.
- Federal Reserve History: "The Federal Reserve Act" and "The Panic of 1907": Free. Short essays by Fed historians on the events of Lessons 5.3 and 5.4.
- Bank of England Museum (online collections): Free. Images and stories from the Bank's history, including early notes and the 1694 charter. Use with Lesson 5.2.

Not required. Every project in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

5.1 The Goldsmiths of London and Fractional-Reserve Banking

3 sessions of 50 minutes

5.2 The Bank of England, 1694, and the Lender of Last Resort

3 sessions of 50 minutes

5.3 American Banking from Hamilton's Bank to the Panic of 1907

3 sessions of 50 minutes

5.4 Jekyll Island and the Federal Reserve, 1913 — 3 sessions of 50 minutes

5.5 How the Classical Gold Standard Worked — 3 sessions of 50 minutes

Unit 5 Test

Calculators are allowed. Show your work for every calculation: write the formula, substitute and solve. Answer the concept questions in complete sentences. The test is worth 100 points.

1. **6 pts**

   How did London goldsmiths become bankers? Name the two steps.

2. **8 pts**

   A $2,000 deposit enters a system with a 15% reserve ratio. (a) Find the money multiplier. (b) Find the maximum total deposits. (c) How much can the first bank lend?

3. **6 pts**

   What was the Stop of the Exchequer, and what did it teach about banking?

4. **6 pts**

   Why was the Bank of England founded in 1694, and what were the terms of its first loan?

5. **6 pts**

   State Bagehot's rule and explain each part.

6. **6 pts**

   A central bank lends £50 million with a 20% haircut. How much collateral is needed?

7. **6 pts**

   A $50 note trades at a 5% discount, and a $20 note at 2%. Find their total value.

8. **6 pts**

   Why did free-banking notes trade at discounts, and how did the National Banking Acts change this?

9. **8 pts**

   Describe the Panic of 1907: its trigger, the key run, and how it was stopped.

10. **6 pts**

    Describe the structure of the Federal Reserve System and why it was designed that way.

11. **8 pts**

    A Reserve Bank lends $60 million to member banks, which withdraw $45 million as notes. Show the net changes to the Reserve Bank's assets and liabilities.

12. **6 pts**

    With a 40% gold requirement and $360 million in gold, what is the most notes a Reserve Bank could issue?

13. **8 pts**

    The U.S. price of gold was $20.67 an ounce and the German price 86.8 marks an ounce. (a) Find the mark–dollar parity. (b) If shipping cost 0.02 marks per dollar, find the gold points.

14. **6 pts**

    Explain Hume’s price-specie-flow mechanism.

15. **8 pts**

    Short essay: What were the main strengths and weaknesses of the classical gold standard? Who gained and who lost?

ANSWER KEY

1. They took gold for safekeeping and issued receipts that circulated as money; then they lent out part of the gold at interest, keeping a fraction as reserves.
2. (a) $1/0.15 \approx 6.67$. (b) $2{,}000/0.15 \approx \$13{,}333$. (c) $\$1{,}700$.
3. Charles II's 1672 suspension of payments on his debts to goldsmiths, which caused runs and failures. Banks are only as sound as their loans and depend on depositors' trust.
4. To lend to William III's government for war with France; it lent £1,200,000 at 8% in return for a charter and the right to issue notes.
5. Lend freely (to stop the panic), against good collateral (to protect the central bank and lend only to solvent banks), at a high rate (to discourage needless borrowing).
6. $50/0.8 = £62.5$ million.
7. $47.50 + 19.60 = \$67.10$.
8. Notes from distant or risky banks cost more to redeem and might be worthless. The acts created uniform national banknotes backed by government bonds, and a tax drove out state notes.
9. A failed copper corner brought suspicion on linked banks and trust companies; depositors ran on the Knickerbocker Trust, which closed October 22. J. P. Morgan organized bankers to support sound institutions and clearinghouses issued certificates.
10. A Board in Washington and twelve regional Reserve Banks owned by member banks, balancing fears of Wall Street control and of control from Washington and serving different regions.
11. Assets: loans +$60 million. Liabilities: bank reserves +$15 million (60 − 45), notes +$45 million. Both sides rise by $60 million.
12. $360/0.40 = \$900$ million.
13. (a) $86.8/20.67 \approx 4.20$ marks per dollar. (b) About 4.18 to 4.22.
14. A trade deficit sends gold abroad, shrinking the money supply and lowering prices; cheaper goods raise exports and lower imports until the deficit closes. A surplus does the opposite.
15. Strengths: long-run price stability, confidence, fixed exchange rates. Weaknesses: money depended on gold discoveries, long deflations, painful

adjustment for deficit countries. Lenders and traders gained; debtors such as farmers in falling-price periods lost.

PORTFOLIO PIECE: A BANKER'S HISTORY OF THE UNITED STATES

Write an illustrated history, six to eight pages, of American banking from 1791 to 1914, organized around five turning points (for example 1791, 1836, 1863, 1907 and 1913). For each, explain what problem people faced, what was tried, and what it meant for the six stakeholders. Include at least three calculations from the unit (a money multiplier, a discounted note, a central-bank balance sheet or a mint parity) and a timeline.

LOOK FOR	WHAT IT MEANS
Accuracy	Dates, names and events are correct and in order.
Analysis	Each turning point explains the problem, the solution and its effect on stakeholders.
Calculations	At least three correct calculations, clearly explained.
Writing	Clear, organized and well illustrated with labeled pictures or diagrams.

5.1 The Goldsmiths of London and Fractional-Reserve Banking

OBJECTIVES

- Tell how London goldsmiths became bankers in the seventeenth century.
- Explain fractional-reserve banking and calculate the simple money multiplier.
- Explain why fractional-reserve banks are exposed to runs, using the Stop of the Exchequer of 1672.

> **Warm-up.** A friend leaves $100 with you for a month and takes a written receipt. Another friend asks to borrow $60 for two weeks. Write what you would need to believe before lending it, and what could go wrong.

WATCH

Fractional Reserve Banking and the Money Multiplier Made Simple

Marginal Revolution University · 6:55

https://www.youtube.com/watch?v=93_Va7I7Lgg

> **WHEN TO WATCH**
> After the story, before the worked examples.

BACKUP VIDEO

Overview of fractional reserve banking | The monetary system | Macroeconomics | Khan Academy

Khan Academy · 8:28

https://www.youtube.com/watch?v=3mUi9IZb4T4

During the worked examples.

KEY TERMS

deposit

Money left with a bank, which the bank promises to repay.

reserves

The part of deposits a bank keeps as cash (or, today, on account at the central bank) rather than lending out.

reserve ratio

Reserves divided by deposits.

fractional-reserve banking

A system in which banks keep only a fraction of deposits as reserves and lend the rest.

money multiplier

The maximum ratio of total deposits to reserves in a simple banking system: 1 divided by the reserve ratio.

bank run

A rush of depositors to withdraw their money because they fear the bank cannot pay.

CORE IDEAS

The story. In the seventeenth century, London merchants often kept their gold in the king's mint in the Tower of London. In 1640 King Charles I, short of money, seized about £130,000 of it, returning it only after loud complaints and a forced loan. Merchants looked for safer keepers and turned to the goldsmiths of Lombard Street and Cheapside, who had strong vaults. A goldsmith gave a written receipt for each deposit. Soon depositors found it easier to pay their debts by handing over the receipts than by withdrawing gold, and receipts, and then the goldsmiths' written notes payable to bearer, began to pass from hand to hand as money.

How they figured it out. The goldsmiths noticed that on any given day only a small share of depositors came for their gold. The rest sat in the vault. So they began lending part of it at interest, to merchants and to the government, while keeping enough on hand to meet ordinary withdrawals. They had invented **fractional-reserve banking**. It worked well until confidence failed. In January 1672 King Charles II, whose government owed the goldsmiths about £1.3 million, announced the **Stop of the Exchequer**: he would stop repaying his loans for a year. Depositors rushed to the goldsmiths for their gold, and several of the leading goldsmith-bankers failed. The lesson that banks are only as sound as their loans, and only as safe as their depositors' trust, was learned the hard way.

The big idea. A bank that keeps a fraction rr of its deposits as reserves can lend the rest. When those loans are spent and redeposited in other banks, they are lent again, so the banking system as a whole can create deposits, which are money, several times larger than its reserves. In the simplest model, the maximum is $\Delta D = \Delta R / rr$, and $1/rr$ is the **money multiplier**. Real multipliers are smaller, because people hold some cash and banks hold extra reserves. The same arrangement creates a

weakness: since a bank cannot pay all depositors at once, fear can cause a **run**, and a run can bring down even a sound bank. Every later institution in this unit, from the Bank of England to deposit insurance, was in part a response to that weakness.

In business today. Commercial banks still take deposits and make loans, and most of the money people use is bank deposits. Banks must hold capital (the owners' own money) as a cushion against bad loans, keep liquid assets to meet withdrawals, and can borrow from the central bank in an emergency. Deposit insurance, which you will study in Unit 8, makes runs far rarer. For a borrower, the old wisdom still holds: "the borrower is servant to the lender" (Proverbs 22:7).

Who gained? Merchants gained safekeeping, convenient payments and access to credit; goldsmiths gained a new business and interest income; borrowers gained loans for trade; the community gained more money and credit for commerce. But when the king defaulted, depositors who had trusted the goldsmiths lost heavily, showing that risk does not disappear when it is hidden in a vault.

PICTURE STUDY



The Moneylender and His Wife, Quentin Matsys, 1514 · Oil on panel · Musée du Louvre, Paris

Image: Wikimedia Commons, public domain

Painted in Antwerp, then the busiest money market in northern Europe, this picture shows a money-changer weighing coins while his wife, holding a book of prayers, glances at his scale. Coins from many lands crossed his table, and only a careful weighing could tell their true value. A frame once carried a line from Leviticus: “Let the balance be just and the weights equal.”

Look closely

- Find the balance in the man’s hands. What is he weighing?
- Look at the coins, pearls and rings on the table. How many kinds of wealth can you see?
- Find the prayer book. Where is the wife looking?
- Find the small round mirror. What is reflected in it?

Talk about it

1. Why did money-changers and goldsmiths need to weigh coins so carefully?
2. How did people like this become bankers?
3. What does the prayer book next to the scale suggest about the moral side of handling money?

PROJECT

A Banking System on the Kitchen Table

You will play the roles of several banks, track deposits and loans in a ledger for each, find the money multiplier from your results, and then stage a bank run.

You will need

- Play money
- Index cards for receipts and loan notes
- A ledger page for each of three to five banks
- A spreadsheet

Steps

1. Set a reserve ratio of 20%. Bank A receives a deposit of $1,000 in play money. Record it in Bank A's ledger.
2. Bank A keeps the required reserve and lends the rest to a borrower, who spends it at a shop that deposits it in Bank B.
3. Repeat through at least five banks, recording deposits, reserves and loans in each ledger.
4. Total the deposits across all banks. Compare with the formula $\Delta D = \Delta R / rr$.
5. Build the full table in a spreadsheet for 30 rounds and graph total deposits as the rounds go on.
6. Stage a run on Bank B: depositors ask for 40% of their deposits at once. Can Bank B pay? What could it do?
7. Write a paragraph comparing your run with the Stop of the Exchequer of 1672.

Tips

- Write every entry in each bank's ledger as you go; the totals must balance.
- In the run, let Bank B try to borrow from another bank. Who would lend to it, and on what terms?

Check your work

☐ I can explain how fractional reserves create deposits.

- ☐ I can compute the money multiplier and maximum deposits.
- ☐ I can explain why banks are exposed to runs.

LEDGER NOTEBOOK

1. Copy the ledgers for your banks and the spreadsheet graph of total deposits.
2. Draw a goldsmith's balance sheet before and after the Stop of the Exchequer.
3. Write the geometric series for deposits and show that it sums to D_0/rr.

KEY FORMULAS

$$\text{Reserve ratio } rr = \frac{\text{Reserves}}{\text{Deposits}}$$

$$\text{Money multiplier} = \frac{1}{rr}, \qquad \Delta D_{\max} = \frac{\Delta R}{rr}$$

$$\text{Excess reserves} = \text{Reserves} - rr \times \text{Deposits}$$

> **From history.** Lombard Street, home of many goldsmith-bankers, took its name from the Italian bankers from Lombardy who had worked there in the Middle Ages. Walter Bagehot later gave the title *Lombard Street* to his famous book on the London money market (1873).

WORKED EXAMPLES

Example 1. A goldsmith holds £10,000 of deposited gold and decides to keep 20% in the vault. How much can he lend? Show his balance sheet after lending.

Show solution

1. Reserves to keep: $0.20 \times 10{,}000 = £2{,}000$.
2. He can lend $£8{,}000$.
3. Assets: gold £2,000 + loans £8,000 = £10,000. Liabilities: deposits (receipts) £10,000.

Answer: He lends £8,000; his books balance with £2,000 of gold and £8,000 of loans against £10,000 owed to depositors.

Example 2. A new deposit of $1,000 enters a banking system with a 10% reserve requirement. Trace the first three rounds of lending and find the maximum total new deposits.

Show solution

1. Bank A: deposit $1,000, keeps $100, lends $900.
2. Bank B: deposit $900, keeps $90, lends $810.
3. Bank C: deposit $810, keeps $81, lends $729.
4. Maximum total deposits: $\$1{,}000 \times \dfrac{1}{0.10} = \$10{,}000$.

Answer: The deposits form a geometric series 1,000 + 900 + 810 + … that sums to at most $10,000.

Example 3. A goldsmith has £50,000 of deposits, £10,000 of gold and £40,000 lent to the king. The king stops paying, and depositors demand £15,000 in one week. What happens?

Show solution

1. Gold on hand: £10,000. Demands: £15,000.
2. The loans to the king cannot be collected, so they cannot be turned into gold.
3. Shortfall: $£5{,}000$; the goldsmith cannot pay and fails, unless someone lends to him.

Answer: He fails. A bank can be ruined by a run when its assets cannot be turned into cash quickly, especially when a large borrower defaults.

PRACTICE

1. Easy Why did London merchants start keeping gold with goldsmiths?

   Show answer

   They needed safe vaults, especially after Charles I seized merchants' gold from the mint in the Tower in 1640.

2. Easy What is a reserve ratio?

   Show answer

   Reserves divided by deposits.

3. **Easy** What was the Stop of the Exchequer?

Show answer

Charles II's suspension of repayments on government debt in 1672, which ruined several goldsmith-bankers.

4. **Medium** With a reserve ratio of 25%, what is the money multiplier?

Show answer

$1/0.25 = 4$.

5. **Medium** A \$5,000 deposit enters a system with a 12.5% reserve ratio. Find the maximum total deposits.

Show answer

$5{,}000/0.125 = \$40{,}000$.

6. **Medium** A bank has deposits of \$200,000 and reserves of \$30,000. The required ratio is 10%. Find its excess reserves.

Show answer

$30{,}000 - 20{,}000 = \$10{,}000$.

7. **Medium** Why is the real-world multiplier smaller than $1/rr$?

Show answer

People hold some cash rather than depositing it, and banks may keep extra reserves or find fewer good borrowers.

8. **Hard** Explain why even a sound bank can fail in a run.

Show answer

Its loans cannot be turned into cash quickly. If enough depositors demand cash at once, the bank cannot pay, even though its loans may be good in the long run.

9. **Hard** How did the goldsmiths' notes become money?

Show answer

Receipts and notes payable to bearer were trusted and could be handed over in payment, so people used them in place of gold.

10. **Challenge** Show that $1 + (1 - rr) + (1 - rr)^2 + \cdots = 1/rr$ and compute the deposits created after 10 rounds of a $1,000 deposit at a 10% ratio.

Show answer

Geometric series with ratio $1 - rr$: sum $1/(1 - (1 - rr)) = 1/rr$. After 10 rounds: $1{,}000 \times \dfrac{1 - 0.9^{10}}{0.1} \approx \$6{,}513$.

COMMON MISTAKES

- Thinking banks lend out depositors' money and therefore have less money in total. Lending creates new deposits in the banking system.
- Using the reserve ratio as the multiplier. The multiplier is its reciprocal.
- Assuming a bank with good loans cannot fail. Liquidity, not only soundness, matters in a run.

Make it a game · Multiplier Guess and Check. A 1,000-dollar deposit meets a 10 percent reserve ratio. Before calculating, guess how much total money the banking system can create. Then compute the first five rounds of lending by hand and apply the formula for the simple money multiplier. The closer guess scores. Explain how London goldsmiths became bankers and what happens in a bank run.

Scripture. "The rich ruleth over the poor, and the borrower is servant to the lender." (Proverbs 22:7, KJV)

Banking made borrowing easier, but it did not change this truth. Debt binds the borrower, and wise people and wise nations borrow with care.

5.2 The Bank of England, 1694, and the Lender of Last Resort

OBJECTIVES

- Explain why the Bank of England was founded in 1694 and how its loan to the government worked.
- Describe the Bank's growth into a central bank and the meaning of convertibility and its suspension (1797–1821).
- State Bagehot's rule for a lender of last resort and apply it to a banking panic.

> **Warm-up.** Write down three reasons a government might want a bank of its own, and three dangers in letting a government own or control a bank.

WATCH

Discover the Bank of England Museum

Bank of England · 1:52

https://www.youtube.com/watch?v=VozhNp789Jg

> **WHEN TO WATCH**
> With the picture study, as a short tour of the Bank's museum.

Note: Short; the lesson text carries the history.

KEY TERMS

central bank

A bank that serves the government and other banks, issues currency and acts as lender of last resort.

banknote

A paper note issued by a bank, promising to pay the bearer on demand.

convertibility

The right to exchange a banknote for gold (or silver) at a fixed price.

lender of last resort

An institution that lends to sound banks in a panic when no one else will.

collateral

Assets pledged to secure a loan, which the lender may take if the loan is not repaid.

CORE IDEAS

The story. In 1694 King William III's government needed money for its war with France, and its credit was poor after the Stop of the Exchequer. A Scottish merchant named William Paterson proposed a scheme: investors would subscribe £1,200,000 to form a new company, the Governor and Company of the Bank of England, which would lend the whole sum to the government at 8% interest. In return, the Bank received a royal charter and the right to issue notes. The subscription filled in about twelve days. The Bank began work in the Mercers' Hall, with a staff of about nineteen.

How they figured it out. The Bank grew as the government's banker and as a bank for merchants. Its notes, promising to pay the bearer in gold or silver, circulated widely in London. In 1797, during the war with France, a run on its gold led Parliament to suspend convertibility: the Bank's notes could no longer be exchanged for gold, a period called the Restriction, which lasted until 1821. During the nineteenth century, panics struck the London money market again and again. In 1866 the great discount house Overend, Gurney and Company failed, and the Bank lent heavily to other banks to stop the panic. Walter Bagehot, editor of *The Economist*, drew the lessons in *Lombard Street* (1873).

The big idea. A central bank stands at the center of a fractional-reserve system. It holds other banks' reserves, issues the most trusted money and can lend when others will not. Bagehot's rule for a panic is still quoted: lend **freely**, to solvent banks, against **good collateral**, at a **high rate** of interest. Lending freely stops the run; good collateral protects the central bank; a high rate discourages banks from borrowing when they do not need to and from relying on rescue in calm times. The danger is moral hazard: if banks expect to be rescued whatever they do, they may take too much risk.

In business today. Nearly every country has a central bank. The Bank of England, nationalized in 1946 and made independent in setting interest rates in 1998, still issues Britain's banknotes and lends to banks under the principles Bagehot

described. Businesses feel central banks mainly through interest rates and the availability of credit, which you will study in Unit 6.

Who gained? The government gained a reliable lender, allowing it to borrow at lower rates than before; the Bank's shareholders (the financiers) gained a steady return; merchants gained trusted notes and a safer money market; the country gained financial strength that helped it in the wars of the eighteenth century. The cost was that the government's ease of borrowing tempted it into larger debts.

PICTURE STUDY



The Great Hall, Bank of England (from The Microcosm of London), Thomas Rowlandson and Augustus Charles Pugin; aquatint by John Hill; published by Rudolph Ackermann, 1808 · Hand-colored aquatint and etching · The Metropolitan Museum of Art, New York

Image: Wikimedia Commons, public domain

Pugin drew the architecture and Rowlandson the people in this view of the Bank's Great Hall in 1808, during the Restriction, when its notes could not be exchanged for gold. Clerks at long counters record transactions; merchants, clerks and messengers come and go. It is a picture of trust at work: thousands of people bringing their money to one institution.

Look closely

- Find the clerks behind the counters. What are they doing?
- Look at the people on the floor. Can you tell merchants from messengers?
- Find the statue at the far end. Why might a bank place a statue there?
- Look at the windows and the height of the hall. What impression did the building give?

Talk about it

1. Why would a bank build such a grand hall?
2. In 1808 these notes could not be turned into gold. Why did people still accept them?
3. What would a panic look like in this room?

PROJECT

Lender of Last Resort: A Panic Simulation

You will play out a banking panic with several banks and one central bank, following Bagehot's rule, and record what happens to each bank.

You will need

- Play money
- Cards describing four banks' balance sheets
- A central-bank ledger
- Four or five players
- Your ledger notebook

Steps

1. Make balance-sheet cards for four banks: two sound with good collateral, one sound but short of cash, one insolvent (its bad loans exceed its capital).
2. Announce a rumor. Each bank faces withdrawals of 30% of deposits.
3. Banks short of cash may apply to the central bank. The central bank follows Bagehot: it lends freely at a 10% penalty rate against good collateral, with a 20% haircut.
4. Record each loan, the collateral pledged and the interest charged.
5. Determine which banks survive and which fail. Compute each surviving bank's cost of borrowing.
6. Replay the panic with no lender of last resort. How many banks fail now?
7. Write a one-page memo to the Bank's directors explaining why Bagehot's rule works and what danger it brings.

Tips

- Make the insolvent bank's card look tempting; part of the lesson is learning to say no.
- Keep all ledgers balanced as you go.

Check your work

- ☐ I can explain how the Bank of England began and how it became a central bank.
- ☐ I can state and apply Bagehot's rule.
- ☐ I can calculate collateral with a haircut.

LEDGER NOTEBOOK

1. Copy the central-bank ledger and the results of both rounds of the panic.
2. Make a timeline of the Bank of England: 1694, 1797, 1821, 1866, 1873, 1946, 1998.
3. Copy Bagehot's rule and explain each of its three parts in one sentence.

KEY FORMULAS

$$\text{Annual interest} = \text{principal} \times \text{rate}$$

$$\text{Collateral needed} = \frac{\text{loan}}{1 - \text{haircut}}$$

From history. The Bank's own first governor was Sir John Houblon, whose portrait appeared on the £50 note from 1994 to 2014. The Bank moved to Threadneedle Street in 1734, and its nickname, "the Old Lady of Threadneedle Street," comes from a 1797 cartoon about the Restriction.

WORKED EXAMPLES

Example 1. The Bank of England lent £1,200,000 to the government at 8% a year. Find the annual interest. The government also paid the Bank £4,000 a year for managing the loan. What did the shareholders receive each year in total?

Show solution

1. Interest: $0.08 \times £1{,}200{,}000 = £96{,}000$.
2. Total: $£96{,}000 + £4{,}000 = £100{,}000$ a year.

Answer: £100,000 a year, about 8.3% on the subscribed capital, before the Bank's other banking profits.

Example 2. In a panic, a bank asks the central bank for a £10 million loan. The central bank requires collateral with a 20% haircut (it lends only 80% of the collateral's value). How much collateral must the bank pledge?

Show solution

1. Loan = 80% of collateral, so collateral = $10/0.80 = £12.5$ million.

Answer: £12.5 million of good collateral. The haircut protects the central bank if the collateral loses value.

Example 3. Apply Bagehot's rule to three banks in a panic: Bank X is sound and has good bonds; Bank Y has lost most of its capital on bad loans; Bank Z is sound but wants to borrow cheaply to expand. What should the central bank do?

Show solution

1. Bank X: lend freely against its bonds at a penalty rate.
2. Bank Y: it is insolvent; lending would only delay failure and put public money at risk. Let it be resolved.
3. Bank Z: the high rate will discourage borrowing it does not need.

Answer: Lend to X, not to Y; Z will stay away because of the high rate.

PRACTICE

1. Easy Who proposed the Bank of England, and how much did it first lend to the government?

   Show answer

   William Paterson; £1,200,000, at 8%.

2. Easy What was the Restriction of 1797–1821?

   Show answer

   A suspension of the convertibility of Bank of England notes into gold during the wars with France.

3. Easy State Bagehot's rule.

   Show answer

   In a panic, lend freely to solvent institutions, against good collateral, at a high rate.

4. Medium Find the annual interest on £1,200,000 at 8%. How much is that per month?

Show answer

£96,000 a year; £8,000 a month.

5. Medium A central bank lends £30 million with a 25% haircut. How much collateral is needed?

Show answer

$30 / 0.75 = £40$ million.

6. Medium Why does Bagehot's rule call for a high rate?

Show answer

To discourage banks from borrowing unless they truly need to, and to avoid encouraging risky behavior in calm times.

7. Medium What is moral hazard in central banking?

Show answer

The risk that banks take more risk because they expect to be rescued.

8. Hard Why did the government of William III need the Bank, and what did the Bank gain?

Show answer

The government needed war funds and had poor credit after the Stop of the Exchequer. The Bank gained a charter, interest income and the right to issue notes.

9. Hard Explain why a central bank should not lend to an insolvent bank in a panic.

Show answer

An insolvent bank's assets are worth less than its debts; lending only delays failure, risks public money and rewards poor management.

10. **Challenge** During the Restriction, Bank of England notes fell to a discount against gold: at one point about £1 in notes bought only about 80% of the gold it had bought before. Use this to explain what convertibility does, and calculate the percent premium on gold.

    Show answer

    Convertibility ties notes to a fixed quantity of gold, so notes cannot lose value against it. Without it, notes floated. If £1 of notes buys 0.8 of the gold, gold costs $1/0.8 = 1.25$ in notes: a 25% premium.

COMMON MISTAKES

- Thinking the Bank of England was a government department from the start. It was a private company with a royal charter until 1946.
- Thinking a lender of last resort should rescue every bank. Bagehot's rule is for solvent banks with good collateral.
- Confusing convertibility with the value of the paper itself. Convertible notes are promises to pay gold.

> **Make it a game · Panic at the Counter.** Your parent plays frightened depositors, and you are the Bank of England. Decide how much to lend, against what collateral, and at what penalty rate, as a lender of last resort. Explain what the Bank's 1694 loan to the government did, and what convertibility meant. Describe what happened when it was suspended from 1797 to 1821.

5.3 American Banking from Hamilton's Bank to the Panic of 1907

OBJECTIVES

- Trace American banking from the First Bank of the United States (1791) through free banking and the national banks to 1907.
- Explain why banknotes of the free-banking era traded at discounts and calculate their value.
- Explain how the Panic of 1907 unfolded and how J. P. Morgan organized its rescue.

> **Warm-up.** Imagine every bank in town printing its own dollars, each with a different design. Write three problems a shopkeeper would face. Then write one way he might protect himself.

WATCH

Segment 201: The First Bank of the United States

Philadelphia Fed · 4:10

https://www.youtube.com/watch?v=gTS4kuWT9lE

> **WHEN TO WATCH**
> After the section on Hamilton's bank.

KEY TERMS

national bank

A bank chartered by the federal government; in the First and Second Banks of the United States, a single large bank with branches; after 1863, many banks under federal charter.

free banking

The period (about 1837–1863) when many states let anyone meeting set rules open a bank and issue notes.

bank-note discount

The amount by which a bank's note traded below face value, reflecting the risk and distance of the issuing bank.

trust company

A financial firm that managed estates and took deposits, often with fewer rules and smaller reserves than banks before 1907.

clearinghouse

An association through which banks settle checks with each other and, in panics, pool reserves.

CORE IDEAS

The story. In 1791 Congress chartered the First Bank of the United States, proposed by Treasury Secretary Alexander Hamilton. It held the government's funds, issued notes and opened branches in major cities. Its twenty-year charter was not renewed in 1811. A Second Bank was chartered in 1816, but in 1832 President Andrew Jackson vetoed the renewal of its charter, and it lost its federal role in 1836. For the next quarter century, state-chartered banks issued thousands of different kinds of notes. Shopkeepers relied on monthly "bank-note reporters" and counterfeit detectors to know which notes were good and at what discount. The National Banking Acts of 1863 and 1864 created federally chartered banks with uniform notes backed by government bonds, and a tax drove state banknotes out of use.

How they figured it out. The national system gave the country a uniform currency, but it had a serious flaw: the amount of currency could not expand quickly when it was needed, such as at harvest time or in a panic, and reserves were scattered among thousands of banks and piled up in New York. In October 1907 a failed attempt to corner the stock of a copper company brought suspicion on the banks and trust companies tied to the speculators. Depositors ran on the Knickerbocker Trust Company, one of the largest in New York, which closed its doors on October 22. The panic spread to other trust companies and the stock market. With no central bank, J. P. Morgan, seventy years old, gathered the city's bankers in his library, judged which institutions were sound, and organized pools of money to support them. Clearinghouses issued certificates as substitutes for cash. The panic eased in November, but many banks had suspended payments and the economy fell into a sharp recession.

The big idea. A banking system needs both a sound currency and a way to supply liquidity in a crisis. Free banking gave many currencies of uneven quality, so notes from distant or weak banks traded at a **discount**: the further and riskier the bank, the less its note was worth. The national banks gave a uniform currency but an inelastic one. In 1907 private bankers acted as lender of last resort, but it depended

on one man's judgment and influence. Many Americans, including bankers themselves, concluded that the country needed a public institution to do that job.

In business today. A business accepting payment needs to trust the money it receives, which is why uniform national currency and reliable payment systems matter so much. The bank-note reporter's job, judging the soundness of distant issuers, is now done by bank examiners, deposit insurance and credit-rating agencies. The 1907 panic is still studied by central bankers as a classic case of how a run on less-regulated institutions can spread.

Who gained? Hamilton's bank gave the young government sound credit; free banking let many communities found banks and gain credit, but customers and shopkeepers bore the losses of failed and fraudulent banks. In 1907 Morgan and his fellow financiers prevented a worse collapse, though critics worried that so much power over the country's finances lay in a few private hands.

PICTURE STUDY



A crowd on Wall Street during the Panic of 1907, Unknown photographer, October 1907 · Photograph · New York Public Library

Image: Wikimedia Commons, public domain

In late October 1907, crowds gathered on Wall Street as rumors spread and depositors lined up outside trust companies. Photographs like this one appeared in newspapers across the country and helped convince Americans that the banking system needed reform.

Look closely

- Look at the crowd. How many people can you estimate?
- Look at their faces and postures. Are they calm or anxious?
- Look at the buildings. What kinds of businesses might be inside?
- Is anyone trying to keep order? Look for police or officials.

Talk about it

1. Why does a crowd itself make a panic worse?
2. What would a depositor in this crowd want to know, and who could tell him?
3. How might a central bank have changed this scene?

PROJECT

The Bank-Note Reporter

You will act as a shopkeeper in the free-banking era, receive notes from banks of varying distance and soundness, and use a reporter you build to value them.

You will need

- Index cards as “banknotes” from eight imaginary banks
- A table of discounts you create
- A calculator
- Your ledger notebook

Steps

1. Create eight banks with names, states and a note on their soundness (for example, “sound, 300 miles away” or “rumored weak”).
2. Build a reporter table: assign each bank a discount based on distance (one percent per 200 miles) plus risk (0% sound, 5% doubtful, 25% rumored failing).
3. A family member pays you for goods with a mix of 12 notes. Record the face value and discounted value of each.
4. Compute your total receipts at face value and at true value.
5. One bank fails during the week; its notes become worthless. Recompute your losses.
6. Compare with a week in which all notes are national banknotes at par.
7. Write a paragraph explaining why the National Banking Acts were welcomed by shopkeepers.

Tips

- Make your banks’ names and towns realistic for the 1850s.
- Keep a running ledger as each note comes in.

Check your work

- ☐ I can value notes at a discount.
- ☐ I can describe the main stages of American banking before 1913.

- [ ] I can explain how the Panic of 1907 unfolded and was stopped.

LEDGER NOTEBOOK

1. Copy your reporter table and your week's receipts.
2. Draw a timeline: 1791, 1811, 1816, 1832, 1836, 1837–1863, 1863–64, 1907.
3. List the steps of the Panic of 1907 in order, from the copper corner to Morgan's library.

KEY FORMULAS

$$\text{Value of a discounted note} = \text{face value} \times (1 - d)$$

$$\text{Run coverage ratio} = \frac{\text{cash and liquid assets}}{\text{withdrawals demanded}}$$

From history. The First Bank's handsome building on South Third Street in Philadelphia, finished in 1797, still stands in Independence National Historical Park. It is one of the oldest bank buildings in the country.

WORKED EXAMPLES

Example 1. In 1850 a Philadelphia shopkeeper receives a $10 note from a small Ohio bank, quoted at a 4% discount in the bank-note reporter, and a $5 note from a Philadelphia bank at par. What are they worth to him?

Show solution

1. Ohio note: $\$10 \times (1 - 0.04) = \$9.60$.
2. Philadelphia note: $\$5$.
3. Total: $\$14.60$ for notes with a face value of $\$15$.

Answer: $14.60. The discount reflects the cost of sending the note back to Ohio for redemption and the risk that the bank fails.

Example 2. A trust company has \$60 million of deposits and keeps \$3 million in cash. Depositors demand \$8 million on the first day of a run. The company can sell \$4 million of bonds quickly. Can it survive the day?

Show solution

1. Cash and liquid assets: $\$3 + \$4 = \$7$ million.
2. Coverage: $7/8 = 0.875$.
3. Shortfall: \$1 million; it must borrow or close.

Answer: Not without help: it is \$1 million short. This was the Knickerbocker's situation on a larger scale, when the banks declined to support it.

Example 3. Using the six stakeholders, evaluate J. P. Morgan's role in 1907.

Show solution

1. Financiers: Morgan and his bankers risked their own money to support sound institutions.
2. Customers (depositors): many were protected by the rescue; Knickerbocker's depositors suffered.
3. Workers: the recession that followed cost many jobs.
4. Community: a broader collapse was avoided, but the episode showed the danger of depending on private power.

Answer: The rescue served most stakeholders, yet it convinced the country to build a public lender of last resort.

PRACTICE

1. Easy Who proposed the First Bank of the United States, and when was it chartered?

   Show answer

   Alexander Hamilton; 1791.

2. Easy What happened to the Second Bank of the United States?

   Show answer

   President Jackson vetoed its recharter in 1832, and its federal charter ended in 1836.

3. Easy What did the National Banking Acts create?

Show answer

Federally chartered national banks issuing uniform notes backed by U.S. government bonds.

4. Medium A $20 note trades at a 6% discount. What is it worth?

Show answer

$18.80.

5. Medium Why did notes from distant banks trade at larger discounts?

Show answer

It cost more and took longer to send them back for redemption, and it was harder to know whether the distant bank was sound.

6. Medium What triggered the Panic of 1907?

Show answer

A failed attempt to corner a copper company's stock, which brought suspicion on banks and trust companies tied to the speculators, leading to runs, especially on the Knickerbocker Trust.

7. Medium What was the main weakness of the national banking system?

Show answer

The currency was inelastic: it could not expand when demand for cash rose, and reserves were scattered and concentrated in New York.

8. Hard A trust company has $5 million in cash and $10 million in sellable bonds. A run demands $18 million. What is its coverage ratio, and what must it do?

Show answer

$15/18 \approx 0.83$; it must borrow $3 million or suspend payments.

9. Hard Why did many Americans, including bankers, want a central bank after 1907?

Show answer

The panic showed that the system had no reliable lender of last resort and no elastic currency; depending on one private banker was risky.

10. **Challenge** A shopkeeper receives $500 in notes each week, averaging a 3% discount, and one bank in fifty fails each year, its notes becoming worthless. Estimate the shopkeeper's yearly loss from discounts and failures (assume 50 weeks and notes from fifty banks in equal shares).

    Show answer

    Discounts: $0.03 \times 500 \times 50 = \$750$. Failures: one in fifty banks means about 2% of notes held when a failure strikes; if he holds a week's notes, about $0.02 \times 500 = \$10$ per failure. Total roughly $760 a year, about 3% of receipts.

COMMON MISTAKES

- Thinking the United States had a central bank continuously since 1791. There were long gaps (1811–1816 and 1836–1913).
- Confusing the national banks of 1863 with a central bank. They were many private banks under federal charter.
- Thinking J. P. Morgan held a public office in 1907. He acted as a private banker.

> **Make it a game · Bank-Note Reporter Auction.** Write six bank names on cards and assign each a distance and reputation. As the bank-note reporter, set a discount for each, for example 2, 8 or 15 percent. Your parent pays you in play money for a 100-dollar note from each. Compute the value, and explain why free-banking notes traded below face value and how clearinghouses helped.

5.4 Jekyll Island and the Federal Reserve, 1913

OBJECTIVES

- Tell the story of the meeting on Jekyll Island in 1910 and the passage of the Federal Reserve Act in 1913.
- Describe the structure of the Federal Reserve System and how it was meant to provide an elastic currency.
- Read a simple central-bank balance sheet and show how a discount loan creates reserves.

> **Warm-up.** A panic shows a country needs a lender of last resort. Some people fear a single central bank in the capital; others fear leaving the job to private bankers. Sketch a design that might satisfy both.

WATCH

Jekyll Island and the Creation of the Federal Reserve

Atlanta Fed · 4:44

https://www.youtube.com/watch?v=Xoz4jbEZzlc

> **WHEN TO WATCH**
> After the story of the Jekyll Island meeting.

BACKUP VIDEO

The Fed in Five | A History of the Federal Reserve

Federal Reserve Bank of St. Louis · 4:54

https://www.youtube.com/watch?v=M7nj2X-yl_U

After the big idea, as a review.

KEY TERMS

Federal Reserve System

The central bank of the United States, created in 1913: a Board in Washington and twelve regional Reserve Banks.

elastic currency

A currency whose supply can expand and contract with the needs of trade.

discount window

The facility through which a Reserve Bank lends to banks against collateral.

Federal Reserve note

The paper currency issued by the Federal Reserve Banks, today's dollar bill.

member bank

A commercial bank that belongs to the Federal Reserve System and holds stock in its regional Reserve Bank.

CORE IDEAS

The story. After 1907 Congress created the National Monetary Commission, chaired by Senator Nelson Aldrich, to study banking systems in Europe. In November 1910 Aldrich and five bankers and economists, including Paul Warburg of Kuhn, Loeb and Frank Vanderlip of National City Bank, traveled in secret to the Jekyll Island Club off the coast of Georgia. For about ten days they drafted a plan for a central banking system. Aldrich's plan was not passed as written, but after long debate Congress passed a different bill, and President Woodrow Wilson signed the Federal Reserve Act on December 23, 1913. The twelve Reserve Banks opened in November 1914.

How they figured it out. The designers had to balance two fears: of control by Wall Street and of control by officials in Washington. The answer was a federal structure: twelve regional Reserve Banks, each owned by the member banks in its district, supervised by a Board in Washington whose members were appointed by the President. The Reserve Banks would hold member banks' reserves, lend to them at a **discount window** against good collateral such as short-term business loans, and issue a new currency, the Federal Reserve note, which could expand when banks brought in loans to be discounted and shrink when they were repaid. This was the **elastic currency** the 1907 panic had shown was missing. The dollar remained tied to gold at $20.67 an ounce.

The big idea. A central bank changes the money supply through its balance sheet. When a Reserve Bank lends $1 million to a member bank, it credits that bank's reserve account with $1 million: the Reserve Bank gains an asset (the loan) and a liability (the reserves). The member bank now has more reserves to meet withdrawals or to support new lending. In a panic, this lets the central bank supply cash quickly; in calm times, it lets the currency grow with trade. The same power

that can calm a panic can also, if misused, create too much money, which is why the Fed's structure and rules mattered so much.

In business today. The Federal Reserve still has twelve regional banks and a Board of Governors. It holds banks' reserves, runs payment systems that move trillions of dollars a day, supervises many banks, lends at its discount window and sets interest rates, as you will learn in Lesson 6.4. Every dollar bill in your wallet says "Federal Reserve Note" across the top.

Who gained? Banks gained a reliable lender in emergencies; businesses and farmers gained a currency that could expand at harvest time; depositors gained a safer system, though not yet deposit insurance. The community gained an institution designed to prevent panics, though its first great test, the Depression of the 1930s, would show that it could also fail (Unit 9).

PICTURE STUDY



The Federal Reserve Board, 1914, Unknown photographer, 1914 · Photograph · Library of Congress

Image: Wikimedia Commons, public domain

The first Federal Reserve Board took office in August 1914. By law it included the Secretary of the Treasury and the Comptroller of the Currency, along with five members appointed by the President to represent different parts of the country and of the economy. Within weeks, the First World War began in Europe, and the new system's first months were spent dealing with a crisis no one had planned for.

Look closely

- Count the members. How many are there?
- Look at the setting. Does it look grand or plain?
- Look at the men's ages. Were they young or experienced?
- What details of dress or posture show how they wanted to be seen?

Talk about it

1. Why did the designers include members from different regions and kinds of business?
2. What would this Board need to watch in its first year, as war broke out in Europe?
3. Who are the stakeholders in a central bank's decisions?

PROJECT

Design and Run a Reserve Bank

You will set up a Reserve Bank's balance sheet and the balance sheets of two member banks, then run a harvest season and a small panic, recording every change.

You will need

- Balance-sheet templates for one Reserve Bank and two member banks
- A spreadsheet
- Your ledger notebook

Steps

1. Start the Reserve Bank with gold $500, bonds $200, loans to banks $0; notes $400, bank reserves $280, capital $20 (in millions). Check that it balances.
2. Give each member bank deposits of $1,000, reserves of $140 and loans of $900, with capital to balance.
3. Harvest: farmers withdraw $60 in cash from each member bank. Record the changes.
4. The member banks borrow at the discount window to restore reserves. Record the loans on all three balance sheets.
5. Check the 40% gold requirement. How much more could the Reserve Bank issue?
6. Panic: one member bank faces a $200 run. Decide, using Bagehot's rule, whether to lend and against what collateral.
7. Write a short report explaining how the Reserve Bank kept the system liquid.

Tips

- After every step, check that every balance sheet still balances.
- A spreadsheet with formulas makes the checks automatic.

Check your work

☐ I can describe the Federal Reserve's structure.

☐ I can show how a discount loan changes balance sheets.

- [ ] I can explain what an elastic currency is.

LEDGER NOTEBOOK

1. Copy the three balance sheets at each step.
2. Draw a map of the twelve Federal Reserve districts and mark the city of each Reserve Bank.
3. Write a short timeline: 1907, 1908, November 1910, December 23, 1913, November 1914.

KEY FORMULAS

$$\text{Central bank: Assets} = \text{Liabilities} + \text{Capital}$$

$$\text{Discount loan: } \Delta\text{Loans to banks} = \Delta\text{Bank reserves}$$

From history. The Jekyll Island guests traveled in a private railroad car and used only first names to avoid notice. Frank Vanderlip later wrote that the secrecy had been necessary because any plan known to come from Wall Street bankers would have been rejected at once.

WORKED EXAMPLES

Example 1. A Reserve Bank's simplified balance sheet: assets — gold \$300 million, government bonds \$100 million, loans to banks \$50 million; liabilities — Federal Reserve notes \$250 million, bank reserves \$180 million; capital \$20 million. Check that it balances.

Show solution

1. Assets: $300 + 100 + 50 = \$450$ million.
2. Liabilities plus capital: $250 + 180 + 20 = \$450$ million.

Answer: It balances at \$450 million.

Example 2. During harvest season, member banks borrow $40 million at the discount window and withdraw $30 million of it as Federal Reserve notes for farmers. Show the changes to the Reserve Bank's balance sheet.

Show solution

1. Loans to banks rise by $40 million (assets: $490 million).
2. Bank reserves rise by $40 million, then fall by $30 million as notes are withdrawn: net +$10 million.
3. Federal Reserve notes rise by $30 million.
4. Liabilities plus capital: $280 + 190 + 20 = \$490$ million.

Answer: Currency expands by $30 million to meet the harvest demand: an elastic currency at work.

Example 3. In 1914 the law required each Reserve Bank to hold gold equal to at least 40% of the Federal Reserve notes it issued. With $300 million in gold, what is the most it could issue?

Show solution

1. Gold $\geq 0.40 \times$ notes, so notes $\leq 300/0.40 = \$750$ million.

Answer: $750 million of notes. The gold requirement limited how far the currency could expand.

PRACTICE

1. Easy When was the Federal Reserve Act signed, and by whom?

   Show answer

   December 23, 1913, by President Woodrow Wilson.

2. Easy Where did Aldrich and the bankers meet in secret in 1910?

   Show answer

   The Jekyll Island Club, off the coast of Georgia.

3. Easy How many regional Reserve Banks are there?

   Show answer

   Twelve.

4. Medium What is an elastic currency, and why did the United States need one in 1913?

Show answer

A currency that expands and contracts with demand. The national banking system could not expand currency at harvest time or in panics.

5. Medium A Reserve Bank lends $25 million to member banks. What happens to its assets and liabilities?

Show answer

Assets (loans to banks) rise by $25 million; liabilities (bank reserves) rise by $25 million.

6. Medium Why was the Fed given a regional structure?

Show answer

To balance fears of control by Wall Street and by Washington, and to serve different regions' needs.

7. Medium With a 40% gold requirement and $200 million in gold, what is the maximum note issue?

Show answer

$500 million.

8. Hard Explain how a discount loan helps a bank facing a run.

Show answer

The bank pledges collateral and receives reserves, which it can pay out as cash to depositors, so it does not have to sell assets at a loss or close.

9. Hard Why did the Fed's founders link the dollar to gold?

Show answer

To keep the currency's value stable and limit how much money could be created, preserving confidence.

10. **Challenge** A Reserve Bank holds $400 million of gold and has $800 million of notes outstanding. Under the 40% rule, how much more can it issue? If $50 million of gold is withdrawn for export, how much must notes shrink, if the bank was at its limit?

Show answer

Limit: $400/0.40 = \$1{,}000$ million, so $200 million more. With $350 million of gold, the limit becomes $875 million; at the limit, notes would have to fall by $50/0.40 = \$125$ million.

COMMON MISTAKES

- Thinking the Federal Reserve is a single bank in Washington. It is a Board plus twelve regional banks.
- Thinking the Jekyll Island plan became law as written. Congress passed a different, more decentralized bill.
- Forgetting that the dollar was still tied to gold when the Fed began.

> **Make it a game · Jekyll Island Spot the Slip.** Teach your parent the story of the 1910 Jekyll Island meeting, the Federal Reserve Act of 1913, the regional Reserve Banks and the idea of an elastic currency. Your parent secretly inserts one wrong detail, such as a wrong year or number. Catch it and give the correct detail. Switch roles with a new set of facts.

5.5 How the Classical Gold Standard Worked

OBJECTIVES

- Describe the classical gold standard (about 1870s–1914) and how countries fixed their currencies to gold.
- Calculate mint parity between two gold currencies.
- Explain Hume's price-specie-flow mechanism and the strengths and weaknesses of the gold standard.

> **Warm-up.** If a dollar were always worth exactly 1/20 of an ounce of gold, what would happen to the price of a loaf of bread if a huge new gold mine were found? If no new gold were found for fifty years while the economy grew?

WATCH

The Classical Gold Standard

Marginal Revolution University · 8:40

https://www.youtube.com/watch?v=_2nYIxh3B0s

> **WHEN TO WATCH**
> After the story, before the big idea.

KEY TERMS

gold standard

A monetary system in which the currency is defined as a fixed weight of gold and can be converted into gold at that price.

mint parity

The exchange rate between two gold-standard currencies implied by their gold contents.

gold points

The range around mint parity, set by the cost of shipping gold, within which exchange rates moved.

specie

Money in the form of coins of precious metal.

balance of payments

A record of all a country's transactions with the rest of the world.

CORE IDEAS

The story. In 1717 Sir Isaac Newton, Master of the Royal Mint, set the price of gold in silver coin in a way that left Britain, in practice, on gold. After the wars with Napoleon, Britain made it official: from 1821 the Bank of England paid its notes in gold sovereigns. Other nations followed in the 1870s: the new German Empire in 1871–73, then much of Europe, and the United States, which resumed paying gold for its paper dollars in 1879 and wrote the gold standard into law in 1900 at $20.67 per troy ounce. By 1900 most trading nations defined their money in gold, and their currencies were, in effect, fixed to one another.

How they figured it out. In 1752 the Scottish philosopher Hume explained how a gold standard keeps itself in balance. Suppose a country imports more than it exports and pays the difference in gold. Gold flows out; its money supply shrinks; its prices fall. Its goods become cheaper abroad, and foreign goods dearer at home, so exports rise and imports fall until the flow stops. The opposite happens in a country gaining gold. Hume's **price-specie-flow mechanism** showed why no country could pile up gold forever. In practice, central banks, led by the Bank of England, also raised interest rates when gold flowed out, attracting capital and speeding the adjustment.

The big idea. Under a gold standard, the money supply is tied to the stock of gold, and exchange rates are fixed at **mint parity**. The great strength was long-run price stability and confidence: a pound or a dollar meant a fixed weight of gold, and contracts could be written for decades. The weaknesses were serious. The money supply depended on gold discoveries, not on the needs of trade, so prices fell for long periods when gold was scarce (as in the 1870s–1890s) and rose when gold was plentiful (after the discoveries in South Africa and the Klondike in the 1890s). And the discipline that kept currencies fixed could force painful deflation and unemployment on a country losing gold. The system broke down when the First World War began in 1914.

In business today. No country uses a gold standard now, but its ideas live on. Fixed exchange rates, currency boards and monetary unions face the same trade-off

between stability and flexibility. Many central banks still hold gold as a reserve asset. Businesses that trade internationally care deeply whether exchange rates are fixed or floating, as you will see in Units 6 and 10.

Who gained? Lenders and savers gained from stable money; international traders gained from fixed exchange rates; London's financiers prospered at the center of the system. Debtors, especially farmers in the American West during the falling prices of the 1880s and 1890s, suffered as their debts became heavier in real terms.

PICTURE STUDY



Twenty-dollar gold piece (double eagle), designed by Augustus Saint-Gaudens, Augustus Saint-Gaudens (design); U.S. Mint, 1907 · Gold (90% fine), 34 mm · National Numismatic Collection, Smithsonian Institution

Image: Wikimedia Commons, public domain

In 1905 the White House asked the sculptor Augustus Saint-Gaudens to make America's coins beautiful, and this $20 piece is often called the most beautiful American coin. Under the gold standard, its weight of gold, nearly an ounce of 90% fine gold, was exactly worth its face value of $20 at the official price of $20.67 an ounce of pure gold.

Look closely

- Find Liberty. What is she holding in each hand?
- Look behind her for the Capitol building. Why might it be there?
- Turn to the other side. What is the eagle flying over?
- Look at the edge and the lettering. What words or dates can you find?

Talk about it

1. This coin contained about 0.9675 ounces of pure gold. Multiply by $20.67. What do you get, and why?
2. Why did Americans trust a coin like this?
3. What would happen to the value of this coin today if you sold it for its gold?

PROJECT

The Gold Standard Trading Game

You will model two countries on the gold standard, run trade between them for several rounds and watch gold flows adjust prices, as Hume described.

You will need

- Tokens for gold
- Cards for goods from two countries
- Two or more players
- A spreadsheet
- Your ledger notebook

Steps

1. Country A and Country B each start with 100 gold tokens and a price level of 1. Each country produces 100 units of goods.
2. Each round, A buys more from B than B buys from A when A's prices are higher; set a rule such as: A's imports = 30 × (P_A / P_B), A's exports = 30 × (P_B / P_A).
3. Pay the difference in gold. Update each country's gold stock.
4. Set each country's price level proportional to its gold stock (P = gold / 100).
5. Start with A's price level at 1.2 and B's at 0.8. Run at least eight rounds in a spreadsheet.
6. Graph gold stocks and price levels over the rounds. Do they converge?
7. Write a paragraph explaining what happened, what it would feel like for workers in the country losing gold, and how Hume's mechanism works.

Tips

- A spreadsheet makes the rounds fast and the graphs easy.
- Try a version in which one country finds a new gold mine. What happens to prices in both countries?

Check your work

☐ I can compute mint parity and gold points.

- ☐ I can explain the price-specie-flow mechanism.
- ☐ I can name strengths and weaknesses of the gold standard.

LEDGER NOTEBOOK

1. Copy your spreadsheet results and the graph of gold and prices.
2. Make a two-column chart of the gold standard's strengths and weaknesses.
3. Make a timeline: 1717, 1821, 1871–73, 1879, 1900, 1914.

KEY FORMULAS

$$\text{Mint parity} = \frac{\text{dollars per ounce of gold}}{\text{pounds per ounce of gold}}$$

$$\text{Gold export point} = \text{parity} + \text{shipping cost per pound}$$

From history. When the First World War began in 1914, the warring nations stopped paying gold freely and printed money to pay for the war. Britain returned to gold at the old parity in 1925, a decision Keynes criticized sharply, and left again in 1931. The classical gold standard was never fully restored.

WORKED EXAMPLES

Example 1. The U.S. price of gold was $20.67 per fine ounce; the British price was about £4.2477 per fine ounce. Find the mint parity of the dollar and the pound.

Show solution

1. Parity: $\dfrac{\$20.67}{£4.2477} \approx \$4.866$ per pound.

Answer: About $4.87 per pound, the famous rate that held, within narrow limits, for decades before 1914.

Example 2. Shipping and insuring gold across the Atlantic cost about 2 cents per pound sterling of value. Find the gold points. If the market exchange rate rose to $4.90, what would an American importer owing £1,000 do?

Show solution

1. Gold points: 4.866 ± 0.02, so about $4.846 to $4.886.
2. At $4.90 the pound costs more than the gold export point.
3. The importer would buy gold at $20.67 an ounce, ship it to London and sell it for pounds: cost about $1{,}000 \times 4.886 = \$4{,}886$ versus $4,900 in the market.

Answer: He would ship gold, saving about $14. Such shipments kept the exchange rate inside the gold points.

Example 3. Country A loses 10% of its gold through a trade deficit. Its money supply is tied to gold, velocity and output are steady. Use the quantity equation to predict its price level.

Show solution

1. Money falls 10%; with V and Y steady, P falls about 10%.
2. Lower prices make A's exports cheaper and imports dearer, shrinking the deficit.

Answer: Prices fall about 10%, which tends to correct the deficit: Hume's mechanism.

PRACTICE

1. Easy What was the official U.S. gold price from 1900 to 1933?

   Show answer

   $20.67 per fine ounce.

2. Easy Who described the price-specie-flow mechanism, and when?

   Show answer

   Hume, in 1752.

3. Easy What is mint parity?

Show answer

The exchange rate between two currencies implied by their fixed gold prices.

4. Medium France fixed gold at 3,444.44 francs per kilogram (about 107.1 francs per ounce). Find the franc–dollar parity in francs per dollar.

Show answer

$107.1/20.67 \approx 5.18$ francs per dollar.

5. Medium Parity is $4.866 and shipping costs 3 cents per pound. Find the gold points.

Show answer

$4.836 and $4.896.

6. Medium Why did prices fall in the 1870s–1890s under the gold standard?

Show answer

Output grew faster than the world's gold supply, so money grew slowly and prices fell.

7. Medium What brought prices back up after the mid-1890s?

Show answer

New gold discoveries in South Africa and the Klondike and new refining methods increased the gold supply.

8. Hard Why did American farmers in the 1890s often oppose the gold standard?

Show answer

Falling prices meant their crops brought less money while their debts stayed the same in dollars, making debts heavier in real terms.

9. Hard Explain how the Bank of England used interest rates to protect its gold.

Show answer

When gold flowed out, it raised its lending rate, attracting foreign capital to London and slowing the outflow.

10. **Challenge** A country on gold has M = 1,000 (all backed by gold), V = 4, Y = 2,000. Gold supply grows one percent a year; output grows 3%. Find the price level now and the approximate yearly change in prices.

Show answer

$P = 4{,}000/2{,}000 = 2$. $\%\Delta P \approx 1\% - 3\% = -2\%$ a year: steady deflation.

COMMON MISTAKES

- Thinking the gold standard meant everyone paid with gold coins. Most payments used notes and checks convertible into gold.
- Assuming the gold standard guaranteed stable prices every year. It gave long-run stability but allowed long periods of falling or rising prices.
- Dividing the gold prices the wrong way. Parity in dollars per pound is the dollar price of gold divided by the pound price.

> **Make it a game · Mint Parity Gold Points.** Country A defines its currency as 2 grams of gold; Country B defines its currency as 0.5 grams. Compute mint parity quickly. Your parent adds shipping costs, and you compute the gold points, where gold would flow instead of buying currency. Explain what happens if a country loses gold. Do five rounds of new numbers and beat your best.

UNIT 5

The Story of Money II: Banks and the Gold Standard

In this unit money becomes paper and ledger entries, and banks take center stage. You will meet the goldsmiths of London, who invented fractional-reserve banking and learned its danger when the king stopped paying in 1672; the Bank of England, founded in 1694 to lend to a government at war, which grew into the model of a central bank; and America's long struggle over banking, from Hamilton's bank and the free-banking era to the Panic of 1907, when J. P. Morgan rescued Wall Street from his library.

Then you will follow the secret meeting on Jekyll Island and the creation of the Federal Reserve in 1913, and see how the classical gold standard tied the world's money together until 1914. You will compute money multipliers, read central-bank balance sheets, value discounted banknotes and calculate mint parity, and you will stage your own bank run and rescue.

PREREQUISITES

- Unit 4 (functions of money, the quantity equation)
- Basic balance sheets (assets, liabilities, capital)
- Geometric series (helpful, not required)

MASTERY CHECKLIST

- ☐ I can explain fractional-reserve banking and compute the money multiplier.
- ☐ I can explain why banks are exposed to runs and what a lender of last resort does.
- ☐ I can tell the history of the Bank of England and state Bagehot's rule.
- ☐ I can trace American banking from 1791 to 1907 and value discounted banknotes.
- ☐ I can describe the founding and structure of the Federal Reserve and show how a discount loan changes balance sheets.
- ☐ I can compute mint parity and explain how the classical gold standard adjusted.

OPTIONAL BOOKS AND GAMES FOR THIS UNIT

- *Lombard Street*, by Walter Bagehot (1873): Free. The classic account of the London money market and the lender of last resort. Read chapter 7 with Lesson 5.2. Ages 15+.
- Federal Reserve History: "The Federal Reserve Act" and "The Panic of 1907": Free. Short essays by Fed historians on the events of Lessons 5.3 and 5.4.
- Bank of England Museum (online collections): Free. Images and stories from the Bank's history, including early notes and the 1694 charter. Use with Lesson 5.2.

Not required. Every project in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

5.1 The Goldsmiths of London and Fractional-Reserve Banking

3 sessions of 50 minutes

5.2 The Bank of England, 1694, and the Lender of Last Resort

3 sessions of 50 minutes

5.3 American Banking from Hamilton's Bank to the Panic of 1907

3 sessions of 50 minutes

5.4 Jekyll Island and the Federal Reserve, 1913 3 sessions of 50 minutes

5.5 How the Classical Gold Standard Worked 3 sessions of 50 minutes

Unit 5 test

Calculators are allowed. Show your work for every calculation: write the formula, substitute and solve. Answer the concept questions in complete sentences. The test is worth 100 points.

1. **6 pts**

   How did London goldsmiths become bankers? Name the two steps.

2. **8 pts**

   A $2,000 deposit enters a system with a 15% reserve ratio. (a) Find the money multiplier. (b) Find the maximum total deposits. (c) How much can the first bank lend?

3. **6 pts**

   What was the Stop of the Exchequer, and what did it teach about banking?

4. **6 pts**

   Why was the Bank of England founded in 1694, and what were the terms of its first loan?

5. **6 pts**

   State Bagehot's rule and explain each part.

6. **6 pts**

   A central bank lends £50 million with a 20% haircut. How much collateral is needed?

7. **6 pts**

   A $50 note trades at a 5% discount, and a $20 note at 2%. Find their total value.

8. **6 pts**

   Why did free-banking notes trade at discounts, and how did the National Banking Acts change this?

9. **8 pts**

   Describe the Panic of 1907: its trigger, the key run, and how it was stopped.

10. **6 pts**

    Describe the structure of the Federal Reserve System and why it was designed that way.

11. **8 pts**

    A Reserve Bank lends $60 million to member banks, which withdraw $45 million as notes. Show the net changes to the Reserve Bank's assets and liabilities.

12. **6 pts**

With a 40% gold requirement and $360 million in gold, what is the most notes a Reserve Bank could issue?

13. **8 pts**

The U.S. price of gold was $20.67 an ounce and the German price 86.8 marks an ounce. (a) Find the mark–dollar parity. (b) If shipping cost 0.02 marks per dollar, find the gold points.

14. **6 pts**

Explain Hume’s price-specie-flow mechanism.

15. **8 pts**

Short essay: What were the main strengths and weaknesses of the classical gold standard? Who gained and who lost?

ANSWER KEY

1. They took gold for safekeeping and issued receipts that circulated as money; then they lent out part of the gold at interest, keeping a fraction as reserves.
2. (a) $1/0.15 \approx 6.67$. (b) $2{,}000/0.15 \approx \$13{,}333$. (c) $\$1{,}700$.
3. Charles II's 1672 suspension of payments on his debts to goldsmiths, which caused runs and failures. Banks are only as sound as their loans and depend on depositors' trust.
4. To lend to William III's government for war with France; it lent £1,200,000 at 8% in return for a charter and the right to issue notes.
5. Lend freely (to stop the panic), against good collateral (to protect the central bank and lend only to solvent banks), at a high rate (to discourage needless borrowing).
6. $50/0.8 = £62.5$ million.
7. $47.50 + 19.60 = \$67.10$.
8. Notes from distant or risky banks cost more to redeem and might be worthless. The acts created uniform national banknotes backed by government bonds, and a tax drove out state notes.
9. A failed copper corner brought suspicion on linked banks and trust companies; depositors ran on the Knickerbocker Trust, which closed October 22. J. P. Morgan organized bankers to support sound institutions and clearinghouses issued certificates.
10. A Board in Washington and twelve regional Reserve Banks owned by member banks, balancing fears of Wall Street control and of control from Washington and serving different regions.
11. Assets: loans +$60 million. Liabilities: bank reserves +$15 million (60 − 45), notes +$45 million. Both sides rise by $60 million.
12. $360/0.40 = \$900$ million.
13. (a) $86.8/20.67 \approx 4.20$ marks per dollar. (b) About 4.18 to 4.22.
14. A trade deficit sends gold abroad, shrinking the money supply and lowering prices; cheaper goods raise exports and lower imports until the deficit closes. A surplus does the opposite.
15. Strengths: long-run price stability, confidence, fixed exchange rates. Weaknesses: money depended on gold discoveries, long deflations, painful

adjustment for deficit countries. Lenders and traders gained; debtors such as farmers in falling-price periods lost.

PORTFOLIO PIECE: A BANKER'S HISTORY OF THE UNITED STATES

Write an illustrated history, six to eight pages, of American banking from 1791 to 1914, organized around five turning points (for example 1791, 1836, 1863, 1907 and 1913). For each, explain what problem people faced, what was tried, and what it meant for the six stakeholders. Include at least three calculations from the unit (a money multiplier, a discounted note, a central-bank balance sheet or a mint parity) and a timeline.

LOOK FOR	WHAT IT MEANS
Accuracy	Dates, names and events are correct and in order.
Analysis	Each turning point explains the problem, the solution and its effect on stakeholders.
Calculations	At least three correct calculations, clearly explained.
Writing	Clear, organized and well illustrated with labeled pictures or diagrams.

UNIT 6

Fiat Money and Central Banking

This unit follows money through the twentieth century, as the link to gold was loosened and then cut. You will study the banking crisis of 1933, the order calling in gold and the new $35 price; the Bretton Woods conference of 1944 and the system of fixed exchange rates it created; and the evening of August 15, 1971, when the United States closed the gold window and the dollar became fiat money.

Then you will learn how a modern central bank works: how the Federal Reserve sets interest rates and how it fought the great inflation of the 1970s, and what happens when money fails completely, in the hyperinflations of Weimar Germany in 1923 and Zimbabwe in 2008. You will calculate devaluations, cross rates, real interest rates, a policy rule and a price index from your own family's spending.

PREREQUISITES

- Units 4–5 (money, banks, the gold standard)
- Percents, exponents and roots
- Reading graphs of data over time

MASTERY CHECKLIST

- ☐ I can tell the story of 1933–34 and compute the dollar's devaluation.
- ☐ I can describe the Bretton Woods system, compute cross rates and explain the Triffin dilemma.
- ☐ I can explain why the gold window closed in 1971 and what fiat money is.
- ☐ I can explain how the Fed sets interest rates, compute real rates and apply Taylor's rule.
- ☐ I can build a price index, compute inflation and real values, and explain the causes and cures of hyperinflation.

OPTIONAL BOOKS AND GAMES FOR THIS UNIT

- **Federal Reserve History (federalreservehistory.org): essays on the Gold Reserve Act, Bretton Woods, the end of Bretton Woods and the Great Inflation**: Free. Short, careful essays by Fed historians on every lesson in this unit.
- **FRED, the St. Louis Fed's free economic data site**: Free. Graphs of interest rates, inflation, the CPI and exchange rates going back decades. Used in the projects for Lessons 6.1, 6.4 and 6.5. A parent can help set up any graphs; no account is needed.

Not required. Every project in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

6.1	**1933: Gold Is Called In and Repriced at $35**	3 sessions of 50 minutes
6.2	**Bretton Woods, 1944**	3 sessions of 50 minutes
6.3	**August 15, 1971: The Gold Window Closes**	3 sessions of 50 minutes
6.4	**How the Fed Sets Interest Rates and the Money Supply**	3 sessions of 50 minutes
6.5	**Inflation, Deflation and Hyperinflation: Weimar Germany and Zimbabwe**	3 sessions of 50 minutes

Unit 6 test

Calculators are allowed. Show your work for every calculation: write the formula, substitute and solve. Answer the concept questions in complete sentences. The test is worth 100 points.

1. **6 pts**
   What did Executive Order 6102 require, and what did the Gold Reserve Act of 1934 do?

2. **6 pts**
   Find the percent devaluation of the dollar in gold when the price rose from $20.67 to $35, and the percent rise in the gold price.

3. **6 pts**

   Who gained and who lost from the gold measures of 1933–34?

4. **6 pts**

   Describe the Bretton Woods system in three sentences.

5. **6 pts**

   The yen was 360 per dollar and the pound $2.40 (after 1967). Find yen per pound.

6. **6 pts**

   Explain the Triffin dilemma.

7. **8 pts**

   The U.S. had 300 million ounces of gold at $35 and foreign official claims of $42 billion. (a) Find the coverage ratio. (b) What gold price would give 100% coverage?

8. **6 pts**

   What happened on August 15, 1971, and what followed in December 1971 and March 1973?

9. **6 pts**

   What is fiat money, and what gives the dollar value today?

10. **8 pts**

    A bank pays 5% on deposits. (a) If inflation is 3%, find the real rate. (b) If inflation is 7%, find the real rate and explain what happens to savers.

11. **6 pts**

    Taylor's rule: $r^* = 1$, $\pi^* = 2$, inflation 5%, output gap +1 percent. Find the suggested rate.

12. **6 pts**

    How does the Fed raise short-term interest rates today?

13. **6 pts**

    Describe the Fed's fight against inflation from 1979 to 1983: what it did, what it cost and what it achieved.

14. **6 pts**

A basket costs $500 in the base year, $540 the next year and $567 the year after. (a) Find the CPI each year. (b) Find the inflation rate each year.

15. **6 pts**

A wage of $50,000 when the CPI was 220 is $56,000 when the CPI is 260. Did the real wage rise or fall, and by how much?

16. **6 pts**

Short essay: Compare the German hyperinflation of 1923 with the Zimbabwean hyperinflation of 2007–2009. What caused each, what did it do to ordinary people, and how did each end?

ANSWER KEY

1. 6102 required delivery of most private gold to the Federal Reserve at $20.67. The Gold Reserve Act moved monetary gold to the Treasury, and the price was then set at $35.
2. Devaluation $1 - 20.67/35 \approx 41\%$; gold price rise $14.33/20.67 \approx 69\%$.
3. Debtors gained as deflation ended; the Treasury gained a gold profit; holders of gold and gold-clause creditors lost.
4. Other currencies were pegged to the dollar at par values within one-percent bands. The United States converted dollars held by foreign governments into gold at $35. The IMF lent to members with payment problems and oversaw changes in par values.
5. $360 \times 2.40 = 864$ yen per pound.
6. The world needed growing dollar reserves, supplied by U.S. deficits, but as dollars abroad grew relative to U.S. gold, confidence in the $35 promise fell.
7. (a) $10.5/42 = 0.25$. (b) $35 \times 4 = \$140$ an ounce.
8. The gold window was closed, with a wage-price freeze and import surcharge. The Smithsonian Agreement set $38 gold and new pars. By March 1973 major currencies floated.
9. Money not convertible into a commodity. The dollar is legal tender for debts and taxes, is trusted, and holds value as long as it is not issued much faster than goods and services grow.
10. (a) About 2%. (b) About −2%: savers lose purchasing power even while earning interest.
11. $1 + 5 + 1.5 + 0.5 = 8\%$.
12. It raises the interest rate it pays on reserve balances (and related rates), which lifts the federal funds rate; historically it also sold securities to drain reserves.
13. It let interest rates rise to about 20% to slow money growth; two recessions and unemployment near 11% followed; inflation fell from over 13% to about 3%.
14. (a) 100, 108, 113.4. (b) 8% and 5%.
15. Real wage: $56{,}000 \times 220/260 \approx \$47{,}385$; it fell about 5%.
16. A strong answer names money printing to pay government bills plus falling output (Ruhr occupation and reparations; collapse of farm output and exports), describes lost savings and daily hardship, explains rising velocity, and describes

the cures: the Rentenmark and strict limits in 1923, and the abandonment of the Zimbabwean dollar for foreign currencies in 2009.

PORTFOLIO PIECE: THE DOLLAR'S CENTURY

Write a six- to eight-page history of the U.S. dollar from 1913 to today, organized around five turning points (1913, 1933–34, 1944, 1971, 1979). For each, explain what changed in the rules of money, why, and what it meant for the six stakeholders. Include a graph of the CPI since 1913 (from FRED or BLS data), your family price index from Lesson 6.5, and at least three calculations from the unit.

LOOK FOR	WHAT IT MEANS
Accuracy	Dates, laws, prices and events are correct.
Analysis	Each turning point explains causes and effects on stakeholders, fairly and without partisan language.
Data	The CPI graph and the calculations are correct, labeled and sourced.
Writing	Clear, organized and well argued.

UNIT 6 · FIAT MONEY AND CENTRAL BANKING · LESSON 6.1 OF 50 · 3 SESSIONS OF 50 MINUTES

6.1 1933: Gold Is Called In and Repriced at $35

OBJECTIVES

- Tell the story of the banking crisis of 1933, Executive Order 6102 and the Gold Reserve Act of 1934.
- Calculate the devaluation of the dollar when the gold price rose from $20.67 to $35 an ounce.
- Explain how leaving the gold standard allowed the money supply to grow, and weigh the costs to those who held gold or gold contracts.

> **Warm-up.** You hold a contract promising you $1,000 “in gold coin of the present standard.” The government changes the gold price so that $1,000 buys much less gold. Write what you think you are owed, and why.

WATCH

The Emergency Banking Act and Gold Confiscation of 1933 (HOM 34-A)

Professor Barth · 22:18

https://www.youtube.com/watch?v=gcmfaX--Pu8

> **WHEN TO WATCH**
> After the story, before the worked examples.

Note: A lecture from a university historian’s course on the history of money, with period photographs and documents on the slides.

KEY TERMS

bank holiday

A government-ordered closing of banks to stop a run; in March 1933 every bank in the United States was closed for several days.

Executive Order 6102

The order of April 5, 1933, requiring Americans to deliver most gold coin, bullion and gold certificates to the Federal Reserve at $20.67 an ounce.

devaluation

A reduction in the official value of a currency in terms of gold or of other currencies.

gold clause

A clause in a contract requiring payment in gold or in dollars of a fixed gold value.

Gold Reserve Act

The law of January 30, 1934, that transferred the Federal Reserve's gold to the Treasury; the next day the gold price was set at $35 an ounce.

CORE IDEAS

The story. From 1930 to 1932 more than five thousand American banks failed, and in the winter of 1933 a new wave of runs swept the country. Depositors withdrew not only paper money but gold, and foreigners converted dollars into gold. On March 6, two days after taking office, the new president closed every bank in the country for a "bank holiday," and Congress quickly passed an emergency banking law. On April 5 he issued Executive Order 6102, requiring Americans to deliver almost all their gold coin, gold bullion and gold certificates to the Federal Reserve Banks, which paid $20.67 an ounce in paper money. Small amounts, jewelry and rare coins were exempt. In June Congress declared gold clauses in contracts unenforceable. In late 1933 the government bought gold at rising prices, and on January 30, 1934, the Gold Reserve Act moved the nation's monetary gold to the Treasury. The next day the price was fixed at $35 an ounce.

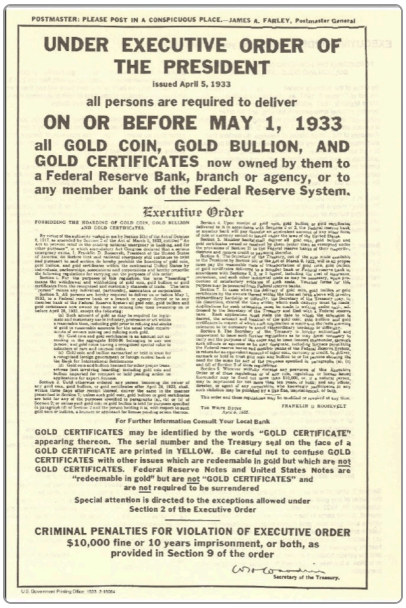
How they figured it out. The government's advisers argued that the gold standard had tied the money supply down just when the economy needed more money: prices had fallen by about a quarter since 1929, making every debt heavier, and banks were failing for lack of cash. Raising the gold price to $35 made the Treasury's gold worth more dollars and allowed the money supply to expand. Gold flowed into the United States from abroad, attracted by the new price and by rising fear in Europe. The money supply grew rapidly from 1933 to 1937, prices stopped falling, and output recovered, though unemployment stayed high for years. Many economists today count leaving the old gold parity as one of the main reasons the recovery began. In 1935 the Supreme Court upheld the cancellation of gold clauses in private contracts, though it criticized the government's refusal to honor the clauses in its own bonds.

The big idea. Raising the official price of gold from $20.67 to $35 cut the gold value of the dollar by about 41%: a **devaluation**. Under a gold standard, the quantity of money is limited by gold; changing the gold price changes that limit. Devaluation can relieve debtors and end deflation, but it transfers wealth: those who held gold or were owed gold-clause payments lost what they had been promised. A government that changes the rules of money must weigh relief for the many against fairness to those who trusted the old promise.

In business today. Americans have been free to own gold again since 1975, and the dollar has had no fixed gold price since 1971. But 1933 still matters: it shows how monetary rules can change suddenly in a crisis, why businesses read the fine print of contracts about how and in what money they will be paid, and why central banks today are expected to prevent deflation rather than wait for gold to arrive.

Who gained? Debtors, including farmers and homeowners, gained as deflation ended. Banks and depositors gained a safer system (deposit insurance came the same year; see Unit 8). The Treasury gained a large accounting profit on its gold. Holders of gold and of gold-clause bonds lost the extra value the higher price would have given them. Foreign countries still on gold faced a cheaper dollar and stronger American competition.

PICTURE STUDY



POSTMASTER: PLEASE POST IN A CONSPICUOUS PLACE.—JAMES A. FARLEY, Postmaster General

UNDER EXECUTIVE ORDER OF THE PRESIDENT

issued April 5, 1933

all persons are required to deliver

ON OR BEFORE MAY 1, 1933

all GOLD COIN, GOLD BULLION, AND GOLD CERTIFICATES now owned by them to a Federal Reserve Bank, branch or agency, or to any member bank of the Federal Reserve System.

Executive Order

FORBIDDING THE HOARDING OF GOLD COIN, GOLD BULLION AND GOLD CERTIFICATES.

For Further Information Consult Your Local Bank

GOLD CERTIFICATES may be identified by the words "GOLD CERTIFICATE" appearing thereon. The serial number and the Treasury seal on the face of a GOLD CERTIFICATE are printed in YELLOW. Be careful not to confuse GOLD CERTIFICATES with other issues which are redeemable in gold but which are not GOLD CERTIFICATES. Federal Reserve Notes and United States Notes are "redeemable in gold" but are not "GOLD CERTIFICATES" and are not required to be surrendered

Special attention is directed to the exceptions allowed under Section 2 of the Executive Order

CRIMINAL PENALTIES FOR VIOLATION OF EXECUTIVE ORDER
$10,000 fine or 10 years imprisonment, or both, as provided in Section 9 of the order

Secretary of the Treasury.

Executive Order 6102: the gold delivery notice, U.S. Government Printing Office, April 1933 · Printed public notice · National Archives (copies)

Image: Wikimedia Commons, public domain

Notices like this one were posted in post offices and banks across the country in April 1933. Read it as a primary source: what it orders, by when, the exceptions it allows and the penalties it names. It is a rare example of a government directly changing what its citizens could hold as money.

Look closely

- Find the deadline. How long did people have to comply?
- Find the exceptions. Who could still keep some gold?
- Find the penalty. How serious was it?
- Look at the layout and type. How did the printer make the main point stand out?

Talk about it

1. Why did the government want private gold delivered to the Federal Reserve?
2. Who bore the cost of this order? Who gained from it?
3. How might a family that trusted gold more than banks have felt about this notice?

PROJECT

Reading the Record: Prices, Money and Gold, 1929–1937

You will build a table of real data on prices, the money supply and the gold price from 1929 to 1937, graph it, and judge how the gold measures of 1933–34 fit the story.

You will need

- A computer with a parent's help (FRED, the St. Louis Fed's free data site, or Federal Reserve History essays)
- A spreadsheet
- Your ledger notebook

Steps

1. Find annual values of the U.S. consumer price index for 1929–1937 (FRED series or a table from the Bureau of Labor Statistics).
2. Find a measure of the money supply for the same years (for example, the "M2" estimates of Friedman and Schwartz reproduced in many textbooks, or a FRED series), and note your source.
3. Record the official gold price for each year ($20.67 through 1933, $35 from 1934).
4. Graph prices and money on one chart (use index numbers with 1929 = 100).
5. Mark March 1933 and January 1934 on the chart.
6. Describe the turning points. When did prices stop falling? When did money begin to grow?
7. Write a one-page analysis: did the evidence support the advisers who argued that gold was holding back recovery? Name one other cause that may also have mattered.

Tips

- Use index numbers so that series with different units can share a chart.
- Record every source and its date; historians check each other's numbers.

Check your work

- ☐ I can tell the story of 1933–34 accurately.
- ☐ I can compute the devaluation from gold prices.
- ☐ I can read real data and judge a historical argument.

LEDGER NOTEBOOK

1. Copy your data table, chart and sources.
2. Make a timeline: March 4–6, 1933; April 5, 1933; June 1933; January 30–31, 1934; 1935; 1975.
3. Write a stakeholder scorecard (1–5 with reasons) for the gold measures of 1933–34.

KEY FORMULAS

$$\text{Gold value of } \$1 = \frac{1}{\text{price of gold}} \text{ ounces}$$

$$\text{Devaluation} = 1 - \frac{\text{old price of gold}}{\text{new price of gold}}$$

From history. Americans were not allowed to own gold bullion again until December 31, 1974. The Treasury used part of its 1934 gold profit to create the Exchange Stabilization Fund, which still exists and can buy and sell foreign currencies.

WORKED EXAMPLES

Example 1. Find the gold content of one dollar before and after January 1934, and the percent devaluation.

Show solution

1. Before: $1/20.67 = 0.04838$ ounce.
2. After: $1/35 = 0.02857$ ounce.
3. Devaluation: $1 - 20.67/35 = 0.409$.

Answer: The dollar's gold content fell by about 41%.

Example 2. A citizen turned in 10 ounces of gold in April 1933 and received $20.67 an ounce. What would the same gold have been worth at the 1934 price? How much did he lose compared with keeping it (had that been legal)?

Show solution

1. Received: $10 \times 20.67 = \$206.70$.
2. Worth at $35: $350.
3. Difference: $143.30.

Answer: $143.30, or about 69% more than he was paid. This transfer from gold holders to the government was one of the costs of the policy.

Example 3. Suppose the Treasury held 200 million ounces of gold when the price rose from $20.67 to $35. Find the increase in its dollar value.

Show solution

1. Change per ounce: $35 - 20.67 = \$14.33$.
2. Total: $200 \times 10^6 \times 14.33 \approx \$2.87$ billion.

Answer: About $2.9 billion, roughly the size of the actual “gold profit” the Treasury recorded in 1934.

PRACTICE

1. Easy What did Executive Order 6102 require?

   Show answer

   That Americans deliver most gold coin, bullion and gold certificates to the Federal Reserve Banks at $20.67 an ounce.

2. Easy What gold price did the United States set in January 1934?

   Show answer

   $35 an ounce.

3. Easy What was the bank holiday of March 1933?

   Show answer

   A nationwide closing of banks for several days to stop runs, followed by reopening of sound banks.

4. **Medium** Find the percent devaluation if the gold price rose from $20 to $32.

Show answer

$1 - 20/32 = 37.5\%$.

5. **Medium** A bond promises $1,000 in gold of the 1933 standard. How many ounces is that at $20.67? What would those ounces be worth at $35?

Show answer

$1{,}000/20.67 = 48.38$ ounces, worth $48.38 \times 35 \approx \$1{,}693$.

6. **Medium** Why did advisers think a higher gold price would help the economy?

Show answer

It would let the money supply grow and stop deflation, easing the burden of debts and helping banks and prices recover.

7. **Medium** What happened to gold flows into the United States after 1934?

Show answer

Gold flowed in from abroad, attracted by the higher price and by fear in Europe, enlarging the money supply.

8. **Hard** Explain who gained and who lost from the cancellation of gold clauses.

Show answer

Debtors, including the government, gained because they could repay in devalued dollars; creditors with gold clauses lost the higher gold value they had contracted for.

9. **Hard** Prices fell about 25% from 1929 to 1933. A farmer owed $4,000. By how much did the real burden of his debt rise?

Show answer

In 1929 dollars his debt became $4{,}000/0.75 \approx \$5{,}333$, a rise of about 33%.

10. **Challenge** Using MV = PY, explain how a rise in the gold price could raise prices and output in 1933–37 if V was steady. What does your answer assume about how gold reached the money supply?

Show answer

A higher gold price raised the dollar value of gold reserves and drew gold in, allowing banks and the Fed to expand M. With V steady, higher M raised PY: some as higher prices, some as more output. It assumes the gold was added to bank reserves and lent out, not hoarded or sterilized.

COMMON MISTAKES

- Thinking the United States left gold entirely in 1933. Foreign central banks could still convert dollars to gold at $35 until 1971.
- Computing the devaluation as $(35 - 20.67)/20.67$. That is the rise in the gold price (69%); the fall in the dollar's gold value is 41%.
- Treating the policy as costless. Gold holders and gold-clause creditors lost real value.

> **Make it a game · Gold Price Headline Race.** Write cards for the bank holiday, Executive Order 6102 and the Gold Reserve Act of 1934. Put them in order and give one fact each. Then compute how much the dollar's gold content fell when gold went from 20.67 to 35 dollars an ounce, and by what percent the gold price rose. Do it in two minutes.

6.2 Bretton Woods, 1944

OBJECTIVES

- Describe the Bretton Woods conference of 1944 and the system it created.
- Calculate par values and cross exchange rates under fixed exchange rates.
- Explain the roles of the International Monetary Fund and the World Bank and the Triffin dilemma.

> **Warm-up.** After a long war, many countries' factories are ruined and their currencies weak. List three things those countries would need from the rest of the world to rebuild trade.

WATCH

Out of the Ashes (Rebuilding the International Monetary System)

IMF · 8:08

https://www.youtube.com/watch?v=s2OeN-im044

> **WHEN TO WATCH**
> After the story, before the big idea.

KEY TERMS

Bretton Woods system
The international monetary system of 1944–1971, in which currencies were pegged to the U.S. dollar and the dollar was convertible into gold for foreign governments at $35 an ounce.

par value
A currency's official fixed value in terms of the dollar or gold.

International Monetary Fund (IMF)
An organization created at Bretton Woods to lend to countries with temporary balance-of-payments problems and to oversee exchange rates.

World Bank
The International Bank for Reconstruction and Development, created at Bretton Woods to lend for rebuilding and development.

reserve currency

A currency that central banks hold as part of their reserves; after 1944, chiefly the U.S. dollar.

CORE IDEAS

The story. In July 1944, while war still raged, delegates from 44 countries gathered at the Mount Washington Hotel in Bretton Woods, New Hampshire. For three weeks they designed a new monetary order for the peace to come. The leading figures were John Maynard Keynes for Britain and Harry Dexter White of the U.S. Treasury. Keynes wanted a world clearing union with its own currency; White wanted a system centered on the dollar, and since the United States held most of the world's monetary gold, White's plan largely prevailed. The agreements, signed on July 22, created the International Monetary Fund and the International Bank for Reconstruction and Development, the World Bank.

How they figured it out. The delegates remembered the 1930s, when countries left gold one by one, devalued in turn to win trade, and raised barriers against imports, while world trade collapsed. They wanted fixed exchange rates without the rigid gold standard. Under the new system, the United States promised to convert dollars held by foreign central banks into gold at $35 an ounce. Other countries fixed their currencies to the dollar at par values, keeping market rates within one percent by buying and selling dollars, and could change their par value only to fix a "fundamental disequilibrium," with the IMF's consent. The IMF would lend to members with temporary payment problems so that they would not have to deflate harshly or restrict trade.

The big idea. Bretton Woods was a **gold-exchange standard**: gold backed the dollar, and the dollar backed the rest. It gave the world stable exchange rates and the flexibility of occasional adjustments, and world trade grew rapidly in the 1950s and 1960s. But it had a built-in strain, identified by the economist Robert Triffin in 1960. For the world to have enough dollars for trade and reserves, the United States had to run deficits and send dollars abroad. Yet the more dollars piled up abroad compared with American gold, the less believable the promise to convert them at $35. This is the **Triffin dilemma**.

In business today. The IMF and the World Bank still exist, with nearly every nation as a member. The dollar is still the world's main reserve currency, used to price oil and many commodities and to settle much international trade, although its link to gold ended in 1971. Businesses that trade abroad still feel the legacy of Bretton Woods every time they price a contract in dollars.

Who gained? War-damaged countries gained stable currencies and access to loans; exporters and importers gained predictable exchange rates; the United States gained the advantages of issuing the world's reserve currency. The system demanded discipline from every member, and in the end the strain fell heavily on the United States, as Lesson 6.3 will show.

PICTURE STUDY



Opening of the Bretton Woods Conference, Unknown photographer, July 1944 · Photograph · Bretton Woods, New Hampshire

Image: Wikimedia Commons, public domain

U.S. Treasury Secretary Henry Morgenthau Jr. opened the conference as its president. More than 700 delegates and staff from 44 countries filled the Mount Washington Hotel for three weeks, working in committees on the Fund and the Bank.

Look closely

- Count the flags you can see. How many countries might be represented?
- Find the flags. What do they tell you about the meeting?
- Find the lectern and microphone. Who is speaking, and to whom?
- What would make a meeting like this hard to run?

Talk about it

1. Why did the delegates meet in 1944, before the war was over?
2. What did they most want to avoid repeating from the 1930s?
3. Which countries had the strongest bargaining position, and why?

PROJECT

A Fixed-Exchange-Rate Simulation

You will play a central bank defending a par value against market pressure, track your reserves, and decide when a devaluation becomes necessary.

You will need

- A spreadsheet
- Dice
- Your ledger notebook

Steps

1. Your country's currency has a par value of 4.00 per dollar with a one-percent band. You start with $1,000 million of dollar reserves.
2. Each quarter, roll two dice to set market pressure: subtract 7 from the total, and multiply by $50 million. A negative number means the market is selling your currency.
3. If pressure pushes the rate outside the band, you must use reserves equal to the pressure to defend it. Record reserves after each quarter.
4. Add a steady $30 million outflow each quarter (a trade deficit) on top of the dice.
5. Run 20 quarters. When do your reserves fall below $300 million?
6. At that point, decide: borrow from the IMF (add $300 million that must be repaid), raise interest rates (reduce the outflow to $10 million), or devalue to 4.40 (end the outflow). Record your choice and run 8 more quarters.
7. Write a memo explaining your choice and its effects on exporters, importers and savers.

Tips

- Keep all your rolls and decisions in the spreadsheet.
- Try the game twice with different choices and compare.

Check your work

☐ I can describe the Bretton Woods system.

- ☐ I can compute cross rates and bands.
- ☐ I can explain the Triffin dilemma.

LEDGER NOTEBOOK

1. Copy your simulation table and graph of reserves.
2. Draw a diagram of the Bretton Woods system: gold → dollar → other currencies, with the IMF and World Bank.
3. Compare Keynes's plan and White's plan in two columns.

KEY FORMULAS

$$\text{Cross rate: } \frac{\text{A per \$}}{\text{B per \$}} = \text{A per B}$$

$$\text{Band: par} \times (1 \pm 0.01)$$

From history. Keynes, already ill, worked so hard at Bretton Woods that he suffered a heart attack during the conference. He died in 1946. The Mount Washington Hotel still stands, and the room where the agreements were signed is called the Gold Room.

WORKED EXAMPLES

Example 1. Under Bretton Woods the pound's par value was \$2.80 (from 1949) and the West German mark's was 4.20 marks per dollar (from 1953). Find the cross rate of marks per pound.

Show solution

1. Marks per pound: $4.20 \times 2.80 = 11.76$.

Answer: 11.76 marks per pound.

Example 2. With the pound at a par value of \$2.80 and a one-percent band, find the band. If the market rate fell to \$2.77, what would the Bank of England have to do?

Show solution

1. Band: $2.80 \times 0.99 = \$2.772$ to $2.80 \times 1.01 = \$2.828$.
2. \$2.77 is below the floor of \$2.772.
3. The Bank must buy pounds with its dollar reserves (or raise interest rates) to push the rate back up.

Answer: Band \$2.772–\$2.828; at \$2.77 the Bank of England must sell dollars and buy pounds to defend the par value.

Example 3. Around 1960 the U.S. gold stock was worth about \$17.8 billion at \$35 an ounce, and dollar claims held by foreign official institutions had grown to about the same size. Take the claims as \$18.7 billion. Find the gold coverage ratio and explain Triffin's worry.

Show solution

1. Coverage: $17.8/18.7 \approx 0.95$.
2. Dollar claims now roughly equaled or exceeded the gold available to redeem them.
3. If the world needed more dollars, the ratio would keep falling, and holders might rush to convert before the gold ran out.

Answer: About 95%. As dollars abroad grew faster than gold, the \$35 promise became harder to keep.

PRACTICE

1. Easy Where and when was the Bretton Woods conference held?

   Show answer

   At the Mount Washington Hotel in Bretton Woods, New Hampshire, in July 1944.

2. Easy Name the two institutions created at Bretton Woods.

Show answer

The International Monetary Fund and the International Bank for Reconstruction and Development (the World Bank).

3. Easy At what price did the United States promise to convert dollars into gold for foreign governments?

Show answer

$35 an ounce.

4. Medium The French franc was set at 4.937 francs per dollar (1960) and the mark at 4.00 per dollar (1961). Find francs per mark.

Show answer

$4.937/4.00 \approx 1.234$ francs per mark.

5. Medium A par value is 360 yen per dollar with a one-percent band. Find the band.

Show answer

356.4 to 363.6 yen per dollar.

6. Medium Why did White's plan prevail over Keynes's?

Show answer

The United States held most of the world's monetary gold and was the strongest economy, so its plan centered on the dollar carried the day.

7. Medium What is the Triffin dilemma?

Show answer

The world needed more dollars for reserves, which required U.S. deficits, but more dollars abroad relative to U.S. gold made the gold promise less credible.

8. Hard Why did Bretton Woods allow changes in par values, and why was this both a strength and a weakness?

Show answer

To fix fundamental disequilibrium without harsh deflation. But expected changes invited speculation: if traders expected a devaluation, they sold the currency, forcing the very crisis.

9. Hard Explain how the IMF was meant to help a country with a temporary deficit.

Show answer

It would lend reserves so the country could defend its par value while it corrected the deficit, rather than deflating sharply or restricting trade.

10. Challenge Dollar claims abroad grow 8% a year and the U.S. gold stock falls 3% a year, starting from coverage of 0.95. Find the coverage after 5 years.

Show answer

$$0.95 \times \frac{0.97^5}{1.08^5} \approx 0.95 \times \frac{0.859}{1.469} \approx 0.56.$$

COMMON MISTAKES

- Thinking Bretton Woods was a full gold standard. Only foreign official holders could convert dollars to gold; Americans could not own gold bullion.
- Confusing the IMF and the World Bank. The IMF lends for payment problems; the World Bank lends for rebuilding and development.
- Multiplying when you should divide in cross rates. Check the units: marks per dollar times dollars per pound gives marks per pound.

> **Make it a game · Cross-Rate Drill.** Under a Bretton Woods style system, each currency has a par value against the dollar. Your parent invents three currencies, such as the franc at 4 to the dollar and the mark at 2. Compute cross rates between each pair in ten seconds. Then explain what the IMF and the World Bank were meant to do at the 1944 conference.

6.3 August 15, 1971: The Gold Window Closes

OBJECTIVES

- Explain why the United States could no longer keep its promise to convert dollars into gold at $35 an ounce.
- Describe the events of August 15, 1971, the Smithsonian Agreement and the move to floating exchange rates in 1973.
- Calculate changes in the gold stock, the coverage ratio and the dollar's devaluations.

> **Warm-up.** You have promised to give any friend who asks one candy bar for every token he holds. You hand out more and more tokens, but your stack of candy bars is shrinking. Write what your friends will do, and what you will eventually have to do.

WATCH

Bretton Woods

Marginal Revolution University · 8:25

https://www.youtube.com/watch?v=wuOOK7aU1TY

> **WHEN TO WATCH**
> After the story; focus on the part explaining why the system broke down.

KEY TERMS

gold window

The arrangement by which the U.S. Treasury converted dollars held by foreign central banks into gold at $35 an ounce.

London Gold Pool

An arrangement (1961–1968) in which the United States and European central banks sold gold in London to hold its market price near $35.

floating exchange rate

An exchange rate set by supply and demand in the currency market rather than fixed by a central bank.

Smithsonian Agreement

The December 1971 agreement that set new par values, raised the official gold price to $38 and widened the bands to 2.25%.

fiat money

Money that is not convertible into a commodity; its value rests on law (legal tender) and on public trust.

CORE IDEAS

The story. By the late 1960s the strain Triffin had predicted was obvious. The U.S. gold stock, about 700 million ounces in 1949, had fallen to under 300 million by 1971, while dollars held abroad had multiplied. Spending abroad, inflation at home and a growing appetite for imports sent still more dollars overseas. Foreign central banks, led by France, presented dollars for gold. On Friday, August 13, 1971, President Nixon took his economic advisers to the presidential retreat in the Maryland mountains. On Sunday evening, August 15, he announced on television that the United States would suspend the conversion of dollars into gold, impose a 90-day freeze on wages and prices, and add a temporary 10% surcharge on imports.

How they figured it out. The decision followed years of patches. The London Gold Pool sold gold to hold the market price at $35, but it collapsed in March 1968, and a two-tier market followed, with an official price for central banks and a free price for everyone else. In December 1971, at the Smithsonian Institution in Washington, the major countries agreed to new par values and an official gold price of $38, with wider bands. That too failed. In February 1973 the dollar was devalued again, to $42.22 an ounce, and by March the major currencies were floating. The international link between money and gold, which had lasted in some form for centuries, was ended.

The big idea. A fixed promise is only as strong as the reserves behind it. When claims on gold far exceeded the gold, a run became rational, just as on a bank. Since 1971 the dollar has been **fiat money**: it is legal tender for all debts, public and private, and it is accepted because the law requires it for taxes and debts and because people trust it. Its value depends on how much is issued compared with the goods and services it buys, which places the responsibility for sound money on the central bank. Exchange rates among major currencies now float, moving every minute with supply and demand.

In business today. Floating rates mean that a company buying parts from Japan or selling machines to Germany faces exchange-rate risk, and many protect themselves

with forward contracts. Fiat money gives central banks the ability to respond to crises by creating money, but also the temptation to create too much. The decade after 1971 brought the highest peacetime inflation in American history, which you will study in the next two lessons.

Who gained? The United States gained freedom from a promise it could no longer keep, and its exporters gained from a cheaper dollar. Foreign central banks holding dollars took losses in gold terms. Savers and people on fixed incomes were hurt by the inflation of the 1970s. Traders and businesses had to learn to live with floating rates.

PICTURE STUDY



United States Bullion Depository, Fort Knox, Kentucky, Public Works Administration (photograph), 1939 · Photograph · Published by the Committee on Architectural Surveys and the Public Works Administration

Image: Wikimedia Commons, public domain

The Treasury built this vault at Fort Knox in 1936 to hold much of the gold it had gathered after 1934. Gold arrived by armored train in 1937. For decades it stood as a symbol of the gold behind the dollar. By 1971 the promise to foreigners that this gold stood behind could no longer be kept.

Look closely

- Look at the building's walls and windows. What do they tell you about its purpose?
- Find the gate and the fence. How was the gold protected?
- Look at the guard houses beside the gate. What do they tell you?
- Compare this building with the Bank of England's Great Hall in Lesson 5.2. What is different about the two kinds of trust they show?

Talk about it

1. Why did the government keep so much gold if Americans could not exchange dollars for it?
2. What happened to the gold promise between 1949 and 1971?
3. Does the dollar need gold behind it today? What does stand behind it?

PROJECT

Floating Rates and a Business Decision

You will track exchange rates for two currencies over several weeks, calculate how a small importer's costs change, and decide whether to protect the business with a forward contract.

You will need

- A computer with a parent's help (a central bank's exchange-rate page, such as the Federal Reserve's H.10 release, or FRED)
- A spreadsheet
- Your ledger notebook

Steps

1. Choose two currencies (for example, the euro and the yen). Record their exchange rates against the dollar each week for four weeks, or use past data for the last twelve months.
2. Imagine a small importer who must pay €50,000 (or ¥7,000,000) in three months. Compute the dollar cost at each recorded rate.
3. Find the highest and lowest cost and the percent difference.
4. Suppose a bank offers a forward contract to fix the rate today at a price one percent above the current rate. Compute the dollar cost under the forward contract.
5. Decide whether the importer should take the forward contract. Explain the trade-off between certainty and possible savings.
6. Compare: under Bretton Woods, how would the importer's cost have changed over the same period?
7. Write a one-page memo to the importer.

Tips

- Record the source and date of every rate.
- Note whether the rate is quoted as dollars per euro or euros per dollar; mixing them up is the most common error.

Check your work

- ☐ I can explain why the gold window closed.
- ☐ I can compute coverage ratios and devaluations.
- ☐ I can explain exchange-rate risk under floating rates.

LEDGER NOTEBOOK

1. Copy your exchange-rate table, cost calculations and memo.
2. Make a timeline: 1949, 1960, 1961, March 1968, August 15, 1971, December 1971, February 1973, March 1973.
3. Draw a bar graph of the U.S. gold stock (in millions of ounces) for 1949 and 1971.

KEY FORMULAS

$$\text{Gold coverage} = \frac{\text{gold stock} \times \text{official price}}{\text{foreign official dollar claims}}$$

$$\text{Devaluation from } P_0 \text{ to } P_1 = 1 - \frac{P_0}{P_1}$$

From history. Paul Volcker, then an under secretary of the Treasury, was one of the advisers at that weekend meeting in August 1971. Eight years later, as chairman of the Federal Reserve, he would lead the fight against the inflation of the 1970s (Lesson 6.4).

WORKED EXAMPLES

Example 1. The U.S. gold stock fell from about 700 million ounces in 1949 to about 290 million ounces in 1971. Find the percent decline and its value at $35 an ounce in each year.

Show solution

1. Decline: $(290 - 700)/700 \approx -59\%$.
2. Value 1949: $700 \times 35 = \$24.5$ billion. Value 1971: $290 \times 35 \approx \$10.2$ billion.

Answer: The stock fell about 59%, from about $24.5 billion to about $10.2 billion at the official price.

Example 2. By 1971 foreign official holders had roughly $40 billion of dollar claims (a rough estimate) against about $10.2 billion of gold at $35. Find the coverage ratio. What gold price would have made coverage 100%?

Show solution

1. Coverage: $10.2/40 \approx 0.26$.
2. Needed price: $35 \times 40/10.2 \approx \$137$ an ounce.

Answer: About 26%; the gold price would have had to rise to about $137 to cover every claim, which is why the window could not stay open.

Example 3. Find the devaluation of the dollar against gold from $35 to $38 (December 1971) and from $35 to $42.22 (February 1973).

Show solution

1. To $38: $1 - 35/38 \approx 7.9\%$.
2. To $42.22: $1 - 35/42.22 \approx 17.1\%$.

Answer: About 7.9% and about 17 percent against the old $35 price.

PRACTICE

1. Easy What did President Nixon announce on August 15, 1971?

   Show answer

   Suspension of dollar convertibility into gold, a 90-day wage and price freeze, and a temporary 10% import surcharge.

2. Easy What was the London Gold Pool?

   Show answer

   A group of central banks that sold gold in London from 1961 to 1968 to hold its price near $35.

3. Easy What official gold price did the Smithsonian Agreement set?

   Show answer

   $38 an ounce.

4. **Medium** Gold stock 400 million ounces at $35; foreign claims $28 billion. Find the coverage ratio.

Show answer

$14/28 = 0.5$.

5. **Medium** What is fiat money, and what gives it value?

Show answer

Money not convertible into a commodity; its value rests on legal-tender laws, its acceptance for taxes and debts, public trust, and how much is issued relative to goods.

6. **Medium** Find the devaluation from $38 to $42.22.

Show answer

$1 - 38/42.22 \approx 10.0\%$.

7. **Medium** Why did foreign central banks present dollars for gold in the late 1960s?

Show answer

They feared the United States could not keep the $35 price, so converting early protected them from a devaluation.

8. **Hard** Explain why the closing of the gold window was like a bank suspending payments in a run.

Show answer

Claims (dollars) far exceeded reserves (gold); holders rushed to convert; the issuer stopped paying to protect its remaining reserves.

9. **Hard** Under floating rates, the dollar rises from 0.90 to 1.00 euros. An American firm sells a $10,000 machine in Germany. How does its euro price change, and what might happen to sales?

Show answer

From €9,000 to €10,000, an 11% rise for German buyers, so sales may fall.

10. **Challenge** An importer must pay ¥10,000,000 in 90 days. Today the rate is ¥150 per dollar. The yen could move to ¥140 or ¥160. Compute the dollar cost in each case and the forward cost at ¥148.5. When would the forward contract have been the better choice?

    Show answer

    At 150: $66,667; at 140: $71,429; at 160: $62,500; forward at 148.5: $67,340. The forward contract is better if the yen strengthens past ¥148.5 (as at ¥140); otherwise the importer would have saved by waiting.

COMMON MISTAKES

- Thinking ordinary Americans could exchange dollars for gold before 1971. Only foreign official holders could.
- Confusing the end of convertibility in 1971 with the start of floating rates in 1973.
- Mixing up quotes in dollars per euro and euros per dollar.

> **Make it a game · Gold Coverage Decision.** Your parent gives pretend figures: gold stock in ounces, foreign dollar claims, and the 35-dollar price. Compute the coverage ratio each year as claims grow. Decide when to suspend conversion and defend your choice as an advisor before August 15, 1971. Then compute what happens to a business paying in francs after rates float.

6.4 How the Fed Sets Interest Rates and the Money Supply

OBJECTIVES

- Explain how the Federal Open Market Committee sets a target for the federal funds rate and how the Fed's tools move market rates.
- Distinguish nominal and real interest rates using the Fisher equation, and evaluate a simple policy rule.
- Tell the story of the Federal Reserve's fight against inflation from 1979 to 1983 and its lessons.

> **Warm-up.** Your bank pays 2% on savings, and prices are rising 4% a year. Is your money growing or shrinking in what it can buy? Write your reasoning in two sentences.

WATCH

Monetary policy tools | Financial sector | AP Macroeconomics | Khan Academy

Khan Academy · 9:27

https://www.youtube.com/watch?v=C8Eb4-Wz27A

> **WHEN TO WATCH**
> After the big idea, before the worked examples.

BACKUP VIDEO

Fed Functions: Conducting Monetary Policy

Federal Reserve · 3:48

https://www.youtube.com/watch?v=xHQJBNO0yQc

After the story, as the Federal Reserve's own summary of monetary policy.

KEY TERMS

federal funds rate
The interest rate banks charge one another for overnight loans of reserves; the Fed's main policy target.

Federal Open Market Committee (FOMC)
The Fed committee (the seven Governors and five Reserve Bank presidents) that sets monetary policy.

open market operations

Fed purchases and sales of government securities that change the quantity of bank reserves.

interest on reserve balances

Interest the Fed pays banks on reserves held at the Fed; since 2008 a main tool for steering short-term rates.

real interest rate

The nominal interest rate minus expected inflation: the return in purchasing power.

discount rate

The rate the Fed charges banks that borrow at its discount window.

CORE IDEAS

The story. In the 1970s, after the dollar's link to gold ended, American inflation climbed in waves: about 6% in 1973, over 11% in 1974, and above 13% in 1979 and 1980. Oil shocks played a part, but money had grown too fast for years. In August 1979 Paul Volcker became chairman of the Federal Reserve. In October he announced that the Fed would focus on controlling the growth of money and would let interest rates rise as far as necessary. The federal funds rate rose to about 20% at its peak in 1981; mortgage rates passed 18%. Two recessions followed, and unemployment reached nearly 11% in late 1982. Builders mailed the Fed lumber with angry notes, and farmers circled the Fed's building with tractors. But inflation fell to about 3% by 1983, and it stayed far lower for decades after.

How they figured it out. The Fed learned two hard lessons. First, the public's expectations matter: once people expect high inflation, they demand higher wages and prices, and inflation feeds itself. Breaking those expectations required a central bank willing to accept short-term pain. Second, credibility is an asset. Because the Fed held firm, later generations of Americans came to expect low inflation, which made it easier to keep. Over time the Fed moved from targeting money growth to targeting a short-term interest rate, and in 2012 it announced a long-run goal of 2% inflation.

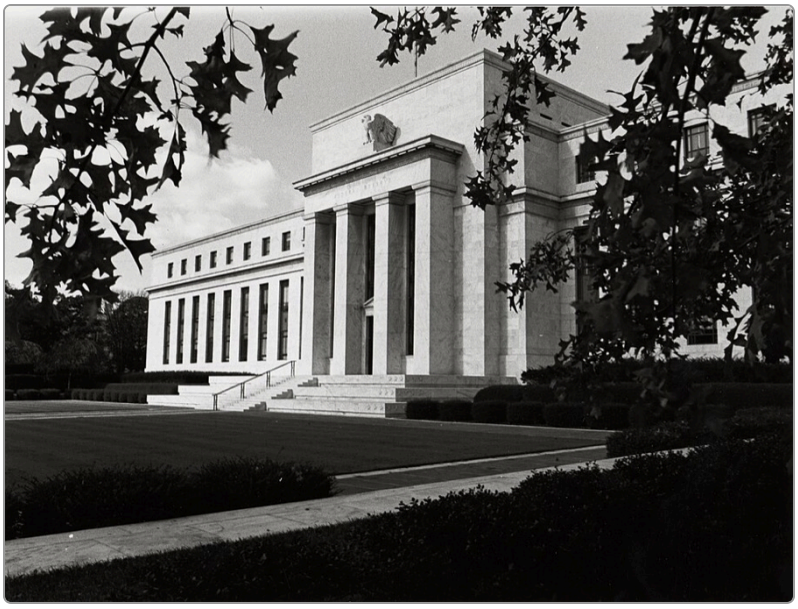
The big idea. The FOMC meets eight times a year and sets a target range for the **federal funds rate**. Before 2008 the Fed hit its target mainly through **open market operations**: buying securities added reserves and pushed the rate down; selling them drained reserves and pushed it up. Since 2008, with large reserves in the system, the Fed steers the rate chiefly by setting the **interest it pays on reserve balances**: banks will not lend reserves to each other for much less than the Fed pays

them. In 2020 the Fed set reserve requirements to zero. Short-term rates in turn affect loan rates, asset prices, the exchange rate, spending and, after a delay, inflation. What matters for borrowers and savers is the **real interest rate**: $r \approx i - \pi^e$.

In business today. When the Fed raises rates, borrowing costs rise for car loans, mortgages and business loans, so spending and investment slow; when it lowers them, the reverse. Businesses watch FOMC statements closely to plan borrowing and investment. Many economists compare the Fed's actual rate with simple rules, such as one proposed by the economist John Taylor in 1993, to judge whether policy is tight or loose. These are tools of judgment, not laws.

Who gained? The fight against inflation had real costs: workers who lost jobs, farmers and builders who could not borrow, and businesses that failed in 1981–82. The gains came later and were widely shared: savers, retirees on fixed incomes, and businesses planning for the long run benefited from decades of low, steady inflation. Sound money, like honest weights, serves the whole community, but the cost of restoring it after it has been lost is high.

PICTURE STUDY



The Federal Reserve Board's building in Washington, Federal Reserve Board (photograph), October 20, 1937 · Photograph · Federal Reserve Board, Washington, D.C.

Image: Wikimedia Commons, public domain

The Board's headquarters was completed in 1937 and later named for Marriner Eccles, its chairman in the 1930s and 1940s. The FOMC meets in a room inside it. Its plain, solid classical style was meant to suggest permanence and stability: qualities the public hopes to find in its money.

Look closely

- Look at the materials and shape of the building. What impression do they give?
- Compare it with the Bank of England's Great Hall (Lesson 5.2). How are they alike and different?
- Look at the entrance. Is it inviting or forbidding?
- Notice what is missing: no vault, no gold. Where is the Fed's power, if not in metal?

Talk about it

1. The Fed's power is in its balance sheet and its decisions, not in this building. Explain what that means.
2. Why does a central bank want to look stable and permanent?

3. Whose interests should the FOMC keep in mind when it sets interest rates?

PROJECT

Be the FOMC

You will gather current economic data, apply the Fisher equation and Taylor's rule, and write your own policy statement as if you were on the FOMC.

You will need

- A computer with a parent's help (FRED from the St. Louis Fed, and the Fed's own website for the latest FOMC statement)
- A spreadsheet
- Your ledger notebook

Steps

1. Find the latest values of: the federal funds target range, inflation (the PCE price index or CPI over the last 12 months), the unemployment rate, and a recent estimate of the output gap (or use unemployment as a rough guide).
2. Compute the real federal funds rate using the Fisher equation.
3. Apply Taylor's rule with $r^* = 1\%$ and $\pi^* = 2\%$. Compare the result with the actual rate.
4. Read the most recent FOMC statement. List the reasons it gives for its decision.
5. Graph the federal funds rate and inflation since 1970 using FRED. Mark 1979–82.
6. Write a one-paragraph FOMC statement of your own: your decision, your reasoning and what data you will watch.
7. Write a second paragraph explaining who would gain and who would bear costs from your decision.

Tips

- Write your statement as economic reasoning only; leave out opinions about parties or officeholders.
- Record each data source and date.

Check your work

- ☐ I can explain how the Fed sets and reaches its interest-rate target.
- ☐ I can compute real rates and apply Taylor's rule.
- ☐ I can tell the story of 1979–83 and its lessons.

LEDGER NOTEBOOK

1. Copy your data table, calculations and policy statement.
2. Draw a flow chart: Fed sets interest on reserves → federal funds rate → loan rates → spending → inflation.
3. Sketch the FRED graph of the federal funds rate and inflation since 1970 and label the 1979–82 peak.

KEY FORMULAS

$$r \approx i - \pi^{e} \quad \text{(Fisher equation)}$$

$$i = r^{*} + \pi + 0.5(\pi - \pi^{*}) + 0.5(\text{output gap}) \quad \text{(Taylor's rule)}$$

$$\text{Real value after } t \text{ years} = \text{nominal} \times \left(\frac{1+i}{1+\pi}\right)^{t}$$

From history. Volcker, a very tall man known for frugal living, insisted on living modestly in Washington while his family stayed in New York. He later wrote that the most important thing a central banker can have is the trust of the public that money will hold its value.

WORKED EXAMPLES

Example 1. In 1980 a saver earned 12% on a certificate of deposit while inflation was 13.5%. In 1985 she earned 8% while inflation was 3.5%. Find the real rate in each year.

Show solution

1. 1980: $12 - 13.5 = -1.5\%$.
2. 1985: $8 - 3.5 = 4.5\%$.

Answer: −1.5% in 1980 (her savings lost purchasing power) and +4.5% in 1985.

Example 2. Use Taylor's rule with $r^* = 2\%$ and $\pi^* = 2\%$. Inflation is 4% and output is one percent above its potential. What rate does the rule suggest?

Show solution

1. $i = 2 + 4 + 0.5(4 - 2) + 0.5(1)$.
2. $i = 2 + 4 + 1 + 0.5 = 7.5\%$.

Answer: 7.5%. If the Fed's actual target were much lower, the rule would call policy loose.

Example 3. The Fed buys $10 billion of Treasury bills from banks in an open market operation. Show the effect on the Fed's balance sheet and on bank reserves.

Show solution

1. Fed assets: securities +$10 billion.
2. Fed liabilities: bank reserves +$10 billion (the Fed pays by crediting the banks' reserve accounts).
3. Banks: securities −$10 billion, reserves +$10 billion.

Answer: Reserves in the banking system rise by $10 billion; other things equal, this pushes short-term rates down.

PRACTICE

1. Easy What is the federal funds rate?

   Show answer

   The rate banks charge each other for overnight loans of reserves.

2. Easy Who sits on the FOMC?

   Show answer

   The seven members of the Board of Governors and five of the twelve Reserve Bank presidents (the New York Fed president always, the others in rotation).

3. Easy What inflation rate does the Fed aim for in the long run?

   Show answer

   2% (announced in 2012).

4. Medium Nominal rate 5%, expected inflation 2%. Find the real rate.

Show answer

About 3%.

5. Medium How do open market purchases affect bank reserves and short-term rates?

Show answer

Purchases add reserves and push short-term rates down; sales drain reserves and push rates up.

6. Medium Why does paying interest on reserves help the Fed control rates when reserves are plentiful?

Show answer

Banks will not lend reserves for less than the Fed pays them, so the rate on reserves sets a floor under short-term rates.

7. Medium Using Taylor's rule with $r^* = 2$, $\pi^* = 2$, inflation 2% and a zero output gap, what rate does the rule suggest?

Show answer

4%.

8. Hard Why did the Fed's fight against inflation in 1979–82 cause recessions?

Show answer

High interest rates reduced borrowing, spending and investment, which cut output and employment before inflation expectations fell.

9. Hard $10,000 is saved for 10 years at 3% while inflation is 4%. Find its real value.

Show answer

$10{,}000 \times (1.03/1.04)^{10} \approx \$9{,}078$ in today's purchasing power.

10. **Challenge** Inflation is 6%, the output gap is −2% (output below potential), $r^* = 1$, $\pi^* = 2$. Find the Taylor-rule rate and the real rate it implies. Explain the tension the Fed faces.

    Show answer

    $i = 1 + 6 + 0.5(4) + 0.5(-2) = 8\%$; real about 2%. High inflation calls for tight policy while weak output calls for ease; the rule weighs both.

COMMON MISTAKES

- Thinking the Fed sets all interest rates directly. It sets a short-term target; market rates follow through competition and expectations.
- Ignoring inflation when judging a savings rate. A 12% rate with 13.5% inflation loses purchasing power.
- Treating Taylor's rule as law. It is a guide that economists use to compare policies.

> **Make it a game · Be the FOMC Dice Roll.** Roll two dice to set inflation and unemployment data for a pretend economy. Choose a federal funds rate target using a simple rule such as inflation plus 2 plus half the gap from a 2 percent target. Compute the real rate with the Fisher equation. Explain how open market operations would move rates. Beat the clock over five meetings.

6.5 Inflation, Deflation and Hyperinflation: Weimar Germany and Zimbabwe

OBJECTIVES

- Measure inflation with a price index and compute inflation rates and real values.
- Explain the costs of inflation and of deflation.
- Tell the stories of the German hyperinflation of 1923 and the Zimbabwean hyperinflation of 2007–2009 and identify their common causes and cures.

> **Warm-up.** Ask an older relative what a loaf of bread, a gallon of gasoline or a movie ticket cost when he or she was your age. Record the answers and today's prices. By how many times has each risen?

WATCH

Introduction to inflation | Inflation - measuring the cost of living | Macroeconomics | Khan Academy

Khan Academy · 7:32

https://www.youtube.com/watch?v=AaR1mPrdbTc

> **WHEN TO WATCH**
> Before the worked examples on price indexes.

BACKUP VIDEO

15th October 1923: Rentenmark introduced in Weimar Germany to stop the hyperinflation crisis

HistoryPod · 2:19

https://www.youtube.com/watch?v=Ueel2Ogirn4

With the story of the Rentenmark.

KEY TERMS

inflation

A sustained rise in the general level of prices; a fall in money's purchasing power.

deflation

A sustained fall in the general level of prices.

hyperinflation

Extremely rapid inflation, often defined as prices rising more than 50% in a month.

consumer price index (CPI)

A measure of the average price of a fixed basket of goods and services bought by households, compared with a base year.

currency reform

Replacing a failed currency with a new one, often with new rules to limit its issue.

CORE IDEAS

The story. In 1914 a U.S. dollar bought 4.2 German marks. Germany paid for the First World War largely by borrowing and printing money, and after the war it faced heavy reparations payments to the Allies. Prices rose steadily until 1922, then exploded. When French and Belgian troops occupied the Ruhr industrial region in January 1923 to collect reparations, the German government supported the idle workers and owners of the Ruhr, who refused to work for the occupiers, by printing still more marks. By November 1923 a dollar cost about 4.2 trillion marks. Workers were paid twice a day and rushed to spend their wages before prices rose again; savings and pensions built over lifetimes became worthless. Eighty years later, in Zimbabwe, a collapse in farm output and exports combined with heavy money printing by the central bank produced one of the worst hyperinflations ever recorded. In 2008 official inflation passed 231 million percent a year; the central bank issued a 100-trillion-dollar note in early 2009, and soon afterward the country abandoned its currency and used U.S. dollars and South African rand.

How they figured it out. In both cases the cure was the same: stop creating money to pay the government's bills, and give people a money they could trust. In November 1923 Germany introduced a new currency, the Rentenmark, worth one trillion old marks, and strictly limited its issue; a new central bank law and a reparations settlement followed in 1924. Prices stabilized almost at once. Zimbabwe ended its hyperinflation in 2009 by abandoning its own currency. The opposite danger, **deflation**, struck the United States from 1930 to 1933, when prices fell by about a quarter: debts grew heavier, borrowers defaulted, banks failed, and people delayed purchases in the hope of lower prices, deepening the slump.

The big idea. Inflation is measured with a **price index**: the cost of a fixed basket of goods in each year compared with a base year. When money grows far faster than output for long, prices rise; when the government finances itself by printing, and people lose faith and spend money as fast as they get it (velocity soars), inflation becomes hyperinflation. Inflation hurts savers, lenders, and people on fixed incomes, blurs price signals and discourages long-term planning; unexpected inflation transfers wealth from creditors to debtors. Deflation does the reverse and can trap an economy in a slump. That is why most central banks aim for low, steady inflation, which lets prices and wages adjust without the dangers of either extreme.

In business today. Businesses index long contracts to inflation, adjust prices more often when inflation rises and build expected inflation into wage agreements and interest rates. In countries with high inflation, firms often price in a foreign currency. Reading the CPI and understanding real values (prices adjusted for inflation) is basic to any business plan that looks beyond a single year.

Who gained? In Weimar Germany debtors, including the government and some large industrialists, saw their debts wiped out, while the middle class lost its savings, pensions and bonds; the social bitterness that followed shaped Germany's troubled public life. In Zimbabwe ordinary families lost their savings and many emigrated to find work. Hyperinflation is never neutral: it is a massive, hidden transfer of wealth from the prudent to the indebted.

PICTURE STUDY



Reichsbank note for 500 million marks, Reichsbank, Berlin, 1923 · Printed banknote · Germany

Image: Wikimedia Commons, public domain

By the autumn of 1923 the Reichsbank was printing notes for millions, then billions, then trillions of marks, often on one side only, with little decoration, because there was no time for fine engraving. A note like this one, worth a small fortune in 1914, would barely buy a loaf of bread by the end of 1923.

Look closely

- Find the number on the note. Read it aloud.
- Compare the design with the coins and notes earlier in this course. What is missing?
- Look for signs that it was printed in a hurry.
- Find the date. What was happening to prices that year?

Talk about it

1. Why would a government print notes in such huge denominations?
2. What happened to the savings of a family that kept its money in marks?
3. What did Germany do to end the hyperinflation, and why did it work?

PROJECT

Build Your Family's Price Index

You will build a simple price index from your family's own spending and compare it with the official CPI, then compute the real value of a wage or allowance over time.

You will need

- Receipts or store prices for 10 items your family buys regularly
- Prices for the same items from at least one year ago (old receipts, a parent's memory, or archived store flyers)
- Official CPI data (FRED or the Bureau of Labor Statistics)
- A spreadsheet

Steps

1. Choose a basket of 10 items and the quantity of each your family buys in a month.
2. Record each item's price now and a year (or more) ago.
3. Compute the basket's cost in each period and your family's price index (earlier period = 100).
4. Compute your family's inflation rate and compare it with the official CPI inflation for the same period.
5. Explain any differences (your basket is different, some items had sales, quality changed).
6. Choose a wage or allowance and compute its real value now in the earlier period's dollars.
7. Write a paragraph applying what you learned to Weimar Germany: what would your index have looked like in 1923?

Tips

- Use the same size and brand of each item in both periods.
- Record the date and store for every price.

Check your work

- ☐ I can build a price index and compute an inflation rate.
- ☐ I can compute real values.
- ☐ I can explain the causes and cures of hyperinflation.

LEDGER NOTEBOOK

1. Copy your basket, prices, index and comparison with the official CPI.
2. Make a two-column chart: costs of inflation and costs of deflation.
3. Write the common causes and cures of the Weimar and Zimbabwean hyperinflations.

KEY FORMULAS

$$\text{CPI}_t = \frac{\text{cost of basket in year } t}{\text{cost of basket in base year}} \times 100$$

$$\text{Inflation rate} = \frac{\text{CPI}_t - \text{CPI}_{t-1}}{\text{CPI}_{t-1}} \times 100\%$$

$$\text{Real value} = \text{nominal value} \times \frac{\text{CPI}_{\text{base}}}{\text{CPI}_t}$$

From history. During 1923 German printers worked around the clock, and more than 130 printing firms supplied the Reichsbank with notes. Some towns and companies printed their own emergency money, called *Notgeld*, on paper, cloth, leather and even porcelain.

WORKED EXAMPLES

Example 1. A basket costs \$200 in 2015 (the base year), \$214 in 2019 and \$236 in 2022. Find the CPI in each year and the average yearly inflation from 2019 to 2022.

Show solution

1. CPI: 2015 = 100; 2019 = $214/200 \times 100 = 107$; 2022 = 118.
2. Inflation 2019–2022: $(118/107)^{1/3} - 1 \approx 3.3\%$ a year.

Answer: CPI 100, 107, 118; average inflation about 3.3% a year from 2019 to 2022.

Example 2. A worker earned \$40,000 in 2015 and \$44,000 in 2022. Using the CPI above, did her real wage rise or fall?

Show solution

1. Real 2022 wage in 2015 dollars: $44{,}000 \times 100/118 \approx \$37{,}288$.
2. Compare with \$40,000 in 2015.

Answer: Her real wage fell about 7%, even though her dollar wage rose 10%.

Example 3. The mark went from 4.2 per dollar (1914) to 4.2 trillion per dollar (November 1923). By what factor did the dollar's price in marks rise? If this happened at a steady rate over the 16 months from mid-1922 to November 1923 (from about 400 to 4.2 trillion), find the average monthly rate.

Show solution

1. Factor since 1914: $4.2 \times 10^{12} / 4.2 = 10^{12}$, a trillion times.
2. From 400 to 4.2×10^{12} is a factor of about 1.05×10^{10}.
3. Monthly rate: $(1.05 \times 10^{10})^{1/16} - 1 \approx 3.2$, that is, about 320% a month.

Answer: A trillion-fold rise since 1914; from mid-1922 the dollar's mark price rose on average more than fourfold every month.

PRACTICE

1. Easy Define inflation, deflation and hyperinflation.

   Show answer

   A sustained rise in prices; a sustained fall; extremely rapid inflation (often over 50% a month).

2. Easy About how many marks did a dollar cost in 1914 and in November 1923?

   Show answer

   4.2 marks; about 4.2 trillion marks.

3. Easy What new currency ended the German hyperinflation?

   Show answer

   The Rentenmark, introduced in November 1923, worth one trillion old marks.

4. **Medium** A basket costs \$150 in the base year and \$171 now. Find the CPI.

Show answer

114.

5. **Medium** The CPI rises from 250 to 265. Find the inflation rate.

Show answer

6%.

6. **Medium** A pension of \$1,500 a month was fixed when the CPI was 200. The CPI is now 260. Find its real value in base-year dollars.

Show answer

$1{,}500 \times 200/260 \approx \$1{,}154$.

7. **Medium** Why does unexpected inflation transfer wealth from lenders to borrowers?

Show answer

Borrowers repay in dollars worth less than those they borrowed, while lenders receive less purchasing power than they expected.

8. **Hard** Why is deflation dangerous in a slump?

Show answer

It raises the real burden of debts, leading to defaults and bank failures, and people delay purchases expecting lower prices, which deepens the slump.

9. **Hard** Name two causes shared by the Weimar and Zimbabwean hyperinflations.

Show answer

The government financed itself by printing money, and output collapsed (the Ruhr occupation and reparations in Germany; the fall in farm output and exports in Zimbabwe), while people lost faith in the currency.

10. **Hard** Prices rise 50% a month for a year. By what factor do they rise in the year?

Show answer

$1.5^{12} \approx 130$ times.

11. **Challenge** Using MV = PY, explain why velocity rises during hyperinflation and why that makes prices rise even faster than money.

Show answer

As money loses value quickly, people spend it as soon as they receive it, so V rises. With Y falling or flat, P rises faster than M because both M and V are increasing.

COMMON MISTAKES

- Thinking a higher dollar wage always means a higher standard of living. Compare real wages.
- Confusing a high price level with a high inflation rate. Inflation is the rate of change.
- Thinking hyperinflation is caused only by greedy sellers. It comes from money growing far faster than output, usually to pay government bills.

> **Make it a game · Family Price Index Hunt.** Search receipts or pantry labels to pick eight items your family buys. Your parent supplies a base-year price for each. Compute a price index for the basket and the inflation rate. Convert one nominal wage to a real wage. Then explain what Weimar Germany and Zimbabwe teach about the cost of hyperinflation, and one cost of deflation.

UNIT 6

Fiat Money and Central Banking

This unit follows money through the twentieth century, as the link to gold was loosened and then cut. You will study the banking crisis of 1933, the order calling in gold and the new $35 price; the Bretton Woods conference of 1944 and the system of fixed exchange rates it created; and the evening of August 15, 1971, when the United States closed the gold window and the dollar became fiat money.

Then you will learn how a modern central bank works: how the Federal Reserve sets interest rates and how it fought the great inflation of the 1970s, and what happens when money fails completely, in the hyperinflations of Weimar Germany in 1923 and Zimbabwe in 2008. You will calculate devaluations, cross rates, real interest rates, a policy rule and a price index from your own family's spending.

PREREQUISITES

- Units 4–5 (money, banks, the gold standard)
- Percents, exponents and roots
- Reading graphs of data over time

MASTERY CHECKLIST

- ☐ I can tell the story of 1933–34 and compute the dollar's devaluation.
- ☐ I can describe the Bretton Woods system, compute cross rates and explain the Triffin dilemma.
- ☐ I can explain why the gold window closed in 1971 and what fiat money is.
- ☐ I can explain how the Fed sets interest rates, compute real rates and apply Taylor's rule.
- ☐ I can build a price index, compute inflation and real values, and explain the causes and cures of hyperinflation.

OPTIONAL BOOKS AND GAMES FOR THIS UNIT

- **Federal Reserve History (federalreservehistory.org): essays on the Gold Reserve Act, Bretton Woods, the end of Bretton Woods and the Great Inflation**: Free. Short, careful essays by Fed historians on every lesson in this unit.
- **FRED, the St. Louis Fed's free economic data site**: Free. Graphs of interest rates, inflation, the CPI and exchange rates going back decades. Used in the projects for Lessons 6.1, 6.4 and 6.5. A parent can help set up any graphs; no account is needed.

Not required. Every project in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

6.1	**1933: Gold Is Called In and Repriced at $35**	3 sessions of 50 minutes
6.2	**Bretton Woods, 1944**	3 sessions of 50 minutes
6.3	**August 15, 1971: The Gold Window Closes**	3 sessions of 50 minutes
6.4	**How the Fed Sets Interest Rates and the Money Supply**	3 sessions of 50 minutes
6.5	**Inflation, Deflation and Hyperinflation: Weimar Germany and Zimbabwe**	3 sessions of 50 minutes

Unit 6 test

Calculators are allowed. Show your work for every calculation: write the formula, substitute and solve. Answer the concept questions in complete sentences. The test is worth 100 points.

1. **6 pts**
   What did Executive Order 6102 require, and what did the Gold Reserve Act of 1934 do?

2. **6 pts**
   Find the percent devaluation of the dollar in gold when the price rose from $20.67 to $35, and the percent rise in the gold price.

3. **6 pts**

   Who gained and who lost from the gold measures of 1933–34?

4. **6 pts**

   Describe the Bretton Woods system in three sentences.

5. **6 pts**

   The yen was 360 per dollar and the pound $2.40 (after 1967). Find yen per pound.

6. **6 pts**

   Explain the Triffin dilemma.

7. **8 pts**

   The U.S. had 300 million ounces of gold at $35 and foreign official claims of $42 billion. (a) Find the coverage ratio. (b) What gold price would give 100% coverage?

8. **6 pts**

   What happened on August 15, 1971, and what followed in December 1971 and March 1973?

9. **6 pts**

   What is fiat money, and what gives the dollar value today?

10. **8 pts**

    A bank pays 5% on deposits. (a) If inflation is 3%, find the real rate. (b) If inflation is 7%, find the real rate and explain what happens to savers.

11. **6 pts**

    Taylor's rule: $r^* = 1$, $\pi^* = 2$, inflation 5%, output gap +1 percent. Find the suggested rate.

12. **6 pts**

    How does the Fed raise short-term interest rates today?

13. **6 pts**

    Describe the Fed's fight against inflation from 1979 to 1983: what it did, what it cost and what it achieved.

14. **6 pts**

A basket costs $500 in the base year, $540 the next year and $567 the year after. (a) Find the CPI each year. (b) Find the inflation rate each year.

15. **6 pts**

A wage of $50,000 when the CPI was 220 is $56,000 when the CPI is 260. Did the real wage rise or fall, and by how much?

16. **6 pts**

Short essay: Compare the German hyperinflation of 1923 with the Zimbabwean hyperinflation of 2007–2009. What caused each, what did it do to ordinary people, and how did each end?

ANSWER KEY

1. 6102 required delivery of most private gold to the Federal Reserve at $20.67. The Gold Reserve Act moved monetary gold to the Treasury, and the price was then set at $35.
2. Devaluation $1 - 20.67/35 \approx 41\%$; gold price rise $14.33/20.67 \approx 69\%$.
3. Debtors gained as deflation ended; the Treasury gained a gold profit; holders of gold and gold-clause creditors lost.
4. Other currencies were pegged to the dollar at par values within one-percent bands. The United States converted dollars held by foreign governments into gold at $35. The IMF lent to members with payment problems and oversaw changes in par values.
5. $360 \times 2.40 = 864$ yen per pound.
6. The world needed growing dollar reserves, supplied by U.S. deficits, but as dollars abroad grew relative to U.S. gold, confidence in the $35 promise fell.
7. (a) $10.5/42 = 0.25$. (b) $35 \times 4 = \$140$ an ounce.
8. The gold window was closed, with a wage-price freeze and import surcharge. The Smithsonian Agreement set $38 gold and new pars. By March 1973 major currencies floated.
9. Money not convertible into a commodity. The dollar is legal tender for debts and taxes, is trusted, and holds value as long as it is not issued much faster than goods and services grow.
10. (a) About 2%. (b) About −2%: savers lose purchasing power even while earning interest.
11. $1 + 5 + 1.5 + 0.5 = 8\%$.
12. It raises the interest rate it pays on reserve balances (and related rates), which lifts the federal funds rate; historically it also sold securities to drain reserves.
13. It let interest rates rise to about 20% to slow money growth; two recessions and unemployment near 11% followed; inflation fell from over 13% to about 3%.
14. (a) 100, 108, 113.4. (b) 8% and 5%.
15. Real wage: $56{,}000 \times 220/260 \approx \$47{,}385$; it fell about 5%.
16. A strong answer names money printing to pay government bills plus falling output (Ruhr occupation and reparations; collapse of farm output and exports), describes lost savings and daily hardship, explains rising velocity, and describes

the cures: the Rentenmark and strict limits in 1923, and the abandonment of the Zimbabwean dollar for foreign currencies in 2009.

PORTFOLIO PIECE: THE DOLLAR'S CENTURY

Write a six- to eight-page history of the U.S. dollar from 1913 to today, organized around five turning points (1913, 1933–34, 1944, 1971, 1979). For each, explain what changed in the rules of money, why, and what it meant for the six stakeholders. Include a graph of the CPI since 1913 (from FRED or BLS data), your family price index from Lesson 6.5, and at least three calculations from the unit.

LOOK FOR	WHAT IT MEANS
Accuracy	Dates, laws, prices and events are correct.
Analysis	Each turning point explains causes and effects on stakeholders, fairly and without partisan language.
Data	The CPI graph and the calculations are correct, labeled and sourced.
Writing	Clear, organized and well argued.

UNIT 7

Labor, Capital and Fair Rules

Owners and workers need each other: capital without labor is idle, and labor without capital produces little. This unit tells the story of how they have struggled and cooperated since the first factories. You will see the gains and the human costs of the first factories at Arkwright's Cromford mill; study how wages follow productivity and why Henry Ford doubled his workers' pay in 1914; and learn how the Factory Acts, Samuel Gompers' unions and the Fair Labor Standards Act limited child labor and long hours.

You will then follow the reforms after the Triangle fire of 1911, the workers' compensation bargain and the economics of insurance, and close with a warning from history: Diocletian's attempt to command prices by decree in AD 301. The unit is taught as settled history: what each rule fixed, how it worked, what it cost, and when rules worked like a fair referee and when they backfired.

PREREQUISITES

- Units 1–3 (marginal thinking, supply and demand, market structures)
- Unit 4.3 (Roman debasement)
- Percents and simple probability

MASTERY CHECKLIST

- ☐ I can describe the gains and costs of early industry and compute growth rates and doubling times.
- ☐ I can compute marginal product and marginal revenue product and find the best number of workers to hire.
- ☐ I can explain Ford's $5 day as an efficiency wage and weigh its paternalism.
- ☐ I can describe the Factory Acts, the AFL and the FLSA and calculate overtime pay.
- ☐ I can tell the story of the Triangle fire and compute expected losses and insurance premiums.
- ☐ I can compute the shortage and deadweight loss of a price ceiling and explain why Diocletian's edict failed.

OPTIONAL BOOKS AND GAMES FOR THIS UNIT

- **Lewis Hine's photographs, Library of Congress (National Child Labor Committee collection)**: Free; search "National Child Labor Committee" at loc.gov. Thousands of Hine's photographs with his original captions. Use with Lessons 7.3 and 7.4. Parents may wish to choose images together with younger siblings.
- **YouthRules!, from the U.S. Department of Labor**: Free. The current federal rules on hours and jobs for workers under 18. Use with the project in Lesson 7.3.
- **The Henry Ford (thehenryford.org) digital collections**: Free. Photographs and documents of Highland Park and the $5 day. Use with Lesson 7.2.

Not required. Every project in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

7.1	**The First Factories: Gains and Costs**	3 sessions of 50 minutes
7.2	**Wages, Productivity and Labor Markets: Ford's $5 Day**	3 sessions of 50 minutes
7.3	**The Factory Acts, Unions and the Fair Labor Standards Act**	3 sessions of 50 minutes
7.4	**Workplace Safety and Workers' Compensation: After the Triangle Fire**	3 sessions of 50 minutes
7.5	**When Rules Backfire: Diocletian's Price Edict and Price Controls**	3 sessions of 50 minutes

Unit 7 test

Calculators are allowed. Show your work for every calculation: write the formula, substitute and solve. Answer the concept questions in complete sentences. The test is worth 100 points.

1. **6 pts**
   Describe Arkwright's mill at Cromford and name one gain and one cost of the early factory system.

2. **6 pts**
   Income per person grows 1.4% a year. Find the doubling time with the rule of 70, and the growth over 100 years.

3. **6 pts**
   A money wage rises from $500 to $560 while the CPI rises from 100 to 115. Find the real wage change.

4. **8 pts**
   A shop's output with 1–5 workers is 30, 55, 75, 90, 100 units. Price $6, wage $100. Find each worker's MRP and the number to hire.

5. **6 pts**

   Why did Ford introduce the $5 day, and what were its results and its drawbacks?

6. **6 pts**

   What did the Factory Act of 1833 require, and why did it work better than earlier laws?

7. **6 pts**

   Describe the main provisions of the Fair Labor Standards Act of 1938.

8. **6 pts**

   A worker earns $20 an hour and works 50 hours. Find the week's pay.

9. **8 pts**

   Labor demand $L_d = 900 - 30W$, supply $L_s = 300 + 30W$. (a) Find the market wage and employment. (b) Find employment and unemployment at a floor of $12.

10. **6 pts**

    Tell the story of the Triangle fire and name two reforms that followed.

11. **8 pts**

    Each of 300 workers has a 3% annual chance of a $12,000 injury. (a) Find the expected annual loss. (b) Find the premium with a 20% loading.

12. **6 pts**

    Explain the workers' compensation "grand bargain."

13. **10 pts**

    Demand $Q_d = 200 - 5P$, supply $Q_s = 5P - 50$. (a) Find the equilibrium. (b) A ceiling of 20 is set. Find the shortage. (c) Find the deadweight loss.

14. **6 pts**

    Why did Diocletian's Edict on Maximum Prices fail?

15. **6 pts**

    Short essay: Using two examples from this unit, explain the difference between a rule that works like a fair referee and one that backfires.

ANSWER KEY

1. A water-powered cotton-spinning mill opened in 1771, running long shifts with many child workers and company housing. Gain: much higher productivity and cheaper cloth. Cost: long hours, child labor, dangerous machines.
2. About 50 years; $1.014^{100} \approx 4.0$ times.
3. $560/1.15 = 487$; a fall of about 2.6%.
4. MPL 30, 25, 20, 15, 10; MRP \$180, \$150, \$120, \$90, \$60. Hire 3.
5. To cut turnover of about 370% and absenteeism and raise effort. Turnover fell and productivity rose. Drawback: the Sociological Department's intrusion into workers' private lives.
6. No children under 9 in most textile mills; limits of 9 hours a day and 48 a week for ages 9–13; some schooling; and paid inspectors, who made enforcement real.
7. A national wage floor (25 cents, rising to 40), a 44-hour week falling to 40 with time-and-a-half overtime, and a ban on most work by children under 16 in interstate industries.
8. $800 + 10 \times 30 = \$1{,}100$.
9. (a) $W = \$10$, L = 600. (b) $L_d = 540$, $L_s = 660$; employment 540, unemployed 120.
10. On March 25, 1911, a fire in a New York garment factory took the lives of 146 workers, trapped by a locked door, a collapsing fire escape and short ladders. Reforms: fire drills, sprinklers, doors opening outward, the Factory Investigating Commission's laws; workers' compensation spread.
11. (a) $300 \times 0.03 \times 12{,}000 = \$108{,}000$. (b) \$129,600.
12. Workers gave up most rights to sue employers in exchange for certain, no-fault benefits; employers gained protection from large lawsuits and predictable costs.
13. (a) $P^* = 25$, $Q^* = 75$. (b) $Q_d = 100$, $Q_s = 50$; shortage 50. (c) $P_d = (200 - 50)/5 = 30$; DWL $\frac{1}{2}(75 - 50)(30 - 20) = 125$.
14. Prices were held below what sellers needed while the money supply kept growing, so goods vanished from markets, black markets spread, and the law was abandoned after much bloodshed.
15. A strong answer contrasts rules that protect safety, children or honest dealing while leaving trade free (Factory Acts, fire codes, workers' compensation) with rules that command prices against scarcity (Diocletian's edict, 1970s controls), explaining effects on stakeholders.

PORTFOLIO PIECE: A STAKEHOLDER HISTORY OF WORK

Write a five- to seven-page report on one industry (textiles, automobiles, steel, garment-making or another) from its early years to today, through the eyes of its workers and owners. Include at least one reform that worked and one rule or practice that backfired, a real wage or productivity calculation, an insurance or safety calculation, and a stakeholder scorecard for the industry in its early years and today. If you can, interview someone who works in the industry now (with a parent).

LOOK FOR	WHAT IT MEANS
History	Events, dates and reforms are accurate and fairly told.
Economics	Calculations are correct and used to support the argument.
Stakeholders	All six stakeholders are considered, with balanced judgments.
Writing	Clear, organized and free of partisan language.

7.1 The First Factories: Gains and Costs

OBJECTIVES

- Describe Richard Arkwright's factory system at Cromford and how machines and power raised output per worker.
- Compute growth rates and doubling times and use them to compare living standards before and after industrialization.
- Weigh the gains and costs of early industrial work honestly, using the six stakeholders.

> **Warm-up.** List five things in your home that would have taken a family weeks of handwork to make in 1750 (cloth, a shirt, nails, a candle, a book). For each, estimate how long it takes to earn the money to buy it today.

WATCH

Discover more: Arkwright's Water Frame

Science and Industry Museum · 2:24

https://www.youtube.com/watch?v=D-6nPEcdvhg

> **WHEN TO WATCH**
> After the story of Cromford, before the big idea.

Note: A short museum film showing a working water frame; the lesson text carries the economics.

BACKUP VIDEO

The rise of industrial capitalism | AP US History | Khan Academy

Khan Academy · 5:28

https://www.youtube.com/watch?v=bSnELaceBdo

After the big idea, to see how the same forces worked in the United States after 1865.

KEY TERMS

Industrial Revolution

The shift, beginning in Britain about 1760–1830, from hand production at home to machine production in factories powered by water and steam.

factory system

Organizing production in a central building where workers tend power-driven machines under supervision and set hours.

productivity

Output per worker (or per hour of work).

real wage

A wage measured by what it can buy, after adjusting for prices.

capital

Machines, buildings and tools used to produce other goods.

CORE IDEAS

The story. In 1771 Richard Arkwright, a former barber and wig maker from Lancashire, built a cotton-spinning mill at Cromford in Derbyshire, beside a stream that could turn a waterwheel. His water frame spun strong cotton thread by machine, and the mill ran day and night in two twelve-hour shifts. Arkwright built houses, a chapel, a school and a market for his workers, many of them families brought from elsewhere and many of them children. Within twenty years cotton mills on his pattern were rising across northern England, and Arkwright, knighted in 1786, died one of the richest commoners in Britain.

How they figured it out. Spinning by hand on a wheel, a worker might produce a few ounces of thread a day; one water frame tended by a few workers did the work of many spinners. Mills grew larger, steam engines replaced waterwheels, and the price of cotton cloth fell steeply over the following decades, putting cheap, washable clothing within reach of ordinary families. Economic historians still debate how quickly ordinary workers shared in the gains. Most find that real wages in Britain rose only slowly before about 1820 and much faster after, while output per person kept climbing. The early decades brought long hours, dangerous machines, crowded towns, polluted air and the employment of young children; later decades brought rising wages, falling prices for goods and, step by step, laws and customs that limited the worst abuses (Lesson 7.3).

The big idea. Before industrialization, output per person in most of the world grew so slowly that living standards barely changed from one generation to the next. When **productivity** began to grow by 1–2% a year and kept growing, everything changed: at one percent a year, income doubles in about 70 years; at 2%, in about 35. The source was **capital** and invention: machines, power and better methods that let each worker produce far more. But growth arrives unevenly. Some workers, such as handloom weavers, saw their skills lose value as machines arrived, and many families paid a high price in health and hardship before the gains spread.

In business today. Every new technology repeats the pattern on a smaller scale: it raises productivity and lowers prices, creates new kinds of work and makes some old skills less valuable. Wise firms invest in training as well as machines, and wise workers keep learning. The question the Industrial Revolution poses still applies: how can a business pursue productivity while treating its workers as people made in God's image, not as parts of the machine?

Who gained? Stakeholder scorecard for Arkwright's Cromford: financiers and risk-takers (Arkwright and his partners) gained great fortunes; builders (mechanics and engineers) gained new skills and trades; workers gained steady wages and housing but worked long hours, children included; customers gained far cheaper cloth; the community of Cromford gained a school, chapel and market, while the wider country gained a new industry and, in time, rising living standards.

PICTURE STUDY



Arkwright's Mills, Joseph Wright of Derby, about 1795–1796 · Oil on canvas · Derby Museum and Art Gallery

Image: Wikimedia Commons, public domain

Wright of Derby, a friend of the industrialists of his county, painted Arkwright's mills set among the hills and woods of the Derwent valley. The tall buildings with their many windows were something new in the English countryside: workplaces lit and run on a schedule rather than by daylight and season.

Look closely

- Find the mill buildings. How many floors and windows can you count?
- Look at the landscape around them. What does the painter want us to feel about this new kind of building in old country?
- Look for the river or stream. Why did the first mills need to be beside water?
- Look for people, roads or houses. Who lived and worked here?

Talk about it

1. Why did mills need so many windows?
2. How did a mill's schedule differ from a farmer's or a home spinner's day?
3. What would a child working here have gained and lost?

PROJECT

Two Centuries of Productivity in Your Closet

You will estimate how many hours of work it takes to buy common goods today and compare them with estimates for 1800, then compute the implied growth in productivity.

You will need

- Current prices of a cotton shirt, a pound of sugar, a loaf of bread and a candle (or a light bulb)
- A typical hourly wage (with a parent, for example a local starting wage)
- Historical estimates provided below
- A spreadsheet

Steps

1. Record today's price of each item and compute the minutes of work at a typical wage needed to buy it.
2. Use these rough historical estimates for an English laborer about 1800: a cotton shirt about 30 hours of work; a pound of sugar about 2 hours; a 4-pound loaf about 2 hours; a pound of candles about 3 hours.
3. Compute the ratio of hours then to hours now for each item.
4. For each ratio, compute the average annual rate of improvement over about 225 years: $\text{ratio}^{1/225} - 1$.
5. Make a bar chart comparing then and now.
6. Explain which items improved most and why (machines, transport, new energy sources).
7. Write a paragraph weighing the gains you measured against the human costs described in the lesson.

Tips

- The historical figures are rough estimates; note the uncertainty in your write-up.
- Use the same wage for all items so the comparison is fair.

Check your work

- ☐ I can compute growth rates and doubling times.
- ☐ I can explain how capital raised productivity in the Industrial Revolution.
- ☐ I can weigh its gains and costs fairly.

LEDGER NOTEBOOK

1. Copy your table of hours then and now and the annual improvement rates.
2. Draw a timeline: 1764 (spinning jenny), 1769 (water frame patent), 1771 (Cromford), 1776 (Watt's engines go into service), 1785–1800 (steam-powered mills spread), 1833 (Factory Act).
3. Write a stakeholder scorecard (1–5 with reasons) for Arkwright's Cromford mill.

KEY FORMULAS

$$\text{Growth rate} = \left(\frac{\text{end}}{\text{start}}\right)^{1/n} - 1$$

$$\text{Doubling time} \approx \frac{70}{\text{growth rate in percent}}$$

From history. Arkwright's patents were overturned in court in 1785, which let other mill owners copy his machines freely and helped the factory system spread. The Cromford mills are now part of the Derwent Valley Mills World Heritage Site.

WORKED EXAMPLES

Example 1. Suppose a hand spinner made 4 ounces of thread a day and a water frame tended by 3 workers made 30 pounds a day. Find output per worker in each case and the ratio.

Show solution

1. Hand: 4 ounces = 0.25 pound per worker.
2. Frame: $30/3 = 10$ pounds per worker.
3. Ratio: $10/0.25 = 40$.

Answer: Output per worker is about 40 times higher with the frame (using these illustrative numbers).

Example 2. Output per person in an economy grows at 0.2% a year (a typical pre-industrial rate) or at 1.5% a year (a typical industrial rate). Find the doubling time in each case.

Show solution

1. 0.2%: $70/0.2 = 350$ years.
2. 1.5%: $70/1.5 \approx 47$ years.

Answer: About 350 years versus about 47: the difference between living standards that barely change and ones that double within a lifetime.

Example 3. A worker's money wage rose from 10 shillings to 12 shillings a week while prices rose 25%. Did his real wage rise or fall?

Show solution

1. Real wage index: $\dfrac{12/10}{1.25} = 0.96$.
2. That is a 4% fall.

Answer: His real wage fell about 4%, even though his money wage rose 20%.

PRACTICE

1. Easy Where and when did Arkwright open his first great cotton mill?

   Show answer

   At Cromford, Derbyshire, in 1771.

2. Easy What is productivity?

   Show answer

   Output per worker or per hour of work.

3. Easy Using the rule of 70, how long does it take income to double at 2% a year?

   Show answer

   About 35 years.

4. **Medium** Income per person rises from 100 to 250 over 80 years. Find the average annual growth rate.

   Show answer

   $2.5^{1/80} - 1 \approx 1.15\%$.

5. **Medium** A money wage rises 30% while prices rise 10%. Find the change in the real wage.

   Show answer

   $1.3/1.1 - 1 \approx 18\%$ rise.

6. **Medium** Why did handloom weavers suffer even as the textile industry boomed?

   Show answer

   Power looms made cloth far more cheaply, so the value of their hand skill fell and their earnings collapsed.

7. **Medium** What did Arkwright build at Cromford besides the mill?

   Show answer

   Houses, a chapel, a school and a market for his workers.

8. **Hard** Historians debate when British workers' real wages began to rise. Why might output per person rise faster than real wages for a time?

   Show answer

   More of the gains may have gone to investment and profits, food prices were high during the wars with France, and growing towns brought costs not shown in wages; workers' share rose later.

9. **Hard** Explain why sustained growth of 1–2% a year changed the world.

   Show answer

   Over a lifetime it doubles or quadruples living standards, whereas before, growth near zero meant each generation lived much as the last.

10. **Challenge** If the hours needed to buy a shirt fell from 30 to 0.5 over 225 years, find the average annual rate of improvement and the doubling time of shirt-buying power.

    Show answer

    Ratio 60; $60^{1/225} - 1 \approx 1.84\%$ a year; doubling time about 38 years.

COMMON MISTAKES

- Telling the Industrial Revolution as only progress or only misery. It brought both, unevenly, over many decades.
- Comparing money wages across centuries without adjusting for prices.
- Using the rule of 70 with the growth rate as a decimal. Use the percent (70/2, not 70/0.02).

> **Make it a game · Doubling Time Productivity Drill.** Your parent names an annual growth rate of output per worker, such as 1, 2 or 3 percent. Use the rule of 70 to find the doubling time in ten seconds, then check with a calculator. Compare Arkwright's Cromford with your own closet: guess how many hours it would take to make one shirt by hand. Do eight rounds.

7.2 Wages, Productivity and Labor Markets: Ford's $5 Day

OBJECTIVES

- Explain how the marginal revenue product of labor determines a firm's demand for workers.
- Find the profit-maximizing number of workers from a production table.
- Analyze Henry Ford's $5 day of 1914 as an efficiency wage and weigh its benefits and its paternalism.

> **Warm-up.** If you ran a lawn-mowing business with one mower, how much extra would a second worker add? A third? A tenth? Write your guesses and the reason the numbers change.

WATCH

The Marginal Product of Labor

Marginal Revolution University · 10:21

https://www.youtube.com/watch?v=G7ai5LAehqg

> **WHEN TO WATCH**
> After the big idea, before the worked examples.

BACKUP VIDEO

Introduction to labor markets | Microeconomics | Khan Academy

Khan Academy · 7:24

https://www.youtube.com/watch?v=Cm69zTuUzMI

During the worked examples.

KEY TERMS

marginal product of labor (MPL)

The extra output from hiring one more worker, other inputs held constant.

marginal revenue product (MRP)

The extra revenue from hiring one more worker: the marginal product times the price of output.

diminishing marginal returns

The tendency for each added worker to add less output when other inputs are fixed.

efficiency wage

A wage above the market rate, paid to reduce turnover, attract better workers and raise effort.

turnover

The rate at which workers leave and must be replaced, often given as a percent of the workforce per year.

CORE IDEAS

The story. In 1913 Ford's Highland Park plant in Michigan introduced the moving assembly line, and the time to assemble a Model T chassis fell from over twelve hours to about an hour and a half. But the work was fast, repetitive and exhausting, and men quit in droves. Ford's own figures showed turnover of about 370% in 1913: to keep a workforce of about 14,000, the company hired more than 50,000 men in a year. On January 5, 1914, Ford and his partner James Couzens announced that qualified workers would earn $5 for an eight-hour day, roughly double the going rate for factory labor, through a plan that gave them a share of the profits.

How they figured it out. Thousands lined up at the gates. Turnover dropped sharply, absenteeism fell, and productivity rose; Ford later called the $5 day one of the finest cost-cutting moves he ever made. But the plan had strings. To qualify for the profit share, a worker had to meet standards of conduct at home, checked by the company's Sociological Department, whose investigators visited homes, asked about savings, drinking and family life, and could withhold the bonus. Many workers welcomed the money and resented the intrusion. The department was scaled back within a few years. The $5 day remains a famous example of a voluntary answer to a labor problem, and of the line between caring for workers and controlling their private lives.

The big idea. A firm hires workers as long as each one adds at least as much revenue as he costs. The extra output from one more worker is the **marginal product of labor**; multiplied by the price of output, it is the **marginal revenue product**. With a fixed plant, each added worker eventually adds less (**diminishing marginal returns**), so a competitive firm hires until $MRP = W$. This is why wages tend to rise with productivity: workers with more capital and skill produce more, so employers will

pay more for them. An **efficiency wage**, paid above the market rate, can still pay for itself when it cuts the costs of turnover, training and poor effort, as Ford found.

In business today. Firms weigh wages against productivity and turnover constantly. Replacing a worker can cost a large share of a year's pay once recruiting, training and lost output are counted. Many firms pay above-market wages, offer training and promote from within for the same reasons Ford did, while respecting workers' private lives. The Christian employer remembers that "the labourer is worthy of his hire" (Luke 10:7) and that wages are owed for work, not for a worker's submission in things that are not the employer's business.

Who gained? Workers gained far higher pay and an eight-hour day, though under conditions some found intrusive; Ford's customers gained as productivity rose and prices fell; the financiers and risk-takers (Ford and his shareholders) gained from lower turnover and higher output; the community of Detroit gained a magnet for workers from across the country and the world. Competitors had to raise wages to keep their own workers.

PICTURE STUDY



The flywheel magneto line, Ford Highland Park plant, Unknown photographer, 1913 · Photograph · Highland Park, Michigan

Image: Wikimedia Commons, public domain

Ford's first moving line, in the spring of 1913, assembled flywheel magnetos, part of the Model T's ignition. Each man did one task as the part slid past; assembly time per magneto fell from about twenty minutes to about five. The idea soon spread to the whole chassis. Output soared; so did the strain of the work, and so did the rate at which men quit, until the $5 day changed the bargain.

Look closely

- Follow the line. Which way are the parts moving?
- Count the workers you can see. What is each one doing?
- Look at the parts and tools. Where are they kept?
- Look at the workers' clothes and posture. What does the work seem like?

Talk about it

1. How did the line raise the marginal product of each worker?
2. Why did so many workers quit in 1913?
3. Was the $5 day generous, shrewd or both? Use the six stakeholders.

PROJECT

The Assembly-Line Labor Market

You will run a small assembly line at home with one to five workers, measure the marginal product of each added worker, and find the best number to hire at different wages.

You will need

- Paper and supplies for a simple product (paper boats, folded letters, or sandwiches)
- A timer
- Up to five helpers
- A spreadsheet

Steps

1. Choose a product and divide its making into steps.
2. Time 5-minute rounds with 1, 2, 3, 4 and 5 workers, counting finished units each time.
3. Compute the marginal product of each added worker.
4. Set a price per unit (for example 50¢) and compute the marginal revenue product.
5. At wages of $1, $2 and $3 per 5-minute round, find how many workers you would hire.
6. Run a sixth round where workers are paid a “bonus” in points for steady effort. Did output change?
7. Write a paragraph connecting your data to diminishing returns and to Ford’s $5 day.

Tips

- Use the same workspace for every round so that only the number of workers changes.
- Watch for crowding: it is a real cause of diminishing returns.

Check your work

- ☐ I can compute MPL and MRP.
- ☐ I can find the profit-maximizing number of workers.
- ☐ I can explain an efficiency wage and its limits.

LEDGER NOTEBOOK

1. Copy your production table, MPL and MRP, and your hiring decisions.
2. Graph MRP against the number of workers and draw horizontal wage lines.
3. Write a stakeholder scorecard (1–5 with reasons) for the $5 day.

KEY FORMULAS

$$MPL = \frac{\Delta Q}{\Delta L}, \qquad MRP = MPL \times P$$

$$\text{Hire until } MRP = W$$

$$\text{Turnover rate} = \frac{\text{workers separated in a year}}{\text{average workforce}} \times 100\%$$

From history. Ford's announcement made front pages across the country, and some newspapers predicted that it would ruin the company or the industry. Instead, Ford's profits rose, and within a few years many other manufacturers raised their wages too.

WORKED EXAMPLES

Example 1. A small bakery's output with 1 to 5 workers is 40, 70, 90, 100 and 105 loaves a day. Bread sells for $4 a loaf and a worker's daily wage is $100. How many workers should it hire?

Show solution

1. MPL: 40, 30, 20, 10, 5 loaves.
2. MRP: $160, $120, $80, $40, $20.
3. Hire while $MRP \geq$ $100: the 1st ($160) and 2nd ($120) qualify; the 3rd ($80) does not.

Answer: Hire 2 workers. A third would add $80 of revenue but cost $100.

Example 2. Ford hired about 52,000 workers in 1913 to keep an average workforce of about 14,000. Find the turnover rate. If hiring and training each new worker cost about $50, estimate the annual cost of turnover.

Show solution

1. Turnover: $52{,}000/14{,}000 \approx 3.7$, about 370%.
2. Replacements beyond the original force: roughly $52{,}000 \times \$50 = \$2.6$ million in hiring and training costs (an illustrative estimate).

Answer: About 370% turnover and, at $50 per hire, about $2.6 million a year: a strong reason to try a higher wage.

Example 3. Before the $5 day, a worker earning $2.50 a day assembled the equivalent of 0.5 car-units a day; after, with lower turnover and better effort, a worker averaged 0.7. If each car-unit is worth $10 in revenue to the firm, compare the revenue per dollar of wages.

Show solution

1. Before: revenue $0.5 \times 10 = \$5$ per $2.50, or $2.00 per dollar of wages.
2. After: revenue $0.7 \times 10 = \$7$ per $5, or $1.40 per dollar of wages.
3. The firm also saves turnover costs not shown here.

Answer: Revenue per wage dollar falls from $2.00 to $1.40, so the plan pays only if savings on turnover, training and absenteeism and the gains in output are large enough, as Ford reported they were. (Illustrative numbers.)

PRACTICE

1. Easy What is the marginal product of labor?

   Show answer

   The extra output from one more worker.

2. Easy What did Ford announce on January 5, 1914?

   Show answer

   A $5 pay for an eight-hour day for qualified workers, paid partly as a share of the profits.

3. Easy What was Ford's turnover rate in 1913?

Show answer

About 370%.

4. Medium Output with 1–4 workers: 20, 36, 48, 56. Price \$5. Find each worker's MRP.

Show answer

\$100, \$80, \$60, \$40.

5. Medium In problem 4, how many workers should be hired at a wage of \$70?

Show answer

2 (the 3rd adds only \$60).

6. Medium Why do wages tend to rise when workers have more capital to work with?

Show answer

More capital raises each worker's marginal product, so the value of their work to employers rises.

7. Medium What was Ford's Sociological Department, and why was it controversial?

Show answer

A staff that checked workers' home lives to decide who qualified for the profit share; many saw it as an intrusion into private life.

8. Hard A firm with 1,000 workers has 60% annual turnover, and each replacement costs \$4,000. A \$2,000 raise per worker would cut turnover to 20%. Is the raise worth it on turnover savings alone?

Show answer

Savings: $(600 - 200) \times 4{,}000 = \$1.6$ million; cost \$2 million. Not on turnover alone, but it could be if productivity also rises.

9. Hard Explain why a competitive firm hires until MRP equals the wage.

Show answer

Each worker below that point adds more revenue than he costs, raising profit; beyond it, each adds less than he costs.

10. **Challenge** Output is $Q = 60L - L^2$, the price is \$2, and the wage is \$40. Find the profit-maximizing number of workers.

    Show answer

    $MPL = 60 - 2L$; $MRP = 120 - 4L = 40$, so $L = 20$ workers.

COMMON MISTAKES

- Using total product instead of marginal product to decide whether to hire.
- Forgetting to multiply by price to get MRP.
- Assuming a higher wage always raises costs. If it cuts turnover and raises effort enough, it can lower cost per unit.

> **Make it a game · Hire the Worker Duel.** Your parent writes a production table showing output as workers are added, with a price per unit and a daily wage, as in Ford's five-dollar day. Guess how many workers to hire, then compute marginal product and marginal revenue product for each. Hire while the marginal revenue product exceeds the wage. Compare the answer with your guess.

7.3 The Factory Acts, Unions and the Fair Labor Standards Act

OBJECTIVES

- Describe the British Factory Act of 1833 and the Ten Hours Act of 1847 and Lord Shaftesbury's part in them.
- Explain the aims and methods of Samuel Gompers' American Federation of Labor and the main provisions of the Fair Labor Standards Act of 1938.
- Calculate overtime pay and analyze a wage floor with supply and demand, as history.

> **Warm-up.** Write down the age at which you think a young person should be allowed to work for pay, the most hours a week a 15-year-old should work during the school year, and your reasons.

WATCH

History Hook: The Factory Act

The National Archives UK · 9:57

https://www.youtube.com/watch?v=dDAwRL5x5BE

> **WHEN TO WATCH**
> After the story of the Factory Act.

BACKUP VIDEO

American Federation of Labor (American Labor Movement)

Tom Richey · 5:32

https://www.youtube.com/watch?v=BQI_BldZeQk

With the section on Gompers and the AFL.

KEY TERMS

Factory Act of 1833

The British law that banned the employment of children under 9 in most textile mills, limited the hours of older children and created factory inspectors.

Ten Hours Act (1847)

The British law limiting women and young people in textile mills to ten hours a day.

labor union

An organization of workers that bargains with employers over wages, hours and conditions.

collective bargaining

Negotiation between an employer and a union representing its workers.

Fair Labor Standards Act (FLSA)

The 1938 U.S. law that set a national wage floor, a standard workweek with overtime pay, and limits on child labor.

CORE IDEAS

The story. In the early British textile mills, children as young as six or seven worked twelve hours or more a day. Lord Ashley, later the seventh Earl of Shaftesbury, an evangelical Christian member of Parliament, took up their cause in 1833, after the reformer Michael Sadler gathered testimony from mill workers. The Factory Act of 1833 banned the employment of children under nine in most textile mills, limited children from nine to thirteen to nine hours a day and forty-eight a week, required them to receive some schooling, and, most important, created four paid factory inspectors to enforce it. In 1847 the Ten Hours Act limited women and young people in the mills to ten hours a day. In the United States, Samuel Gompers, a London-born craftsman who rose through his trade union, led the American Federation of Labor from its founding in 1886. The AFL focused on what Gompers called “pure and simple” unionism: higher wages, shorter hours and better conditions, won through bargaining with employers.

How they figured it out. Earlier British factory laws had failed because no one enforced them; the 1833 Act’s inspectors made the difference. Mill owners warned of ruin, yet the industry kept growing. In America, labor conflict was sometimes bitter,

and the Homestead dispute at Carnegie's steel works in 1892 ended in deadly violence and a defeat for the union. Over time unions and employers learned to bargain, and many states passed their own child-labor and hours laws, encouraged by Lewis Hine's photographs of children at work. In 1938 Congress passed the Fair Labor Standards Act. It set a national wage floor of 25 cents an hour, rising to 40 cents; a standard workweek of 44 hours, falling to 40 by 1940, with time-and-a-half pay for overtime; and a ban on most work by children under 16 in industries selling across state lines.

The big idea. These reforms worked like a fair referee: they protected children and limited dangerous excess while leaving people free to work and employers free to hire. Economists analyze a legal wage floor with supply and demand. If the floor is below the market wage, it has no effect; if it is above, the quantity of labor demanded falls and some workers who would have worked at a lower wage may not find jobs, while those who keep their jobs earn more. How large these effects are depends on the floor's level compared with local wages, which is why economists study such laws carefully. Overtime rules raise the cost of long hours and encourage firms to spread work among more workers or to pay more for it.

In business today. Every employer in the United States follows the FLSA's rules on overtime and child labor, with records of hours worked, and many states add rules of their own. Labor unions still bargain for many workers, especially in public service, construction and manufacturing. A wise business keeps careful time records, pays overtime honestly and treats young workers' schooling as more important than their shifts.

Who gained? Children gained time for school and childhood; workers gained shorter hours and overtime pay; customers paid somewhat more for some goods; owners lost some flexibility but gained a more stable, healthier and better-educated workforce; the community gained families less dependent on children's wages. Shaftesbury, whose faith drove his work, also campaigned for chimney sweeps, miners and the mentally ill, and for "ragged schools" for the poorest children.

PICTURE STUDY



Addie Card, 12 years, spinner in North Pownal Cotton Mill, Vermont, Lewis Hine, 1910 · Gelatin silver print · The Metropolitan Museum of Art, New York (and Library of Congress)

Image: Wikimedia Commons, public domain

Lewis Hine, a former teacher working for the National Child Labor Committee, photographed this girl in a Vermont cotton mill in 1910. His caption noted that the other girls said she was ten. Photographs like this one were shown across the country and helped persuade states, and later Congress, to keep young children out of mills and in school.

Look closely

- Look at the girl's face and posture. What does she seem to feel?
- Follow the long row of spinning frames behind her. How far does it go?
- Look at her clothing and hands. What do they tell you about her work?
- Notice how Hine placed her in the frame. Why might he have chosen this view?

Talk about it

1. Why did photographs persuade people when written reports had not?
2. What did a girl like Addie give up by working in the mill?
3. Which laws described in this lesson would have changed her life?

PROJECT

A Fair Workweek: Records and Rules

You will design a time sheet for a small business, compute pay under the FLSA overtime rule for several employees, and check a teen worker's schedule against child-labor rules.

You will need

- The U.S. Department of Labor's summary of FLSA rules and youth employment rules (dol.gov), with a parent
- A spreadsheet
- Your ledger notebook

Steps

1. Create a weekly time sheet with columns for each day, hours worked and total.
2. Enter hours for four employees, including one who works 45 hours and one aged 15.
3. Compute each adult's weekly pay with overtime at an hourly wage you choose.
4. Look up the federal rules for 14- and 15-year-olds (maximum hours on school days and in school weeks, allowed times of day). Check the 15-year-old's schedule and fix any violations.
5. Compute the business's total weekly wage bill.
6. Find the 1938 wage floor and the 1833 rules for children's hours, and compare them with today's rules in a table.
7. Write a paragraph explaining how these rules protect both workers and honest employers.

Tips

- Keep the time sheet neat: in a real business, these records are required by law.
- Rules differ by state; note that you are using the federal rules.

Check your work

- ☐ I can describe the Factory Acts, the AFL and the FLSA.
- ☐ I can calculate overtime pay.
- ☐ I can analyze a wage floor with supply and demand.

LEDGER NOTEBOOK

1. Copy your time sheet and pay calculations.
2. Make a comparison table: Factory Act 1833, Ten Hours Act 1847, FLSA 1938, today.
3. Draw the labor-market graph from Worked Example 2 and label the effect of the floor.

KEY FORMULAS

$$\text{Weekly pay with overtime} = W \times 40 + 1.5W \times (H - 40) \quad (H > 40)$$

$$\text{Real value of a wage} = \text{nominal wage} \times \frac{\text{CPI}_{\text{base}}}{\text{CPI}_{t}}$$

From history. Shaftesbury's funeral in 1885 drew huge crowds of the poor he had served. The statue at Piccadilly Circus in London, popularly called Eros, is officially the Shaftesbury Memorial Fountain, built in his honor.

WORKED EXAMPLES

Example 1. A worker earns \$18 an hour and works 47 hours in a week. Find her pay under the FLSA overtime rule.

Show solution

1. Regular: $40 \times 18 = \$720$.
2. Overtime: $7 \times 1.5 \times 18 = \$189$.
3. Total: \$909.

Answer: \$909 for the week.

Example 2. In a labor market, demand for unskilled labor is $L_d = 1{,}000 - 50W$ and supply is $L_s = 100 + 40W$ (workers, wage in dollars per hour). Find the market wage. Then find the effect of a legal floor of \$12.

Show solution

1. Equilibrium: $1{,}000 - 50W = 100 + 40W$, $W = \$10$, $L = 500$.
2. At \$12: $L_d = 400$, $L_s = 580$.
3. Employment falls to 400; 180 people want work at that wage but cannot find it.

Answer: In this model, the \$12 floor raises pay for 400 workers but lowers employment by 100 and leaves 180 job-seekers unemployed. Real markets may respond more or less, depending on how far the floor is above the local wage.

Example 3. The FLSA's first wage floor in 1938 was 25 cents an hour. The CPI was about 14.1 in 1938 and about 300 in 2023 (1982–84 = 100). Find its value in 2023 dollars.

Show solution

1. $0.25 \times 300/14.1 \approx \$5.32$ an hour.

Answer: About \$5.32 an hour in 2023 dollars.

PRACTICE

1. Easy What did the Factory Act of 1833 do for children?

   Show answer

   Banned children under 9 from most textile mills, limited children 9–13 to 9 hours a day and 48 a week, required some schooling, and created inspectors.

2. Easy Who led the parliamentary campaign for the Factory Acts?

   Show answer

   Lord Ashley, later the Earl of Shaftesbury.

3. Easy What were the main provisions of the FLSA of 1938?

   Show answer

   A national wage floor, a standard workweek with time-and-a-half overtime, and limits on child labor.

4. **Medium** A worker earns \$16 an hour and works 52 hours. Find his weekly pay.

Show answer

$640 + 12 \times 24 = \$928.$

5. **Medium** Why did the 1833 Act succeed where earlier factory laws failed?

Show answer

It created paid inspectors to enforce it.

6. **Medium** What did Gompers mean by "pure and simple" unionism?

Show answer

Focusing on practical gains for members (wages, hours, conditions) through bargaining, rather than on remaking society.

7. **Medium** In the labor market of Worked Example 2, what happens with a floor of \$9?

Show answer

Nothing: it is below the market wage of \$10.

8. **Hard** Demand $L_d = 800 - 40W$, supply $L_s = 200 + 20W$. Find the market wage and the effect of a floor of \$12.

Show answer

Market: $W = \$10$, L = 400. At \$12: $L_d = 320$, $L_s = 440$; employment falls by 80; 120 job-seekers unemployed.

9. **Hard** Using the six stakeholders, evaluate the Ten Hours Act of 1847.

Show answer

Workers gained shorter hours and health; children gained schooling time; owners lost some output per day but gained a steadier workforce; customers may have paid a little more; the community gained healthier families.

10. **Challenge** The 1938 floor of 25 cents was worth about \$5.32 in 2023 dollars. If a CPI of 14.1 in 1938 grew to 300 in 2023 (85 years), find the average annual inflation rate.

Show answer

$(300/14.1)^{1/85} - 1 \approx 3.7\%$ a year.

COMMON MISTAKES

- Computing overtime on all hours. Time-and-a-half applies only to hours over 40 in a week.
- Assuming any wage floor reduces employment. A floor below the market wage has no effect.
- Thinking the Factory Act of 1833 ended child labor. It limited it in textile mills; later laws went further.

Make it a game · The Ten Hours Debate. Hold a short debate. You argue for the Ten Hours Act of 1847 as Lord Shaftesbury, using evidence from the lesson. Your parent argues as a mill owner. After two minutes each, swap sides. Then recall the main points of the Fair Labor Standards Act and what Gompers' American Federation of Labor hoped to achieve through collective bargaining.

Scripture. “Behold, the hire of the labourers who have reaped down your fields, which is of you kept back by fraud, crieth: and the cries of them which have reaped are entered into the ears of the Lord of sabaoth.” (James 5:4, KJV)

James warns employers who cheat their workers. Fair dealing with labor is not only good economics; God hears the worker’s cry.

7.4 Workplace Safety and Workers' Compensation: After the Triangle Fire

OBJECTIVES

- Tell the story of the Triangle Shirtwaist Factory fire of 1911 and the safety reforms that followed.
- Explain how workers' compensation insurance works and calculate an expected loss and a premium.
- Explain why safety rules and insurance can serve both workers and employers.

> **Warm-up.** Walk through your home or a building you know and list every safety feature you see: exits, extinguishers, railings, signs, smoke alarms. For each, write what accident it prevents.

WATCH

Workers Compensation: A Historic Compromise

WCB Manitoba · 4:42

https://www.youtube.com/watch?v=SOkSdG1GKu4

> **WHEN TO WATCH**
> After the story of the fire and the reforms, before the big idea.

Note: A short film from a Canadian workers' compensation board on how the workers' compensation bargain began.

KEY TERMS

fire code

Rules for buildings that require exits, fire escapes, sprinklers and other protections.

workers' compensation

Insurance, required by law, that pays medical costs and lost wages to workers injured on the job, regardless of fault, in exchange for limiting lawsuits against employers.

expected loss

The average loss per period: the probability of a loss times its size.

premium

The price paid for an insurance policy.

risk pooling

Spreading risk among many people so that each pays a small, predictable amount instead of facing a rare, large loss alone.

CORE IDEAS

The story. On Saturday afternoon, March 25, 1911, fire broke out on the eighth floor of the Asch Building in New York City, where the Triangle Waist Company employed about 500 workers, mostly young women, many of them newcomers from Italy and Eastern Europe, sewing blouses. The fire spread through piles of cloth scraps within minutes. One stairway door on the ninth floor was locked, a common practice to prevent theft and unauthorized breaks; the single fire escape collapsed; the fire department's ladders reached only to the sixth floor. In under half an hour 146 workers died. The owners were tried in court and acquitted.

How they figured it out. The disaster moved the public and the state. New York created a Factory Investigating Commission, which held hearings and inspected hundreds of workplaces; among its staff was Frances Perkins, who had watched the fire from the street and later became the first woman to serve in a U.S. Cabinet. Within a few years New York passed dozens of laws requiring fire drills, sprinklers in tall buildings, unlocked doors that opened outward, and limits on smoking and on clutter. At the same time, states began adopting **workers' compensation**. Before, an injured worker could recover nothing unless he sued and proved his employer at fault, and most could not; with compensation, he received medical care and part of his wages automatically, and employers were protected from large lawsuits. Wisconsin passed the first lasting state law in 1911, and by 1920 most states had followed.

The big idea. Safety has costs and benefits. A sprinkler system costs money; a fire costs lives and property. Employers who bear the cost of injuries through insurance premiums have a reason to prevent them: insurers charge higher premiums to firms with more accidents. Insurance works by **risk pooling**: many employers each pay a

premium near their **expected loss** plus a margin for expenses, and the pool pays the few who suffer losses. The workers' compensation bargain, sometimes called the "grand bargain," traded the right to sue for certain, prompt benefits.

In business today. Every employer in the United States (with small exceptions by state) must carry workers' compensation insurance, and its cost depends on the industry and the firm's own safety record. Fire codes, building inspections and federal workplace-safety rules shape every factory and office. Good managers treat safety as part of quality: a safe workplace has fewer lost days, lower premiums and more loyal workers. The old law of Moses required a builder to put a railing around a flat roof, "that thou bring not blood upon thine house" (Deuteronomy 22:8).

Who gained? Workers gained safer buildings and certain compensation when hurt; employers gained predictable costs and protection from ruinous lawsuits; insurers gained a new business; customers paid slightly more; the community gained fewer disasters and fewer families left destitute by an accident.

PICTURE STUDY



Power House Mechanic Working on Steam Pump, Lewis Hine, 1920 · Gelatin silver print · Library of Congress and other collections

Image: Wikimedia Commons, public domain

After years of photographing children at work to show what was wrong, Hine turned in the 1920s to photographing adult workers to show the dignity and skill of their labor. This mechanic, bent over a great steam pump, became one of the most famous images of American work.

Look closely

- Look at the shape of the worker's body and the shape of the machine. How do they match?
- Find the wrench. What is he doing?
- Look at his clothing and cap. What do they tell you about his job?
- Look for any safety features or dangers near him.

Talk about it

1. How does this photograph show work as skilled and dignified?
2. What dangers would a power-house worker face, and how could they be reduced?
3. Why might Hine have wanted to show this side of work after his child-labor pictures?

> **Safety first.** Do the audit with a parent. Observe only: do not touch wiring, climb ladders or handle chemicals.

PROJECT

A Safety Audit and an Insurance Calculation

You will audit the safety of your home (or, with permission, a family business or church building), estimate the expected cost of hazards you find, and recommend improvements with a cost-benefit analysis.

You will need

- A clipboard and checklist
- A flashlight and tape measure
- A spreadsheet
- Your ledger notebook

Steps

1. Make a checklist: exits and paths, smoke alarms, extinguishers, railings, electrical cords, storage of chemicals, first-aid supplies.
2. Walk the building with a parent and record each item as good, needs attention or missing.
3. For three hazards you find, estimate the probability of an accident per year and its likely cost (use rough, honest guesses).
4. Compute the expected loss for each hazard.
5. Price a fix for each (a new smoke alarm, a railing, a cord cover) from a store website or flyer.
6. Compare the yearly cost of each fix with the reduction in expected loss.
7. Write a one-page safety report with your recommendations, and fix one item with your parent's help.

Tips

- Do not test electrical items or climb anywhere unsafe; just observe and record.
- Remember that expected-loss calculations leave out suffering; mention it in your report.

Check your work

- ☐ I can tell the story of the Triangle fire and the reforms after it.
- ☐ I can compute expected loss and an insurance premium.
- ☐ I can evaluate a safety measure with costs and benefits.

LEDGER NOTEBOOK

1. Copy your audit checklist and expected-loss table.
2. Draw a simple floor plan of the building you audited with exits and safety equipment marked.
3. List three laws passed in New York after 1911 and what each prevents.

KEY FORMULAS

$$\text{Expected loss} = p \times L$$

$$\text{Premium} \approx \text{expected loss} \times (1 + \text{loading})$$

$$\text{Net benefit of a safety measure} = \text{reduction in expected loss} - \text{cost}$$

From history. The Asch Building survived the fire, because it was fireproof; the people inside were not protected. It still stands at the corner of Washington Place and Greene Street in New York, now part of New York University, with a plaque in memory of the victims.

WORKED EXAMPLES

Example 1. In a factory, each worker has a 2% chance per year of an injury costing $15,000 in medical care and lost wages. Find the expected loss per worker and the premium for 200 workers with a 25% loading.

Show solution

1. Expected loss per worker: $0.02 \times 15{,}000 = \$300$.
2. For 200 workers: $60,000.
3. Premium: $60{,}000 \times 1.25 = \$75{,}000$.

Answer: $300 per worker; a premium of $75,000 a year for the factory.

Example 2. Installing guards on machines costs $20,000 a year and would cut the injury rate in Worked Example 1 from 2% to 1.2%. If the insurer lowers the premium in proportion, is the investment worth it on premiums alone?

Show solution

1. New expected loss: $200 \times 0.012 \times 15{,}000 = \$36{,}000$.
2. New premium: $36{,}000 \times 1.25 = \$45{,}000$.
3. Saving: $75{,}000 - 45{,}000 = \$30{,}000$ versus a cost of $20,000.

Answer: Yes: premiums fall $30,000 for a $20,000 cost, a net saving of $10,000, before counting the lives and suffering spared.

Example 3. A building with 500 workers has a 1-in-200 chance per year of a serious fire. Without sprinklers, a fire would cause losses of $5 million; with sprinklers, $500,000. Sprinklers cost $15,000 a year. Compare expected losses.

Show solution

1. Without: $0.005 \times 5{,}000{,}000 = \$25{,}000$.
2. With: $0.005 \times 500{,}000 + 15{,}000 = \$17{,}500$.

Answer: Sprinklers lower the expected annual cost from $25,000 to $17,500, even before counting the lives they save.

PRACTICE

1. Easy When and where was the Triangle fire, and how many died?

   Show answer

   March 25, 1911, in New York City; 146 workers.

2. Easy What is workers' compensation?

   Show answer

   Required insurance that pays medical costs and lost wages to injured workers without proof of fault, in exchange for limits on lawsuits.

3. Easy Which state passed the first lasting workers' compensation law, and when?

Show answer

Wisconsin, in 1911.

4. Medium A 4% chance of a $10,000 loss. Find the expected loss.

Show answer

$400.

5. Medium Expected losses are $50,000 and the loading is 30%. Find the premium.

Show answer

$65,000.

6. Medium Name three conditions that made the Triangle fire so deadly.

Show answer

A locked stairway door, a fire escape that collapsed, ladders that could not reach, and piles of flammable scraps (any three).

7. Medium Why does experience rating (charging firms with more accidents higher premiums) encourage safety?

Show answer

Firms that reduce accidents pay less, so they have a direct financial reason to invest in safety.

8. Hard Explain the "grand bargain" of workers' compensation.

Show answer

Workers gave up the right to sue employers for most injuries; in return they received certain, prompt benefits regardless of fault. Employers gained predictable costs.

9. Hard A safety measure costs $8,000 a year and lowers the probability of a $200,000 accident from 5% to 2%. Is it worth it on expected cost?

Show answer

Expected loss falls from $10,000 to $4,000, a $6,000 reduction, less than $8,000; not on money alone, but lives and injuries may justify it.

10. **Challenge** An insurer covers 10,000 workers, each with a one percent chance of a $20,000 claim. Find the expected total claims and explain why the insurer can predict them closely while a single employer with 5 workers cannot.

    Show answer

    Expected claims: $10{,}000 \times 0.01 \times 20{,}000 = \$2$ million. With many independent risks, the actual total stays close to the average (the law of large numbers); with 5 workers, one claim is a large, unpredictable share.

COMMON MISTAKES

- Treating safety as pure cost. Accidents are costly too, and insurance makes those costs visible.
- Forgetting the probability in expected loss. A large loss that is very unlikely may have a small expected cost, and the reverse.
- Thinking workers' compensation depends on proving fault. It is no-fault.

Make it a game · Safety Audit Walkthrough. Walk through your home like an inspector and find six safety issues a fire code might cover, such as clear exit paths, working smoke alarms and safe cords. Record each in a short report. Then compute the expected loss, a 2 percent chance of a 50,000-dollar claim, and a fair workers' compensation premium. Recall what changed after the Triangle fire.

Scripture. "When thou buildest a new house, then thou shalt make a battlement for thy roof, that thou bring not blood upon thine house, if any man fall from thence." (Deuteronomy 22:8, KJV)

The law of Moses made the builder responsible for a simple safety rail. Responsibility for others' safety is an old principle, not a modern invention.

7.5 When Rules Backfire: Diocletian's Price Edict and Price Controls

OBJECTIVES

- Tell the story of Diocletian's Edict on Maximum Prices (AD 301) and its failure.
- Use supply and demand to calculate the shortage and deadweight loss from a binding price ceiling.
- Explain why some well-meant rules backfire, and how to tell a rule that works like a fair referee from one that chokes a market.

> **Warm-up.** Suppose your town passes a law that a loaf of bread may not cost more than 50 cents. Write what you think bakers will do, what shoppers will do, and what you would see at the bakery a month later.

WATCH

How Price Ceilings Create Shortages and Lower Quality

Marginal Revolution University · 6:26

https://www.youtube.com/watch?v=RBGHmCIBr9M

> **WHEN TO WATCH**
> After the story of the edict, before the worked examples.

KEY TERMS

Edict on Maximum Prices
Diocletian's decree of AD 301 setting maximum prices for over a thousand goods and services across the Roman Empire, under penalty of death.

binding price ceiling
A legal maximum price set below the equilibrium price, so that it changes the market.

black market
Illegal trade at prices above the legal limit.

deadweight loss
The value of mutually beneficial trades that do not happen because of a market distortion.

unintended consequences

Results of a rule that its makers did not intend or foresee.

CORE IDEAS

The story. By the late third century, Rome's debased coinage had driven prices far up (Lesson 4.3). In AD 301 the emperor Diocletian, who had restored order to an empire torn by civil war, issued an edict blaming greedy merchants for high prices. It listed maximum prices for more than a thousand items: wheat, barley, meat, eggs, shoes, cloaks, wages for carpenters and teachers, freight charges by land and sea. Anyone who sold above the maximum, or hoarded goods, faced death. Copies were carved in stone and set up in cities across the eastern provinces; fragments survive today.

How they figured it out. The Christian writer Lactantius, no friend of Diocletian, described the result a few years later: much blood was shed over small and cheap things, goods disappeared from the markets because no one dared to sell, and prices rose even higher, until, after many deaths, the law was set aside out of necessity. The maximum prices were below what sellers needed, especially as the government kept issuing more coins. Merchants withheld goods, traded in secret, or traveled to places where the edict was not enforced. Within a few years the edict was a dead letter. The same pattern has appeared in many places and centuries since, including the U.S. wage and price controls of 1971–74, which brought shortages of beef and other goods before they were lifted.

The big idea. A **binding price ceiling** sets the price below equilibrium. The quantity supplied falls, the quantity demanded rises, and a shortage appears. Fewer goods are traded than at the market price, so some trades that would have benefited both sides never happen: the **deadweight loss**. The goods that are traded go to whoever is first in line, best connected or willing to break the law. Controls also blur price signals, so producers do not learn what people need most. The lesson is not that rules are bad. Rules that protect honest weights, contracts, safety and children work like a fair referee. Rules that try to command prices against the facts of scarcity, or that pile up so heavily that small businesses cannot start, choke the very trade they mean to help.

In business today. Businesses still face rules that help and rules that hinder. A clear rule (a standard weight, a building code, a disclosure requirement) gives everyone a

fair field. A rule that sets prices below cost or requires months of permits for a simple shop discourages supply. Good policy, in any age, asks the economist's questions: what will people actually do in response, who gains, who pays, and what is not seen?

Who gained? Under the edict, almost no stakeholder gained for long: buyers found empty markets, sellers faced ruin or execution, workers' wages were capped while prices rose, and the community suffered black markets and bloodshed. The intended beneficiaries, ordinary people and soldiers paid in coin, were among those hurt most.

PICTURE STUDY



Gold aureus of Diocletian, Roman imperial mint, about AD 284–305 · Gold · The Metropolitan Museum of Art, New York

Image: Wikimedia Commons, public domain

Diocletian struck good gold coins like this one even as the everyday coins in people's hands had become nearly worthless bronze. His edict tried to hold down prices measured in those everyday coins. The gap between this gold and the small change of the markets is part of the story of why the edict failed.

Look closely

- Find the emperor's portrait. What is he wearing on his head?
- Read what you can of the lettering. Whose name is there?
- Look at the metal. How does it compare with the debased coins of Lesson 4.3?
- Look at the edges and the size. What does this coin tell you about the emperor's wealth?

Talk about it

1. Why could an emperor mint good gold coins while ordinary coins lost value?
2. Why did the price edict set prices in the debased everyday money rather than in gold?
3. What does this coin suggest about who was hurt most by inflation?

PROJECT

The Price-Control Market Game

You will run a market twice, once free and once with a strict price ceiling, record what happens to trades, lines and side deals, and compute the deadweight loss from your own data.

You will need

- Index cards for buyers' values and sellers' costs
- Play money
- Six or more players
- A spreadsheet

Steps

1. Make buyer cards with values 20, 18, 16, 14, 12, 10, 8 and seller cards with costs 6, 8, 10, 12, 14, 16, 18.
2. Draw the demand and supply schedules and predict the equilibrium.
3. Round 1 (free): trade for 4 minutes. Record every trade price.
4. Round 2 (ceiling): no trade above 10 is allowed. Trade for 4 minutes. Record trades and how buyers competed (lines, offers of favors).
5. Count trades in each round and compute total gains (value minus cost) for each round.
6. Compute the deadweight loss: the gains from Round 1 minus the gains from Round 2.
7. Write a paragraph connecting your game to Lactantius's account of the edict.

Tips

- Watch for players offering side payments in Round 2; record them as black-market trades.
- Keep the rounds short and lively.

Check your work

☐ I can tell the story of Diocletian's edict and its failure.

☐ I can compute a shortage and deadweight loss.

- [ ] I can tell rules that act as a fair referee from rules that choke a market.

LEDGER NOTEBOOK

1. Copy your schedules, trades and gains for both rounds.
2. Draw the price-ceiling graph from Worked Example 1, shading the deadweight loss.
3. Make a two-column chart: rules that helped (from Units 7 and 8) and rules that backfired, with one sentence each.

KEY FORMULAS

$$\text{Shortage} = Q_d(P_c) - Q_s(P_c)$$

$$\text{Deadweight loss} \approx \tfrac{1}{2}(Q^* - Q_s(P_c)) \times (P_d - P_s)$$

$$P_d = \text{price buyers would pay for } Q_s(P_c), \quad P_s = P_c$$

From history. Diocletian abdicated in 305 and retired to his great palace at Split on the Adriatic coast, where he grew cabbages. Its walls now enclose the old town of Split, in Croatia. He was also responsible for the last and most severe Roman persecution of Christians, which began in 303.

WORKED EXAMPLES

Example 1. In a grain market, $Q_d = 120 - 4P$ and $Q_s = 6P - 30$ (thousands of measures, price in denarii). Find the equilibrium. Then a ceiling of 12 denarii is imposed. Find the shortage.

Show solution

1. Equilibrium: $120 - 4P = 6P - 30$, $P^* = 15$, $Q^* = 60$.
2. At 12: $Q_d = 72$, $Q_s = 42$.
3. Shortage: $72 - 42 = 30$ thousand measures.

Answer: Equilibrium at 15 denarii and 60 thousand measures; the ceiling creates a shortage of 30 thousand measures and cuts the amount sold to 42.

Example 2. Continuing, find the deadweight loss of the ceiling.

Show solution

1. Only 42 thousand measures are sold. Buyers would pay $P_d = (120 - 42)/4 = 19.5$ for the 42nd thousand.
2. Lost trades: $60 - 42 = 18$ thousand measures.
3. Deadweight loss: $\tfrac{1}{2} \times 18 \times (19.5 - 12) = 67.5$ thousand denarii.

Answer: About 67.5 thousand denarii of value lost to trades that would have helped both sides.

Example 3. On the black market, the 42 thousand measures sell to buyers willing to pay most. What price clears the black market for that quantity?

Show solution

1. Set $Q_d = 42$: $120 - 4P = 42$, $P = 19.5$.

Answer: 19.5 denarii: higher than the free-market price of 15. The ceiling meant to lower prices ends with buyers paying more.

PRACTICE

1. Easy When did Diocletian issue his Edict on Maximum Prices?

   Show answer

   AD 301.

2. Easy What penalty did the edict set for selling above the maximum?

   Show answer

   Death.

3. Easy Who described the edict's failure in a surviving account?

   Show answer

   The Christian writer Lactantius.

4. Medium Demand $Q_d = 100 - 2P$, supply $Q_s = 3P$. Find the equilibrium and the shortage at a ceiling of 15.

   Show answer

   $P^* = 20$, $Q^* = 60$; at 15: $Q_d = 70$, $Q_s = 45$; shortage 25.

5. **Medium** In problem 4, find the deadweight loss.

Show answer

$P_d = (100 - 45)/2 = 27.5$; DWL $\tfrac{1}{2}(60 - 45)(27.5 - 15) = 93.75$.

6. **Medium** Why did goods disappear from markets after the edict?

Show answer

At the low legal prices, sellers could not cover their costs and feared death if they charged more, so they withheld goods or sold them secretly.

7. **Medium** What happened to the supply of beef under the U.S. price controls of 1971–74, and why?

Show answer

Beef became scarce, because ranchers and packers held back supply when the controlled price was below their costs.

8. **Hard** Explain why a price ceiling can end up raising the price many buyers actually pay.

Show answer

With less supplied, the goods go through black markets or side payments, where buyers pay what the scarce quantity commands, which can exceed the free-market price.

9. **Hard** Contrast a rule that works like a fair referee with one that backfires, giving an example of each from this unit.

Show answer

Fair referee: the Factory Act or fire codes protect people while leaving trade free. Backfire: Diocletian's edict tried to command prices against scarcity and emptied markets.

10. **Challenge** Show that the black-market price in Worked Example 3 equals the price at which demand equals the quantity supplied under the ceiling, and explain why it exceeds the equilibrium price.

Show answer

Black-market buyers bid for the 42 thousand measures until demand equals 42: P = 19.5. Because the ceiling cuts supply below 60, the price needed to ration the smaller quantity is higher than the equilibrium price of 15.

COMMON MISTAKES

- Blaming sellers' greed for rising prices when the money supply was growing. Diocletian made this mistake.
- Drawing the ceiling above equilibrium and calling it binding.
- Concluding that all rules are harmful. The lesson is to judge rules by what they actually do.

> **Make it a game · Price Ceiling Math Duel.** Use demand Qd = 60 minus 2P and supply Qs = 3P minus 15. Find equilibrium price and quantity. Your parent then sets a binding ceiling of 10. Compute the shortage and the deadweight loss. Trade roles with new equations. Finish by retelling Diocletian's edict of AD 301 and where a black market would appear.

UNIT 7

Labor, Capital and Fair Rules

Owners and workers need each other: capital without labor is idle, and labor without capital produces little. This unit tells the story of how they have struggled and cooperated since the first factories. You will see the gains and the human costs of the first factories at Arkwright's Cromford mill; study how wages follow productivity and why Henry Ford doubled his workers' pay in 1914; and learn how the Factory Acts, Samuel Gompers' unions and the Fair Labor Standards Act limited child labor and long hours.

You will then follow the reforms after the Triangle fire of 1911, the workers' compensation bargain and the economics of insurance, and close with a warning from history: Diocletian's attempt to command prices by decree in AD 301. The unit is taught as settled history: what each rule fixed, how it worked, what it cost, and when rules worked like a fair referee and when they backfired.

PREREQUISITES

- Units 1–3 (marginal thinking, supply and demand, market structures)
- Unit 4.3 (Roman debasement)
- Percents and simple probability

MASTERY CHECKLIST

- ☐ I can describe the gains and costs of early industry and compute growth rates and doubling times.
- ☐ I can compute marginal product and marginal revenue product and find the best number of workers to hire.
- ☐ I can explain Ford's $5 day as an efficiency wage and weigh its paternalism.
- ☐ I can describe the Factory Acts, the AFL and the FLSA and calculate overtime pay.
- ☐ I can tell the story of the Triangle fire and compute expected losses and insurance premiums.
- ☐ I can compute the shortage and deadweight loss of a price ceiling and explain why Diocletian's edict failed.

OPTIONAL BOOKS AND GAMES FOR THIS UNIT

- **Lewis Hine's photographs, Library of Congress (National Child Labor Committee collection)**: Free; search "National Child Labor Committee" at loc.gov. Thousands of Hine's photographs with his original captions. Use with Lessons 7.3 and 7.4. Parents may wish to choose images together with younger siblings.
- **YouthRules!, from the U.S. Department of Labor**: Free. The current federal rules on hours and jobs for workers under 18. Use with the project in Lesson 7.3.
- **The Henry Ford (thehenryford.org) digital collections**: Free. Photographs and documents of Highland Park and the $5 day. Use with Lesson 7.2.

Not required. Every project in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

7.1	**The First Factories: Gains and Costs**	3 sessions of 50 minutes
7.2	**Wages, Productivity and Labor Markets: Ford's $5 Day**	3 sessions of 50 minutes
7.3	**The Factory Acts, Unions and the Fair Labor Standards Act**	3 sessions of 50 minutes
7.4	**Workplace Safety and Workers' Compensation: After the Triangle Fire**	3 sessions of 50 minutes
7.5	**When Rules Backfire: Diocletian's Price Edict and Price Controls**	3 sessions of 50 minutes

Unit 7 test

Calculators are allowed. Show your work for every calculation: write the formula, substitute and solve. Answer the concept questions in complete sentences. The test is worth 100 points.

1. **6 pts**
   Describe Arkwright's mill at Cromford and name one gain and one cost of the early factory system.

2. **6 pts**
   Income per person grows 1.4% a year. Find the doubling time with the rule of 70, and the growth over 100 years.

3. **6 pts**
   A money wage rises from $500 to $560 while the CPI rises from 100 to 115. Find the real wage change.

4. **8 pts**
   A shop's output with 1–5 workers is 30, 55, 75, 90, 100 units. Price $6, wage $100. Find each worker's MRP and the number to hire.

5. **6 pts**

   Why did Ford introduce the $5 day, and what were its results and its drawbacks?

6. **6 pts**

   What did the Factory Act of 1833 require, and why did it work better than earlier laws?

7. **6 pts**

   Describe the main provisions of the Fair Labor Standards Act of 1938.

8. **6 pts**

   A worker earns $20 an hour and works 50 hours. Find the week's pay.

9. **8 pts**

   Labor demand $L_d = 900 - 30W$, supply $L_s = 300 + 30W$. (a) Find the market wage and employment. (b) Find employment and unemployment at a floor of $12.

10. **6 pts**

    Tell the story of the Triangle fire and name two reforms that followed.

11. **8 pts**

    Each of 300 workers has a 3% annual chance of a $12,000 injury. (a) Find the expected annual loss. (b) Find the premium with a 20% loading.

12. **6 pts**

    Explain the workers' compensation "grand bargain."

13. **10 pts**

    Demand $Q_d = 200 - 5P$, supply $Q_s = 5P - 50$. (a) Find the equilibrium. (b) A ceiling of 20 is set. Find the shortage. (c) Find the deadweight loss.

14. **6 pts**

    Why did Diocletian's Edict on Maximum Prices fail?

15. **6 pts**

    Short essay: Using two examples from this unit, explain the difference between a rule that works like a fair referee and one that backfires.

ANSWER KEY

1. A water-powered cotton-spinning mill opened in 1771, running long shifts with many child workers and company housing. Gain: much higher productivity and cheaper cloth. Cost: long hours, child labor, dangerous machines.
2. About 50 years; $1.014^{100} \approx 4.0$ times.
3. $560/1.15 = 487$; a fall of about 2.6%.
4. MPL 30, 25, 20, 15, 10; MRP \$180, \$150, \$120, \$90, \$60. Hire 3.
5. To cut turnover of about 370% and absenteeism and raise effort. Turnover fell and productivity rose. Drawback: the Sociological Department's intrusion into workers' private lives.
6. No children under 9 in most textile mills; limits of 9 hours a day and 48 a week for ages 9–13; some schooling; and paid inspectors, who made enforcement real.
7. A national wage floor (25 cents, rising to 40), a 44-hour week falling to 40 with time-and-a-half overtime, and a ban on most work by children under 16 in interstate industries.
8. $800 + 10 \times 30 = \$1{,}100$.
9. (a) $W = \$10$, L = 600. (b) $L_d = 540$, $L_s = 660$; employment 540, unemployed 120.
10. On March 25, 1911, a fire in a New York garment factory took the lives of 146 workers, trapped by a locked door, a collapsing fire escape and short ladders. Reforms: fire drills, sprinklers, doors opening outward, the Factory Investigating Commission's laws; workers' compensation spread.
11. (a) $300 \times 0.03 \times 12{,}000 = \$108{,}000$. (b) \$129,600.
12. Workers gave up most rights to sue employers in exchange for certain, no-fault benefits; employers gained protection from large lawsuits and predictable costs.
13. (a) $P^* = 25$, $Q^* = 75$. (b) $Q_d = 100$, $Q_s = 50$; shortage 50. (c) $P_d = (200 - 50)/5 = 30$; DWL $\frac{1}{2}(75 - 50)(30 - 20) = 125$.
14. Prices were held below what sellers needed while the money supply kept growing, so goods vanished from markets, black markets spread, and the law was abandoned after much bloodshed.
15. A strong answer contrasts rules that protect safety, children or honest dealing while leaving trade free (Factory Acts, fire codes, workers' compensation) with rules that command prices against scarcity (Diocletian's edict, 1970s controls), explaining effects on stakeholders.

PORTFOLIO PIECE: A STAKEHOLDER HISTORY OF WORK

Write a five- to seven-page report on one industry (textiles, automobiles, steel, garment-making or another) from its early years to today, through the eyes of its workers and owners. Include at least one reform that worked and one rule or practice that backfired, a real wage or productivity calculation, an insurance or safety calculation, and a stakeholder scorecard for the industry in its early years and today. If you can, interview someone who works in the industry now (with a parent).

LOOK FOR	WHAT IT MEANS
History	Events, dates and reforms are accurate and fairly told.
Economics	Calculations are correct and used to support the argument.
Stakeholders	All six stakeholders are considered, with balanced judgments.
Writing	Clear, organized and free of partisan language.

UNIT 8

Government and the Economy

Markets rest on foundations that markets alone do not build: property, contracts and the rule of law. In this unit you will study those foundations through the Land Ordinance of 1785, then look at the things markets do poorly: public goods and spillovers, from England's lighthouses to London's Great Stink and Joseph Bazalgette's sewers. You will learn the principles of taxation from Adam Smith's four maxims and the strange history of the English window tax.

Then you will see three reforms that made markets more honest: the Pure Food and Drug Act of 1906, the securities laws that created the SEC, and federal deposit insurance. The unit closes with the other side of the ledger, government failure and the limits of planning, from Soviet five-year plans to the regulation and deregulation of American railroads. As always, the unit teaches principles and settled history, not present-day debates.

PREREQUISITES

- Units 2, 3 and 7 (supply and demand, market failure, price ceilings)
- Unit 5.1 (bank runs)
- Percents and simple probability

MASTERY CHECKLIST

- ☐ I can explain why secure property and enforceable contracts encourage investment, and describe the 1785 and 1787 ordinances.
- ☐ I can define public goods and externalities and find the efficient quantity with an external cost.
- ☐ I can state Smith's maxims and calculate tax incidence, revenue and deadweight loss.
- ☐ I can explain asymmetric information and the reforms of 1906, 1933 and 1934, and calculate insured deposits.
- ☐ I can explain government failure, public choice and the limits of central planning, with historical examples.

OPTIONAL BOOKS AND GAMES FOR THIS UNIT

- ***The Wealth of Nations*, Book V, chapter 2, part 2, "Of Taxes"**: Free. Smith's four maxims of taxation in his own words, a few pages long. Read with Lesson 8.3. Ages 15+.
- **FDIC: "Your Insured Deposits"**: Free. The FDIC's own explanation of deposit insurance limits and ownership types. Use with Lesson 8.4.
- **U.S. Food and Drug Administration: FDA history**: Free. Photographs and essays on Harvey Wiley, the Poison Squad and the 1906 law. Use with Lesson 8.4.

Not required. Every project in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

8.1 Property, Contracts and the Rule of Law: The Land Ordinance of 1785

3 sessions of 50 minutes

8.2 Public Goods and Spillovers: Lighthouses and London's Great Stink

3 sessions of 50 minutes

8.3 Taxes as Principle: Adam Smith's Maxims and the Window Tax

3 sessions of 50 minutes

8.4 Consumer and Investor Protection: Pure Food (1906), the SEC (1934) and the FDIC (1933)

3 sessions of 50 minutes

8.5 Government Failure and the Limits of Planning 3 sessions of 50 minutes

Unit 8 test

Calculators are allowed. Show your work for every calculation: write the formula, substitute and solve. Answer the concept questions in complete sentences. The test is worth 100 points.

1. **6 pts**

   Why do secure property rights encourage investment? Use an example.

2. **6 pts**

   Describe the Land Ordinance of 1785 and what it did for property.

3. **6 pts**

   An investment costs $8,000 and is worth $12,000 if kept. Find its expected value with a 25% chance of seizure. Is it worth making?

4. **6 pts**

   Define a public good and explain how England paid for its lighthouses.

5. **10 pts**

   MPC = 20 + Q, MB = 80 − Q, external cost $10 per unit. (a) Find the market quantity. (b) Find the efficient quantity. (c) Find the deadweight loss.

6. **6 pts**

   Tell how London solved the problem of the Great Stink and why a market could not have done it alone.

7. **6 pts**

   State Smith's four maxims of taxation.

8. **10 pts**

   Demand $Q_d = 120 - 3P$, supply $Q_s = 2P$. A $5 tax is placed on sellers. Find (a) the buyers' price, sellers' price and quantity, (b) revenue, (c) deadweight loss.

9. **6 pts**

   How did the window tax change behavior, and which of Smith's maxims did it violate?

10. **6 pts**

    Explain asymmetric information and one law of 1906 or 1933–34 that addressed it.

11. **8 pts**

    A depositor has $300,000 at a failing bank; the limit is $250,000 and uninsured funds recover 60%. Find her recovery and loss.

12. **6 pts**

    Why did bank failures drop so sharply after 1934?

13. **6 pts**

    Explain concentrated benefits and dispersed costs with a calculation of your own.

14. **6 pts**

    Why did Soviet planning produce shortages and poor goods?

15. **6 pts**

    Short essay: Using the Staggers Act and one market failure from this unit, explain why economists compare real alternatives.

ANSWER KEY

1. People invest when they expect to keep the returns. A farmer with secure title plants an orchard that pays off years later; with insecure title he will not.
2. It ordered western land surveyed into townships six miles square and 640-acre sections before sale, giving precise, recorded titles and reserving a section for schools.
3. $0.75 \times 12{,}000 = \$9{,}000$; yes, it exceeds $8,000 (but only by $1,000, versus $4,000 with secure title).
4. Non-excludable and non-rival. Light dues were collected from ships at ports for Trinity House or licensed private owners.
5. (a) $Q = 30$. (b) $80 - Q = 30 + Q$, $Q = 25$. (c) $\frac{1}{2} \times 5 \times 10 = 25$.
6. Parliament funded Bazalgette's intercepting sewers (1859–1870s), carrying waste downstream. The harm and the solution spanned the whole city, so a public authority with taxing power was needed.
7. Equality (in proportion to ability), certainty, convenience, economy.
8. Without tax: $P = 24$, Q = 48. (a) $120 - 3P_b = 2(P_b - 5)$, $P_b = 26$, $P_s = 21$, $Q = 42$. (b) $210. (c) $\frac{1}{2} \times 5 \times 6 = \$15$.
9. People bricked up windows and built with fewer; this lost light and air without raising revenue, violating the maxim of economy (and in tenements, equality).
10. When sellers know more than buyers about quality, buyers distrust all sellers. The Pure Food and Drug Act required truthful labels; the Securities Act required honest disclosure for new securities.
11. Recovery: $250{,}000 + 0.6 \times 50{,}000 = \$280{,}000$; loss $20,000.
12. Deposit insurance removed depositors' reason to run, so sound banks no longer failed from panic; supervision also improved.
13. Example: a rule gives $50 million to 500 firms ($100,000 each) and costs 100 million people $50 million ($0.50 each). Firms lobby hard; consumers do not notice, so the rule may pass.
14. Planners lacked the information prices provide and set targets in tons or counts that rewarded the wrong things; without prices and profits, producers did not respond to customers.
15. A strong answer shows that markets can fail (pollution, public goods) and governments can fail (ICC rate rules that weakened railroads until 1980), and that good policy weighs the actual results of each.

PORTFOLIO PIECE: A FAIR REFEREE: RULES THAT WORKED AND RULES THAT DIDN'T

Write a five- to seven-page essay comparing four rules from Units 7 and 8: two that worked like a fair referee and two that backfired. For each, explain the problem it addressed, how it worked, what it cost, and what it meant for the six stakeholders, with at least one calculation per rule. Conclude with your own principles for judging a rule, supported by Scripture and by economic reasoning, written without partisan language.

LOOK FOR	WHAT IT MEANS
History	The four rules are described accurately and in context.
Economics	Each rule is analyzed with correct calculations and concepts (incidence, externalities, shortages, public choice).
Judgment	The essay weighs all six stakeholders and reaches balanced conclusions.
Writing	Clear, well organized and free of partisan language.

UNIT 8 · GOVERNMENT AND THE ECONOMY · LESSON 8.1 OF 50 · 3 SESSIONS OF 50 MINUTES

8.1 Property, Contracts and the Rule of Law: The Land Ordinance of 1785

OBJECTIVES

- Explain why secure property rights and enforceable contracts encourage work, saving and investment.
- Describe the Land Ordinance of 1785 and the Northwest Ordinance of 1787 and what they did for property and contracts.
- Calculate how the risk of losing property changes the value of an investment, and explain the problem of the commons.

> **Warm-up.** Would you plant an apple tree that takes seven years to bear fruit on land you might lose next year? Write what would make you willing to plant it.

WATCH

Property rights in a market system | Basic Economic Concepts | AP(R) Microeconomics | Khan Academy

Khan Academy · 5:54

https://www.youtube.com/watch?v=AJy7pWK0W8g

> **WHEN TO WATCH**
> After the story, before the big idea.

BACKUP VIDEO

Markets and property rights | AP® Microeconomics | Khan Academy

Khan Academy · 6:01

https://www.youtube.com/watch?v=PEG9OQCo2Ls

After the worked examples.

KEY TERMS

property rights

Legal rights to use, keep the fruits of, and sell or give away a thing.

contract

A voluntary, legally enforceable agreement between parties.

rule of law

The principle that everyone, including rulers, is subject to known, fairly applied laws.

title

Legal evidence of ownership, such as a deed recorded in a public office.

tragedy of the commons

The overuse of a resource that everyone may use and no one owns, because each user bears only part of the cost of his use.

CORE IDEAS

The story. After the War of Independence, the new United States held a vast territory northwest of the Ohio River. Congress needed to sell the land to pay its debts and wanted settlers to buy it with confidence. The Land Ordinance of 1785 ordered the land surveyed before sale into a grid of townships six miles square, each divided into 36 sections of one square mile (640 acres). Every parcel would have a precise, recorded description, so that titles would be clear and boundary disputes rare; one section in each township was reserved to support public schools. Two years later the Northwest Ordinance of 1787 promised the territory's settlers trial by jury and declared that no law should ever be made that would interfere with or affect private contracts made in good faith.

How they figured it out. In older settlements, land had often been described by "metes and bounds," such as a line from a large oak to a creek bend, and in Kentucky overlapping claims had led to endless lawsuits. The founders saw that clear titles would attract buyers, raise land values and let owners borrow against their land. Congress sent the geographer Thomas Hutchins to begin surveying the first "Seven Ranges" in eastern Ohio, and the grid he began still shapes the roads and fields of the Midwest, visible from any airplane window. Long before, an older story had made the same point about property and power: when King Ahab wanted Naboth's vineyard, Naboth refused to sell his inheritance, and it took a lie, a false trial and an unjust execution for Ahab to take it (1 Kings 21).

The big idea. People invest when they expect to keep the fruit of their work. **Property rights** give that assurance, **contracts** let strangers cooperate over time, and the **rule of law** means that rulers too are bound. When ownership is insecure, the

expected return on any investment falls, and people stop planting trees, building shops and lending money. Where no one owns a resource, the opposite problem appears: in 1833 the English writer William Forster Lloyd described how village commons were overgrazed, because each herdsman gained the full benefit of adding a cow while the cost of the worn-out pasture fell on everyone. Clear rights, or agreed rules for shared use, solve it.

In business today. Every business depends on property and contracts: deeds and leases for its buildings, titles for its vehicles, contracts with suppliers and customers, and courts to enforce them fairly. Economists find that countries with secure property rights and honest courts tend to have far more investment and higher incomes. A business that keeps its own contracts faithfully builds the trust that makes all this work.

Think it through. “Thou shalt not steal” assumes property; “Let your communication be, Yea, yea; Nay, nay” assumes promises that hold. Biblical law protected landmarks (Deuteronomy 19:14) and condemned unjust judges. Property and contract are not merely economic tools; they are part of justice between neighbors.

PICTURE STUDY



Plat of the Seven Ranges of Townships, Mathew Carey (publisher), from the survey of Thomas Hutchins, 1796 · Printed map with outline color · Rumsey Map Collection, Stanford University

Image: Wikimedia Commons, public domain

This plat shows the first lands surveyed under the Land Ordinance of 1785, in what is now eastern Ohio. Each square is a township six miles on a side, numbered so that any parcel could be described exactly. The neat grid laid over hills and rivers was a new idea: a whole territory measured before it was sold.

Look closely

- Find the Ohio River. How does the grid meet its curving bank?
- Look at the numbers in the squares. How might a buyer use them?
- Count the townships in one range (one column).
- Look for any marks for reserved sections or towns.

Talk about it

1. Why would a clear survey make buyers more willing to pay for land?
2. How did the grid prevent the boundary disputes of older settlements?
3. What does reserving land for schools tell you about the founders' priorities?

Safety first. Use public records only with a parent, and do not copy owners' names into your notebook.

PROJECT

Read a Deed and Map a Section

You will find how property in your area is described and recorded, map a section of land using the 1785 system (or your area's system), and compute values under secure and insecure title.

You will need

- Your county's online property records or a sample deed (with a parent)
- Graph paper and a ruler
- A calculator
- Your ledger notebook

Steps

1. With a parent, look up a public property record in your county (a park, a church or your own home) and note how the land is described (lot and block, section-township-range, or metes and bounds).
2. Copy the description and identify each part.
3. Draw a section of 640 acres on graph paper and divide it into quarters and quarter-quarters (40 acres). Label each with its standard name (for example "NE ¼ of the SW ¼").
4. Compute the area in acres and square feet of a 40-acre parcel (1 acre = 43,560 square feet).
5. Choose an investment (a barn, an orchard, a shop). Estimate its cost and future value, and compute the expected value if the chance of losing the property is 0%, 10% and 40%.
6. Graph expected value against the chance of loss and find the break-even chance.
7. Write a paragraph explaining what your results say about property rights and investment.

Tips

- Public records are public, but be respectful: use them only for this exercise.

- If your area uses lot-and-block descriptions, map your neighborhood's plat instead.

Check your work

- ☐ I can explain how secure property rights encourage investment.
- ☐ I can describe the 1785 and 1787 ordinances.
- ☐ I can explain the tragedy of the commons.

LEDGER NOTEBOOK

1. Copy your section map with labeled parcels.
2. Copy your expected-value table and graph.
3. Retell the story of Naboth's vineyard in three sentences and explain its lesson about property and power.

KEY FORMULAS

$$\text{Expected value of an investment} = (1 - p) \times \text{value if kept}$$

$$1 \text{ township} = 36 \text{ sections}, \quad 1 \text{ section} = 640 \text{ acres} = 1 \text{ square mile}$$

From history. The rectangular survey system eventually covered most of the United States west of Ohio, about three-quarters of the country's land area. Section 16 of each township was set aside for schools, and many rural schools were built on it.

WORKED EXAMPLES

Example 1. A farmer can plant an orchard costing $3,000 that will be worth $5,000 in five years. If there is a 50% chance his land will be seized before then, what is the expected value of the orchard? Should he plant?

Show solution

1. Expected value: $(1 - 0.5) \times 5{,}000 = \$2{,}500$.
2. Cost: $3,000.

Answer: Expected value $2,500 is less than the $3,000 cost, so he will not plant. With secure title (p = 0) he would gain $2,000: insecurity destroys the investment.

Example 2. Find the acreage of a township under the 1785 ordinance, and the acres in a quarter-section. If a section sold at the 1785 minimum of $1 an acre, what did it cost?

Show solution

1. Township: $36 \times 640 = 23{,}040$ acres.
2. Quarter-section: $640/4 = 160$ acres.
3. Section at $1 an acre: $640.

Answer: 23,040 acres per township; 160 acres per quarter-section; $640 per section at $1 an acre.

Example 3. A common pasture supports 100 cows well; each extra cow beyond 100 lowers every cow's milk by one percent. Each herder gains from his own extra cow's milk but shares the loss. With 10 herders of 10 cows each, one herder adds a cow. Does he gain? Does the village?

Show solution

1. After adding: 101 cows, each giving 99% of normal milk.
2. The herder: had 10 cows × 100% = 10 units; now 11 × 0.99 = 10.89. He gains 0.89 units.
3. The village: had 100 units; now $101 \times 0.99 = 99.99$ units, slightly less.
4. Every herder faces the same choice; if all add cows, all lose.

Answer: The herder gains, the village loses a little, and if every herder follows his own gain, the pasture is ruined: the tragedy of the commons.

PRACTICE

1. Easy How large was a township under the Land Ordinance of 1785? A section?

   Show answer

   Six miles square (36 square miles); a section was one square mile, 640 acres.

2. Easy What did the Northwest Ordinance of 1787 promise about contracts?

   Show answer

   That no law should interfere with or affect private contracts made in good faith.

3. Easy What is the rule of law?

Show answer

The principle that everyone, rulers included, is bound by known laws applied fairly.

4. Medium An investment costs $10,000 and will be worth $14,000 if kept. At what chance of loss does it break even?

Show answer

$(1-p)(14{,}000) = 10{,}000$, $p \approx 28.6\%$.

5. Medium How many acres are in a quarter-quarter section? In a township?

Show answer

40 acres; 23,040 acres.

6. Medium Why did clear surveys raise land values?

Show answer

Buyers could be sure of exactly what they owned, avoid costly disputes and borrow against it, so they would pay more.

7. Medium Explain the tragedy of the commons in your own words.

Show answer

When no one owns a shared resource, each user gains the full benefit of extra use but bears only part of the cost, so it is overused.

8. Hard Give two solutions to the tragedy of the commons and an example of each.

Show answer

Private property (dividing the commons into owned fields, as in English enclosure) or agreed rules for shared use (limits on cows per family, enforced by the village).

9. Hard How does Naboth's vineyard illustrate the rule of law?

Show answer

Naboth's right to his land stood against the king's desire; Ahab could take it only through lies and a false trial, which Scripture condemns. Even rulers are bound by justice.

10. **Challenge** A lender will lend against land only if the chance of losing the title is under 5%. A farmer's land is worth \$50,000 and the bank lends 70% of value. How much can he borrow with secure title? If insecure title cuts the land's expected value by 20% and the bank refuses, what investment opportunity is lost?

    Show answer

    Secure: $0.7 \times 50{,}000 = \$35{,}000$. Insecure: nothing, so whatever he could have built or bought with \$35,000 (equipment, a barn, more land) is lost, along with its returns.

COMMON MISTAKES

- Thinking property rights matter only to the rich. Secure rights matter most to ordinary families whose land or shop is their main wealth.
- Confusing the commons problem with greed. Ordinary, decent people overuse a resource when no one owns it.
- Forgetting that contracts need courts. A promise no one can enforce is weak.

Make it a game · Survey the Township. Draw a township as a six-by-six grid of 36 sections, each 640 acres, and mark section 16 for schools as under the Land Ordinance of 1785. Your parent asks acres, square miles and plot sizes within fifteen seconds. Then explain what a deed and a title prove, and how a shared pasture illustrates the tragedy of the commons.

Scripture. "And Naboth said to Ahab, The LORD forbid it me, that I should give the inheritance of my fathers unto thee." (1 Kings 21:3, KJV)

Naboth held his family land as a trust from God. The story shows that even a king had no right to take it, and that injustice in taking property brings judgment.

8.2 Public Goods and Spillovers: Lighthouses and London's Great Stink

OBJECTIVES

- Define public goods and externalities and explain why markets may supply too little or too much of them.
- Use the story of Britain's lighthouses to show how public goods have been financed.
- Calculate social cost and the efficient quantity with a negative externality, using London's sewers as the case.

> **Warm-up.** List three things in your town that everyone benefits from but no one pays for at the point of use (streetlights, a lighthouse, a fire siren). How are they paid for?

WATCH

A Deeper Look at Public Goods

Marginal Revolution University · 7:55

https://www.youtube.com/watch?v=hA2z-X31IvI

> **WHEN TO WATCH**
> After the lighthouse story, before the big idea.

BACKUP VIDEO

Bazalgette: Saviour of the Great Stink

Institution of Civil Engineers · 5:14

https://www.youtube.com/watch?v=5k8AnhNkN04

With the story of Bazalgette's sewers.

KEY TERMS

public good

A good that is non-excludable (people cannot easily be kept from using it) and non-rival (one person's use does not reduce another's).

free rider

Someone who benefits from a good without paying for it.

externality (spillover)

A cost or benefit of an activity that falls on people outside the transaction.

social cost

The full cost of an activity: the private cost to the producer plus the external cost to others.

Pigouvian tax

A tax equal to the external cost per unit, named for the economist Arthur Pigou (1920), which makes producers bear the full cost.

CORE IDEAS

The story. A lighthouse helps every ship that sees it, and a captain cannot be kept from seeing it once it is lit. How, then, can it be paid for? In England the answer, from the 1500s on, was a mix. Trinity House, a guild of mariners chartered by Henry VIII in 1514, built and ran many lighthouses, and private owners built others under licenses from the Crown. Both were paid by "light dues," fees collected from ships at the ports they entered according to the lights they had passed. Two centuries later London faced the opposite problem. Its sewers and cesspools drained into the Thames, which was also a source of drinking water. In the hot summer of 1858 the smell from the river, called the Great Stink, became so overpowering that Parliament, sitting beside the river, voted money within weeks for a vast new sewer system.

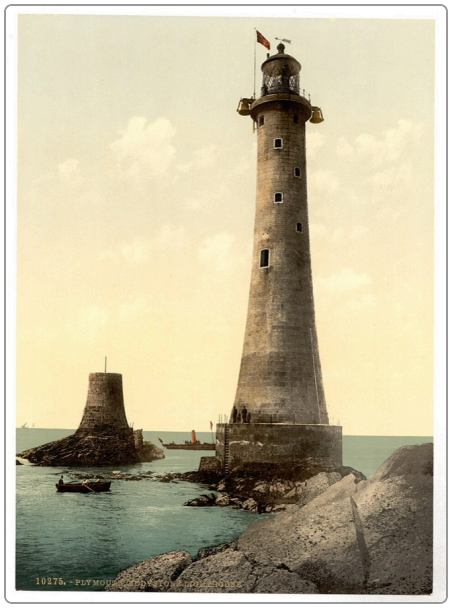
How they figured it out. The engineer Joseph Bazalgette designed intercepting sewers that ran along the river and carried London's waste downstream, away from the city, with great pumping stations. Built between 1859 and the mid-1870s, the system included about 82 miles of main sewers and more than 1,000 miles of street sewers. A few years earlier the physician John Snow had shown that cholera spread through contaminated water; after the new sewers were finished, London's great cholera epidemics did not return. The economist Ronald Coase later studied the lighthouses (1974) to show that public goods could sometimes be privately financed, given a clever way to collect payment, while the sewers showed a case where only a public authority with power to tax and to build across the whole city could solve the problem.

The big idea. Markets work best when the people who decide bear the full costs and receive the full benefits. A **public good** is non-excludable and non-rival, so people can ride free, and private sellers may supply too little. An **externality** is a cost or benefit that spills onto others: the household or factory dumping waste into a river pays nothing for the harm downstream, so there is too much dumping. Remedies include public provision paid by taxes, fees tied to use (as with light dues), assigning property rights so that those harmed can bargain or sue, and charges equal to the external cost. The efficient quantity is where the marginal benefit equals the marginal **social cost**, not just the private cost.

In business today. Businesses pay for public goods through taxes and fees (roads, courts, police), and are charged for many spillovers through permits, fees and liability for damage. A responsible business looks beyond its own costs to the effects on neighbors: honest dealing includes not dumping one's costs onto others. "Thou shalt love thy neighbour as thyself" applies downstream as well as next door.

Who gained? From the sewers: Londoners gained clean water and freedom from cholera; taxpayers bore the cost; engineers and workers gained great projects; the community gained a healthier city and the Victoria Embankment along the river. From the lighthouses: shippers paid modest fees and gained safe passage; the owners earned returns; sailors' lives were saved.

PICTURE STUDY



Eddystone Lighthouse, Plymouth, England, Detroit Publishing Company (Photochrom print), about 1890–1900 · Photochrom (color lithograph from a photograph) · Library of Congress

Image: Wikimedia Commons, public domain

The Eddystone rocks, fourteen miles off Plymouth, wrecked ships for centuries. A series of lighthouses was built there, beginning in 1698; the first two were destroyed by storm and fire. This tower, designed by James Douglass for Trinity House, was finished in 1882. The stump of John Smeaton's earlier tower of 1759 stands beside it.

Look closely

- Find the newer tower and the stump of the older one.
- Look at the rocks and waves. Why would building here be so hard?
- Find the lantern room at the top. What does it do?
- Look for any boats or people. Who keeps a lighthouse running?

Talk about it

1. Why is a lighthouse a classic example of a public good?
2. How did light dues solve the problem of paying for it?
3. Who are the stakeholders in a lighthouse?

PROJECT

A Spillover Study in Your Town

You will identify a real public good and a real spillover in your area, find out how each is paid for or managed, and estimate costs per household.

You will need

- Your town or county budget (online, with a parent)
- A calculator or spreadsheet
- Your ledger notebook

Steps

1. Choose one public good in your town (street lighting, a library, flood control, a fire department).
2. Find its yearly cost in the town budget and the number of households. Compute the cost per household.
3. Explain why a private company would have trouble selling this good. Is there any way to charge users directly?
4. Choose one spillover (noise from a highway, runoff from a parking lot, a beautiful private garden that neighbors enjoy).
5. Describe who causes it, who is affected, and whether any rule, fee or agreement deals with it.
6. Estimate, honestly and roughly, its yearly cost or benefit to those affected.
7. Write a one-page memo to your town council proposing how each should be paid for or managed, using the ideas of this lesson.

Tips

- Town budgets are often long; search for the department's name.
- Positive spillovers count too: a well-kept shop front benefits the whole street.

Check your work

- ☐ I can define public goods and externalities.
- ☐ I can find the efficient quantity with an external cost.
- ☐ I can explain how public goods have been financed in history.

LEDGER NOTEBOOK

1. Copy your budget calculations and memo outline.
2. Draw the externality graph from Worked Example 1, labeling MPC, MSC, MB and the deadweight loss.
3. Sketch a map of London's Thames with Bazalgette's intercepting sewers running along each bank.

KEY FORMULAS

$$MSC = MPC + MEC$$

$$\text{Efficient quantity: } MB = MSC$$

$$\text{Pigouvian tax per unit} = MEC$$

From history. Bazalgette built his sewers larger than London then needed, reasoning that the city would grow and that the job should be done once. His foresight served London for more than a century.

WORKED EXAMPLES

Example 1. A tannery's private marginal cost is $MPC = 10 + Q$ and the demand (marginal benefit) for its leather is $MB = 50 - Q$. Each unit also causes \$8 of harm downstream. Find the market quantity and the efficient quantity.

Show solution

1. Market: $50 - Q = 10 + Q$, $Q = 20$. Price 30.
2. Social cost: $MSC = 18 + Q$.
3. Efficient: $50 - Q = 18 + Q$, $Q = 16$. Price 34.

Answer: The market produces 20 units; the efficient amount is 16. An \$8 tax per unit would bring output to 16.

Example 2. Continuing, find the deadweight loss of the externality.

Show solution

1. Between Q = 16 and Q = 20, each unit's social cost exceeds its benefit.
2. At Q = 20, $MSC = 38$ and $MB = 30$; at Q = 16, both equal 34.
3. Deadweight loss: $\frac{1}{2} \times 4 \times 8 = 16$.

Answer: A deadweight loss of $16: the value of harm caused by units that were not worth their full cost.

Example 3. A lighthouse costs £600 a year to run. Five hundred ships pass it each year. What light due per passage covers the cost? If one ship in five avoided paying, what would the others have to pay?

Show solution

1. Due: $600/500 = £1.20$ per passage.
2. With 400 payers: $600/400 = £1.50$.

Answer: £1.20 per passage; £1.50 if a fifth ride free. Collecting dues at ports was how England limited free riding.

PRACTICE

1. Easy What two features make a good a public good?

   Show answer

   Non-excludable and non-rival.

2. Easy What was the Great Stink, and when?

   Show answer

   The overwhelming smell from the sewage-filled Thames in the hot summer of 1858.

3. Easy Who designed London's new sewer system?

   Show answer

   Joseph Bazalgette.

4. Medium How were England's lighthouses paid for?

Show answer

By light dues collected from ships at ports, for Trinity House or for licensed private owners.

5. Medium MPC = 4 + 2Q, MB = 40 − Q, external cost $6 per unit. Find the market and efficient quantities.

Show answer

Market: $Q = 12$; efficient: $40 - Q = 10 + 2Q$, $Q = 10$.

6. Medium Give an example of a positive externality and explain why a market might produce too little of it.

Show answer

A well-kept garden or a freshly painted house front pleases the whole street; the owner weighs only his own benefit, so there is less of it than the neighborhood would want. (Other examples: education, bees that pollinate a neighbor's orchard.)

7. Medium What did John Snow discover, and why does it matter to this story?

Show answer

That cholera spread through contaminated water, which showed why separating sewage from drinking water was vital.

8. Hard Explain Coase's point about lighthouses.

Show answer

Lighthouses, often thought to require government, were historically financed by user fees collected at ports; public goods can sometimes be privately financed if payment can be tied to use.

9. Hard Why could the Thames problem not be solved by individual households or firms?

Show answer

The harm was spread across the whole city and river; no single party could build city-wide sewers or bargain with millions of people, so a public authority with taxing power was needed.

10. **Challenge** In Worked Example 1, if instead of a tax the town gave downstream residents the right to stop the tannery unless paid, would the efficient amount still result? Explain using Coase's reasoning.

Show answer

Yes, if bargaining is cheap: the tannery would pay residents for each unit whose value to the tannery exceeds the $8 harm, producing 16 units. With many residents and high bargaining costs, a tax or rule may work better.

COMMON MISTAKES

- Calling anything the government provides a public good. Many government services are excludable (tolls, tuition).
- Using private cost to find the efficient quantity when there is a spillover. Use social cost.
- Assuming every externality requires a tax. Property rights, fees and agreements can also work.

> **Make it a game · Lighthouse Fund Game.** Each of you gets ten beans. A lighthouse costs fifteen beans, and both benefit if it is built, even if only one pays. Decide in secret how many beans to give for three rounds. Notice the free rider problem. Then discuss how Britain financed its lighthouses, and what a Pigouvian tax would do about London's Great Stink.

8.3 Taxes as Principle: Adam Smith's Maxims and the Window Tax

OBJECTIVES

- State Adam Smith's four maxims of taxation and use them to judge a tax.
- Explain tax incidence: why the person who sends a tax to the government is not always the one who bears it.
- Calculate tax revenue, incidence and deadweight loss, using the English window tax as a historical example.

> **Warm-up.** Look at a store receipt. Find any tax on it. Who paid it to the store, and who will pay it to the government? Write your answer, then guess who really bears its cost.

WATCH

Who Pays the Tax?

Marginal Revolution University · 9:07

https://www.youtube.com/watch?v=1H5uU_6Ax_4

> **WHEN TO WATCH**
> After the big idea, before the worked examples.

BACKUP VIDEO

A Brief History of....Window Tax

A Brief History Of ... · 2:28

https://www.youtube.com/watch?v=MGE98o4WnnQ

With the story of the window tax.

KEY TERMS

tax incidence

Who actually bears the burden of a tax, after prices adjust.

excise tax

A tax on a particular good, often a set amount per unit.

deadweight loss of a tax

The value of trades that no longer happen because a tax drives a wedge between what buyers pay and what sellers receive.

progressive, proportional, regressive

Taxes that take a rising, constant or falling share of income as income rises.

Smith's maxims

Adam Smith's four principles of taxation: equality (in proportion to ability), certainty, convenience and economy.

CORE IDEAS

The story. In 1696 England introduced a tax on houses according to the number of their windows. Windows could be counted from the street without entering a home, and larger houses with more windows usually belonged to wealthier families, so the tax seemed both easy and fair. It lasted, with changes, until 1851. But householders responded. Many bricked up windows to pay less, and new buildings were designed with fewer of them. Physicians and reformers complained that the poor in crowded tenements, where the tax was charged on the whole building, lived in dark, airless rooms. Bricked-up windows from the period can still be seen on old buildings in Britain.

How they figured it out. In *The Wealth of Nations* (1776), Adam Smith set down four maxims for judging any tax. **Equality**: people should contribute in proportion to their ability. **Certainty**: the amount and time of payment should be clear, not arbitrary. **Convenience**: it should be collected at a time and in a way convenient to the payer. **Economy**: it should take as little as possible from the people beyond what it brings into the treasury, avoiding costly collection and discouraging useful activity. The window tax scored well on certainty and ease of collection but poorly on economy: it took light and air from people in exchange for revenue, a classic deadweight loss.

The big idea. Taxes pay for public goods such as courts, defense and roads, and Scripture teaches citizens to render "tribute to whom tribute is due" (Romans 13:7). Economics adds two lessons. First, **incidence**: who sends the tax to the government does not decide who bears it. When a tax is placed on a good, the price buyers pay

rises and the price sellers keep falls; the more inelastic side bears more of the burden. Second, **deadweight loss**: because a tax drives a wedge between price paid and price received, some trades no longer happen. The loss is larger when demand and supply are more elastic, because people change their behavior more, as householders did by bricking up windows. Good tax design raises needed revenue with the least such loss, as Smith's maxim of economy demands.

In business today. Businesses collect and remit sales taxes, withhold payroll taxes and pay taxes on profits and property. They study incidence too: a firm cannot always pass a tax on to its customers if they can easily switch to substitutes. Honest record-keeping and timely payment of taxes are part of a business's integrity, and paying what is owed is a Christian duty (Matthew 22:21). This lesson teaches principles and history only; it does not take a side in present-day debates about particular taxes.

Who gained? The window tax gave the government a steady revenue with little collection cost, but householders, especially poor tenants, lost light and health, builders designed worse buildings, and the community suffered in public health. When the tax was repealed in 1851, a reform movement for public health counted it a victory.

PICTURE STUDY



The Tax Collectors, After Marinus van Reymerswaele, early 1600s (copy of an original of about 1540) · Oil on panel · National Museum in Warsaw

Image: Wikimedia Commons, public domain

Reymerswaele painted this scene many times, and it was copied often: two tax or toll collectors recording their receipts. The exaggerated faces and fancy clothing suggest that the painter meant to warn against greed in those who handle public money. Look at it as a moral picture as much as a record of work.

Look closely

- Find the ledger and the coins. What is each man doing?
- Look at their faces. What attitudes did the painter give them?
- Look at the papers on the shelf or desk. What might be written on them?
- Look at their clothing. What does it suggest?

Talk about it

1. Why have tax collectors so often been distrusted, from the Gospels to this painting?
2. Which of Smith's maxims protects people from greedy or arbitrary collectors?
3. What virtues should a person who collects public money have?

PROJECT

Who Really Pays? A Tax Incidence Experiment

You will run a small market with and without a per-unit tax and measure how much of the tax falls on buyers and how much on sellers, then design a tax that meets Smith's maxims.

You will need

- Index cards with buyers' values and sellers' costs
- Play money
- Six or more players
- A spreadsheet

Steps

1. Use buyer values 20, 18, 16, 14, 12, 10, 8 and seller costs 6, 8, 10, 12, 14, 16, 18.
2. Round 1 (no tax): trade for 4 minutes. Record prices and the number of trades.
3. Round 2: sellers must pay a tax of $4 per sale to the "treasury" (a parent). Trade again and record.
4. Compute the average price paid by buyers and kept by sellers in each round, and the tax revenue.
5. Find how much of the $4 fell on buyers and how much on sellers.
6. Compute the drop in total gains from trade (value minus cost) between rounds and compare it with the tax revenue.
7. Design a tax for a small imaginary town that meets Smith's four maxims and explain your choices in a paragraph.

Tips

- Make the treasury collect the tax at each sale so it is real to the players.
- Record every trade; averages tell the story.

Check your work

☐ I can state Smith's four maxims.

☐ I can calculate incidence, revenue and deadweight loss.

- [ ] I can explain how the window tax changed behavior.

LEDGER NOTEBOOK

1. Copy your trade records and incidence calculation.
2. Draw the tax graph from Worked Example 1, labeling the buyers' price, sellers' price, revenue rectangle and deadweight-loss triangle.
3. Write Smith's four maxims in your own words with one example each.

KEY FORMULAS

$$\text{With a per-unit tax } t: \;\; P_{\text{buyers}} - P_{\text{sellers}} = t$$

$$\text{Revenue} = t \times Q_t, \qquad DWL = \tfrac{1}{2} \times t \times (Q^* - Q_t)$$

$$\text{Buyers' share} \approx \frac{E_s}{E_s + E_d}$$

From history. The phrase "daylight robbery" is often said to come from the window tax, but word historians say there is no good evidence for that; the phrase appears only in the twentieth century. Bricked-up windows, however, are real and still common on Georgian buildings.

WORKED EXAMPLES

Example 1. Demand $Q_d = 100 - 2P$, supply $Q_s = 3P$. A tax of \$5 per unit is placed on sellers. Find the new quantity, the price buyers pay, the price sellers keep, the revenue and the deadweight loss.

Show solution

1. Without tax: $100 - 2P = 3P$, $P^* = 20$, $Q^* = 60$.
2. With tax: sellers keep $P_s = P_b - 5$: $100 - 2P_b = 3(P_b - 5)$, $P_b = 23$, $P_s = 18$. Quantity $100 - 46 = 54$.
3. Revenue: $5 \times 54 = \$270$.
4. Deadweight loss: $\tfrac{1}{2} \times 5 \times (60 - 54) = \$15$.

Answer: Buyers pay \$23 (up \$3), sellers keep \$18 (down \$2), so buyers bear 60% of the tax. Revenue \$270; deadweight loss \$15.

Example 2. A house has 12 windows. Under one version of the window tax, houses with up to 9 windows paid a flat 2 shillings, and houses with 10–19 windows paid 6 shillings extra. How much could the owner save by bricking up 3 windows?

Show solution

1. With 12 windows: 2 + 6 = 8 shillings.
2. With 9 windows: 2 shillings.
3. Saving: 6 shillings a year.

Answer: Six shillings a year: enough to tempt many owners to give up light for money, which is exactly the deadweight loss Smith's maxim of economy warns against. (Illustrative rates.)

Example 3. Judge the window tax by Smith's four maxims.

Show solution

1. Equality: partly; larger houses paid more, but crowded tenements were charged as single houses, burdening the poor.
2. Certainty: good; windows could be counted.
3. Convenience: fair; paid yearly.
4. Economy: poor; people lost light, air and health to avoid it.

Answer: Strong on certainty, weak on equality and economy: a tax easy to collect but costly to the people.

PRACTICE

1. Easy Name Adam Smith's four maxims of taxation.

   Show answer

   Equality, certainty, convenience and economy.

2. Easy When was the English window tax introduced and when was it repealed?

   Show answer

   1696; 1851.

3. **Easy** What is tax incidence?

Show answer

Who actually bears the burden of a tax after prices adjust.

4. **Medium** Demand $Q_d = 80 - P$, supply $Q_s = P$. A \$10 tax is placed on sellers. Find the buyers' price, sellers' price and quantity.

Show answer

$80 - P_b = P_b - 10$, $P_b = 45$, $P_s = 35$, $Q = 35$.

5. **Medium** In problem 4, find the revenue and deadweight loss.

Show answer

Revenue \$350; original Q = 40, so DWL $\frac{1}{2} \times 10 \times 5 = \$25$.

6. **Medium** Why did the window tax cause a deadweight loss?

Show answer

People bricked up windows and built houses with fewer of them, giving up light and air (real value) to avoid the tax, without any revenue being raised from those windows.

7. **Medium** If demand is very inelastic and supply elastic, who bears most of a tax?

Show answer

Buyers.

8. **Hard** Why does a tax on a good with elastic demand raise less revenue and cause more deadweight loss than one with inelastic demand?

Show answer

Buyers cut purchases sharply, so the tax base shrinks (less revenue) and many trades are lost (more deadweight loss).

9. **Hard** Judge a tax on bread by Smith's maxim of equality.

Show answer

It takes a larger share of income from the poor, who spend more of their income on bread, so it is regressive and weak on equality.

10. **Challenge** With $E_s = 2$ and $E_d = 0.5$, what share of a tax falls on buyers? Explain why it does not matter whether the law places it on buyers or sellers.

    Show answer

    Buyers' share $2/(2 + 0.5) = 80\%$. Incidence depends on elasticities, not on who writes the check; prices adjust to the same result either way.

COMMON MISTAKES

- Assuming the party that hands the tax to the government bears it.
- Forgetting the deadweight loss. A tax's cost to the people is more than the revenue it raises.
- Judging a tax only by how easy it is to collect, ignoring how it changes behavior.

Make it a game · Who Really Pays Duel. Your parent names a good and a tax, such as an excise tax on salt or on concert tickets. Decide whether buyers or sellers bear more of the burden by judging elasticity, and compute the split from numbers your parent gives. Recite Adam Smith's four maxims in thirty seconds, then judge the window tax by each maxim.

Scripture. "Render therefore to all their dues: tribute to whom tribute is due; custom to whom custom; fear to whom fear; honour to whom honour." (Romans 13:7, KJV)

Paul teaches that paying taxes is a duty. Smith's maxims add that rulers have duties too: taxes should be fair, certain, convenient and no more burdensome than necessary.

8.4 Consumer and Investor Protection: Pure Food (1906), the SEC (1934) and the FDIC (1933)

OBJECTIVES

- Explain the problem of asymmetric information and why it can cause markets to fail.
- Describe the Pure Food and Drug Act of 1906, the securities laws of 1933–34 and federal deposit insurance, and what each fixed.
- Calculate how deposit insurance changes a depositor's expected loss and why it stopped bank runs.

> **Warm-up.** Think of a time you bought something and could not judge its quality before buying (a used item, a medicine, a meal at a new restaurant). How did you decide whom to trust?

WATCH

Chapter 1 | The Poison Squad | American Experience | PBS

American Experience | PBS · 9:11

https://www.youtube.com/watch?v=euBoKIm1v6Q

> **WHEN TO WATCH**
> After the story of Harvey Wiley, before the big idea.

BACKUP VIDEO

90 Years of the FDIC

FDICchannel · 2:51

https://www.youtube.com/watch?v=UsHtV_QS_e4

With the section on deposit insurance.

KEY TERMS

asymmetric information

A situation in which one side of a trade knows much more about the quality of what is traded than the other.

adulteration

Making food or drugs impure by adding cheaper or harmful substances.

disclosure

Required public reporting of true, material information, such as a company's finances or a food's ingredients.

deposit insurance

A guarantee that depositors will be repaid up to a limit if their bank fails; in the U.S., provided by the FDIC since 1934.

Securities and Exchange Commission (SEC)

The federal agency created in 1934 to enforce honest disclosure and fair dealing in securities markets.

CORE IDEAS

The story. In the late 1800s, packaged foods were often adulterated: milk thinned with water and colored with chalk, "honey" made of corn syrup, canned meat preserved with borax and formaldehyde, and patent medicines laced with alcohol and narcotics sold as cures for anything. Harvey Wiley, chief chemist of the U.S. Department of Agriculture, began testing. In 1902 he recruited twelve young volunteers, soon nicknamed the "Poison Squad," who ate meals containing measured amounts of common preservatives while their health was recorded. The results, and public alarm after Upton Sinclair's novel *The Jungle* (1906) described Chicago meatpacking, led Congress to pass the Pure Food and Drug Act and the Meat Inspection Act, both signed on June 30, 1906. Labels had to be truthful, and adulterated foods and drugs were banned from interstate commerce.

How they figured it out. A generation later, the crash of 1929 and the Depression exposed problems in finance. Hearings in the Senate from 1932 to 1934, led by its counsel Ferdinand Pecora, revealed that some banks had sold investors securities they knew were poor, and that companies had hidden losses. Congress responded with the Securities Act of 1933, requiring companies selling new securities to register and disclose true information, and the Securities Exchange Act of 1934, which created the SEC to enforce honest reporting and fair trading. Meanwhile, some 9,000 banks had failed between 1930 and 1933. The Banking Act of 1933 created the Federal Deposit Insurance Corporation, which began insuring deposits up to $2,500 on January 1, 1934. Bank failures, which had numbered in the thousands each year, fell to a handful.

The big idea. Markets need trust. When sellers know much more than buyers, buyers may assume the worst and pay only for low quality, driving honest sellers out; economists call this the problem of **asymmetric information**. Reputation, brands and warranties help (Lesson 3.2), but in some markets, such as food safety, medicines, securities and bank deposits, honest rules that require **disclosure** or provide guarantees let the market work. Deposit insurance also solves the run problem of Lesson 5.1: if depositors know they will be repaid, they have no reason to rush to withdraw, so sound banks no longer fail from panic. Insurance brings its own danger, moral hazard, so it is paired with supervision and limits.

In business today. Food makers list ingredients and nutrition facts; drug makers must show safety and effectiveness before selling; public companies file audited reports with the SEC four times a year; and bank deposits are insured up to a set limit per depositor, per bank, for each ownership type. Honest firms benefit from these rules, because customers and investors can trust them. “A false balance is abomination to the LORD” (Proverbs 11:1) applies to labels and financial statements as much as to scales.

Who gained? Customers gained safe, honestly labeled food and medicine; investors gained truthful information; depositors gained security; honest firms gained trust and protection from dishonest competitors; the community gained public health and a stable banking system. Firms bore the costs of testing, reporting and insurance premiums, which are passed in part to customers.

PICTURE STUDY



Harvey Wiley and the "Poison Squad", U.S. Department of Agriculture (photograph), about 1903 · Photograph · U.S. Food and Drug Administration history collection

Image: Wikimedia Commons, public domain

The volunteers ate at a special dining room in the Department of Agriculture's building, where their meals were measured and their health checked. Wiley's careful experiments, and the public attention they drew, helped build support for the 1906 law. Wiley later served as the first commissioner enforcing it.

Look closely

- Find Harvey Wiley. How does he stand out from the volunteers?
- Look at the table. What tells you this was a carefully run experiment?
- Look at the volunteers' faces and clothing. Who were they?
- Look at the room. Does it look like a laboratory or a dining room?

Talk about it

1. Why did Wiley test preservatives on volunteers rather than simply warn the public?
2. How did honest testing help honest food companies?
3. Who were the stakeholders in the pure-food fight?

Safety first. A parent helps with all online research. Never enter personal or account information on any website.

PROJECT

Reading the Disclosures

You will read three kinds of required disclosure, a food label, a bank's deposit-insurance notice and a summary of a public company's annual report, and explain what each protects you from.

You will need

- A packaged food from your pantry
- A bank's website or brochure (with a parent)
- A public company's annual report summary (from the company's investor-relations page or the SEC's EDGAR system, with a parent)
- Your ledger notebook

Steps

1. Copy the ingredients and nutrition facts of a packaged food. Look up one ingredient you do not know.
2. Find the deposit-insurance notice on a bank's website. Record the current insurance limit and how it applies.
3. Compute the insured and uninsured amounts for a family with $300,000 in one bank under a single ownership type, using the current limit.
4. Choose a well-known public company. In its annual report summary, find revenue, net income and total assets for the last year.
5. Write what each of the three disclosures protects the buyer, depositor or investor from.
6. Compare: what would you have known about each in 1900?
7. Write a paragraph on the role of honesty and of law in each case.

Tips

- Use official sources only (the company, the bank, the FDIC, the SEC).
- Do not enter any personal information on any website.

Check your work

☐ I can explain asymmetric information.

- ☐ I can describe the laws of 1906, 1933 and 1934 and what they fixed.
- ☐ I can calculate insured and uninsured deposits.

LEDGER NOTEBOOK

1. Copy your three disclosures and your notes on each.
2. Make a timeline: 1902, 1906, 1929, 1930–33, 1932–34, 1933, 1934.
3. Write a stakeholder scorecard for the Pure Food and Drug Act.

KEY FORMULAS

$$\text{Expected loss without insurance} = p_{\text{fail}} \times \text{deposit} \times (1 - \text{recovery rate})$$

$$\text{Insured loss} = p_{\text{fail}} \times \max(0, \text{deposit} - \text{limit}) \times (1 - \text{recovery rate})$$

From history. Bank failures fell from about 4,000 in 1933 to fewer than 10 insured banks in 1934. Henry Heinz, whose clear bottles you met in Lesson 3.2, was among the few food manufacturers who supported the 1906 law.

WORKED EXAMPLES

Example 1. Before 1934 a depositor kept \$2,000 in a bank with a 3% chance of failing in a year; if it failed, depositors recovered 60%. Find the expected loss. Then find it with insurance up to \$2,500.

Show solution

1. Without insurance: $0.03 \times 2{,}000 \times 0.40 = \$24$.
2. With insurance: the deposit is fully covered, so the expected loss is \$0.

Answer: \$24 a year without insurance, \$0 with it. More important, the depositor no longer has a reason to run when rumors spread.

Example 2. A depositor has $3,500 in a failing bank under the 1934 limit of $2,500. If uninsured amounts recover 50%, how much does he get back?

Show solution

1. Insured: $2,500.
2. Uninsured: $0.5 \times 1{,}000 = \$500$.
3. Total: $3,000.

Answer: $3,000; he loses $500. Spreading deposits across banks keeps each under the limit.

Example 3. In a used-equipment market, half the machines are good (worth $1,000 to buyers) and half are poor (worth $400). Buyers cannot tell which is which and offer the average. Sellers of good machines value them at $800. What happens?

Show solution

1. Buyers offer $0.5 \times 1{,}000 + 0.5 \times 400 = \$700$.
2. Owners of good machines will not sell for $700 (they value them at $800), so they withdraw.
3. Only poor machines remain, and buyers, realizing this, offer only $400.

Answer: The good machines leave the market. A trustworthy inspection or required disclosure would let good machines sell for a price both sides accept.

PRACTICE

1. Easy What was the Poison Squad?

   Show answer

   Volunteers recruited by Harvey Wiley in 1902 who ate measured amounts of food preservatives so their effects could be studied.

2. Easy What did the Pure Food and Drug Act of 1906 require?

   Show answer

   Truthful labels and a ban on adulterated or misbranded foods and drugs in interstate commerce.

3. **Easy** When did the FDIC begin insuring deposits, and up to what limit?

Show answer

January 1, 1934, up to $2,500.

4. **Medium** What did the Securities Act of 1933 and the Securities Exchange Act of 1934 do?

Show answer

The first required registration and disclosure for new securities; the second created the SEC to enforce honest reporting and fair trading.

5. **Medium** A bank has a 2% chance of failure; recovery is 70%. Find the expected loss on an uninsured $10,000 deposit.

Show answer

$0.02 \times 10{,}000 \times 0.30 = \$60$.

6. **Medium** Why did deposit insurance stop bank runs?

Show answer

Insured depositors know they will be repaid, so they have no reason to rush to withdraw when rumors spread.

7. **Medium** What is asymmetric information? Give an example.

Show answer

When one side knows much more about quality than the other, such as a seller of a used car or a company issuing stock.

8. **Hard** Explain how asymmetric information can drive good products out of a market.

Show answer

If buyers cannot tell quality, they pay an average price; sellers of good products find it too low and withdraw, lowering average quality and price further.

9. Hard What is moral hazard in deposit insurance, and how is it limited?

Show answer

Insured banks may take more risk because depositors stop watching; it is limited by supervision, capital requirements, insurance limits and risk-based premiums.

10. Challenge A depositor has $400,000 at one bank, and the limit is $250,000. The bank fails; uninsured funds recover 75%. How much does she lose? How could she have protected all of it?

Show answer

Uninsured $150,000 recovers $112,500; she loses $37,500. She could have split the money among two banks (or ownership types) so each was under the limit.

COMMON MISTAKES

- Thinking deposit insurance covers investments such as stocks. It covers deposits, up to a limit.
- Assuming disclosure guarantees a good investment. It guarantees honest information, not profit.
- Thinking only government can solve information problems. Brands, warranties and inspections help too; law adds a floor of honesty.

Make it a game · Lemon Cards Disclosure Game. Prepare six cards, three marked good and three marked bad, hidden in an envelope. You are the seller who knows the quality; your parent is a buyer who only offers an average price. Play three rounds and watch what happens. Then add disclosure and compare. Explain how the Pure Food and Drug Act, the SEC and deposit insurance each fixed a similar problem.

Scripture. “A false balance is abomination to the LORD: but a just weight is his delight.” (Proverbs 11:1, KJV)

A false label or a hidden loss in a company’s books is a false balance. Honest disclosure is the just weight of modern markets.

8.5 Government Failure and the Limits of Planning

OBJECTIVES

- Explain why central planning struggled to coordinate an economy, using Soviet five-year plans as history.
- Explain public-choice ideas: concentrated benefits, dispersed costs, and regulators captured by the industries they oversee.
- Analyze the regulation of American railroads and the Staggers Act of 1980 with numbers.

> **Warm-up.** Imagine you must plan every meal for every family in your town for a year: what to grow, ship, cook and when. List five things you would need to know and how you would find them out.

WATCH

Command and market economies | Basic economics concepts | AP Macroeconomics | Khan Academy

Khan Academy · 9:44

https://www.youtube.com/watch?v=Ve6K10-Yx_M

> **WHEN TO WATCH**
> After the story of the five-year plans, before the big idea.

KEY TERMS

central planning

An economic system in which a government agency decides what to produce, how and for whom, and sets prices.

output target

A quota of production set by planners for a factory or farm.

government failure

When government action produces a worse result than the problem it was meant to fix.

public choice

The study of government decisions using economic tools, treating officials and voters as people who respond to incentives.

regulatory capture

When a regulatory agency comes to serve the interests of the industry it regulates rather than the public.

CORE IDEAS

The story. From 1928 the Soviet Union ran its economy by five-year plans. A central agency, Gosplan, set output targets for every industry, allocated materials and fixed prices. The plans built steel mills, dams and heavy industry quickly, at an enormous human cost, especially in the forced collectivization of farms in the early 1930s, which brought famine. Over the following decades the system produced persistent shortages of consumer goods, long lines, poor quality and waste. Factories judged by tons produced made goods too heavy; those judged by number produced made them too small. Stores might be full of one item nobody wanted and empty of another everyone needed. By the 1980s the economy had stagnated, and the Soviet Union dissolved in 1991.

How they figured it out. As early as 1920 the Austrian economist Ludwig von Mises argued that without market prices for factories, machines and materials, planners would have no way to calculate which uses of resources were efficient. Hayek added the point you met in Lesson 2.5: the knowledge needed is scattered among millions of people and changes daily, so no planning board can gather it. Later, the American economist James Buchanan (Nobel Prize, 1986) and others developed **public choice**: officials and voters respond to incentives like everyone else. A rule that gives large benefits to a small, organized group and spreads small costs over millions will often pass, even if its total cost exceeds its benefit. Regulators may come to see the world through the eyes of the industry they oversee.

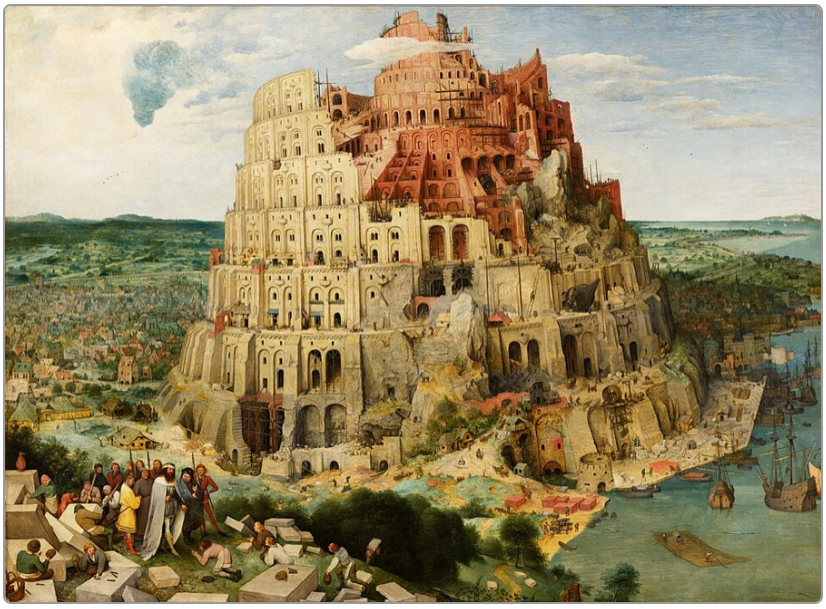
The big idea. Markets can fail (Units 3 and 8), but so can governments. A good economist compares the real alternatives, not a perfect government with an imperfect market or the reverse. American railroads offer a peaceful case. The

Interstate Commerce Commission, created in 1887 to stop railroad abuses, came to set rates in detail and to limit railroads' freedom to cut prices or abandon unprofitable lines. By the 1970s many railroads were failing; the Penn Central, the largest, went bankrupt in 1970. The Staggers Rail Act of 1980 gave railroads freedom to set most rates and make contracts with shippers. In the following decades rail rates, adjusted for inflation, fell substantially, traffic grew, and the industry returned to health, while the government kept protections for shippers with no other choice.

In business today. Businesses live with rules that help and rules that hinder. A wise business leader supports honest, clear rules that protect customers and fair competition, and is wary of seeking special favors that shift costs onto the public. The Tower of Babel stands as an old picture of human planning that overreaches: "let us make us a name" (Genesis 11:4). Humility about what any planner can know is a lesson for governments and companies alike.

Who gained? Under Soviet planning, a favored few gained access to scarce goods while ordinary families waited in lines; workers lacked freedom to choose jobs or form independent unions; customers had little choice; and the community suffered shortages and, at times, terrible famines. Under American rail regulation before 1980, some shippers and communities gained protected service, but railroads, their workers and customers lost as the industry decayed; after 1980 most stakeholders gained.

PICTURE STUDY



The Tower of Babel, Pieter Bruegel the Elder, 1563 · Oil on oak panel · Kunsthistorisches Museum, Vienna

Image: Wikimedia Commons, public domain

Bruegel set the story of Genesis 11 in a busy sixteenth-century port. A king visits the stoneworks below while thousands of laborers swarm the tower. Look closely: the arches do not line up, the lower levels are already crumbling while the upper ones rise, and the whole tower leans. It is a picture of a grand plan that outruns human knowledge.

Look closely

- Find the king and his attendants in the foreground. What are the workers doing as he arrives?
- Look at the cranes, ramps and boats. How were materials moved?
- Look for signs that the tower is badly built: arches that do not match, leaning walls, unfinished parts.
- Find the city around the tower. How small are the houses compared with it?

Talk about it

1. What does this painting suggest about a single plan imposed from the top?
2. How is a planning board like the king, and how is a market different?
3. What virtue does the story of Babel teach about human plans?

PROJECT

The Planner's Game

You will try to allocate goods to a group by central plan and then by a simple market, and compare how well each matches what people want.

You will need

- Index cards for 10 kinds of goods (3 of each)
- A secret want list for each player
- Play money
- Five or more players
- Your ledger notebook

Steps

1. Give each player a secret list of three goods he wants, with values.
2. Round 1 (plan): the planner (a parent) hands out the 30 goods by a rule of his or her choosing, without seeing the want lists. Record how many wanted items each player received.
3. Round 2 (plan with targets): the planner may ask one question of the whole group, then allocate again. Record.
4. Round 3 (market): give each player $20; post a starting price for each good; let players buy and trade freely for 5 minutes. Record.
5. Compute the total value received (sum of values of wanted goods) in each round.
6. Discuss: what information did the planner lack? What did prices do?
7. Write a paragraph comparing your results with the history of Soviet planning and with Hayek's point about knowledge.

Tips

- Keep want lists secret; that is the planner's real problem.
- Let the planner try hard to be fair; the lesson is about knowledge, not good intentions.

Check your work

- ☐ I can explain why central planning struggled.
- ☐ I can explain concentrated benefits and dispersed costs.
- ☐ I can analyze the Staggers Act case with real-value calculations.

LEDGER NOTEBOOK

1. Copy your results table for the three rounds.
2. Make a two-column chart: market failures (Units 3 and 8) and government failures (Units 7 and 8), with an example of each.
3. Write a timeline of U.S. railroad regulation: 1887, 1970, 1980.

KEY FORMULAS

$$\text{Real rate index} = \frac{\text{nominal rate}}{\text{price index}} \times 100$$

$$\text{Benefit per member} = \frac{\text{total benefit}}{\text{group size}}$$

From history. The Interstate Commerce Commission, the first major federal regulatory agency, was abolished in 1995, and its remaining duties were moved to a smaller board. In the decades after the Staggers Act, American freight railroads became among the most efficient in the world.

WORKED EXAMPLES

Example 1. A rule gives $60 million a year to 2,000 firms and costs 120 million consumers a total of $120 million a year. Find the benefit per firm and the cost per consumer, and explain why the rule might pass anyway.

Show solution

1. Benefit per firm: $60{,}000{,}000 / 2{,}000 = \$30{,}000$.
2. Cost per consumer: $120{,}000{,}000 / 120{,}000{,}000 = \$1$.
3. Total cost exceeds total benefit by $60 million.

Answer: Each firm has $30,000 at stake and will organize and lobby; each consumer has $1 at stake and will not notice. Concentrated benefits and dispersed costs can carry a rule that makes the country poorer.

Example 2. A railroad's average rate was 3.0 cents per ton-mile in 1981 and 4.0 cents in 2010, while the price index rose from 100 to 240. Find the real rate in 1981 prices and the percent change.

Show solution

1. Real 2010 rate: $4.0 \times 100/240 \approx 1.67$ cents.
2. Change: $(1.67 - 3.0)/3.0 \approx -44\%$.

Answer: The real rate fell about 44%. (Illustrative numbers in line with estimates often cited for the decades after 1980.)

Example 3. A planned factory is judged by the weight of nails it produces. It can make 1,000 kg as 10 large spikes or as 100,000 small nails. Builders need small nails. What will the factory make, and why?

Show solution

1. Both choices meet the 1,000 kg target.
2. Large spikes take less work per kilogram.
3. With no prices telling it what builders want, and rewards tied to weight, the factory makes spikes.

Answer: It makes spikes that builders do not need: the target, not the customer, guides production. A market price would have signaled the value of small nails.

PRACTICE

1. Easy What was Gosplan?

   Show answer

   The Soviet central planning agency that set output targets, allocated materials and fixed prices.

2. Easy What did the Staggers Rail Act of 1980 do?

   Show answer

   Gave railroads freedom to set most rates and make contracts with shippers.

3. Easy What is government failure?

Show answer

When government action produces a worse result than the problem it meant to fix.

4. Medium Explain Mises's argument about calculation in a planned economy.

Show answer

Without market prices for capital goods and materials, planners cannot compare costs and benefits of different uses, so they cannot know which plans are efficient.

5. Medium A subsidy gives $90 million to 300 farms and costs 150 million taxpayers $150 million. Find the benefit per farm and cost per taxpayer.

Show answer

$300,000 per farm; $1 per taxpayer.

6. Medium What is regulatory capture?

Show answer

When a regulator comes to serve the regulated industry's interests rather than the public's.

7. Medium Why did targets measured in tons or in numbers of items produce poor goods?

Show answer

Factories met the measure rather than customers' needs, making goods too heavy (by tons) or too small and flimsy (by count).

8. Hard A rate rose from 5 to 6 cents while the price index rose from 100 to 150. Find the real change.

Show answer

$6/1.5 = 4$ cents in base prices: a 20% real fall.

9. Hard Why should an economist compare real alternatives rather than ideal ones?

Show answer

Both markets and governments fail in practice; comparing a perfect version of one with a flawed version of the other leads to bad choices.

10. Challenge A planner must set prices for 10,000 goods, each adjusted monthly, and each price takes 30 minutes to review. How many full-time (2,000 hours a year) staff are needed? What does this suggest about planning a modern economy with millions of goods?

Show answer

$10{,}000 \times 12 \times 0.5 = 60{,}000$ hours, or 30 staff, for just 10,000 goods. With millions of goods changing daily, the task becomes impossible, while markets adjust prices continuously through millions of decisions.

COMMON MISTAKES

- Concluding that because markets sometimes fail, government will always do better, or the reverse.
- Thinking public choice means officials are wicked. It means they respond to incentives, like everyone else.
- Treating the Soviet system as a failure only of bad leaders. Its problems of knowledge and incentives were built into central planning.

> **Make it a game · Plan Target Trap.** Your parent plays a factory manager making nails. You, the planner, set the quota by count of nails. See what happens. Then set it by weight and see what changes. Explain why the Soviet five-year plans struggled. Then describe how concentrated benefits and dispersed costs explain why regulators can end up serving the industry they oversee.

UNIT 8

Government and the Economy

Markets rest on foundations that markets alone do not build: property, contracts and the rule of law. In this unit you will study those foundations through the Land Ordinance of 1785, then look at the things markets do poorly: public goods and spillovers, from England's lighthouses to London's Great Stink and Joseph Bazalgette's sewers. You will learn the principles of taxation from Adam Smith's four maxims and the strange history of the English window tax.

Then you will see three reforms that made markets more honest: the Pure Food and Drug Act of 1906, the securities laws that created the SEC, and federal deposit insurance. The unit closes with the other side of the ledger, government failure and the limits of planning, from Soviet five-year plans to the regulation and deregulation of American railroads. As always, the unit teaches principles and settled history, not present-day debates.

PREREQUISITES

- Units 2, 3 and 7 (supply and demand, market failure, price ceilings)
- Unit 5.1 (bank runs)
- Percents and simple probability

MASTERY CHECKLIST

- ☐ I can explain why secure property and enforceable contracts encourage investment, and describe the 1785 and 1787 ordinances.
- ☐ I can define public goods and externalities and find the efficient quantity with an external cost.
- ☐ I can state Smith's maxims and calculate tax incidence, revenue and deadweight loss.
- ☐ I can explain asymmetric information and the reforms of 1906, 1933 and 1934, and calculate insured deposits.
- ☐ I can explain government failure, public choice and the limits of central planning, with historical examples.

OPTIONAL BOOKS AND GAMES FOR THIS UNIT

- ***The Wealth of Nations*, Book V, chapter 2, part 2, "Of Taxes"**: Free. Smith's four maxims of taxation in his own words, a few pages long. Read with Lesson 8.3. Ages 15+.
- **FDIC: "Your Insured Deposits"**: Free. The FDIC's own explanation of deposit insurance limits and ownership types. Use with Lesson 8.4.
- **U.S. Food and Drug Administration: FDA history**: Free. Photographs and essays on Harvey Wiley, the Poison Squad and the 1906 law. Use with Lesson 8.4.

Not required. Every project in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

8.1 **Property, Contracts and the Rule of Law: The Land Ordinance of 1785**

3 sessions of 50 minutes

8.2 **Public Goods and Spillovers: Lighthouses and London's Great Stink**

3 sessions of 50 minutes

8.3 **Taxes as Principle: Adam Smith's Maxims and the Window Tax**

3 sessions of 50 minutes

8.4 **Consumer and Investor Protection: Pure Food (1906), the SEC (1934) and the FDIC (1933)**

3 sessions of 50 minutes

8.5 **Government Failure and the Limits of Planning** 3 sessions of 50 minutes

Unit 8 test

Calculators are allowed. Show your work for every calculation: write the formula, substitute and solve. Answer the concept questions in complete sentences. The test is worth 100 points.

1. **6 pts**

   Why do secure property rights encourage investment? Use an example.

2. **6 pts**

   Describe the Land Ordinance of 1785 and what it did for property.

3. **6 pts**

   An investment costs $8,000 and is worth $12,000 if kept. Find its expected value with a 25% chance of seizure. Is it worth making?

4. **6 pts**

   Define a public good and explain how England paid for its lighthouses.

5. **10 pts**

   MPC = 20 + Q, MB = 80 − Q, external cost $10 per unit. (a) Find the market quantity. (b) Find the efficient quantity. (c) Find the deadweight loss.

6. **6 pts**

   Tell how London solved the problem of the Great Stink and why a market could not have done it alone.

7. **6 pts**

   State Smith's four maxims of taxation.

8. **10 pts**

   Demand $Q_d = 120 - 3P$, supply $Q_s = 2P$. A $5 tax is placed on sellers. Find (a) the buyers' price, sellers' price and quantity, (b) revenue, (c) deadweight loss.

9. **6 pts**

   How did the window tax change behavior, and which of Smith's maxims did it violate?

10. **6 pts**

    Explain asymmetric information and one law of 1906 or 1933–34 that addressed it.

11. **8 pts**

    A depositor has $300,000 at a failing bank; the limit is $250,000 and uninsured funds recover 60%. Find her recovery and loss.

12. **6 pts**

    Why did bank failures drop so sharply after 1934?

13. **6 pts**

    Explain concentrated benefits and dispersed costs with a calculation of your own.

14. **6 pts**

    Why did Soviet planning produce shortages and poor goods?

15. **6 pts**

    Short essay: Using the Staggers Act and one market failure from this unit, explain why economists compare real alternatives.

ANSWER KEY

1. People invest when they expect to keep the returns. A farmer with secure title plants an orchard that pays off years later; with insecure title he will not.
2. It ordered western land surveyed into townships six miles square and 640-acre sections before sale, giving precise, recorded titles and reserving a section for schools.
3. $0.75 \times 12{,}000 = \$9{,}000$; yes, it exceeds $8,000 (but only by $1,000, versus $4,000 with secure title).
4. Non-excludable and non-rival. Light dues were collected from ships at ports for Trinity House or licensed private owners.
5. (a) $Q = 30$. (b) $80 - Q = 30 + Q$, $Q = 25$. (c) $\frac{1}{2} \times 5 \times 10 = 25$.
6. Parliament funded Bazalgette's intercepting sewers (1859–1870s), carrying waste downstream. The harm and the solution spanned the whole city, so a public authority with taxing power was needed.
7. Equality (in proportion to ability), certainty, convenience, economy.
8. Without tax: $P = 24$, Q = 48. (a) $120 - 3P_b = 2(P_b - 5)$, $P_b = 26$, $P_s = 21$, $Q = 42$. (b) $210. (c) $\frac{1}{2} \times 5 \times 6 = \$15$.
9. People bricked up windows and built with fewer; this lost light and air without raising revenue, violating the maxim of economy (and in tenements, equality).
10. When sellers know more than buyers about quality, buyers distrust all sellers. The Pure Food and Drug Act required truthful labels; the Securities Act required honest disclosure for new securities.
11. Recovery: $250{,}000 + 0.6 \times 50{,}000 = \$280{,}000$; loss $20,000.
12. Deposit insurance removed depositors' reason to run, so sound banks no longer failed from panic; supervision also improved.
13. Example: a rule gives $50 million to 500 firms ($100,000 each) and costs 100 million people $50 million ($0.50 each). Firms lobby hard; consumers do not notice, so the rule may pass.
14. Planners lacked the information prices provide and set targets in tons or counts that rewarded the wrong things; without prices and profits, producers did not respond to customers.
15. A strong answer shows that markets can fail (pollution, public goods) and governments can fail (ICC rate rules that weakened railroads until 1980), and that good policy weighs the actual results of each.

PORTFOLIO PIECE: A FAIR REFEREE: RULES THAT WORKED AND RULES THAT DIDN'T

Write a five- to seven-page essay comparing four rules from Units 7 and 8: two that worked like a fair referee and two that backfired. For each, explain the problem it addressed, how it worked, what it cost, and what it meant for the six stakeholders, with at least one calculation per rule. Conclude with your own principles for judging a rule, supported by Scripture and by economic reasoning, written without partisan language.

LOOK FOR	WHAT IT MEANS
History	The four rules are described accurately and in context.
Economics	Each rule is analyzed with correct calculations and concepts (incidence, externalities, shortages, public choice).
Judgment	The essay weighs all six stakeholders and reaches balanced conclusions.
Writing	Clear, well organized and free of partisan language.

UNIT 9

The Whole Economy

So far you have studied markets one at a time. In this unit you step back to see the whole economy: how it is measured, why it rises and falls, and why some nations grow rich. You will learn how Simon Kuznets built the first national income accounts in the depths of the Depression, how the government learned to count the unemployed, and how economists measure the business cycle, a pattern Joseph understood when he stored grain for seven lean years.

Then you will study the Great Depression itself, the worst economic collapse in modern history, and weigh the leading explanations of its causes and recovery. The unit closes with the great question of economic history: why are some nations rich and others poor? West Germany's currency reform of 1948 shows how much depends on sound money, free prices and good institutions.

PREREQUISITES

- Units 4–8
- Percents, exponents and logarithms (helpful for growth calculations)
- Reading line graphs of data over time

MASTERY CHECKLIST

- ☐ I can compute GDP, real GDP, the deflator and real growth, and explain what GDP leaves out.
- ☐ I can compute the unemployment and participation rates and classify kinds of unemployment.
- ☐ I can describe the business cycle and measure the depth and length of a contraction.
- ☐ I can describe the Great Depression and weigh the main explanations of its causes.
- ☐ I can use the rule of 70 and compound growth and explain why institutions matter for growth.

OPTIONAL BOOKS AND GAMES FOR THIS UNIT

- **FRED, the St. Louis Fed's free economic data site**: Free. Graph real GDP, unemployment and recessions for the projects in Lessons 9.1–9.3. A parent can help; no account is needed.
- **Bureau of Labor Statistics: "How the Government Measures Unemployment"**: Free; search the title at bls.gov. The official explanation of the household survey and its definitions. Use with Lesson 9.2.
- **Federal Reserve History: "The Great Depression"**: Free. A clear essay on the monetary side of the Depression. Use with Lesson 9.4.

Not required. Every project in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

9.1	**Measuring the Whole Economy: Simon Kuznets and GDP**	3 sessions of 50 minutes
9.2	**Unemployment: Counting the Jobless**	3 sessions of 50 minutes
9.3	**The Business Cycle: Seven Fat Years and Seven Lean**	3 sessions of 50 minutes
9.4	**The Great Depression**	3 sessions of 50 minutes
9.5	**Why Some Nations Grow Rich**	3 sessions of 50 minutes

Unit 9 test

Calculators are allowed. Show your work for every calculation: write the formula, substitute and solve. Answer the concept questions in complete sentences. The test is worth 100 points.

1. **6 pts**
   Define GDP and explain why only final goods are counted.

2. **6 pts**
   C = 15, I = 4, G = 5, X = 3, M = 4 (trillions). Find GDP.

3. **8 pts**

   An economy produces apples and pens. Base year: 1,000 apples at $1, 200 pens at $2. Current year: 1,100 apples at $1.50, 250 pens at $2.20. Find nominal GDP, real GDP (base-year prices), the deflator and real growth.

4. **6 pts**

   What did Kuznets warn about national income?

5. **8 pts**

   Adult population 250 million; employed 155 million; unemployed 7 million. Find the labor force, unemployment rate and participation rate.

6. **6 pts**

   Classify and explain: (a) a teacher who moved and is looking for a new school; (b) a typesetter replaced by computers; (c) a builder laid off in a recession.

7. **6 pts**

   How did the United States learn to measure unemployment after the Depression?

8. **6 pts**

   Name the four phases of the business cycle and say who dates U.S. recessions.

9. **6 pts**

   Real GDP: peak 22.0, trough 20.9. Find the depth of the contraction. Annualize quarterly growth of 0.8%.

10. **8 pts**

    Describe the chain of events from the crash of 1929 to the depth of the Depression in 1933, naming at least four links.

11. **6 pts**

    Prices fell 25% from 1929 to 1933. A farmer owed $8,000. Find the real burden in 1929 dollars.

12. **6 pts**

    Explain why countries that left the gold standard earlier generally recovered earlier.

13. **6 pts**

    Use the rule of 70 to find doubling times at 1.4% and 3.5%.

14. **6 pts**

    Describe West Germany’s reforms of June 1948 and their effects.

15. **10 pts**

    Short essay: Why are some nations rich and others poor? Use at least three ideas from this course.

ANSWER KEY

1. The market value of all final goods and services produced in a country in a year. Intermediate goods are included in final goods' prices; counting them separately would double count.
2. $\$23$ trillion.
3. Nominal: $1{,}650 + 550 = \$2{,}200$; real: $1{,}100 + 500 = \$1{,}600$; deflator 137.5; real growth from \$1,400: 14.3%.
4. That the welfare of a nation can scarcely be inferred from national income; it leaves out much that matters.
5. Labor force 162 million; unemployment 4.3%; participation 64.8%.
6. (a) frictional; (b) structural; (c) cyclical.
7. From 1940 it used a monthly sample survey of households (now the Current Population Survey), counting as unemployed those without work who had actively looked.
8. Expansion, peak, contraction, trough; the NBER's business-cycle dating committee.
9. -5.0%; $1.008^4 - 1 \approx 3.2\%$.
10. Crash and lost confidence; waves of bank failures; collapse of the money supply by a third; deflation of about a quarter, raising debt burdens and defaults; falling spending and investment; the gold standard spreading deflation; trade barriers and retaliation; unemployment near 25%.
11. $8{,}000 / 0.75 \approx \$10{,}667$.
12. Leaving gold freed them to expand money and stop deflation, while countries on gold had to keep money tight to defend their parities.
13. About 50 and 20 years.
14. The Deutsche Mark replaced the nearly worthless Reichsmark with limits on its issue, and most price controls were lifted. Hoarded goods appeared in shops, work resumed, and industrial production rose by about half within six months.
15. A strong answer discusses institutions (property, contracts, rule of law), sound money and free prices, human and physical capital, technology and openness to trade, with historical examples and growth calculations.

PORTFOLIO PIECE: AN ECONOMIC REPORT ON A DECADE

Choose one decade of American economic history (for example the 1920s, 1930s, 1950s, 1970s or 1990s). Using FRED and historical sources, write a six- to eight-page report with graphs of real GDP, unemployment and inflation; identify any recessions and their causes; describe one business and one family's experience of the decade (from history or an interview); and conclude with lessons for a household and a business. Write as an economist and historian, without partisan language.

LOOK FOR	WHAT IT MEANS
Data	Graphs are accurate, labeled and sourced; calculations of growth, inflation and unemployment are correct.
Analysis	The report explains causes and effects using the tools of Units 4–9.
Human story	The business and family stories are well chosen and connected to the data.
Writing	Clear, organized, balanced and free of partisan language.

9.1 Measuring the Whole Economy: Simon Kuznets and GDP

OBJECTIVES

- Define gross domestic product and compute it by the expenditure approach (C + I + G + NX).
- Distinguish nominal from real GDP and compute real GDP and growth with a price index or deflator.
- Explain what GDP measures well and what it leaves out, as its inventor warned.

> **Warm-up.** How would you measure how much your town produced last year? List three things you would count and two things you would find hard to count.

WATCH

Gross Domestic Product – Economic Lowdown

Federal Reserve Bank of St. Louis · 7:52

https://www.youtube.com/watch?v=1Il5IQHcYP8

> **WHEN TO WATCH**
> After the story, before the big idea.

BACKUP VIDEO

Real vs Nominal GDP

Federal Reserve Bank of St. Louis · 3:41

https://www.youtube.com/watch?v=TW_zfbbOu9k

Before the worked examples on real GDP.

KEY TERMS

gross domestic product (GDP)
The market value of all final goods and services produced within a country in a year.

final good
A good bought by its end user, not used up in making something else; counting only final goods avoids double counting.

nominal GDP

GDP measured in the prices of the year it is produced.

real GDP

GDP measured in the prices of a base year, so that changes reflect quantities, not prices.

GDP deflator

A price index equal to nominal GDP divided by real GDP, times 100.

CORE IDEAS

The story. When the Depression struck in 1929, no one knew how much the American economy was actually producing. Policymakers had only scattered numbers: freight car loadings, stock prices, steel output. In 1932 the Senate asked the Commerce Department for estimates of national income, and the work was given to a young economist, Simon Kuznets, who had come to America from Russia. In January 1934 he delivered his report, *National Income, 1929–1932*. It showed that the nation's income had fallen by roughly half in three years. For the first time, Americans could see the size of the collapse in one number.

How they figured it out. Kuznets and his team gathered data from tax returns, censuses, industry reports and payrolls and added up what every sector produced, taking care not to count the same product twice: the steel in a car is counted once, in the car's price. During the Second World War, government planners extended the work to measure total spending, and the system of national accounts was born. Kuznets received the Nobel Prize in 1971. He also warned, in his first report, that the welfare of a nation can scarcely be inferred from a measure of national income: GDP counts market production, not happiness, leisure, family work at home or the quality of life.

The big idea. GDP is the market value of all final goods and services produced in a country in a year. It can be measured three ways that should agree: by adding up spending, by adding up incomes, or by adding up the value added at each stage of production. By spending: $GDP = C + I + G + NX$, where C is household consumption, I is business investment in equipment and buildings plus new housing and inventories, G is government purchases, and NX is exports minus imports. Because prices change, economists use **real GDP**, valued at base-year

prices, to compare output over time. GDP per person is a rough but useful guide to a nation's material standard of living.

In business today. Businesses watch GDP reports, released by the Bureau of Economic Analysis every quarter, to judge whether the economy is growing or shrinking and plan hiring, inventory and investment accordingly. Investors, banks and governments use the same numbers. But wise leaders remember Kuznets's warning: a family that cares for its own children, a church that feeds the poor and a farmer who grows his own vegetables add real value that GDP never sees.

Think it through. GDP measures what is bought and sold, not what is good. A rise in GDP can include repairing storm damage (remember Bastiat's broken window in Lesson 1.1), and a fall can include a parent choosing to leave a paid job to care for a newborn. The number is a tool, not a verdict.

PICTURE STUDY



Jones and Laughlin steel mills, Pittsburgh, Detroit Publishing Company, about 1900–1915 · Photograph · Library of Congress

Image: Wikimedia Commons, public domain

Pittsburgh's steel mills were among the largest workplaces in the world in the early 1900s. Steel went into rails, bridges, buildings and machines, so its output was one of the indicators people watched before GDP existed. In GDP, though, most of this steel would be counted only once, in the final goods it became.

Look closely

- Count the smokestacks you can see.
- Find the railroad tracks and the river. How did raw materials arrive and steel leave?
- Look at the size of the buildings. How many workers might a mill like this need?
- Look for anything that shows the mill was running when the picture was taken.

Talk about it

1. Is the steel made here a final good or an intermediate good in most cases? Why does that matter for GDP?
2. Before GDP, why might people have used steel output to judge the economy?

3. What would GDP miss about life in this city?

Safety first. Use household receipts only with a parent's permission, and leave out card numbers and personal details.

PROJECT

Your Household's "GDP" and the Nation's

You will track your household's spending for two weeks in the four GDP categories, then compare it with the latest U.S. GDP release and compute real growth from official data.

You will need

- Receipts for two weeks (with a parent's permission)
- The Bureau of Economic Analysis GDP release or FRED (with a parent)
- A spreadsheet

Steps

1. Sort two weeks of household spending into consumption (goods, services), investment (if any, such as a new home improvement), and any taxes or fees that pay for government services (for discussion only).
2. Compute each group's share of the total and annualize it (multiply by 26).
3. Find the latest U.S. nominal GDP and its components from the BEA or FRED. Compute each component's share.
4. Compare your household's shares with the nation's. Explain the differences.
5. Find real GDP for the last two years and compute real growth.
6. Find nominal GDP for the same years and compute the implicit deflator and inflation.
7. List three things your family produces that GDP does not count.

Tips

- Keep amounts approximate if your family prefers; percentages are what matter.
- The BEA reports GDP at annual rates; read the notes.

Check your work

- ☐ I can compute GDP by the expenditure approach.
- ☐ I can compute real GDP, the deflator and real growth.
- ☐ I can explain what GDP leaves out.

LEDGER NOTEBOOK

1. Copy your household table and the national GDP shares.
2. Draw the circular flow: households, firms, government and the rest of the world, with spending and income arrows.
3. Copy Kuznets's warning in your own words.

KEY FORMULAS

$$GDP = C + I + G + NX, \qquad NX = X - M$$

$$\text{Real GDP}_t = \sum P_{\text{base}} \times Q_t$$

$$\text{GDP deflator} = \frac{\text{Nominal GDP}}{\text{Real GDP}} \times 100$$

From history. Kuznets later studied how incomes and growth change as nations develop, and he was cautious about every number he produced. He argued that national accounts should be read alongside other measures of how people actually live.

WORKED EXAMPLES

Example 1. An economy has consumption of \$14 trillion, investment \$4 trillion, government purchases \$4.5 trillion, exports \$3 trillion and imports \$3.8 trillion. Find GDP and the share of consumption.

Show solution

1. Net exports: $3 - 3.8 = -0.8$ trillion.
2. GDP: $14 + 4 + 4.5 - 0.8 = \$21.7$ trillion.
3. Consumption share: $14 / 21.7 \approx 64.5\%$.

Answer: GDP is \$21.7 trillion; consumption is about 64.5% of it.

Example 2. A tiny economy makes only bread and shoes. In 2020: 100 loaves at \$3, 20 pairs of shoes at \$50. In 2024: 110 loaves at \$4, 22 pairs at \$60. With 2020 as the base year, find nominal and real GDP for 2024, the deflator and real growth.

Show solution

1. Nominal 2020 = real 2020: $300 + 1{,}000 = \$1{,}300$.
2. Nominal 2024: $440 + 1{,}320 = \$1{,}760$.
3. Real 2024 (2020 prices): $110(3) + 22(50) = 330 + 1{,}100 = \$1{,}430$.
4. Deflator 2024: $1{,}760/1{,}430 \times 100 \approx 123.1$.
5. Real growth: $1{,}430/1{,}300 - 1 = 10\%$.

Answer: Nominal GDP rose 35%, but real GDP rose only 10%; the rest was higher prices (deflator 123.1).

Example 3. A logger sells timber for \$500 to a mill, which sells lumber for \$1,200 to a furniture maker, who sells a table for \$2,000 to a family. What does the table add to GDP? Show the value-added method.

Show solution

1. Value added: logger \$500; mill $1{,}200 - 500 = \$700$; maker $2{,}000 - 1{,}200 = \$800$.
2. Sum: $500 + 700 + 800 = \$2{,}000$, equal to the final sale.

Answer: \$2,000. Adding all three sales (\$3,700) would double count.

PRACTICE

1. Easy Define GDP.

   Show answer

   The market value of all final goods and services produced within a country in a year.

2. Easy Who prepared the first official U.S. national income estimates, and when?

   Show answer

   Simon Kuznets, in a report delivered in January 1934.

3. Easy Why are intermediate goods not counted separately in GDP?

Show answer

Their value is already included in the final goods; counting them would double count.

4. Medium C = 12, I = 3, G = 4, X = 2, M = 2.5 (trillions). Find GDP.

Show answer

$18.5 trillion.

5. Medium Nominal GDP is $25 trillion and the deflator is 125. Find real GDP.

Show answer

$25/1.25 = \$20$ trillion.

6. Medium Real GDP grows from 20 to 20.6 trillion. Find the growth rate.

Show answer

3%.

7. Medium Which of these count in this year's GDP? (a) a new car; (b) a used car; (c) shares of stock; (d) a haircut.

Show answer

(a) yes; (b) no (only any dealer's services); (c) no (a financial transfer); (d) yes.

8. Hard Explain why nominal GDP can rise while real GDP falls.

Show answer

If prices rise faster than quantities fall, the value at current prices rises even though less is produced.

9. Hard Give two reasons GDP per person is an imperfect measure of well-being.

Show answer

It leaves out household and volunteer work and leisure, and it ignores how income is distributed, the quality of goods, health and the environment.

10. **Challenge** Using Worked Example 2, compute real GDP in 2024 using 2024 prices for both years, and the growth rate. Why does it differ from the 10% found with 2020 prices?

    Show answer

    2020 at 2024 prices: $100(4) + 20(60) = 1{,}600$; 2024: 1,760; growth 10%. Here both happen to give 10% because both goods grew 10%; in general the base year matters when quantities of different goods grow at different rates, which is why agencies use chained indexes.

COMMON MISTAKES

- Counting intermediate goods or used goods in GDP.
- Comparing nominal GDP across years without adjusting for prices.
- Treating GDP as a measure of happiness or of the good life.

> **Make it a game · C I G NX Sort.** Your parent calls out transactions from a pretend year: a family buys a car, a firm builds a factory, a city repairs a bridge, a bakery sells bread abroad, a baker buys flour. Sort each as consumption, investment, government, net exports or an intermediate good that does not count. Then compute real GDP from nominal GDP using a deflator.

9.2 Unemployment: Counting the Jobless

OBJECTIVES

- Compute the unemployment rate and the labor-force participation rate from survey data.
- Distinguish frictional, structural and cyclical unemployment and explain the natural rate.
- Tell how the United States learned to measure unemployment after the Depression.

> **Warm-up.** Your neighbor is a full-time college student, your uncle is retired, your cousin lost his job and is applying everywhere, and your aunt stopped looking because she found nothing for a year. Which of them would you count as unemployed? Why?

WATCH

Natural, cyclical, structural, and frictional unemployment rates | AP Macroeconomics | Khan Academy

Khan Academy · 5:38

https://www.youtube.com/watch?v=W9MuBVpEc78

> **WHEN TO WATCH**
> After the big idea, before the worked examples.

BACKUP VIDEO

Understanding BLS Unemployment Statistics

BLS Videos · 1:24

https://www.youtube.com/watch?v=BPCbBP7wJ6c

Before the worked examples, to see how the Bureau of Labor Statistics counts.

KEY TERMS

labor force

People 16 and older who are either employed or unemployed (without a job and actively looking for one).

unemployment rate

The number unemployed divided by the labor force, as a percent.

labor-force participation rate

The labor force divided by the adult (16+) civilian population, as a percent.

discouraged worker

Someone who wants a job but has stopped looking because he believes none is available; not counted as unemployed.

natural rate of unemployment

The unemployment that remains when the economy is at its normal level: frictional plus structural.

CORE IDEAS

The story. In the early 1930s no one knew how many Americans were out of work. The 1930 census asked about unemployment, but the counts were taken before the worst of the slump and were disputed. Estimates in 1932 and 1933 ranged from about 10 million to more than 15 million. Leaders were trying to fight the Depression without knowing its size. Historians' later estimates put the unemployment rate near 25% in 1933, one worker in four. Families stood in line for relief and charity, as in Dorothea Lange's photograph of workers waiting for relief checks in California in 1935.

How they figured it out. Instead of trying to count everyone, statisticians turned to sampling. In 1940 the federal government began a monthly survey of a scientifically chosen sample of households, asking each person over a set age whether he had worked, whether he had looked for work, and why. The survey became the Current Population Survey, still run each month by the Census Bureau for the Bureau of Labor Statistics. Today it questions about 60,000 households. The key idea was to count as **unemployed** only those without work who had actively looked for it, and to define the **labor force** as the employed plus the unemployed.

The big idea. The **unemployment rate** is the unemployed divided by the labor force. Not everyone without a job is unemployed: students, retirees and those caring for family full time are outside the labor force, and so are **discouraged workers**, which is why economists also watch the **participation rate**. Unemployment has three kinds. *Frictional* unemployment is the normal time people spend between jobs or searching for a first one. *Structural* unemployment comes from a mismatch between workers' skills or locations and the jobs available. *Cyclical* unemployment rises in

recessions when spending falls. Frictional plus structural is the **natural rate**; cyclical is the part that business cycles add.

In business today. Businesses watch the monthly jobs report to judge the strength of the economy and of the labor market they hire from. Low unemployment means competition for workers and rising wages; high unemployment means more applicants. Firms reduce frictional unemployment by advertising openings clearly, and they reduce structural unemployment by training. For the unemployed worker, the Bible's picture of the laborers waiting in the marketplace (Matthew 20:6–7), "because no man hath hired us," captures the hardship and the hope of work.

Who gained? Accurate counting served everyone: policymakers could see problems early, businesses could plan, and unemployed workers' needs became visible. The cost was the expense of a monthly survey and the burden on households asked to answer it.

PICTURE STUDY



Waiting for the semimonthly relief checks at Calipatria, Imperial Valley, California, Dorothea Lange, March 1935 · Photograph · Library of Congress and National Archives

Image: Wikimedia Commons, public domain

Dorothea Lange photographed farm workers and families during the Depression for a federal agency, so her pictures are part of the public record. Here, two men in a farming town wait for relief payments. Each is a number in the unemployment statistics of the 1930s, and each had a family and a story.

Look closely

- Look at the men's clothing: the caps, the overalls, the jacket. What kinds of work might they have done?
- Look at their faces and how they stand. What does waiting feel like?
- Look at the building and the setting. Where are they?
- Look for any signs, notices or officials.

Talk about it

1. Would these men be counted as unemployed, discouraged or employed today? What would you need to know?
2. Why was it hard in 1935 to know how many people were in this situation across the country?

3. What kind of unemployment (frictional, structural or cyclical) does this picture show? Explain.

Safety first. A parent helps choose respondents. Record no names or personal details.

PROJECT

A Labor-Force Survey

You will design and conduct a small labor-force survey of at least 20 adults you know (with a parent's help), classify each response the way the Bureau of Labor Statistics does, and compare your results with the national figures.

You will need

- A short written survey form
- A parent to help choose respondents and to protect privacy
- The latest BLS Employment Situation summary (bls.gov)
- A spreadsheet

Steps

1. Write four questions: Did you work for pay last week? If not, did you look for work in the last four weeks? If not, why not (school, retired, caring for family, believe no job is available, other)? Are you 16 or older?
2. With a parent, ask at least 20 adults. Record answers anonymously (no names).
3. Classify each person: employed, unemployed, or not in the labor force (and discouraged, if so).
4. Compute your sample's unemployment and participation rates.
5. Compare with the latest national figures from the BLS.
6. Explain why your sample might differ (size, ages, location).
7. Write a paragraph on how the 1940 sampling method made national figures possible.

Tips

- Keep answers anonymous: number the forms instead of writing names.
- A sample of 20 is too small to be precise; discuss that honestly.

Check your work

☐ I can compute the unemployment and participation rates.

☐ I can classify kinds of unemployment.

- [ ] I can explain how unemployment came to be measured.

LEDGER NOTEBOOK

1. Copy your anonymous survey tally and calculations.
2. Draw a diagram of the adult population divided into employed, unemployed and not in the labor force.
3. Write one example each of frictional, structural and cyclical unemployment.

KEY FORMULAS

$$\text{Labor force} = E + U$$

$$\text{Unemployment rate} = \frac{U}{E + U} \times 100\%$$

$$\text{Participation rate} = \frac{E + U}{\text{adult civilian population}} \times 100\%$$

From history. The monthly survey begun in 1940 was first run by the Work Projects Administration and later moved to the Census Bureau. The questions have been revised several times, but the basic definitions of employed, unemployed and labor force have stayed much the same for over eighty years.

WORKED EXAMPLES

Example 1. A town has 10,000 adults: 6,200 employed, 300 unemployed and looking, 1,500 retired, 1,200 students, 500 caring for family, and 300 discouraged workers. Find the labor force, the unemployment rate and the participation rate.

Show solution

1. Labor force: $6{,}200 + 300 = 6{,}500$.
2. Unemployment rate: $300 / 6{,}500 \approx 4.6\%$.
3. Participation rate: $6{,}500 / 10{,}000 = 65\%$.

Answer: Labor force 6,500; unemployment 4.6%; participation 65%.

Example 2. If the 300 discouraged workers in Example 1 were counted as unemployed, what would the rate be?

Show solution

1. Labor force: 6,800; unemployed: 600.
2. Rate: $600/6{,}800 \approx 8.8\%$.

Answer: About 8.8%, nearly double. This is why economists look at broader measures as well as the headline rate.

Example 3. In 1933 an estimated 12.8 million were unemployed out of a labor force of about 51 million. Find the rate. If the labor force had been the same and unemployment fell to 7.7 million by 1937, what would the rate have been?

Show solution

1. 1933: $12.8/51 \approx 25.1\%$.
2. 1937: $7.7/51 \approx 15.1\%$.

Answer: About 25% in 1933 and about 15% in 1937 (using these estimates): a large improvement, yet still very high.

PRACTICE

1. Easy Who is counted as unemployed?

   Show answer

   People 16 or older without work who have actively looked for work in the past four weeks (or are waiting to return to a job).

2. Easy What survey measures U.S. unemployment today?

   Show answer

   The Current Population Survey, a monthly sample of about 60,000 households.

3. Easy What was the approximate U.S. unemployment rate in 1933?

   Show answer

   About 25%.

4. **Medium** Employed 150 million, unemployed 6 million. Find the unemployment rate.

Show answer

$6/156 \approx 3.8\%$.

5. **Medium** In problem 4, the adult civilian population is 260 million. Find the participation rate.

Show answer

$156/260 = 60\%$.

6. **Medium** Classify: (a) a graduate searching for a first job; (b) a coal miner whose mine closed and whose skills do not match local jobs; (c) a factory worker laid off in a recession.

Show answer

(a) frictional; (b) structural; (c) cyclical.

7. **Medium** Why can the unemployment rate fall even when no one finds a job?

Show answer

If unemployed people become discouraged and stop looking, they leave the labor force and are no longer counted.

8. **Hard** Why does the economy always have some unemployment, even in good times?

Show answer

People change jobs, enter the labor force and search, and skills or places do not always match openings: frictional and structural unemployment.

9. **Hard** Explain why sampling 60,000 households can give a reliable national estimate.

Show answer

A random, well-designed sample represents the population; larger samples reduce random error, and statistical methods measure the remaining uncertainty.

10. **Challenge** A labor force of 160 million has 8 million unemployed; the natural rate is 4%. Find cyclical unemployment in people and as a rate.

    Show answer

    Actual rate 5%; cyclical $5\% - 4\% = 1\%$, that is $0.01 \times 160 = 1.6$ million people.

COMMON MISTAKES

- Dividing by the whole population instead of the labor force.
- Counting students, retirees or discouraged workers as unemployed.
- Thinking the natural rate means zero unemployment.

> **Make it a game · Labor Force Survey Sort.** Your parent reads ten short profiles, such as someone laid off and searching, a full-time student, a worker who has stopped looking, or someone employed part time. Classify each as employed, unemployed or not in the labor force. Compute the unemployment rate and participation rate. Then name each type of unemployment: frictional, structural or cyclical.

9.3 The Business Cycle: Seven Fat Years and Seven Lean

OBJECTIVES

- Describe the phases of the business cycle and how recessions are identified.
- Compute changes in real GDP and the depth and length of expansions and contractions from data.
- Explain common causes of recessions and the wisdom of preparing in good years.

> **Warm-up.** Think of something in your life that goes up and down in a pattern (seasons, sales at a store, sports seasons). What causes the ups and downs? Can you predict them?

WATCH

What causes an economic recession? - Richard Coffin

TED-Ed · 5:04

https://www.youtube.com/watch?v=SwaCg7Gwtzw

> **WHEN TO WATCH**
> After the big idea, before the worked examples.

BACKUP VIDEO

Macro: Unit 1.1 -- The Business Cycle

You Will Love Economics · 6:45

https://www.youtube.com/watch?v=Y5jr_zv2Y9M

As a review of the phases of the cycle.

KEY TERMS

business cycle
The recurring rise and fall of economic activity around its long-run trend.

expansion
A period when real GDP, employment and incomes are rising.

peak
The high point of activity before a contraction begins.

recession
A significant decline in economic activity spread across the economy, lasting more than a few months.

trough

The low point of activity before an expansion begins.

CORE IDEAS

The story. The oldest record of a planned response to an economic cycle is in Genesis. Joseph interpreted Pharaoh's dream of seven fat cows and seven lean, seven good ears of grain and seven thin, as seven years of plenty followed by seven of famine. He advised storing a fifth of the harvest in the good years, and Egypt survived the lean years and fed its neighbors. In modern times, economists noticed that industrial economies also rose and fell. In the 1800s the French physician and economist Clément Juglar studied repeated commercial crises, and in 1946 Arthur Burns and Wesley Mitchell of the National Bureau of Economic Research (NBER) published *Measuring Business Cycles*, the result of decades of work tracing hundreds of economic series through expansions and contractions.

How they figured it out. Burns and Mitchell found that many measures, such as production, employment, sales, incomes and prices, tend to move together, with some leading and some lagging. They dated the turning points, peaks and troughs, by looking at all of them at once rather than at any single number. The NBER still dates U.S. recessions this way through a committee of economists, which declares turning points months after the fact, when the data are clear. Since 1854 the NBER has identified more than thirty U.S. business cycles. Since 1945, expansions have usually lasted several years and recessions about ten or eleven months on average.

The big idea. The **business cycle** has four phases: **expansion**, **peak**, contraction (a **recession** when it is significant and widespread), and **trough**. Underneath, the long-run trend of real GDP rises with productivity. Recessions can be triggered by shocks to spending (a fall in investment or confidence), to supply (an oil shock or a harvest failure), to the financial system (a banking panic), or by tight money. Cycles are irregular: no one can predict their timing precisely. Joseph's wisdom still applies: save in good years, avoid debts that cannot be carried in bad ones, and plan for a downturn without knowing exactly when it will come.

In business today. Firms plan for the cycle by keeping cash reserves, avoiding excessive debt, watching leading indicators such as new orders and building permits, and keeping flexible costs. A family does the same with an emergency fund.

Governments and central banks try to soften recessions, with results that economists continue to study.

Who gained? In Joseph's Egypt, careful saving in the good years protected the people, fed neighboring nations (including Joseph's own family) and strengthened the state. In modern cycles, those who prepare, whether households, firms or governments, weather downturns best; those who borrowed heavily at the peak suffer most.

PICTURE STUDY



Joseph Interpreting Pharaoh's Dream, Peter von Cornelius, 1816–1817 · Fresco (transferred), from the Casa Bartholdy in Rome · Alte Nationalgalerie, Berlin

Image: Wikimedia Commons, public domain

Cornelius and other German painters decorated a room in Rome with scenes from the life of Joseph. Here Joseph, brought from prison, explains Pharaoh's dreams: seven years of plenty and seven of famine. Pharaoh will then set him over the land to store grain in the good years.

Look closely

- Find Joseph. How does the painter show that he is speaking with authority?
- Look at Pharaoh. What is his reaction?
- Look for any signs of the dreams themselves: cows, ears of grain.
- Look at the courtiers and wise men. How do they respond?

Talk about it

1. What advice did Joseph give, and why was it wise economics?
2. How is a modern business's cash reserve like Joseph's granaries?
3. Why is it hard for people to save in good years?

PROJECT

Charting America's Business Cycles

You will graph real GDP and the unemployment rate since 1948 using FRED, mark the official recessions, and measure several cycles.

You will need

- A computer with a parent's help (FRED from the St. Louis Fed)
- A spreadsheet
- Your ledger notebook

Steps

1. In FRED, graph real GDP (series GDPC1) and the unemployment rate (UNRATE) since 1948. FRED shades official recessions in gray.
2. Choose three recessions. For each, record the peak and trough dates from the shading.
3. Download real GDP at each peak and trough and compute the depth of each contraction.
4. Record the unemployment rate at each peak and its highest level during or just after the recession.
5. Compute the average length of the expansions between your chosen recessions.
6. Look for a pattern: does unemployment rise before, during or after GDP falls?
7. Write a one-page report comparing your three cycles and drawing one lesson for a family or a business.

Tips

- Record the dates and values carefully; small errors change the percentages.
- Leave out opinions about who was in office; this is a report on the economy, not on officeholders.

Check your work

☐ I can describe and identify the phases of the business cycle.

- ☐ I can compute the depth and length of a contraction.
- ☐ I can explain why preparing in good years matters.

LEDGER NOTEBOOK

1. Sketch your FRED graph with recessions labeled.
2. Copy your table of peaks, troughs, depths and lengths.
3. Draw the business cycle diagram with the trend line and label the four phases.

KEY FORMULAS

$$\text{Percent change in real GDP} = \frac{Y_t - Y_{t-1}}{Y_{t-1}} \times 100\%$$

$$\text{Depth of contraction} = \frac{Y_{\text{trough}} - Y_{\text{peak}}}{Y_{\text{peak}}} \times 100\%$$

$$\text{Annualized quarterly growth} = (1 + g_q)^4 - 1$$

From history. Arthur Burns later served as chairman of the Federal Reserve (1970–1978), during the rising inflation you studied in Lesson 6.4. Wesley Mitchell had founded the NBER's business-cycle research in 1920.

WORKED EXAMPLES

Example 1. Quarterly real GDP (trillions): Q1 20.0, Q2 20.2, Q3 20.3, Q4 20.1, Q5 19.8, Q6 19.7, Q7 19.9, Q8 20.3. Identify the peak and trough, and the depth and length of the contraction.

Show solution

1. Peak: Q3 (20.3). Trough: Q6 (19.7).
2. Depth: $(19.7 - 20.3)/20.3 \approx -3.0\%$.
3. Length: Q3 to Q6, three quarters (nine months).

Answer: A contraction of about 3% lasting three quarters.

Example 2. Real GDP grew 0.6% in one quarter. Find the annualized rate.

Show solution

1. $(1.006)^4 - 1 \approx 0.0242$, about 2.4%.

Answer: About 2.4% a year. U.S. quarterly growth is usually reported at an annualized rate.

Example 3. Joseph stored one-fifth of the harvest for seven good years. If each good harvest was 100 units and each lean harvest 40 units, and the people needed 80 units a year, was the store enough for seven lean years?

Show solution

1. Stored: $7 \times 20 = 140$ units (people used 80 of each good year's 100).
2. Shortfall each lean year: $80 - 40 = 40$ units; over seven years 280 units.
3. 140 units cover only half the shortfall.

Answer: Not by itself under these numbers: the store would cover about three and a half lean years. In Genesis, Joseph gathered "corn as the sand of the sea" (Genesis 41:49), far more than a fifth suggests, and sold it in the famine. The lesson: plan with honest numbers.

PRACTICE

1. Easy Name the four phases of the business cycle.

   Show answer

   Expansion, peak, contraction (recession), trough.

2. Easy Who published *Measuring Business Cycles* in 1946?

   Show answer

   Arthur Burns and Wesley Mitchell of the NBER.

3. Easy What fraction of the harvest did Joseph store?

   Show answer

   A fifth.

4. **Medium** Real GDP falls from 18.0 to 17.4. Find the percent change.

Show answer

-3.3%.

5. **Medium** Quarterly growth of −0.5%: find the annualized rate.

Show answer

$(0.995)^4 - 1 \approx -2.0\%$.

6. **Medium** Why does the NBER wait months to declare a recession?

Show answer

It needs revised data across many indicators to be sure a significant, widespread decline occurred and to date its turning points.

7. **Medium** Name three possible causes of recessions.

Show answer

A fall in investment or confidence, a supply shock such as an oil price spike, a financial panic, or tight monetary policy (any three).

8. **Hard** Why can no one reliably predict the timing of recessions?

Show answer

They are triggered by shocks and shifts in confidence that are not regular, and many forces interact.

9. **Hard** Explain why heavy borrowing at a peak makes a recession worse for a business.

Show answer

Revenues fall in the recession while debt payments stay fixed, so the business may be unable to pay and may have to cut workers or fail.

10. **Challenge** A firm's revenue falls 15% in a recession. Its costs are 60% fixed and 40% variable (which fall in proportion to revenue). Before the recession it had revenue 100 and costs 90. Find its profit before and during the recession.

Show answer

Before: 10. During: revenue 85; costs $54 + 36 \times 0.85 = 84.6$; profit 0.4. A 15% revenue fall wipes out 96% of profit: operating leverage.

COMMON MISTAKES

- Thinking cycles are regular like seasons. Their length and depth vary widely.
- Confusing a slowdown in growth with a recession. A recession is an actual, widespread decline.
- Forgetting that the long-run trend rises even though cycles go up and down.

Make it a game · Draw the Cycle. In sixty seconds, sketch the business cycle and label the peak, recession, trough and expansion. Your parent then reads a series of ten quarterly real GDP changes. Plot them, mark the turning points, and compute the depth of the contraction and the length of the expansion. Link the pattern to Joseph's seven fat years and seven lean.

Scripture. “And let them gather all the food of those good years that come, and lay up corn under the hand of Pharaoh, and let them keep food in the cities. And that food shall be for store to the land against the seven years of famine, which shall be in the land of Egypt; that the land perish not through the famine.” (Genesis 41:35-36, KJV)

Joseph’s plan is the first recorded policy for a business cycle: save in plenty for the lean years that will surely come.

9.4 The Great Depression

OBJECTIVES

- Describe the main events of the Great Depression from the crash of 1929 to the recovery after 1933.
- Explain the leading economic explanations: the collapse of the money supply and banks, the gold standard, falling spending and trade barriers.
- Compute the size of the collapse in output, prices, money and trade.

> **Warm-up.** Ask an older relative if anyone in your family told stories about the 1930s. Write down one story or habit (saving string, never wasting food) that may come from that time.

WATCH

The Great Depression - 5 Minute History Lesson

The Plain Bagel · 5:41

https://www.youtube.com/watch?v=62DxELjuRec

> **WHEN TO WATCH**
> After the story, before the big idea.

BACKUP VIDEO

The Great Depression in 12 Minutes (Casual Economics)

Casual Economics · 12:00

https://www.youtube.com/watch?v=qF3ekm9Gx_E

As a longer review after the worked examples.

KEY TERMS

stock market crash

A sudden, steep fall in stock prices; in October 1929 the New York market fell sharply on Black Thursday (October 24) and Black Tuesday (October 29).

bank run

A rush of depositors to withdraw money from a bank they fear will fail.

money supply

The total of currency and bank deposits that people can spend.

deflation

A sustained fall in the general price level.

import duty

A tax on imported goods; the Smoot-Hawley Act of 1930 raised American import duties to some of their highest levels.

CORE IDEAS

The story. In the 1920s American stock prices soared, much of the buying done with borrowed money. On October 24, 1929, Black Thursday, and October 29, Black Tuesday, prices plunged. The Dow Jones average, which had peaked at 381 in September 1929, kept falling for nearly three years and reached 41 in July 1932, a loss of about 89%. The crash was only the beginning. Waves of bank failures swept the country in 1930, 1931 and early 1933; about 9,000 banks failed in four years, taking depositors' savings with them. Between 1929 and 1933, real output fell by about a quarter, prices by about a quarter, and unemployment rose to about 25%. Farmers lost their land to foreclosure; families lost homes.

How they figured it out. Economists have argued about the causes for ninety years, and several explanations each hold part of the truth. In *A Monetary History of the United States* (1963), Milton Friedman and Anna Schwartz showed that the money supply fell by about a third from 1929 to 1933 as banks failed and people held cash, and they argued that the Federal Reserve failed to act as a lender of last resort. Other historians, notably Barry Eichengreen, showed how the gold standard spread the collapse across countries, which is why nations that left gold earliest, like Britain in 1931, generally recovered earliest. Keynes emphasized the collapse of spending, especially investment. The Smoot-Hawley Act of 1930 raised American import duties, other countries retaliated, and world trade shrank by about two-thirds in value between 1929 and 1934. Recovery began in 1933 after the banking holiday, the end of the dollar's gold link at the old price (Lesson 6.1) and the growth of money that followed; a sharp second slump came in 1937–38.

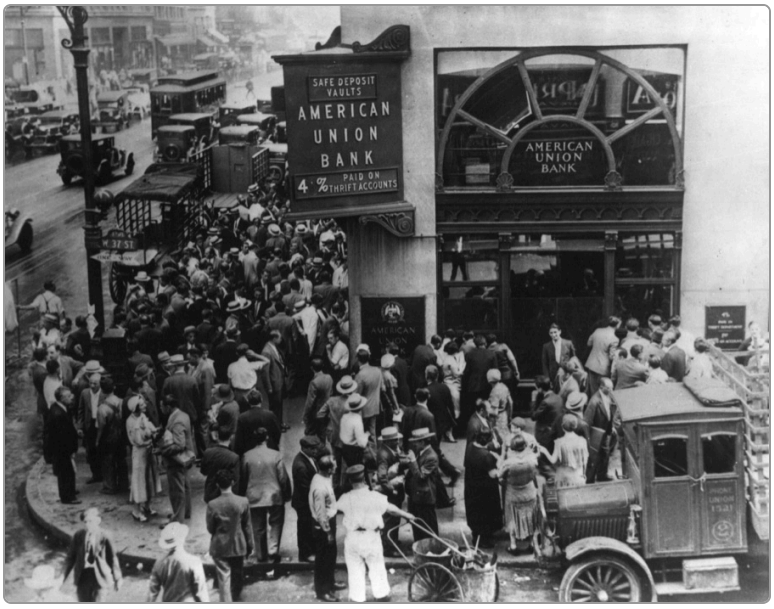
The big idea. The Depression was not one mistake but a chain: a stock crash that hurt confidence, banking panics that destroyed money and credit, a gold standard

that tied central banks' hands and spread deflation abroad, collapsing spending and investment, and trade barriers that shrank world markets. Deflation made debts heavier and drove more borrowers into default, which caused more bank failures. Many of the reforms you have studied came out of it: deposit insurance (Lesson 8.4), securities disclosure (Lesson 8.4) and central banks that act as lenders of last resort (Lesson 5.2).

In business today. Businesses, banks and central banks still study the Depression. Its lessons shape how crises are handled: keep the banking system working, prevent a collapse of money and credit, and avoid policies that shrink trade. For families and firms, it taught the value of savings, modest debt and diversified risks. Many who lived through it kept frugal habits all their lives.

Who gained? Almost no one gained in the slump. Savers who kept cash outside failing banks saw its purchasing power rise as prices fell, but many lost savings in bank failures. Debtors, farmers and workers suffered most. The community's churches, charities and neighbors carried a great load of relief. The lasting gain was in lessons learned and in reforms that made later downturns far milder.

PICTURE STUDY



Crowd at the American Union Bank, New York, Unknown photographer, 1931 · Photograph · National Archives

Image: Wikimedia Commons, public domain

In 1931 depositors crowded the street outside the American Union Bank in New York after rumors that it was failing. Scenes like this were repeated across the country. Without deposit insurance, the first in line might get their money; the last might get nothing, so everyone rushed.

Look closely

- Look at the crowd. How many people can you estimate?
- Look for anyone trying to keep order or direct the crowd.
- Look at the people's faces and clothes. What do they suggest about who they were?
- Look at the bank building. What signs or details can you see?

Talk about it

1. Why does a rumor alone cause a crowd like this?
2. How did bank runs shrink the money supply?
3. Which reform of 1933 was meant to end scenes like this, and how?

PROJECT

The Depression in Numbers and Voices

You will build a data chart of the Depression from official historical statistics and pair it with first-hand accounts, then write a short report connecting numbers and lives.

You will need

- FRED or Federal Reserve History (with a parent)
- A library book or online collection of Depression-era oral histories (for example, the Library of Congress)
- A spreadsheet

Steps

1. Collect yearly data for 1929–1939: real GDP (or an index), the unemployment rate, consumer prices and the number of bank failures. Record your sources.
2. Convert each to an index with 1929 = 100 and graph them together.
3. Mark 1929, 1931, March 1933, 1934 and 1937–38 on the graph.
4. Read two or three first-hand accounts of the Depression (a farmer, a worker, a shopkeeper).
5. Match each account to a point on your graph.
6. Identify which explanations from the lesson (money, banks, gold, spending, trade) each account illustrates.
7. Write a two-page report weaving the numbers and the voices together.

Tips

- Use historical tables for data before the modern series begin; note when sources disagree.
- Oral histories are primary sources: quote briefly and accurately, with the speaker and source.

Check your work

☐ I can describe the main events of the Depression.

☐ I can explain the main economic explanations.

- [ ] I can compute the size of the collapse and the burden of deflation.

LEDGER NOTEBOOK

1. Copy your index table and graph.
2. Draw a chain diagram: crash → bank failures → money supply falls → prices fall → debts heavier → more failures.
3. Write a short timeline of 1929–1938.

KEY FORMULAS

$$\text{Percent change} = \frac{\text{new} - \text{old}}{\text{old}} \times 100\%$$

$$MV = PY \;\Rightarrow\; \%\Delta M + \%\Delta V \approx \%\Delta P + \%\Delta Y$$

From history. Anna Schwartz worked at the National Bureau of Economic Research for about seventy years. She and Milton Friedman spent more than a decade assembling the money-supply data behind their book, much of it by hand from bank records.

WORKED EXAMPLES

Example 1. The Dow fell from 381 (September 1929) to 41 (July 1932). Find the percent fall and the percent rise needed to return to 381.

Show solution

1. Fall: $(41 - 381)/381 \approx -89\%$.
2. Rise needed: $381/41 - 1 \approx 829\%$.

Answer: An 89% fall; prices would have had to rise more than ninefold to recover (the Dow did not regain 381 until 1954).

Example 2. From 1929 to 1933, the money supply fell about 33% and prices fell about 25%. Using the quantity equation with velocity also falling about 10%, estimate the change in real output.

Show solution

1. $\%\Delta M + \%\Delta V \approx \%\Delta P + \%\Delta Y$.
2. $-33 - 10 \approx -25 + \%\Delta Y$, so $\%\Delta Y \approx -18\%$.

Answer: About an 18% fall by this rough estimate; the measured fall in real GDP was about 26%, close enough to show how a collapse of money and spending translates into lost output. (The approximation is rough for changes this large.)

Example 3. A farmer in 1929 owed \$5,000 and sold wheat at \$1.00 a bushel. By 1932 wheat sold for about 40 cents. How many bushels did his debt equal in each year?

Show solution

1. 1929: $5{,}000 / 1.00 = 5{,}000$ bushels.
2. 1932: $5{,}000 / 0.40 = 12{,}500$ bushels.

Answer: His debt grew from 5,000 to 12,500 bushels of wheat: deflation multiplied the real burden by 2.5.

PRACTICE

1. Easy What were Black Thursday and Black Tuesday?

   Show answer

   October 24 and October 29, 1929, the days of the sharpest falls in the stock market crash.

2. Easy About how many U.S. banks failed from 1930 to 1933?

   Show answer

   About 9,000.

3. Easy What did Friedman and Schwartz find about the money supply from 1929 to 1933?

   Show answer

   It fell by about a third.

4. Medium Real GDP fell from an index of 100 to 74. Find the percent fall and the rise needed to recover.

Show answer

26% fall; $100/74 - 1 \approx 35\%$ rise needed.

5. Medium Why did deflation make the Depression worse?

Show answer

Falling prices raised the real burden of debts, causing defaults and bank failures, and encouraged people to delay spending.

6. Medium How did the gold standard spread the Depression across countries?

Show answer

Countries on gold had to keep money tight to defend their gold parities, transmitting deflation; those leaving gold could expand money and recovered sooner.

7. Medium What was the Smoot-Hawley Act and what followed?

Show answer

A 1930 law raising U.S. import duties; other countries retaliated, and world trade shrank sharply.

8. Hard Explain how bank failures reduced the money supply, using the money multiplier from Lesson 5.1.

Show answer

When banks failed, deposits vanished, and surviving banks kept more reserves while people held more cash, lowering the multiplier, so the money supply fell even if reserves did not.

9. Hard A $10,000 mortgage at fixed payments: prices fall 25%. By how much does the real burden rise?

Show answer

$1/0.75 - 1 \approx 33\%$.

10. **Challenge** Britain left gold in September 1931; the United States changed its gold price in 1933–34. Suppose Britain's output began rising in 1932 and America's in 1933. Explain how this timing supports Eichengreen's argument, and name one other factor that could explain it.

Show answer

Countries that freed themselves from gold earlier could expand money and stop deflation sooner, so they recovered sooner. Other factors could include differences in banking crises (Britain had no wave of bank failures) or in other policies.

COMMON MISTAKES

- Thinking the stock market crash alone caused the Depression. Banking failures, falling money, the gold standard and trade collapse all mattered.
- Assuming falling prices helped everyone. Deflation hurt debtors and deepened the slump.
- Treating one explanation as the whole truth. Economists weigh several.

> **Make it a game · Depression Evidence Board.** Make three explanation cards: collapse of money supply and banks, the gold standard, and falling spending with trade barriers. Your parent reads event cards from 1929 to 1933 and you place each on the best explanation and argue the match. Then build a one-minute timeline of the crash, bank runs and the recovery after 1933.

9.5 Why Some Nations Grow Rich

OBJECTIVES

- Use the rule of 70 and compound growth to compare nations' incomes over time.
- Explain the main sources of growth: capital, human capital, technology and institutions.
- Analyze West Germany's currency reform of 1948 as a case of institutions and incentives.

> **Warm-up.** If your income grew 2% a year, how many years until it doubled? 4%? 7%? Guess first, then check with a calculator by multiplying year by year.

WATCH

Why Are Some Countries So Rich and Others So Poor?

Federal Reserve Bank of St. Louis · 3:26

https://www.youtube.com/watch?v=n5-jsV_GqFM

> **WHEN TO WATCH**
> After the story, before the big idea.

BACKUP VIDEO

What Is the Rule of 70?

Marginal Revolution University · 3:28

https://www.youtube.com/watch?v=YYSW8CaA-0w

Before the worked examples on the rule of 70.

KEY TERMS

economic growth
A sustained increase in real GDP per person.

rule of 70
A shortcut: the number of years for a quantity to double is about 70 divided by its percent growth rate.

institutions

The rules of the game in a society: property rights, courts, honest government, sound money and the customs that support them.

currency reform

Replacing a failed money with a new one, often with new rules.

human capital

The skills, knowledge, health and habits of a population (Lesson 1.5).

CORE IDEAS

The story. In 1947 western Germany lay in ruins. Factories stood idle, and shops were nearly empty. The old Reichsmark was nearly worthless after years of wartime money printing, but prices were still frozen by law, so goods were hoarded or traded on black markets, often for coffee, nylon stockings or other scarce goods. On June 20, 1948, the Western occupying powers replaced the Reichsmark with a new currency, the Deutsche Mark, at a steep discount, with strict limits on its issue. At the same time Ludwig Erhard, director of the economic administration, announced on his own authority that most price controls would end.

How they figured it out. Almost overnight, goods that had been hoarded appeared in shop windows, because sellers could now sell for money that would hold its value at prices that covered their costs. Germans called it the "shop-window effect." Workers returned to regular jobs instead of foraging for food. Industrial production in the western zones rose by about half in the six months after the reform. Over the next decade West Germany grew so fast that people spoke of an economic miracle. Similar stories, with their own details, could be told of other nations that grew rapidly after adopting sound money, secure property, open trade and education.

The big idea. Small differences in growth rates compound into huge differences in living standards. By the **rule of 70**, income growing one percent a year doubles in about 70 years; at 3.5%, in about 20. Before 1800, income per person in most of the world was nearly flat for centuries. Today the richest countries have incomes per person dozens of times higher than the poorest. Growth comes from more and better capital, from human capital, and above all from new technology and better methods, and these depend on **institutions**: secure property, enforceable contracts, sound money, honest courts, open markets and a culture that honors work, saving

and learning. Germany in 1948 had skilled people and a long industrial tradition; what changed overnight were the rules.

In business today. Businesses invest where institutions are trustworthy, money is stable and workers are skilled. Investors compare countries by these features, and governments that improve them attract capital and grow. For a Christian, the question “why are some nations rich?” is also a question about justice and stewardship: the virtues of honesty, diligence and thrift, and the rule of law protecting the weak, are part of the answer.

Who gained? In 1948 Germans with savings in old marks lost most of their value in the conversion, while those with goods and skills gained; workers gained jobs and real wages; customers found goods in the shops again; the community began a long rebuilding. The reform was hard on some, but the restored price system and sound money benefited almost everyone within a few years.

PICTURE STUDY



View of Delft, Johannes Vermeer, about 1660–1661 · Oil on canvas · Mauritshuis, The Hague

Image: Wikimedia Commons, public domain

In the 1600s the small Dutch Republic became the richest nation in Europe per person, with a merchant fleet that sailed the world, sound money, secure property, a stock exchange, and printing, banking and trade. Vermeer's quiet view of his home city shows the brick gates, the busy harbor and the well-kept town of a prosperous people.

Look closely

- Find the boats in the harbor. What might they carry?
- Look at the city's walls, gates and towers. What do they tell you about the town's wealth?
- Find the small figures on the near shore. What are they doing?
- Look at how the light falls on the roofs. Where is the brightest part of the city?

Talk about it

1. What institutions helped the Dutch Republic grow rich in the 1600s?
2. How does this peaceful picture suggest a society where property and trade were secure?

3. What would the rule of 70 say about a city whose income grew one percent a year for a century?

PROJECT

Comparing Nations' Growth

You will compare the growth of income per person in three countries over several decades, compute growth rates and doubling times, and research the institutions that may explain the differences.

You will need

- Real GDP per person data (for example, from the World Bank's open data site or FRED, with a parent)
- A spreadsheet
- Your ledger notebook

Steps

1. Choose three countries with different histories (for example, one that grew very fast, one steady, one slow).
2. Record real GDP per person for each in 1960 (or the earliest year available) and the latest year.
3. Compute each country's average annual growth rate and doubling time.
4. Graph the three series on one chart (a log scale makes growth rates easy to compare).
5. Research, from encyclopedias or reliable sources, each country's property rights, money, trade and education over the period.
6. Write which factors best explain the differences, and what you cannot explain.
7. Write a short conclusion on what a family or a business can learn from your study.

Tips

- Use real (inflation-adjusted) data in a common currency.
- Report what the data show without praising or blaming present-day leaders.

Check your work

☐ I can use the rule of 70 and compound growth.

- ☐ I can name the sources of growth.
- ☐ I can explain the German currency reform of 1948.

LEDGER NOTEBOOK

1. Copy your growth table and chart.
2. Make a list of the institutions that support growth, with one example of each from this course.
3. Draw a timeline of June 1948 in western Germany: currency reform, end of price controls, the shop-window effect.

KEY FORMULAS

$$\text{Doubling time} \approx \frac{70}{g\%}$$

$$Y_t = Y_0(1+g)^t$$

$$\text{Ratio after } t \text{ years} = \left(\frac{1+g_A}{1+g_B}\right)^t$$

From history. Each West German received an initial 40 Deutsche Marks at the reform, with 20 more soon after. Erhard later became West Germany's economics minister and, in 1963, its chancellor.

WORKED EXAMPLES

Example 1. Country A has income per person of \$5,000 growing 5% a year; Country B has \$40,000 growing one percent a year. In how many years will A catch B?

Show solution

1. Set $5{,}000(1.05)^t = 40{,}000(1.01)^t$.
2. $(1.05/1.01)^t = 8$, so $t = \dfrac{\ln 8}{\ln(1.05/1.01)} \approx \dfrac{2.079}{0.0388} \approx 54$ years.

Answer: About 54 years: faster growth closes even a large gap within a lifetime.

Example 2. World income per person grew about 0.05% a year from 1000 to 1800 and about 1.5% a year from 1950 to 2000 (rough historical estimates). Find each doubling time.

Show solution

1. 1000–1800: $70/0.05 = 1{,}400$ years.
2. 1950–2000: $70/1.5 \approx 47$ years.

Answer: About 1,400 years versus about 47 years: the modern era of growth is new in human history.

Example 3. Industrial production in western Germany rose from an index of 50 just before June 1948 to about 78 by December 1948. Find the percent rise and the monthly growth rate over six months.

Show solution

1. Rise: $78/50 - 1 = 56\%$.
2. Monthly: $1.56^{1/6} - 1 \approx 7.7\%$ a month.

Answer: A 56% rise in six months, about 7.7% a month, an extraordinary pace once money and prices worked again.

PRACTICE

1. Easy State the rule of 70.

   Show answer

   Doubling time is about 70 divided by the percent growth rate.

2. Easy What happened in western Germany on June 20, 1948?

   Show answer

   The Deutsche Mark replaced the Reichsmark; at the same time most price controls were lifted.

3. Easy Name four sources of economic growth.

   Show answer

   Physical capital, human capital, technology, and good institutions (property, contracts, sound money, open trade).

4. **Medium** Income grows 2.5% a year. Find the doubling time.

Show answer

About 28 years.

5. **Medium** $10,000 grows at 3% for 50 years. Find the result.

Show answer

$10{,}000 \times 1.03^{50} \approx \$43{,}840$.

6. **Medium** Explain the “shop-window effect.”

Show answer

Once sellers could charge prices that covered costs in money that held its value, hoarded goods appeared in shop windows almost overnight.

7. **Medium** Why did lifting price controls matter as much as the new currency?

Show answer

Sound money without free prices would still leave shortages; free prices let supply respond and signals work.

8. **Hard** Country A grows 6% and B grows 2%. A starts at one-fourth of B’s income. When does A catch up?

Show answer

$(1.06/1.02)^t = 4$, $t = \ln 4 / \ln(1.0392) \approx 36$ years.

9. **Hard** Why do small differences in growth rates matter so much over a lifetime?

Show answer

Growth compounds: a 2-point difference sustained for 50 years makes one economy about 2.7 times larger relative to the other.

10. **Challenge** Show that the rule of 70 comes from $\ln 2 \approx 0.693$, using $(1+g)^t = 2$ and $\ln(1+g) \approx g$ for small g.

Show answer

$t \ln(1+g) = \ln 2$, so $t \approx 0.693/g$. With g in percent, $t \approx 69.3/g\% \approx 70/g\%$.

COMMON MISTAKES

- Using growth as a decimal in the rule of 70. Use the percent: 70/3, not 70/0.03.
- Comparing nominal incomes across countries without adjusting for prices.

- Thinking natural resources alone make a nation rich. Many resource-rich nations are poor, and many resource-poor nations are rich.

Make it a game · Growth Rate Race. Two pretend nations start with the same income. One grows 1 percent a year, the other 3 percent. Guess their income ratio after 100 years, then compute it using compound growth and the rule of 70. The closer guess wins. Finish by naming the four sources of growth and explaining why institutions matter.

Scripture. “But thou shalt remember the LORD thy God: for it is he that giveth thee power to get wealth, that he may establish his covenant which he sware unto thy fathers, as it is this day.” (Deuteronomy 8:18, KJV)

Moses reminded Israel, about to enter a prosperous land, that the power to produce wealth is God’s gift. Growth is a blessing to be received with gratitude and used for good.

UNIT 9

The Whole Economy

So far you have studied markets one at a time. In this unit you step back to see the whole economy: how it is measured, why it rises and falls, and why some nations grow rich. You will learn how Simon Kuznets built the first national income accounts in the depths of the Depression, how the government learned to count the unemployed, and how economists measure the business cycle, a pattern Joseph understood when he stored grain for seven lean years.

Then you will study the Great Depression itself, the worst economic collapse in modern history, and weigh the leading explanations of its causes and recovery. The unit closes with the great question of economic history: why are some nations rich and others poor? West Germany's currency reform of 1948 shows how much depends on sound money, free prices and good institutions.

PREREQUISITES

- Units 4–8
- Percents, exponents and logarithms (helpful for growth calculations)
- Reading line graphs of data over time

MASTERY CHECKLIST

- ☐ I can compute GDP, real GDP, the deflator and real growth, and explain what GDP leaves out.
- ☐ I can compute the unemployment and participation rates and classify kinds of unemployment.
- ☐ I can describe the business cycle and measure the depth and length of a contraction.
- ☐ I can describe the Great Depression and weigh the main explanations of its causes.
- ☐ I can use the rule of 70 and compound growth and explain why institutions matter for growth.

OPTIONAL BOOKS AND GAMES FOR THIS UNIT

- **FRED, the St. Louis Fed's free economic data site**: Free. Graph real GDP, unemployment and recessions for the projects in Lessons 9.1–9.3. A parent can help; no account is needed.
- **Bureau of Labor Statistics: "How the Government Measures Unemployment"**: Free; search the title at bls.gov. The official explanation of the household survey and its definitions. Use with Lesson 9.2.
- **Federal Reserve History: "The Great Depression"**: Free. A clear essay on the monetary side of the Depression. Use with Lesson 9.4.

Not required. Every project in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

9.1	**Measuring the Whole Economy: Simon Kuznets and GDP**	3 sessions of 50 minutes
9.2	**Unemployment: Counting the Jobless**	3 sessions of 50 minutes
9.3	**The Business Cycle: Seven Fat Years and Seven Lean**	3 sessions of 50 minutes
9.4	**The Great Depression**	3 sessions of 50 minutes
9.5	**Why Some Nations Grow Rich**	3 sessions of 50 minutes

Unit 9 test

Calculators are allowed. Show your work for every calculation: write the formula, substitute and solve. Answer the concept questions in complete sentences. The test is worth 100 points.

1. **6 pts**
   Define GDP and explain why only final goods are counted.

2. **6 pts**
   C = 15, I = 4, G = 5, X = 3, M = 4 (trillions). Find GDP.

3. **8 pts**

   An economy produces apples and pens. Base year: 1,000 apples at $1, 200 pens at $2. Current year: 1,100 apples at $1.50, 250 pens at $2.20. Find nominal GDP, real GDP (base-year prices), the deflator and real growth.

4. **6 pts**

   What did Kuznets warn about national income?

5. **8 pts**

   Adult population 250 million; employed 155 million; unemployed 7 million. Find the labor force, unemployment rate and participation rate.

6. **6 pts**

   Classify and explain: (a) a teacher who moved and is looking for a new school; (b) a typesetter replaced by computers; (c) a builder laid off in a recession.

7. **6 pts**

   How did the United States learn to measure unemployment after the Depression?

8. **6 pts**

   Name the four phases of the business cycle and say who dates U.S. recessions.

9. **6 pts**

   Real GDP: peak 22.0, trough 20.9. Find the depth of the contraction. Annualize quarterly growth of 0.8%.

10. **8 pts**

    Describe the chain of events from the crash of 1929 to the depth of the Depression in 1933, naming at least four links.

11. **6 pts**

    Prices fell 25% from 1929 to 1933. A farmer owed $8,000. Find the real burden in 1929 dollars.

12. **6 pts**

    Explain why countries that left the gold standard earlier generally recovered earlier.

13. **6 pts**

    Use the rule of 70 to find doubling times at 1.4% and 3.5%.

14. **6 pts**

    Describe West Germany’s reforms of June 1948 and their effects.

15. **10 pts**

    Short essay: Why are some nations rich and others poor? Use at least three ideas from this course.

ANSWER KEY

1. The market value of all final goods and services produced in a country in a year. Intermediate goods are included in final goods' prices; counting them separately would double count.
2. $\$23$ trillion.
3. Nominal: $1{,}650 + 550 = \$2{,}200$; real: $1{,}100 + 500 = \$1{,}600$; deflator 137.5; real growth from \$1,400: 14.3%.
4. That the welfare of a nation can scarcely be inferred from national income; it leaves out much that matters.
5. Labor force 162 million; unemployment 4.3%; participation 64.8%.
6. (a) frictional; (b) structural; (c) cyclical.
7. From 1940 it used a monthly sample survey of households (now the Current Population Survey), counting as unemployed those without work who had actively looked.
8. Expansion, peak, contraction, trough; the NBER's business-cycle dating committee.
9. -5.0%; $1.008^4 - 1 \approx 3.2\%$.
10. Crash and lost confidence; waves of bank failures; collapse of the money supply by a third; deflation of about a quarter, raising debt burdens and defaults; falling spending and investment; the gold standard spreading deflation; trade barriers and retaliation; unemployment near 25%.
11. $8{,}000 / 0.75 \approx \$10{,}667$.
12. Leaving gold freed them to expand money and stop deflation, while countries on gold had to keep money tight to defend their parities.
13. About 50 and 20 years.
14. The Deutsche Mark replaced the nearly worthless Reichsmark with limits on its issue, and most price controls were lifted. Hoarded goods appeared in shops, work resumed, and industrial production rose by about half within six months.
15. A strong answer discusses institutions (property, contracts, rule of law), sound money and free prices, human and physical capital, technology and openness to trade, with historical examples and growth calculations.

PORTFOLIO PIECE: AN ECONOMIC REPORT ON A DECADE

Choose one decade of American economic history (for example the 1920s, 1930s, 1950s, 1970s or 1990s). Using FRED and historical sources, write a six- to eight-page report with graphs of real GDP, unemployment and inflation; identify any recessions and their causes; describe one business and one family's experience of the decade (from history or an interview); and conclude with lessons for a household and a business. Write as an economist and historian, without partisan language.

LOOK FOR	WHAT IT MEANS
Data	Graphs are accurate, labeled and sourced; calculations of growth, inflation and unemployment are correct.
Analysis	The report explains causes and effects using the tools of Units 4–9.
Human story	The business and family stories are well chosen and connected to the data.
Writing	Clear, organized, balanced and free of partisan language.

UNIT 10

Trade and the Wealth of Nations

The last unit returns to Adam Smith's great question: what makes nations wealthy? You will trace trade from the caravans of the Silk Road and the merchants of Amsterdam to Malcom McLean's first container ship in 1956, learn how exchange rates and purchasing power parity work, and study the Corn Laws, whose repeal in 1846 became the most famous episode in the history of the case for trade.

Then you will see how capital and, above all, innovation sustain growth, through Robert Solow's model and Norman Borlaug's wheat, which fed hundreds of millions. The course ends with a capstone research paper on an episode in economic history of your choice, modeled on John Law's Mississippi Bubble of 1720, which draws on nearly every tool you have learned.

PREREQUISITES

- Units 1–9
- Spreadsheet skills for tables and graphs
- Research and citation skills (taught in Lesson 10.5)

MASTERY CHECKLIST

- ☐ I can explain how falling transport costs widened markets and compute transport-cost savings.
- ☐ I can convert currencies, compute appreciation and depreciation, and apply purchasing power parity.
- ☐ I can tell the history of the Corn Laws and compute the effects of an import duty.
- ☐ I can explain diminishing returns to capital and why innovation sustains growth.
- ☐ I can write a research paper in economic history with primary sources, data and a stakeholder analysis.

OPTIONAL BOOKS AND GAMES FOR THIS UNIT

- ***The Wealth of Nations*, Book IV, chapter 2**: Free. Smith's argument about restraints on imports, including the famous "invisible hand" passage. Read with Lesson 10.3. Ages 15+.
- **Federal Reserve History (federalreservehistory.org)**: Free. Reliable essays and primary-source links for capstone topics in American monetary history.
- **Library of Congress digital collections**: Free; browse the digital collections at loc.gov. Photographs, newspapers and documents for primary sources in the capstone paper.

Not required. Every project in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

10.1 Trade Through History: From the Silk Road to the Container Ship

3 sessions of 50 minutes

10.2 Exchange Rates and Purchasing Power Parity 3 sessions of 50 minutes

10.3 The Corn Laws and the Case for Trade 3 sessions of 50 minutes

10.4 Capital, Innovation and Growth: Norman Borlaug's Wheat

3 sessions of 50 minutes

10.5 Capstone: Writing Economic History, with John Law's Mississippi Bubble as a Model

3 sessions of 50 minutes

Unit 10 test

Calculators are allowed. Show your work for every calculation: write the formula, substitute and solve. Answer the concept questions in complete sentences. The test is worth 100 points.

1. **6 pts**

   Tell the story of the Ideal-X and explain why containers lowered transport costs.

2. **6 pts**

   Loading costs fall from $5.50 to $0.25 a ton. Find the savings on 40,000 tons and the percent reduction.

3. **6 pts**

   How does cheaper transport extend the division of labor?

4. **6 pts**

   The rate moves from 0.85 to 0.95 euros per dollar. Did the dollar appreciate or depreciate, by how much, and what happens to the dollar price of a €190 item?

5. **8 pts**

   A good costs $4.00 in the U.S. and 26 yuan in China; the market rate is 7.2 yuan per dollar. (a) Find the PPP rate. (b) Is the yuan over- or undervalued by this test, and by how much?

6. **6 pts**

   Why do exchange rates often stray from PPP for long periods?

7. **6 pts**

   Describe the Corn Law of 1815, the campaign against it and its repeal.

8. **12 pts**

   Demand $Q_d = 150 - 2P$, supply $Q_s = 2P - 10$, world price 30. (a) Find imports with free trade. (b) A duty of 5 is imposed: find imports, revenue and deadweight loss.

9. **6 pts**

   Who gained and who lost from the Corn Laws?

10. **8 pts**

    With $y = 4\sqrt{k}$: (a) find y at k = 16 and k = 64; (b) what rise in A (from 4) would give the same output at k = 16 as k = 64 gives?

11. **6 pts**

    Explain why innovation, not capital alone, sustains long-run growth.

12. **6 pts**

    Describe Norman Borlaug’s achievement and one cost critics noted.

13. **6 pts**

    A Mississippi share rose from 500 to 10,000 livres and fell to 2,000. Find the return for buying at 500 and selling at 2,000.

14. **12 pts**

    Short essay: Choose one episode from this course and explain how at least three tools you have learned (for example opportunity cost, supply and demand, the quantity equation, comparative advantage, the six stakeholders) help explain what happened.

ANSWER KEY

1. On April 26, 1956, McLean's Ideal-X carried 58 containers from Newark to Houston. Standard sealed boxes lifted by crane cut loading time, labor, theft and damage, lowering costs dramatically.
2. \$210,000; about 95%.
3. It widens the market each producer can reach, so producers can specialize further, as Smith said: the division of labor is limited by the extent of the market.
4. Appreciated by about 11.8%; price falls from about \$224 to \$200.
5. (a) 6.5 yuan per dollar. (b) Undervalued: at 7.2 the good costs $26/7.2 \approx \$3.61$ in China, about 10% less than in the U.S.
6. Many goods and services are not traded, transport costs and duties exist, and currencies are bought and sold for investment.
7. It barred foreign wheat until the British price reached 80 shillings. The Anti-Corn Law League (1838), led by Cobden and Bright, campaigned against it; after the Irish famine began, Peel won repeal in 1846.
8. (a) $Q_d = 90$, $Q_s = 50$; imports 40. (b) At 35: $Q_d = 80$, $Q_s = 60$; imports 20; revenue 100; DWL $\frac{1}{2}(5)(10) + \frac{1}{2}(5)(10) = 50$.
9. Landowners gained higher rents; consumers, especially factory workers' families, paid more for bread; manufacturers paid higher wages; the nation lost from the deadweight loss and suffered most in famine years.
10. (a) 16 and 32. (b) A must double to 8.
11. Capital faces diminishing returns; new ideas raise the productivity of all inputs and can be used by many at once.
12. He bred rust-resistant, semi-dwarf high-yield wheat that made Mexico self-sufficient and greatly raised wheat output in India and Pakistan in the 1960s, earning the 1970 Nobel Peace Prize. Critics noted heavier fertilizer and water use and uneven benefits.
13. 300%.
14. A strong answer chooses a well-defined episode, applies three tools accurately with at least one calculation, weighs the stakeholders and reaches a balanced conclusion.

PORTFOLIO PIECE: THE CAPSTONE RESEARCH PAPER

Your portfolio for this unit is the research paper from Lesson 10.5: 1,500–2,500 words on an episode in economic history, with at least two primary and three secondary sources, at least one table or graph of real data, a stakeholder analysis, and a short oral summary presented to your family.

LOOK FOR	WHAT IT MEANS
Question and thesis	A clear, focused question and a debatable thesis stated early.
Evidence	Primary and secondary sources are used accurately and cited fully; data are correct and well presented.
Analysis	Tools from the course are applied correctly; the six stakeholders are weighed fairly.
Writing and presentation	Clear, organized, honest and free of partisan language; the oral summary is confident and accurate.

10.1 Trade Through History: From the Silk Road to the Container Ship

OBJECTIVES

- Trace how falling transport costs have widened markets from the Silk Road to the modern container ship.
- Tell the story of Malcom McLean and the Ideal-X (1956) and calculate the savings from containerization.
- Explain how cheaper transport extends specialization, as Adam Smith predicted.

> **Warm-up.** Look at the labels of five things in your home (clothing, a tool, a toy, a fruit, an appliance). Where was each made? Estimate how far each traveled to reach you.

WATCH

How containerization shaped the modern world

TED-Ed · 4:46

https://www.youtube.com/watch?v=Gn7IoT_WSRA

> **WHEN TO WATCH**
> After the story of the Ideal-X, before the big idea.

BACKUP VIDEO

Malcom McLean and Containerisation | Maersk

Maersk · 4:33

https://www.youtube.com/watch?v=gAs01Xr1U8w

With the worked examples, to see how a container moves.

KEY TERMS

transport cost

The cost of moving goods from producer to buyer, including loading, shipping, insurance and time.

break-bulk cargo

Goods loaded and unloaded piece by piece, in sacks, crates and barrels, as most cargo was before containers.

container

A standard steel box that can move between ship, truck and train without its contents being unpacked.

intermodal

Using more than one kind of transport (ship, rail, truck) with the same container.

extent of the market

Smith's phrase for the size of the market a producer can reach, which limits how far specialization can go.

CORE IDEAS

The story. For most of history, long-distance trade carried only goods worth a great deal for their weight: silk, spices, silver, porcelain. Caravans on the routes later called the Silk Road passed goods from hand to hand across Asia; ships in the Mediterranean and Indian Ocean followed the seasons and the winds. Even in 1950, a ship spent as much time in port being loaded and unloaded by gangs of dockworkers as at sea. Malcom McLean, a trucking businessman from North Carolina, had waited for hours at docks watching his trucks' cargo lifted out piece by piece. He wondered: why not lift the whole trailer body onto the ship? On April 26, 1956, the converted tanker *Ideal-X* sailed from Newark, New Jersey, to Houston, Texas, carrying 58 metal containers.

How they figured it out. McLean worked with engineers to design containers that could be stacked, locked together and lifted by cranes, and he bought ships and rebuilt them to carry them. According to the historian Marc Levinson, McLean calculated that loading the *Ideal-X* cost about 16 cents a ton, compared with about $5.83 a ton for ordinary cargo. Standard sizes, agreed internationally in the 1960s, let containers move between companies and countries. Ports built giant cranes; ships grew larger; theft and damage fell because boxes stayed sealed. Time in port fell from days to hours, and the cost of shipping a box of goods across an ocean fell to a small fraction of the price of what was inside.

The big idea. Adam Smith wrote that the division of labor is limited by the extent of the market (Lesson 1.4). Every fall in transport costs widens the market, so producers can specialize further and buyers can choose among more sellers. That is why trade grew so much faster than world output in the decades after containerization. Cheaper shipping also changed where things are made: a product

can now be designed in one country, assembled in another from parts made in several more, and sold everywhere. The gains are real and large; so are the adjustments, as dockworkers whose jobs disappeared and port cities that lost business learned.

In business today. Firms plan supply chains around container shipping, ordering parts from far away and holding smaller inventories. A disruption anywhere along the chain, a closed port or a shortage of ships, can stop production thousands of miles away, so wise firms keep backup suppliers and some extra stock. Ezekiel's lament over Tyre, the great trading city whose wares "went forth out of the seas," is a reminder that trade brings wealth and also dependence.

Who gained? Customers gained cheaper goods and wider choice; McLean and his financiers gained a large company; builders and engineers gained new industries; many dockworkers lost their jobs as loading was mechanized, though unions bargained for compensation and pensions; port communities that adopted containers early (such as the new port at Newark–Elizabeth) gained, while older piers declined.

PICTURE STUDY



The Courtyard of the Old Exchange in Amsterdam, Emanuel de Witte, 1653 · Oil on panel · Museum Boijmans Van Beuningen, Rotterdam

Image: Wikimedia Commons, public domain

In the 1600s Amsterdam's Exchange was the meeting place of the world's trade. Merchants gathered here at set hours to buy and sell cargoes from the Baltic, the Mediterranean, Asia and the Americas, and shares of the East India Company. The numbered pillars marked where traders in particular goods could be found.

Look closely

- Look at the groups of merchants. What are they doing?
- Look at the arcades around the courtyard. Why would traders want a covered walkway?
- Look for anyone who is not a merchant: a child, a dog, a beggar, a servant.
- Look at the light and shadows. What time of day is it?

Talk about it

1. What goods might be traded here, and where did they come from?
2. How did Amsterdam's trade depend on ships and the cost of transport?
3. How is this courtyard like a modern port or exchange, and how is it different?

PROJECT

The Journey of a Product

You will trace the journey of one product you own from raw materials to your home, estimate its transport costs, and compare with what the journey would have cost before containers.

You will need

- One manufactured product (a shirt, shoes, a toy, a small appliance)
- Maps or a globe
- Internet access with a parent
- A spreadsheet

Steps

1. Record where the product was made (from its label) and its price.
2. Research where its main materials probably came from (cotton, rubber, plastic, metal).
3. Draw a map of its likely journey, with each stage: raw material, factory, port, ship, port, warehouse, store, your home.
4. Estimate the shipping cost per unit today (search for typical container rates and how many units fit in a container) and its share of the price.
5. Estimate the same share if loading cost were 36 times higher, as before containers (using the ratio from Worked Example 1).
6. Discuss which stakeholders gained from cheaper transport and which bore costs.
7. Write a one-page “biography” of your product.

Tips

- Estimates are fine; show how you made them.
- A standard 40-foot container holds roughly 10,000 shirts or 5,000 pairs of shoes; check a source for your product.

Check your work

☐ I can describe how transport costs shaped trade through history.

- ☐ I can tell the story of the Ideal-X.
- ☐ I can compute transport-cost shares and savings.

LEDGER NOTEBOOK

1. Draw your product's journey map with distances.
2. Copy your transport-cost calculations.
3. Make a timeline of trade: Silk Road, Age of Sail, steamships, railroads, the Ideal-X (1956), standard containers (1960s).

KEY FORMULAS

$$\text{Transport cost share} = \frac{\text{transport cost per unit}}{\text{price of the good}} \times 100\%$$

$$\text{Savings} = (c_{\text{old}} - c_{\text{new}}) \times \text{tons}$$

From history. McLean sold his trucking company to concentrate on shipping, and his firm became Sea-Land. When he died in 2001, container ships around the world sounded their horns in his honor.

WORKED EXAMPLES

Example 1. Using Levinson's figures of \$5.83 a ton for break-bulk loading and 16 cents a ton for the Ideal-X, find the savings on a 10,000-ton cargo and the percent reduction.

Show solution

1. Old: $10{,}000 \times 5.83 = \$58{,}300$.
2. New: $10{,}000 \times 0.16 = \$1{,}600$.
3. Savings: \$56,700, a reduction of $1 - 0.16/5.83 \approx 97\%$.

Answer: \$56,700 saved, about a 97% cut in loading cost (in 1956 dollars).

Example 2. A pair of shoes sells for \$60. Shipping it across the Pacific once cost \$3 a pair; with containers it costs 30 cents. Find the transport-cost share before and after.

Show solution

1. Before: $3/60 = 5\%$.
2. After: $0.30/60 = 0.5\%$.

Answer: From 5% of the price to half a percent. When transport is so cheap, production can move to wherever it is cheapest.

Example 3. A factory can make a part for \$10 at home, or buy it abroad for \$7 plus shipping. At what shipping cost per part does importing stop paying?

Show solution

1. Import if $7 + s < 10$, so $s < \$3$.

Answer: Importing pays only while shipping costs less than \$3 a part. Falling transport costs keep moving that line.

PRACTICE

1. Easy When and from where did the Ideal-X sail, and how many containers did it carry?

   Show answer

   April 26, 1956, from Newark to Houston, with 58 containers.

2. Easy What is break-bulk cargo?

   Show answer

   Goods loaded and unloaded piece by piece rather than in containers.

3. Easy Who was Malcom McLean?

   Show answer

   A trucking businessman who pioneered container shipping.

4. Medium Loading costs fall from $6 to $0.20 a ton. Find the savings on 25,000 tons.

Show answer

$25{,}000 \times 5.80 = \$145{,}000.$

5. Medium A $40 jacket costs $2 to ship. Find the transport-cost share. If shipping falls to $0.40, find the new share.

Show answer

5% and one percent.

6. Medium Why did containers reduce theft and damage?

Show answer

Boxes were sealed at the factory and not opened until they arrived, so goods were handled far less.

7. Medium How does cheaper transport extend specialization?

Show answer

It widens the market each producer can reach, so producers can specialize more narrowly and sell to more buyers.

8. Hard Using the six stakeholders, evaluate containerization for a port city.

Show answer

Customers and shippers gained cheaper, faster trade; financiers and risk-takers who invested in container ports gained; many dockworkers lost jobs; communities with new container ports gained, while those with old piers declined.

9. Hard A part costs $12 at home or $8 abroad plus shipping. Shipping was $5 and falls to $1. When does importing become worthwhile, and what are the savings per part after the fall?

Show answer

Before: 8 + 5 = $13 > $12, so make at home. After: 8 + 1 = $9 < $12; import, saving $3 a part.

10. **Challenge** World trade grew about twice as fast as world output for several decades after 1960. If output grew 3.5% a year and trade 7%, by what factor did each grow over 30 years?

    Show answer

    Output $1.035^{30} \approx 2.8$; trade $1.07^{30} \approx 7.6$. Trade's share of output nearly tripled.

COMMON MISTAKES

- Thinking the container itself was the whole invention. The system of standard sizes, cranes, ships and trucks made it work.
- Ignoring time and reliability as costs of transport.
- Telling the story only as gain. Dockworkers and some port cities bore real losses.

Make it a game · Made In Scavenger Hunt. Find eight household items with a label showing where they were made. Place each on a rough hand-drawn world map. Count the steps each might have traveled. Then calculate savings: suppose loading cost 6 dollars a ton before containers and 20 cents after. How much is saved on 15,000 tons? Retell Malcom McLean's Ideal-X voyage of 1956.

Scripture. "When thy wares went forth out of the seas, thou filledst many people; thou didst enrich the kings of the earth with the multitude of thy riches and of thy merchandise." (Ezekiel 27:33, KJV)

Ezekiel describes Tyre, the great trading port of the ancient world. Trade enriched many nations, yet the chapter is a lament: wealth from trade is a blessing that must not become arrogance.

10.2 Exchange Rates and Purchasing Power Parity

OBJECTIVES

- Read and convert exchange rates and compute appreciation and depreciation.
- Explain what shifts the demand for and supply of a currency.
- Use purchasing power parity and the Big Mac index to judge whether a currency is over- or undervalued.

> **Warm-up.** If $1 buys 0.90 euros, how many dollars does a €45 museum ticket cost? If the dollar later buys 1.00 euro, what does the ticket cost? Who gained from the change?

WATCH

Purchasing Power Parity: When in India, Get a Haircut

Marginal Revolution University · 4:27

https://www.youtube.com/watch?v=13y49v0Zp1c

> **WHEN TO WATCH**
> After the big idea, before the worked examples on PPP.

BACKUP VIDEO

The Foreign Exchange Market- Macro 6.3

Jacob Clifford · 5:07

https://www.youtube.com/watch?v=D41EuDh3epI

Before the big idea, as an introduction to currency markets.

KEY TERMS

exchange rate

The price of one currency in terms of another.

appreciation

A rise in a currency's value against another; it buys more foreign currency.

depreciation

A fall in a currency's value against another.

law of one price

The idea that an identical good should sell for the same price everywhere once prices are converted to one currency, if trade is free and cheap.

purchasing power parity (PPP)

The exchange rate at which a currency would buy the same basket of goods in two countries.

CORE IDEAS

The story. Money-changers sat at tables in the market towns of the Bible, the fairs of Champagne and the Exchange of Amsterdam, weighing coins from many mints and converting one into another. Their trade required judgment: how much silver was in a foreign coin, and what could it buy? In 1986 the British magazine *The Economist* found a light-hearted modern way to ask the same question. Because a McDonald's Big Mac is made to nearly the same recipe in dozens of countries, the magazine compared its price around the world, converted to dollars at market exchange rates. If a Big Mac cost much less in dollars in one country than another, that country's currency was, by this rough test, undervalued.

How they figured it out. The Big Mac index rests on an old idea, **purchasing power parity**, studied by the Swedish economist Gustav Cassel during and after the First World War, when exchange rates swung wildly. If identical goods could be traded freely, buyers would buy where they were cheap and sell where they were dear, until prices converted at the exchange rate were equal: the **law of one price.** In practice exchange rates often stray far from PPP for years, because many goods (haircuts, rent, restaurant meals) cannot be traded, because of transport costs and duties, and because currencies are also bought and sold for investment. Over long periods, however, high-inflation countries' currencies do tend to depreciate, roughly as PPP predicts.

The big idea. An exchange rate is a price set by supply and demand in the currency market. Foreigners demand dollars to buy American exports and investments; Americans supply dollars to buy imports and foreign investments. If American goods become more popular abroad, or American interest rates rise and attract

investment, demand for dollars rises and the dollar **appreciates**. A stronger dollar makes imports cheaper for Americans and American exports dearer abroad; a weaker dollar does the reverse. **PPP** gives a benchmark: the exchange rate at which a basket costs the same in both countries.

In business today. Every firm that buys or sells abroad watches exchange rates. An exporter's profits rise when its home currency weakens; an importer's costs rise. Firms set prices in different currencies, use forward contracts to fix future rates (Lesson 6.3), and sometimes build factories abroad to match costs and revenues in the same currency. Travelers and students abroad face the same arithmetic on a smaller scale.

Think it through. Jesus overturned the tables of the money-changers in the Temple (Matthew 21:12), not because exchanging currency is wrong, but because the house of prayer had been turned into a market where worshipers were exploited. Honest exchange at fair rates is a service; exploitation of those who have no choice is not.

PICTURE STUDY



The Moneychanger and His Wife, Marinus van Reymerswaele, 1538 · Oil on panel · Museo del Prado, Madrid

Image: Wikimedia Commons, public domain

In Antwerp and other trading cities, coins from dozens of mints passed across tables like this one. Each had to be weighed and valued against the others. Reymerswaele painted this subject many times, following an earlier composition by Quentin Matsys (Lesson 5.1); here the wife keeps the accounts.

Look closely

- Find the coins on the table. How many different kinds can you see?
- Find the box with compartments on the table. What might it be for?
- Look at the wife's book. What might she be recording?
- Look at the objects on the shelf. What do they tell you about the business?

Talk about it

1. Why did money-changers need to weigh foreign coins?
2. How is an exchange rate today like the money-changer's valuation?
3. What makes a money-changer honest or dishonest?

Safety first. A parent helps with all online research; do not create accounts or enter personal information.

PROJECT

Your Own Price Index Across Borders

You will compare the prices of a few identical goods in the United States and in two other countries (from official store websites or published price lists, with a parent), compute PPP rates, and compare them with market exchange rates.

You will need

- Internet access with a parent
- Current exchange rates from a central bank or the Federal Reserve's H.10 release
- A spreadsheet

Steps

1. Choose three identical items sold in many countries (a particular book edition, a global brand of soda, a smartphone model).
2. Find their prices in the U.S. and in two other countries from official sources.
3. Record market exchange rates for those currencies.
4. Compute each item's price in dollars abroad and the PPP rate for each item.
5. Average your three items to make a mini-PPP for each country; compare with the market rate.
6. Explain why your items might not obey the law of one price (taxes, transport, local costs, competition).
7. Write a paragraph advising a family traveling to each country whether things will feel cheap or expensive, and why.

Tips

- Use identical products; a different size or model spoils the comparison.
- Note sales taxes and value-added taxes, which differ by country.

Check your work

- ☐ I can convert currencies and compute appreciation and depreciation.
- ☐ I can compute a PPP rate and judge over- or undervaluation.
- ☐ I can explain why exchange rates move.

LEDGER NOTEBOOK

1. Copy your price table, PPP rates and comparison.
2. Draw a supply-and-demand graph for dollars in the euro market and show the effect of a rise in foreign demand for U.S. goods.
3. Make a two-column chart of who gains and who loses when the dollar appreciates.

KEY FORMULAS

$$\text{Amount in foreign currency} = \text{amount in dollars} \times (\text{foreign per dollar})$$

$$\text{PPP rate} = \frac{P_{\text{foreign}}}{P_{\text{US}}}, \qquad \text{Over/undervaluation} = \frac{\text{PPP rate}}{\text{market rate}} - 1$$

$$\%\Delta e = \frac{e_{\text{new}} - e_{\text{old}}}{e_{\text{old}}} \times 100\%$$

From history. The economist Gustav Cassel developed purchasing power parity as a guide for resetting exchange rates after the First World War, when wartime inflation had changed price levels so much that the old parities no longer made sense.

WORKED EXAMPLES

Example 1. The exchange rate moves from 140 yen per dollar to 154 yen per dollar. Did the dollar appreciate or depreciate, and by how much? What happens to the dollar price of a ¥30,000 Japanese camera?

Show solution

1. The dollar buys more yen: it appreciated by $(154 - 140)/140 = 10\%$.
2. Camera at 140: $30{,}000/140 \approx \$214$; at 154: $30{,}000/154 \approx \$195$.

Answer: The dollar appreciated 10%, and the camera's dollar price fell from about $214 to about $195.

Example 2. A Big Mac costs \$5.69 in the United States and 4.49 pounds in Britain. The market rate is \$1.27 per pound (0.787 pounds per dollar). Find the PPP rate and whether the pound is over- or undervalued.

Show solution

1. PPP rate (pounds per dollar): $4.49/5.69 \approx 0.789$.
2. Market rate: 0.787 pounds per dollar.
3. Big Mac in Britain in dollars: $4.49 \times 1.27 \approx \$5.70$, almost the same as in the U.S.

Answer: The pound is very close to its Big Mac PPP value (illustrative prices). Real comparisons often show gaps of 20% or more.

Example 3. Over ten years, prices rise 2% a year in the U.S. and 8% a year in Country Z. If PPP held at the start with 10 zeds per dollar, what rate does relative PPP predict after ten years?

Show solution

1. Relative prices: $(1.08/1.02)^{10} \approx 1.77$.
2. Predicted rate: $10 \times 1.77 \approx 17.7$ zeds per dollar.

Answer: About 17.7 zeds per dollar: the high-inflation currency depreciates to keep purchasing power roughly equal.

PRACTICE

1. Easy Define appreciation and depreciation.

   Show answer

   Appreciation: a currency buys more foreign currency. Depreciation: it buys less.

2. Easy What is the law of one price?

   Show answer

   Identical goods should sell for the same price everywhere when converted at the exchange rate, if trade is free and cheap.

3. Easy When did The Economist begin its Big Mac index?

Show answer

1986.

4. Medium $500 is converted at 0.92 euros per dollar. How many euros?

Show answer

€460.

5. Medium The rate moves from 1.30 to 1.20 Canadian dollars per U.S. dollar. Did the U.S. dollar appreciate or depreciate, and by what percent?

Show answer

Depreciated by about 7.7%.

6. Medium A Big Mac costs 300 rupees in India and $5 in the U.S.; the market rate is 83 rupees per dollar. Find the PPP rate and whether the rupee is under- or overvalued.

Show answer

PPP = 60 rupees per dollar; at 83 the rupee buys less than PPP implies, so it is undervalued by about $1 - 60/83 \approx 28\%$.

7. Medium Why do haircuts not obey the law of one price?

Show answer

They cannot be traded across borders; their price reflects local wages and rents.

8. Hard U.S. interest rates rise relative to Europe's. Predict the effect on the dollar and on American exporters.

Show answer

Investors demand dollars, so the dollar appreciates; American exports become dearer abroad, hurting exporters.

9. Hard Inflation is 3% at home and 13% abroad for five years. By roughly what percent does relative PPP predict the foreign currency will depreciate?

Show answer

$(1.13/1.03)^5 - 1 \approx 59\%$ more foreign currency per dollar.

10. **Challenge** An American firm sells machines in Europe for €100,000 each and its costs are $95,000 per machine. At 1.10 dollars per euro, find the profit. At what exchange rate does it break even?

Show answer

Revenue $110,000, profit $15,000. Break-even at 0.95 dollars per euro.

COMMON MISTAKES

- Mixing up quotes in dollars per euro and euros per dollar.
- Thinking a strong currency is always good. It helps importers and travelers but hurts exporters.
- Expecting PPP to hold exactly at every moment. It is a long-run tendency.

> **Make it a game · Currency Conversion Duel.** Your parent invents two currencies and rates against the dollar. Convert prices in ten seconds, compute the percent appreciation or depreciation after a change, and name what shifted the demand for the currency. Then compare the price of the same sandwich in both countries to find the purchasing power parity rate. Whoever answers more rounds correctly wins.

10.3 The Corn Laws and the Case for Trade

OBJECTIVES

- Tell the history of Britain's Corn Laws (1815–1846) and the campaign that ended them.
- Use supply and demand to calculate the effects of an import duty on prices, quantities, revenue and deadweight loss.
- Explain who gains and who loses from trade barriers, as history and principle.

> **Warm-up.** Suppose your town passed a rule that bread could be sold only by local bakers, and no bread could come in from the next town. Write who in your town would gain, who would lose and why.

WATCH

The Corn Laws (Political Reform in 19th Century Britain - Part 3) #REPEEL

Tom Richey · 8:05

https://www.youtube.com/watch?v=-iostWBLJ0M

> **WHEN TO WATCH**
> After the story, before the big idea.

BACKUP VIDEO

The Corn Law debates

Marginal Revolution University · 6:38

https://www.youtube.com/watch?v=B3oCxfCMOcc

After the big idea, for the economists' side of the debate.

KEY TERMS

Corn Laws

British laws (in their strictest form from 1815) restricting imports of grain ("corn" in British usage) to keep domestic grain prices high.

import duty

A tax on imported goods.

import quota

A limit on the quantity of a good that may be imported.

free trade

Trade between countries without duties, quotas or other barriers.

Anti-Corn Law League

The campaign organization founded in Manchester in 1838, led by Richard Cobden and John Bright, that worked to repeal the Corn Laws.

CORE IDEAS

The story. After the Napoleonic Wars ended in 1815, grain prices in Britain fell as foreign grain became available again. Parliament, in which landowners held great power, passed a law forbidding imports of foreign wheat until the British price reached 80 shillings a quarter, a very high level. The law kept bread expensive for the growing population of factory towns. In 1838 manufacturers and reformers in Manchester founded the Anti-Corn Law League. Its leaders, the cotton manufacturer Richard Cobden and the Quaker mill owner John Bright, held thousands of meetings, published pamphlets and argued that the Corn Laws taxed the poor man's bread to enrich landlords. When a blight struck Ireland's potato crop in 1845 and famine began, the Prime Minister, Sir Robert Peel, decided the laws must go. Repeal passed in 1846, after a long and bitter fight in Parliament.

How they figured it out. The economists of the time had laid the groundwork. Smith had argued that it is wise to buy abroad what can be had more cheaply there (Lesson 1.4). Ricardo, in 1815, showed that the Corn Laws raised the rents of landowners at the expense of profits and wages, as more and poorer land was farmed to feed the nation. Cobden and Bright added a moral argument: trade between nations encourages peace and mutual dependence, and cheap bread is a mercy to the poor. After repeal, British grain imports rose, bread became cheaper over the following decades, and British agriculture, contrary to the warnings, continued to prosper for a generation by improving its methods.

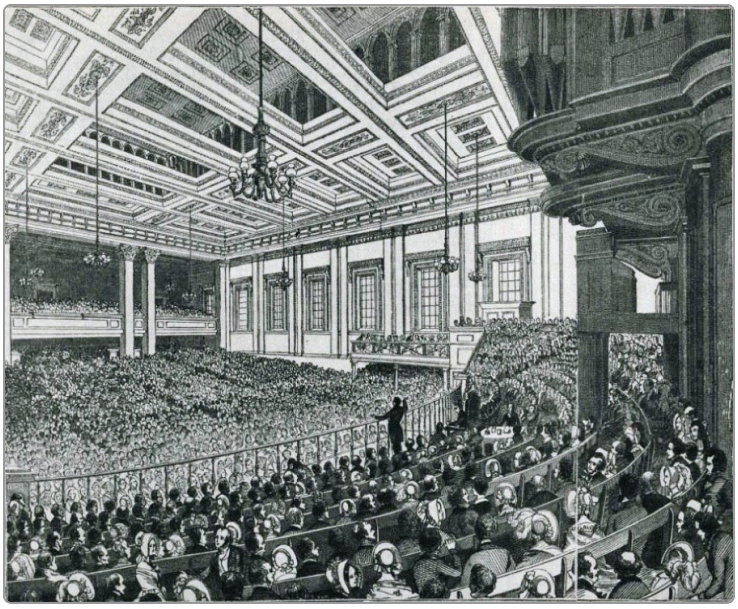
The big idea. An **import duty** raises the domestic price of the good. Domestic producers gain: they sell more at a higher price. The government gains the revenue on the remaining imports. Consumers lose more than producers and government together gain, because some consumers buy less and some production shifts to

higher-cost domestic farms. The difference is the deadweight loss. A quota works the same way, except that the gain on the remaining imports goes to whoever holds the import licenses. The case for trade does not say that no one loses; it says that the gains to the nation exceed the losses, so the winners could compensate the losers and still be better off.

In business today. Trade rules still affect what businesses pay for materials and what they can sell abroad, and they remain a subject of public debate. This lesson teaches the history of the Corn Laws and the economics of trade barriers, not a position on any present-day policy. A good business leader analyzes any trade rule with the same questions: who gains, who pays, how much, and what is not seen?

Who gained? Under the Corn Laws, landowners (financiers and risk-takers in agriculture) gained higher rents; farm workers gained little; factory workers and their families, the customers for bread, paid more; manufacturers paid higher wages to cover the cost of food; the community suffered most when harvests failed. After repeal, consumers and manufacturing gained, while landowners adjusted.

PICTURE STUDY



A meeting of the Anti-Corn Law League in Exeter Hall, Unknown artist, 1846 · Engraving · Published in the illustrated press, London

Image: Wikimedia Commons, public domain

The League held great public meetings across Britain, like this one in London's Exeter Hall, a building more often used for religious and charitable gatherings. Its campaign was one of the first modern public campaigns, with paid lecturers, mass mailings made possible by the new penny post, and petitions signed by millions.

Look closely

- Look at the size of the crowd. How many people might be there?
- Find the speakers' platform. How are the speakers arranged?
- Look at the galleries. Who might be sitting there?
- Look at the people's clothes. What classes of society can you see?

Talk about it

1. Why did manufacturers and workers both join the campaign against the Corn Laws?
2. How did the League use new technology (cheap printing, railways, the penny post) to spread its message?
3. Which stakeholders were in this hall, and which were not?

PROJECT

Calculate a Trade Barrier

You will build a spreadsheet model of an import duty, test different duty levels, and graph revenue, deadweight loss and imports, then apply it to the Corn Laws.

You will need

- A spreadsheet
- Graph paper
- Your ledger notebook

Steps

1. Enter the demand and supply equations from Worked Example 1 and the world price of 40.
2. Create columns for duties from 0 to 12 shillings in steps of 1.
3. For each duty, compute the domestic price, quantity demanded, quantity supplied, imports, revenue, consumer loss, producer gain and deadweight loss.
4. Graph revenue and deadweight loss against the duty. At what duty is revenue greatest?
5. Find the duty at which imports reach zero (the prohibitive duty).
6. Compare with the Corn Laws: what did the 80-shilling rule do to imports when harvests were good, and when harvests failed?
7. Write a one-page explanation of your results for a reader in 1840.

Tips

- Use formulas in the spreadsheet so the whole table updates when you change an input.
- Check one row by hand against the worked examples.

Check your work

- ☐ I can tell the history of the Corn Laws and their repeal.
- ☐ I can compute the effects of an import duty.

- [ ] I can explain who gains and who loses from trade barriers.

LEDGER NOTEBOOK

1. Copy your spreadsheet table and graphs.
2. Draw the import-duty diagram, labeling world price, domestic price, imports before and after, revenue and the two deadweight-loss triangles.
3. Write a timeline: 1815, 1838, 1845, 1846.

KEY FORMULAS

$$\text{With duty } t: P_{\text{domestic}} = P_{\text{world}} + t$$

$$\text{Revenue} = t \times \text{imports}$$

$$\text{Deadweight loss} = \tfrac{1}{2} t\,(\Delta Q_s) + \tfrac{1}{2} t\,(\Delta Q_d)$$

From history. Repeal split Peel's party and ended his time as Prime Minister soon after, but he defended it as the right thing to do. Cobden later negotiated a trade treaty with France (1860) that lowered duties on both sides.

WORKED EXAMPLES

Example 1. A country's wheat demand is $Q_d = 200 - 2P$ and domestic supply is $Q_s = 3P - 50$ (millions of bushels, price in shillings). The world price is 40. With free trade, find domestic production, consumption and imports.

Show solution

1. At P = 40: $Q_d = 120$, $Q_s = 70$.
2. Imports: $120 - 70 = 50$.

Answer: Production 70, consumption 120, imports 50 (millions of bushels).

Example 2. Now an import duty of 10 shillings is imposed. Find the new domestic price, production, consumption, imports, revenue and deadweight loss.

Show solution

1. Domestic price: $40 + 10 = 50$.
2. $Q_d = 200 - 100 = 100$; $Q_s = 150 - 50 = 100$.
3. Imports: $100 - 100 = 0$: the duty stops imports entirely, so revenue is 0.
4. Deadweight loss: $\tfrac{1}{2}(10)(100 - 70) + \tfrac{1}{2}(10)(120 - 100) = 150 + 100 = 250$ million shillings.

Answer: The price rises to 50, imports stop, the government collects nothing, and the deadweight loss is 250 million shillings: a prohibitive duty, like the Corn Laws at their strictest.

Example 3. With a smaller duty of 4 shillings, find production, consumption, imports, revenue and deadweight loss.

Show solution

1. Price 44: $Q_d = 112$, $Q_s = 82$; imports 30.
2. Revenue: $4 \times 30 = 120$.
3. Deadweight loss: $\tfrac{1}{2}(4)(12) + \tfrac{1}{2}(4)(8) = 24 + 16 = 40$.

Answer: Imports 30, revenue 120 and deadweight loss 40 (millions of shillings). Consumers lose $4 \times \frac{120+112}{2} = 464$, producers gain $4 \times \frac{70+82}{2} = 304$. The difference, 464 − 304 − 120 = 40, is the deadweight loss.

PRACTICE

1. Easy What did the Corn Law of 1815 forbid?

   Show answer

   Imports of foreign wheat until the British price reached 80 shillings a quarter.

2. Easy Who led the Anti-Corn Law League?

   Show answer

   Richard Cobden and John Bright.

3. Easy When were the Corn Laws repealed, and under which Prime Minister?

Show answer

1846, under Sir Robert Peel.

4. Medium World price 30, duty 5. Demand $Q_d = 100 - P$, supply $Q_s = P - 10$. Find imports before and after the duty.

Show answer

Before: 70 − 20 = 50. After (P = 35): 65 − 25 = 40.

5. Medium In problem 4, find the duty revenue and the deadweight loss.

Show answer

Revenue $5 \times 40 = 200$; DWL $\frac{1}{2}(5)(5) + \frac{1}{2}(5)(5) = 25$.

6. Medium Why did manufacturers support repeal of the Corn Laws?

Show answer

Cheaper bread meant workers could live on lower wages and had more to spend on manufactured goods; manufacturers also wanted foreign countries able to buy British goods with grain sales.

7. Medium How does a quota differ from a duty in who gets the gain on remaining imports?

Show answer

With a duty, the government collects revenue; with a quota, the holders of import licenses capture the price difference.

8. Hard Explain why consumers' losses from a duty exceed the gains to producers and government together.

Show answer

Some consumers stop buying, and some output shifts to higher-cost domestic producers; these lost trades and wasted resources are the deadweight loss.

9. Hard Why did the Irish famine bring the Corn Laws to a crisis?

Show answer

With millions facing starvation, keeping out cheap grain was indefensible; Peel concluded the laws must be repealed to allow food to flow freely.

10. **Challenge** In Worked Example 1, find the duty that maximizes revenue. (Hint: imports at duty t are $50 - 5t$.)

Show answer

Revenue $R = t(50 - 5t)$, maximized at $t = 5$, revenue $5 \times 25 = 125$ million shillings.

COMMON MISTAKES

- Thinking an import duty is paid only by foreigners. Domestic consumers pay the higher price.
- Forgetting the producer gain when calculating deadweight loss.
- Treating the Corn Law history as a statement about any current question of trade. It is history and principle.

> **Make it a game · Corn Law Speech and Sum.** Give a sixty-second speech, as if for the Anti-Corn Law League, on why free trade in grain helped families. Your parent then supplies a world price of 10, a duty of 4, and supply and demand schedules. Calculate the effect on price, quantity, government revenue and deadweight loss. Retell why the Corn Laws were repealed in 1846.

10.4 Capital, Innovation and Growth: Norman Borlaug's Wheat

OBJECTIVES

- Explain diminishing returns to capital and why capital alone cannot sustain growth.
- Explain how innovation sustains growth, using Norman Borlaug's high-yield wheat and Schumpeter's creative destruction.
- Compute output with a simple production function and growth from technology.

> **Warm-up.** A farmer with one tractor gets a second. Then a third. Then a tenth. How much extra does each new tractor help? What would make all the tractors more useful at once?

WATCH

The Iron Logic of Diminishing Returns (Solow Model Explained)

Marginal Revolution University · 5:02

https://www.youtube.com/watch?v=SljsIacQDbc

> **WHEN TO WATCH**
> After the big idea, before the worked examples.

BACKUP VIDEO

Norman Borlaug & The Green Revolution

ndsubeancap · 8:11

https://www.youtube.com/watch?v=Lg9-HTtgFOk

With the story of Borlaug.

KEY TERMS

capital deepening

Increasing the amount of capital per worker.

diminishing returns to capital

Each added unit of capital, with other inputs fixed, adds less output than the one before.

total factor productivity

Output beyond what capital and labor alone explain, reflecting technology and organization.

innovation

A new product, method or organization put into practical use.

creative destruction

Joseph Schumpeter's term (1942) for the process by which new products and firms replace old ones.

CORE IDEAS

The story. In 1944 Norman Borlaug, a young plant scientist from an Iowa farm family of Norwegian descent, went to Mexico to fight a fungus called stem rust that was destroying wheat. He and his team crossed thousands of varieties by hand and, to speed the work, grew two generations a year, one in the cool highlands and one in the warm northwest. They bred wheat that resisted rust and, crucially, short-stemmed "semi-dwarf" wheat that could carry heavy heads of grain without falling over when fertilized. Mexico, which had imported much of its wheat, became self-sufficient by the 1950s. In the mid-1960s, with famine feared in India and Pakistan, Borlaug's seed was shipped there; within a few years wheat production in both countries rose dramatically. Borlaug received the Nobel Peace Prize in 1970.

How they figured it out. Economists had shown why innovation like Borlaug's matters so much. In 1956 the economist Robert Solow built a model of growth in which output depends on capital and labor. Adding more capital per worker raises output, but with diminishing returns: the tenth tractor adds less than the first. If saving and investment alone drove growth, growth would slow and stop. Solow found that most of the long-run rise in American output per worker came instead from improvements in technology and methods, the part later called total factor productivity. Earlier, in 1942, Joseph Schumpeter had described how innovation drives capitalism forward by "creative destruction": new products and methods replace old ones, and new firms displace old ones.

The big idea. Growth comes from three sources: more capital, better-trained workers, and better technology. The first two are essential but run into diminishing returns. Only steady innovation, new ideas put to work, can raise output per worker year after year without limit. Ideas are special: one person's use of a better seed or a

better method does not use it up for others. Innovation depends on research, education, property rights in inventions (patents, Lesson 3.4), and freedom to try new things and to fail. Creative destruction brings real losses to the people and firms displaced, which is why wise societies help workers retrain and move to new work.

In business today. Firms invest in research and development, training and new equipment to raise productivity. Farmers adopt better seeds and methods; factories adopt automation; offices adopt new software. Every innovation creates winners and losers, and successful companies often fail when they cannot adapt. Borlaug's life shows another side of innovation: work done not for riches but to feed the hungry. He was raised in a Lutheran home and spoke often of the duty to use science to serve the poor.

Who gained? Hundreds of millions of people gained food, and farmers gained higher yields and incomes; the foundations and governments that financed the research saw a remarkable return; the scientists and workers who bred the seed gained little money but much honor. Critics later noted costs: heavier use of fertilizer and water, and advantages to farmers who could afford them. Weighed fairly, the gains in lives were immense.

PICTURE STUDY



Forging the Shaft, John Ferguson Weir, 1874–1877 · Oil on canvas · The Metropolitan Museum of Art, New York

Image: Wikimedia Commons, public domain

Weir painted the West Point Foundry in Cold Spring, New York, as workers forged a propeller shaft for a steamship. The scene shows capital at its most dramatic: furnaces, cranes and enormous hammers, guided by teams of skilled men. Weir painted it as a scene of almost heroic labor.

Look closely

- Find the glowing shaft. How is it being moved?
- Count the workers you can see. What is each one doing?
- Look at the crane and the furnace. What do they tell you about the capital needed?
- Look at the light and shadow. How does the painter make the work seem important?

Talk about it

1. How does this picture show capital and labor working together?
2. What would happen to this foundry's output if it added more cranes but no new methods?
3. What innovations might later have replaced some of this work?

PROJECT

A Growth Experiment with Your Own Production Function

You will measure how output changes as you add "capital" (tools) to a simple task, and then how much a better method changes it, separating capital deepening from innovation.

You will need

- A simple task (sorting coins, folding letters, assembling paper boxes)
- Tools that help (a coin tray, a bone folder, a template)
- A timer
- A spreadsheet

Steps

1. Time yourself doing the task for 3 minutes with no tools. Record output.
2. Add one tool and repeat. Then add a second and third tool. Record output each time.
3. Compute the extra output from each added tool. Do you see diminishing returns?
4. Now invent or look up a better method for the task (a new folding order, a sorting rule) and repeat with your original tools.
5. Compare the gain from the new method with the gain from adding tools.
6. Fit your data roughly to $y = A\sqrt{k}$ (count each tool as one unit of k) and estimate A before and after the new method.
7. Write a paragraph comparing your results with Solow's finding and with Borlaug's seed.

Tips

- Practice the task once before timing so learning does not swamp the results.
- Repeat each round twice and use the average.

Check your work

☐ I can explain diminishing returns to capital.

☐ I can explain why innovation sustains growth.

- [ ] I can compute growth contributions with a simple production function.

LEDGER NOTEBOOK

1. Copy your output table and the estimated A before and after the new method.
2. Graph output per worker against capital per worker for two values of A.
3. Write a short biography of Norman Borlaug with three dates.

KEY FORMULAS

$$Y = A\,K^{\alpha}L^{1-\alpha}$$

$$\text{Output per worker: } y = A\,k^{\alpha}, \quad k = K/L$$

$$\%\Delta Y \approx \%\Delta A + \alpha\,\%\Delta K + (1-\alpha)\,\%\Delta L$$

From history. Borlaug kept working into his nineties, promoting agricultural research in Africa. He received the Congressional Gold Medal in 2007, two years before his death, and his statue stands in the U.S. Capitol for the state of Iowa.

WORKED EXAMPLES

Example 1. Output per worker is $y = 10\sqrt{k}$. Find output per worker when capital per worker is 1, 4, 9 and 16, and the extra output from each step.

Show solution

1. k = 1: y = 10. k = 4: y = 20. k = 9: y = 30. k = 16: y = 40.
2. Each step adds 10 units of output, but needs more capital each time: 3, then 5, then 7 units of k.

Answer: Output rises by 10 each time while the capital needed rises from 3 to 5 to 7: diminishing returns to capital.

Example 2. Now technology doubles A from 10 to 20 with $k = 9$. Compare output with adding capital to reach the same output with A = 10.

Show solution

1. With A = 20: $y = 20 \times 3 = 60$.
2. With A = 10, y = 60 requires $\sqrt{k} = 6$, so $k = 36$, four times as much capital.

Answer: Doubling technology gives the same output as quadrupling capital.

Example 3. Capital grows 4% a year, labor one percent, output 3%, with α = 0.3. Estimate the contribution of technology (total factor productivity).

Show solution

1. $3 \approx \%\Delta A + 0.3(4) + 0.7(1)$.
2. $\%\Delta A \approx 3 - 1.2 - 0.7 = 1.1\%$.

Answer: About 1.1 percentage points of the 3% growth come from technology and better methods.

PRACTICE

1. Easy What problem did Borlaug first work on in Mexico?

   Show answer

   Stem rust, a fungus destroying wheat.

2. Easy What is diminishing returns to capital?

   Show answer

   Each added unit of capital adds less output than the one before, with other inputs fixed.

3. Easy What did Schumpeter call the process of new products and firms replacing old ones?

   Show answer

   Creative destruction.

4. Medium With $y = 5\sqrt{k}$, find y at k = 25 and k = 36.

   Show answer

   25 and 30.

5. Medium Why can saving and investment alone not sustain growth forever?

   Show answer

   Diminishing returns mean each added unit of capital adds less, so growth slows; only better technology keeps raising output per worker.

6. Medium Why were semi-dwarf wheat varieties important?

Show answer

Short stems could carry heavy heads of grain under fertilizer without falling over, greatly raising yields.

7. Medium Output grows 2.5%, capital 3%, labor 0.5%, α = 0.35. Estimate TFP growth.

Show answer

$2.5 - 1.05 - 0.325 \approx 1.1\%$.

8. Hard Why are ideas different from machines as sources of growth?

Show answer

An idea can be used by many people at once without being used up, so it can raise output everywhere; a machine can be used by only one worker at a time.

9. Hard Using the six stakeholders, weigh the spread of high-yield seeds in the 1960s.

Show answer

Customers (consumers) gained cheaper food and famine relief; farmers who adopted the seeds gained yields; financiers (foundations, governments) gained a great return; costs included heavier fertilizer and water use and uneven benefits among farmers; the community of hundreds of millions gained food security.

10. Challenge With $y = Ak^{0.5}$, how much must k rise to raise y by 50% with A fixed? How much must A rise to do the same with k fixed?

Show answer

k must rise $1.5^2 = 2.25$ times (125% more); A must rise only 50%.

COMMON MISTAKES

- Thinking more machines alone can make a nation rich forever. Diminishing returns set in.
- Treating technology as only gadgets. Better methods, organization and seeds count too.
- Ignoring the losers from creative destruction.

Make it a game · Who Am I Innovator. Your parent reads clues about Norman Borlaug and Joseph Schumpeter, one clue at a time, and you guess who is described and what idea they stand for. Then use a fertilizer-yield table from your parent to compute marginal product and find where diminishing returns begin. Explain why capital alone cannot sustain growth without innovation.

10.5 Capstone: Writing Economic History, with John Law's Mississippi Bubble as a Model

OBJECTIVES

- Plan and write a research paper on an episode in economic history using primary and secondary sources.
- Analyze a historical episode (John Law's Mississippi scheme, 1716–1720) with the tools of the whole course.
- Cite sources honestly and support claims with data.

> **Warm-up.** Name three episodes from this course that you would like to know more about. For each, write one question you would want a research paper to answer.

WATCH

John Law and the Mississippi Bubble

NFB · 9:43

https://www.youtube.com/watch?v=diEVmQZ1QfM

> **WHEN TO WATCH**
> After the story, before the model outline.

KEY TERMS

primary source
A document or object from the time being studied: a letter, a newspaper, a price list, a law, a photograph.

secondary source
A later work that interprets the past, such as a history book or scholarly article.

thesis
The main claim a paper argues, stated clearly early on.

citation
A note telling the reader exactly where a fact or quotation came from.

speculative bubble

A period when an asset's price rises far above any reasonable value because buyers expect to sell to others at higher prices, followed by a collapse.

CORE IDEAS

The story. John Law, a Scottish financier with a brilliant mind for numbers, persuaded the French regent in 1716 to let him open a bank, the Banque Générale, that issued paper notes. France was deep in debt after the wars of Louis XIV. Law then took over the Mississippi Company, which held a monopoly of trade with French Louisiana, merged it with other trading companies and offered its shares in exchange for government debt. He promised riches from the colonies and kept issuing banknotes to help people buy shares. In 1719 the price of a share, first issued at 500 livres, rose to about 10,000 livres. Crowds jammed the narrow Rue Quincampoix in Paris to trade them; the word *millionaire* came into use.

How they figured it out. In 1720 the scheme unraveled. The colony produced little, profits could not justify the price, and holders began selling shares and turning banknotes into gold and silver. Law tried to stop them with decrees limiting the gold and silver anyone could hold and by forcing down the share price. Confidence collapsed; share prices and banknotes fell toward worthlessness, and Law fled France in December 1720, poor. The same year, London had its own South Sea Bubble; even Sir Isaac Newton is said to have lost a large sum in it. Historians and economists have studied both bubbles ever since, using letters, share price lists, decrees and the satirical prints and plays of 1720 as primary sources.

The big idea. A research paper in economic history asks a clear question, gathers evidence, and answers it with a thesis supported by data and reasoning. Law's scheme is a model case because it uses nearly every tool of this course: money and banking (Units 4–5), fiat money and inflation (Unit 6), monopoly (Unit 3), incentives and prices (Units 1–2), government rules that backfired (Units 7–8) and the six stakeholders. A good paper separates what happened (facts, with citations) from why it happened (analysis) and what it means (judgment), and treats the people of the past fairly. Proverbs warns that "he that maketh haste to be rich shall not be innocent" (Proverbs 28:20); a historian's task is to show how that haste played out, with honesty about both the folly and the real innovations involved.

In business today. Businesses rely on the same research skills: framing a question, finding reliable data, checking sources, writing a clear argument, and presenting it honestly. Investors study past bubbles to recognize the signs: prices rising far faster than earnings, borrowing to buy, and a widespread belief that this time is different.

Who gained? A few early sellers gained fortunes; most later buyers lost heavily; the French government reduced its debt but lost the public's trust in paper money and banks for generations; Law, the risk-taker and builder of the scheme, ended in poverty. His failure delayed the development of banking in France for decades.

PICTURE STUDY



Rue Quincampoix in the year 1720, Antoine Humblot (engraver), about 1720 · Engraving · Musée Carnavalet, Paris

Image: Wikimedia Commons, public domain

The Rue Quincampoix was a narrow street in Paris where shares of the Mississippi Company were traded in 1719–1720. Contemporary accounts describe crowds so dense that carriages could not pass, rooms rented by the hour for trading, and fortunes made and lost in days. This print, made at the time, is a primary source for the bubble.

Look closely

- Look at the crowd. How tightly packed is it?
- Find people holding papers. What might they be?
- Look at the windows and doorways of the houses. Who is watching?
- Find the carriages and horses. Can they move?

Talk about it

1. What does this print tell a historian that a table of share prices cannot?
2. What questions would you ask about who made this print and why?
3. How does the scene show the incentives of a bubble?

PROJECT

The Capstone Research Paper

You will write a research paper of 1,500–2,500 words on an episode in economic history, using at least two primary sources and three secondary sources, with at least one table or graph of real data and a stakeholder analysis.

You will need

- Library and online sources (Federal Reserve History, Project Gutenberg, the Library of Congress, FRED, scholarly books)
- A word processor and spreadsheet
- Your ledger notebook for notes

Steps

1. Choose an episode (from this course or beyond): for example, Potosí and the rise in prices it caused, the Panic of 1907, Bretton Woods, the Corn Laws, the Weimar hyperinflation, the Mississippi Bubble, or the Staggers Act.
2. Write a research question and get it approved by your parent or teacher.
3. Find at least two primary sources (laws, letters, price lists, newspapers, photographs) and three secondary sources. Record full citations.
4. Take notes in your own words, marking quotations exactly and noting page numbers.
5. Gather data for at least one table or graph (prices, output, money, trade) and analyze it with a tool from this course.
6. Write a thesis and an outline, then a first draft with an introduction, body sections, a stakeholder analysis and a conclusion.
7. Revise for clarity, accuracy and fairness; check every citation; read the paper aloud to a family member.
8. Prepare a five-minute oral summary to present to your family.

Tips

- Choose a narrow question; a good paper goes deep, not wide.
- Quote briefly; explain in your own words. Never present another writer’s words or ideas as your own.

Check your work

- ☐ I can frame a question and a thesis.
- ☐ I can use and cite primary and secondary sources.
- ☐ I can analyze an episode with data and the six stakeholders.

LEDGER NOTEBOOK

1. Keep your research notes, with a citation for each.
2. Make a timeline of your episode.
3. Draw a graph of your key data series.

KEY FORMULAS

$$\text{Return} = \frac{P_{\text{sell}} - P_{\text{buy}}}{P_{\text{buy}}} \times 100\%$$

$$\text{Price–earnings ratio} = \frac{\text{share price}}{\text{earnings per share}}$$

From history. Law died in Venice in 1729, still trying to win back his fortune. Some historians now credit him with ideas, about paper money and credit, that were ahead of his time, even as his scheme showed their dangers when pushed too far and too fast.

WORKED EXAMPLES

Example 1. A Mississippi share issued at 500 livres rose to 10,000 livres in 1719 and fell to about 2,000 livres by late 1720. Find the return for a buyer at 500 who sold at the peak, and for a buyer at the peak who sold at 2,000.

Show solution

1. Early buyer: $(10{,}000 - 500)/500 = 1{,}900\%$.
2. Peak buyer: $(2{,}000 - 10{,}000)/10{,}000 = -80\%$.

Answer: The early seller gained 1,900%; the peak buyer lost 80%. (Rounded historical figures; sources vary.)

Example 2. Suppose the company was expected to pay a dividend of 200 livres a share, and investors expected a 4% return on safe investments. What share price does the dividend justify? Compare with 10,000.

Show solution

1. Price justified: $200 / 0.04 = 5{,}000$ livres.
2. The peak price was twice that, and the expected dividend itself depended on colonial profits that never came.

Answer: About 5,000 livres at most; the peak of 10,000 required buyers to expect others to pay even more: the mark of a bubble.

Example 3. Write a thesis and outline for a paper on the Mississippi Bubble.

Show solution

1. Question: Why did John Law's scheme collapse in 1720?
2. Thesis: The scheme collapsed because Law issued paper money far faster than the real wealth behind it grew, so that when holders tried to turn notes and shares into gold, no promise could be kept.
3. Outline: (1) France's debt and Law's ideas; (2) the bank and the company, 1716–1719; (3) the rise in share prices and notes, with data; (4) the collapse in 1720 and Law's decrees; (5) the stakeholders; (6) conclusion and lessons.
4. Sources: primary (decrees, price lists, letters, prints of 1720) and secondary (scholarly histories).

Answer: A clear question, a debatable thesis, an outline in logical order and a plan for sources.

PRACTICE

1. Easy What is the difference between a primary and a secondary source?

   Show answer

   A primary source comes from the time studied; a secondary source is a later interpretation.

2. Easy Who was John Law, and what company did he control?

Show answer

A Scottish financier who founded a bank in France (1716) and controlled the Mississippi Company.

3. Easy In what year did the Mississippi Bubble collapse?

Show answer

1720.

4. Medium What is a thesis? Give an example for a paper on the Corn Laws.

Show answer

The main claim a paper argues. Example: The Corn Laws were repealed in 1846 because the Irish famine made the cost of protecting landowners' rents morally and practically indefensible.

5. Medium A share bought at 1,500 is sold at 9,000. Find the return.

Show answer

500%.

6. Medium Name three tools from this course that help explain Law's scheme.

Show answer

Fiat money and the quantity equation, bank runs and convertibility, monopoly, incentives, price controls/decrees that backfired (any three).

7. Medium Why must a paper's citations be exact?

Show answer

So readers can check the evidence, and so the writer gives honest credit to others' work.

8. Hard A company pays 150 a year in dividends and safe investments yield 5%. What price does the dividend justify? If the share trades at 9,000, what does that imply?

Show answer

$150 / 0.05 = 3{,}000$; a price of 9,000 implies buyers expect much higher future dividends or are counting on resale to others: bubble conditions.

9. Hard How would you judge whether a satirical print from 1720 is a reliable source?

Show answer

Ask who made it, when, for whom and why; compare it with other sources; use it as evidence of attitudes, not as an exact record of events.

10. Challenge Law's notes in circulation rose from about 100 million livres in 1718 to about 2.7 billion in mid-1720 (rounded estimates). By what factor did they rise? Using the quantity equation, what would you expect to happen to prices, and what did Law's decrees try to prevent?

Show answer

About 27 times. With output far from rising 27-fold, prices would rise sharply; Law's decrees tried to stop people from turning notes into gold and silver and to hold down prices, but they destroyed confidence.

COMMON MISTAKES

- Choosing a topic too broad to cover well.
- Mixing facts and opinions without signaling which is which.
- Copying sources' words without quotation marks and citation.

Make it a game · Thesis Showdown. Write a one-sentence thesis about John Law's Mississippi scheme in two minutes. Your parent challenges it, asking for a primary source and a secondary source that would support it. Defend the thesis in thirty seconds, then revise it. Track the price of a pretend Mississippi share through six rounds of speculation and collapse to see a bubble.

Scripture. "A faithful man shall abound with blessings: but he that maketh haste to be rich shall not be innocent." (Proverbs 28:20, KJV)

The bubbles of 1720 were driven by haste to be rich. Faithfulness, patience and honest work build lasting wealth.

UNIT 10

Trade and the Wealth of Nations

The last unit returns to Adam Smith's great question: what makes nations wealthy? You will trace trade from the caravans of the Silk Road and the merchants of Amsterdam to Malcom McLean's first container ship in 1956, learn how exchange rates and purchasing power parity work, and study the Corn Laws, whose repeal in 1846 became the most famous episode in the history of the case for trade.

Then you will see how capital and, above all, innovation sustain growth, through Robert Solow's model and Norman Borlaug's wheat, which fed hundreds of millions. The course ends with a capstone research paper on an episode in economic history of your choice, modeled on John Law's Mississippi Bubble of 1720, which draws on nearly every tool you have learned.

PREREQUISITES

- Units 1–9
- Spreadsheet skills for tables and graphs
- Research and citation skills (taught in Lesson 10.5)

MASTERY CHECKLIST

- ☐ I can explain how falling transport costs widened markets and compute transport-cost savings.
- ☐ I can convert currencies, compute appreciation and depreciation, and apply purchasing power parity.
- ☐ I can tell the history of the Corn Laws and compute the effects of an import duty.
- ☐ I can explain diminishing returns to capital and why innovation sustains growth.
- ☐ I can write a research paper in economic history with primary sources, data and a stakeholder analysis.

OPTIONAL BOOKS AND GAMES FOR THIS UNIT

- ***The Wealth of Nations*, Book IV, chapter 2**: Free. Smith's argument about restraints on imports, including the famous "invisible hand" passage. Read with Lesson 10.3. Ages 15+.
- **Federal Reserve History (federalreservehistory.org)**: Free. Reliable essays and primary-source links for capstone topics in American monetary history.
- **Library of Congress digital collections**: Free; browse the digital collections at loc.gov. Photographs, newspapers and documents for primary sources in the capstone paper.

Not required. Every project in this unit works without them. School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

10.1 Trade Through History: From the Silk Road to the Container Ship

3 sessions of 50 minutes

10.2 Exchange Rates and Purchasing Power Parity 3 sessions of 50 minutes

10.3 The Corn Laws and the Case for Trade 3 sessions of 50 minutes

10.4 Capital, Innovation and Growth: Norman Borlaug's Wheat

3 sessions of 50 minutes

10.5 Capstone: Writing Economic History, with John Law's Mississippi Bubble as a Model

3 sessions of 50 minutes

Unit 10 test

Calculators are allowed. Show your work for every calculation: write the formula, substitute and solve. Answer the concept questions in complete sentences. The test is worth 100 points.

1. **6 pts**

   Tell the story of the Ideal-X and explain why containers lowered transport costs.

2. **6 pts**

   Loading costs fall from $5.50 to $0.25 a ton. Find the savings on 40,000 tons and the percent reduction.

3. **6 pts**

   How does cheaper transport extend the division of labor?

4. **6 pts**

   The rate moves from 0.85 to 0.95 euros per dollar. Did the dollar appreciate or depreciate, by how much, and what happens to the dollar price of a €190 item?

5. **8 pts**

   A good costs $4.00 in the U.S. and 26 yuan in China; the market rate is 7.2 yuan per dollar. (a) Find the PPP rate. (b) Is the yuan over- or undervalued by this test, and by how much?

6. **6 pts**

   Why do exchange rates often stray from PPP for long periods?

7. **6 pts**

   Describe the Corn Law of 1815, the campaign against it and its repeal.

8. **12 pts**

   Demand $Q_d = 150 - 2P$, supply $Q_s = 2P - 10$, world price 30. (a) Find imports with free trade. (b) A duty of 5 is imposed: find imports, revenue and deadweight loss.

9. **6 pts**

   Who gained and who lost from the Corn Laws?

10. **8 pts**

    With $y = 4\sqrt{k}$: (a) find y at k = 16 and k = 64; (b) what rise in A (from 4) would give the same output at k = 16 as k = 64 gives?

11. **6 pts**

    Explain why innovation, not capital alone, sustains long-run growth.

12. **6 pts**

Describe Norman Borlaug’s achievement and one cost critics noted.

13. **6 pts**

A Mississippi share rose from 500 to 10,000 livres and fell to 2,000. Find the return for buying at 500 and selling at 2,000.

14. **12 pts**

Short essay: Choose one episode from this course and explain how at least three tools you have learned (for example opportunity cost, supply and demand, the quantity equation, comparative advantage, the six stakeholders) help explain what happened.

ANSWER KEY

1. On April 26, 1956, McLean's Ideal-X carried 58 containers from Newark to Houston. Standard sealed boxes lifted by crane cut loading time, labor, theft and damage, lowering costs dramatically.
2. \$210,000; about 95%.
3. It widens the market each producer can reach, so producers can specialize further, as Smith said: the division of labor is limited by the extent of the market.
4. Appreciated by about 11.8%; price falls from about \$224 to \$200.
5. (a) 6.5 yuan per dollar. (b) Undervalued: at 7.2 the good costs $26/7.2 \approx \$3.61$ in China, about 10% less than in the U.S.
6. Many goods and services are not traded, transport costs and duties exist, and currencies are bought and sold for investment.
7. It barred foreign wheat until the British price reached 80 shillings. The Anti-Corn Law League (1838), led by Cobden and Bright, campaigned against it; after the Irish famine began, Peel won repeal in 1846.
8. (a) $Q_d = 90$, $Q_s = 50$; imports 40. (b) At 35: $Q_d = 80$, $Q_s = 60$; imports 20; revenue 100; DWL $\frac{1}{2}(5)(10) + \frac{1}{2}(5)(10) = 50$.
9. Landowners gained higher rents; consumers, especially factory workers' families, paid more for bread; manufacturers paid higher wages; the nation lost from the deadweight loss and suffered most in famine years.
10. (a) 16 and 32. (b) A must double to 8.
11. Capital faces diminishing returns; new ideas raise the productivity of all inputs and can be used by many at once.
12. He bred rust-resistant, semi-dwarf high-yield wheat that made Mexico self-sufficient and greatly raised wheat output in India and Pakistan in the 1960s, earning the 1970 Nobel Peace Prize. Critics noted heavier fertilizer and water use and uneven benefits.
13. 300%.
14. A strong answer chooses a well-defined episode, applies three tools accurately with at least one calculation, weighs the stakeholders and reaches a balanced conclusion.

PORTFOLIO PIECE: THE CAPSTONE RESEARCH PAPER

Your portfolio for this unit is the research paper from Lesson 10.5: 1,500–2,500 words on an episode in economic history, with at least two primary and three secondary sources, at least one table or graph of real data, a stakeholder analysis, and a short oral summary presented to your family.

LOOK FOR	WHAT IT MEANS
Question and thesis	A clear, focused question and a debatable thesis stated early.
Evidence	Primary and secondary sources are used accurately and cited fully; data are correct and well presented.
Analysis	Tools from the course are applied correctly; the six stakeholders are weighed fairly.
Writing and presentation	Clear, organized, honest and free of partisan language; the oral summary is confident and accurate.

COURSE EXAM

Midterm Exam

Covers Units 1–5. Time: 100 minutes.

You have 100 minutes. A calculator is allowed; no notes. For every calculation, write the formula, substitute the numbers and give the answer with units. Answer concept questions in complete sentences. Correct work earns partial credit even if a final number slips. The exam has 25 problems worth 4 points each, a total of 100 points.

---

1. **4 pts** **Lesson 1.1**

   Define opportunity cost. A student gives up a job paying $12 an hour for 10 hours a week to take a free class; her next-best alternative was the job. What is the weekly opportunity cost?

2. **4 pts** **Lesson 1.1**

   A PPF passes through (0, 60), (10, 50), (20, 30), (30, 0) (tools, food). Find the opportunity cost of each group of 10 tools.

3. **4 pts** **Lesson 1.2**

   What changed at Plymouth in 1623, and why did it change behavior?

4. **4 pts** **Lesson 1.3**

   Total benefits of 1–4 hours of practice: 30, 50, 62, 68. Each hour costs 10. How many hours should be chosen?

5. **4 pts** **Lesson 1.3**

   State and resolve the diamond-water paradox in two sentences.

6. **4 pts** **Lesson 1.4**

   A makes 8 shirts or 4 hats a day; B makes 6 shirts or 1 hat. Who has the comparative advantage in hats? Give terms of trade that help both.

7. **4 pts** **Lesson 1.5**

   State Wesley’s three rules and define human capital.

8. **4 pts** **Lesson 2.1**

   Distinguish a change in demand from a change in quantity demanded, with a Model T example.

9. **4 pts** **Lesson 2.2**

   Name the supply shifter and direction: (a) a new drilling method; (b) higher steel prices for pipe; (c) a tax per barrel.

10. **4 pts** **Lesson 2.3**

    Demand $Q_d = 90 - 3P$, supply $Q_s = 2P - 10$. Find the equilibrium.

11. **4 pts** **Lesson 2.4**

    Price rises from \$8 to \$12 and quantity falls from 110 to 90. Find the midpoint elasticity and say what happens to revenue.

12. **4 pts** **Lesson 2.5**

    Using the equations in problem 10, find the shortage at a ceiling of 16.

13. **4 pts** **Lesson 2.5**

    Summarize Hayek's tin example in two sentences.

14. **4 pts** **Lesson 3.1**

    A competitive firm sells at \$20; MC of units 1–5 is \$8, \$12, \$16, \$20, \$26; ATC at 4 units is \$15. Find output and profit.

15. **4 pts** **Lesson 3.2**

    Why do monopolistically competitive firms earn zero economic profit in the long run?

16. **4 pts** **Lesson 3.3**

    Payoffs (A, B): both Hold (60, 60); A Cut, B Hold (80, 30); A Hold, B Cut (30, 80); both Cut (40, 40). Find the Nash equilibrium and explain the dilemma.

17. **4 pts** **Lesson 3.4**

    Monopoly demand $P = 60 - Q$, MC = 20. Find Q, P, profit and deadweight loss.

18. **4 pts** **Lesson 3.5**

    Why are natural monopolies usually regulated rather than broken up? What price do regulators usually set?

19. **4 pts** **Lesson 4.1**

    How many barter exchange rates are needed for 60 goods?

20. **4 pts** **Lesson 4.2–4.3**

Define seigniorage and debasement, and state Gresham’s law.

21. **4 pts** **Lesson 4.4**

A merchant sends 300 florins to Bruges at 54 groats per florin; the return bill is at 60 groats per florin. How many florins return, and what is the bank’s percent gain?

22. **4 pts** **Lesson 4.5**

M = 600, V = 5, Y = 1,500. Find P. If M rises 20% with V and Y unchanged, find the new P.

23. **4 pts** **Lesson 5.1**

A $4,000 deposit enters a system with a 20% reserve ratio. Find the multiplier and maximum total deposits.

24. **4 pts** **Lesson 5.2–5.4**

State Bagehot’s rule and name two features of the Federal Reserve’s design in 1913.

25. **4 pts** **Lesson 5.5**

The U.S. gold price was $20.67 and the British £4.2477 an ounce. Find mint parity and explain Hume’s price-specie-flow mechanism in one sentence.

ANSWER KEY

1. The value of the best alternative given up: $10 \times \$12 = \$120$ a week.
2. 1, 2 and 3 units of food per tool: increasing opportunity cost.
3. Families received plots for their own use instead of working for a common store; each now kept the fruit of its labor, so effort rose.
4. Marginal benefits 30, 20, 12, 6; choose 3 hours (12 ≥ 10, but 6 < 10).
5. Water is more useful than diamonds yet cheaper. Price reflects marginal utility: water is plentiful so its last unit is worth little, while diamonds are scarce.
6. A: 1 hat costs 2 shirts; B: 6 shirts. A has it in hats, B in shirts. Any rate between 2 and 6 shirts per hat.
7. Gain all you can, save all you can, give all you can. Human capital is the skill, knowledge, health and habits that make a person productive.
8. Ford's price cuts changed quantity demanded (movement along); rising incomes and better roads changed demand (shift).
9. (a) technology, right; (b) input cost, left; (c) tax, left.
10. $90 - 3P = 2P - 10$, $P = 20$, $Q = 30$.
11. $\%\Delta Q = -20/100 = -20\%$; $\%\Delta P = 4/10 = 40\%$; $E = 0.5$ (inelastic); revenue rises from \$880 to \$1,080.
12. $Q_d = 42$, $Q_s = 22$; shortage 20.
13. When tin becomes scarcer for any reason, its price rises and users economize without needing to know why. Prices carry dispersed knowledge no planner could gather.
14. 4 units; $(20 - 15)(4) = \$20$.
15. Profits attract entrants with close substitutes, shifting each firm's demand down until price equals average total cost.
16. Cut is dominant for both, so both Cut (40, 40), though both Hold (60, 60) is better: individual incentives defeat cooperation.
17. $MR = 60 - 2Q = 20$, $Q = 20$, $P = 40$, profit \$400; competitive Q = 40; DWL $\frac{1}{2}(20)(20) = \$200$.
18. One firm serves the market at the lowest average cost; breaking it up raises costs. Regulators usually require average-cost pricing.
19. $60 \times 59/2 = 1{,}770$.

20. Seigniorage: the issuer's profit from face value above production cost. Debasement: cutting precious metal while keeping face value. Gresham's law: bad money drives out good when both must be accepted at the same value.
21. $16{,}200/60 = 270$ florins; the bank gains 30 florins, 10%.
22. $P = 2$; new $P = 2.4$.
23. 5; \$20,000.
24. Lend freely, against good collateral, at a high rate. Twelve regional Reserve Banks under a Board; a discount window and an elastic currency (Federal Reserve notes), still tied to gold.
25. $\approx$ \$4.87 per pound. Gold flows from deficit to surplus countries, lowering prices in the first and raising them in the second until trade balances.

COURSE EXAM

Final Exam

Covers Units 1–10. Time: 120 minutes.

You have 120 minutes. A calculator is allowed; no notes. For every calculation, write the formula, substitute the numbers and give the answer with units. Answer concept questions in complete sentences. Correct work earns partial credit even if a final number slips. The exam has 27 problems: problems 1–4 are worth 2 points each and problems 5–27 are worth 4 points each, a total of 100 points. Problem 27 is a short essay.

---

1. **2 pts** **Lesson 1.1–1.3**

   Explain opportunity cost and marginal thinking with one example each.

2. **2 pts** **Lesson 1.4**

   Country A: 6 cars or 30 tons of grain per worker; B: 2 cars or 20 tons. Who should make cars? Give terms of trade.

3. **2 pts** **Lesson 2.3**

   Demand $Q_d = 120 - 4P$, supply $Q_s = 2P$. Find the equilibrium and the surplus at a floor of 25.

4. **2 pts** **Lesson 2.4**

   Explain King's Law and the total-revenue test.

5. **4 pts** **Lesson 3.4**

   Monopoly demand $P = 100 - 2Q$, MC = 20, fixed cost 300. Find Q, P and profit.

6. **4 pts** **Lesson 3.5**

   Compare the breakups of Standard Oil (1911) and the Bell System (1984).

7. **4 pts** **Lesson 4.3**

   A coin falls from 3.6 g of silver to 1.8 g. If prices adjust to silver content, by what percent do prices rise? Why is debasement a hidden tax?

8. **4 pts** **Lesson 4.5**

   Money grows 7%, velocity is steady, output grows 3%. Estimate inflation. Prices doubled over 50 years: find the average annual rate.

9. **4 pts** **Lesson 5.1**

   Why can a sound bank fail in a run, and what two institutions were created to prevent such failures?

10. **4 pts** **Lesson 6.1**

    Find the devaluation of the dollar when gold went from $20.67 to $35, and name one group that lost.

11. **4 pts** **Lesson 6.2–6.3**

    Explain the Triffin dilemma and what happened on August 15, 1971.

12. **4 pts** **Lesson 6.4**

    Nominal rate 6%, expected inflation 4%: find the real rate. With Taylor's rule ($r^* = 1$, $\pi^* = 2$), inflation 4% and a zero gap, find the suggested rate.

13. **4 pts** **Lesson 6.5**

    A basket costs $250, then $265, then $286.20. Find the CPI each year (first = 100) and inflation each year.

14. **4 pts** **Lesson 7.1–7.2**

    Output with 1–4 workers: 50, 90, 120, 140. Price $4, wage $100. Find MRP of each worker and the number to hire.

15. **4 pts** **Lesson 7.3**

    A worker earns $22 an hour and works 46 hours. Find the week's pay under the FLSA.

16. **4 pts** **Lesson 7.4**

    Each of 400 workers has a 2.5% chance of a $16,000 injury per year. Find the expected loss and the premium with a 20% loading.

17. **4 pts** **Lesson 7.5**

    Demand $Q_d = 100 - P$, supply $Q_s = P - 20$. Find the shortage and deadweight loss at a ceiling of 50.

18. **4 pts** **Lesson 8.1–8.2**

    Explain why secure property encourages investment, and define a public good with an example.

19. **4 pts** **Lesson 8.3**

Demand $Q_d = 60 - P$, supply $Q_s = P$. A \$6 tax on sellers: find buyers' price, sellers' price, revenue and deadweight loss.

20. **4 pts** **Lesson 8.4–8.5**

Explain asymmetric information and one reform that addressed it; then explain concentrated benefits and dispersed costs.

21. **4 pts** **Lesson 9.1**

C = 16, I = 4, G = 5, X = 2.5, M = 3.5 (trillions). Find GDP. If nominal GDP is 26 and the deflator 130, find real GDP.

22. **4 pts** **Lesson 9.2**

Adult population 200 million; employed 120 million; unemployed 6 million. Find the unemployment and participation rates.

23. **4 pts** **Lesson 9.3–9.4**

Name the four phases of the business cycle and three causes of the Great Depression's depth.

24. **4 pts** **Lesson 9.5**

Income per person grows 2% in A and 5% in B, and B starts at one-fourth of A. Find doubling times and when B catches A.

25. **4 pts** **Lesson 10.2**

The rate moves from 1.25 to 1.10 dollars per pound. Did the dollar appreciate or depreciate? What happens to the dollar price of a £50 book?

26. **4 pts** **Lesson 10.3**

Demand $Q_d = 100 - 2P$, supply $Q_s = 2P - 20$, world price 20. Find imports with free trade and with a duty of 5, and the duty revenue.

27. **4 pts** **Lesson 10.4–10.5**

Short essay (one paragraph): Using one episode from the course, explain why innovation and sound institutions matter more for long-run wealth than the quantity of money or treasure.

ANSWER KEY

1. Opportunity cost: the next-best alternative given up (a Saturday job given up for a class). Marginal thinking: comparing the extra benefit and cost of one more unit (one more hour of study).
2. A's car costs 5 tons, B's 10 tons; A makes cars. Any rate between 5 and 10 tons per car.
3. $P = 20$, Q = 40; at 25: $Q_d = 20$, $Q_s = 50$; surplus 30.
4. A small harvest shortfall raises grain prices much more than in proportion because demand is inelastic, so farmers' total revenue rises. With inelastic demand, price and revenue move together; with elastic demand, in opposite directions.
5. $100 - 4Q = 20$, $Q = 20$, $P = 60$, profit $800 - 300 = \$500$.
6. Standard Oil was split into 34 firms for monopolizing by restraining trade; the Bell System was split into seven regional firms plus AT&T after technology made parts of telephone service competitive and an antitrust suit was settled.
7. About 100%. The issuer gains purchasing power from more coins, and money holders lose it through higher prices without an open tax.
8. About 4%; $2^{1/50} - 1 \approx 1.4\%$.
9. Its loans cannot quickly be turned into cash. Lenders of last resort (central banks) and deposit insurance (the FDIC, 1934).
10. $1 - 20.67/35 \approx 41\%$; holders of gold or gold-clause creditors.
11. The world needed growing dollar reserves supplied by U.S. deficits, but more dollars abroad relative to gold undermined the $35 promise. In 1971 the United States suspended convertibility of dollars into gold.
12. About 2%; $1 + 4 + 1 + 0 = 6\%$.
13. 100, 106, 114.48; 6% and 8%.
14. MRP $200, $160, $120, $80; hire 3.
15. $880 + 6 \times 33 = \$1{,}078$.
16. $160,000; $192,000.
17. Equilibrium P = 60, Q = 40. At 50: $Q_d = 50$, $Q_s = 30$; shortage 20. $P_d = 70$; DWL $\tfrac{1}{2}(70 - 50)(40 - 30) = 100$.
18. People invest when they expect to keep the returns. A public good is non-excludable and non-rival, such as a lighthouse.

19. $P_b = 33$, $P_s = 27$, Q = 27; revenue \$162; DWL $\frac{1}{2}(6)(3) = \$9$.
20. When sellers know more than buyers, trust fails; the Pure Food and Drug Act required truthful labels (or the SEC required disclosure). A rule giving large gains to a few and small costs to many can pass even if it makes the nation poorer.
21. \$24 trillion; $26/1.3 = 20$ trillion.
22. $6/126 \approx 4.8\%$; $126/200 = 63\%$.
23. Expansion, peak, contraction, trough. Bank failures and the collapse of the money supply; deflation raising debt burdens; the gold standard spreading deflation; falling spending; trade barriers (any three).
24. 35 and 14 years; $(1.05/1.02)^t = 4$, $t \approx 48$ years.
25. The dollar appreciated (each pound costs fewer dollars); the book falls from \$62.50 to \$55.
26. Free trade: $60 - 20 = 40$. At 25: $50 - 30 = 20$; revenue \$100.
27. A strong answer uses, for example, Spain's silver (more money, little lasting wealth) against Borlaug's seeds or West Germany's 1948 reform (better methods and sound rules raising output), with at least one number and a clear conclusion.