Instructor's Manual

for

Macroeconomics

Fifth Edition

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Chapter 1
Introduction

■ Teaching Goals

Macroeconomics primarily studies economic growth and business cycles. Over time, there is a prevailing upward trend in the standard of living. However, such growth can be rather erratic. There are some periods of very rapid growth, some periods of rather anemic growth, and also some periods of temporary economic decline. Explanations for the overall upward trend in standards of living are the subject of economic growth analysis. Explanations of variations in growth over shorter time horizons are the subject of business cycle analysis. Students should be able to distinguish between microeconomic topics and macroeconomic topics. Students should understand the distinction between growth analysis and business cycle analysis.

Although microeconomics and macroeconomics are separate branches of study, both branches are guided by the same set of economic principles. Standard economic theory is guided by the assumption of maximizing behavior. As a first approximation, we therefore view the macroeconomy as a collection of markets with maximizing participants. These participants are price-taking agents and the economy is closely approximated by a competitive equilibrium.

Because the economy as a whole is extremely complex, macroeconomists must rely on somewhat abstract models. Although the structure of such models does not correspond to all of the details of life in a complex society, these models offer the best hope of providing simple, yet accurate descriptions of how the macroeconomy works, and how government policies may affect macroeconomic outcomes.

Economists are in broad consensus about the mechanisms of economic growth. There is less agreement about the causes and consequences of business cycles. While there are strong regularities in macroeconomic data, competing theories have been developed that each have a claim to explaining those regularities. There are Keynesian and non-Keynesian models of the business cycle. Examples of the former are Keynesian coordination failure models and New Keynesian sticky price models. Examples of the latter are the Lucas-Friedman money surprise model, the real business cycle model, and new monetarist models.

■ Classroom Discussion Topics

One good way to get the ball rolling is to list some macroeconomic concerns like stagnant economic growth, unemployment, inflation, the recent recession, government budget deficits, tax burdens, balance of trade deficits, financing of Social Security, and the like. Draw on current news or look at various policy proposals discussed in Washington. Ask or poll students as to whether they are personally concerned about such problems and what original prejudices they might have about causes and effects. Sometimes students express concerns about topics that are perhaps more microeconomic in nature, like inequality in the distribution of income and environmental concerns. Emphasize that economic growth may provide enough extra resources to help deal with these issues.

Students often have conflicting ideas about the current state of the economy. Sometimes their perspectives may be governed by their individual circumstances, what they read in the paper, what they see on TV and the like. Ask them whether they believe that times are currently good or bad. Ask them why they think the way that they do. Ask them how they can more objectively back up or check out their casual impressions about the current state of the economy.

■ Outline

I. What Is Macroeconomics?
II. Gross National Product, Economic Growth, and Business Cycles
III. Macroeconomic Models
IV. Microeconomic Principles
V. Disagreement in Macroeconomics
VI. What Do We Learn from Macroeconomic Analysis?
- A. Fundamentals: Preferences and Productive Capacity
- B. The Efficiency of Market Outcomes
- C. The Implications of Unemployment
- D. The Source of Long-run Improvements in the Standard of Living
- E. A Tax Cut is not a Free Lunch
- F. Credit Markets
- G. Expectations about the Future
- H. The Role of Money
- I. Business Cycles
- J. International Trade in Goods and Assets
- K. Money Growth and Inflation
- L. The Phillips Curve

VII. Understanding Current and Recent Macroeconomic Events
- A. Aggregate Productivity
- B. Unemployment and Vacancies
- C. Taxes, Government Spending, and the Government Deficit
- D. Inflation
- E. Interest Rates
- F. Business Cycles in the United States
- G. Credit Markets and the Financial Crisis
- H. The Current Account Surplus

■ Solutions to End-of-Chapter Problems

1. Calculating percentage growth rates, and log approximations to percentage growth rates, we obtain:

Year	Percentage Growth Rate	Log Approximation
2003	1.597484	1.584858
2004	2.466649	2.436718

2005	2.073992	2.052778
2006	1.667763	1.654008
2007	1.162146	1.155445
2008	-1.13738	-1.14389
2009	-4.41241	-4.51272
2010	2.257293	2.232193
2011	0.997377	0.992436

In this case, calculating the change in the natural logarithm from one year to the next gives a good approximation to the percentage growth rate, as the growth rates are small. But if we do the same thing for growth rates over ten-year periods, as below, the approximation is poor, as the growth rates are relatively large.

	Ten-year percentage growth rate	Log Approximation
1960	19.09544	17.4755
1970	33.10087	28.59371
1980	22.66362	20.42756
1990	25.33007	22.57806
2000	23.14175	20.81659

2. Some obvious possibilities include Federal Reserve open market purchases to keep the money supply from shrinking, instituting bank reforms before the Depression started, avoiding high tariff rates, etc.

3. Newton's model of falling bodies.

   Ignores air resistance.

   Works well for most dense objects, doesn't work well for feathers.

   Diagrams of plays in football and basketball.

   Ignores the characteristics of individual players, and opponent reactions.

   Works well for evenly matched teams.

Scale models of new aircraft designs.

Ignores working engines and interior contents.

Wind tunnel testing approximates aerodynamics of actual aircraft.

4. The time series for unemployment exhibits an *asymmetry*. The unemployment rate typically increases at a much higher rate than the rate at which it decreases. Thus, when the unemployment rate is unusually high, it takes a long time to fall to "normal" levels. After the 2001 recession, the unemployment rate took about 7 years to fall by about 1.8 points. In 2000, the unemployment rate was 4%, and the peak unemployment rate in 2010 was about 10%. Based on previous experience, it may take until 2033 for the unemployment rate to fall to 4%.

5. The deficit is large in 2011 because taxes have fallen and spending has risen. However, the contribution of increased spending to the deficit is larger than the contribution of decreased taxation.

6. In Figure 1.10, the money growth rate is more variable after 1980 than before 1980, but the inflation rate is more variable before 1980 than after 1980. These observations seem to contradict the view that there is a tight link between money growth and inflation. Possibly an active monetary policy that makes money growth more variable in the short run is necessary to make the inflation rate stable.

7. In Figure 1.12, there have been some sharp movements in the real interest rate. Before late 2008, those movements in the real interest rate were due both to variability in inflation, and to variability in the nominal interest rate. The latter movements in the nominal interest rate were driven primarily by the Federal Reserve System. However, in late 2008, the Fed adopted a policy of essentially zero nominal interest rates, and so after late 2008, movements in the real rate are due entirely to fluctuations in the inflation rate.

8. The recent recession, in 2008-09, in figure 1.13, was more severe than the previous two recessions, but slightly less severe than the 1981-82 recession, and about as severe as the 1974-75 recession. An issue here is how we determine the deviation from trend, and what the trend is. Given the way the trend is calculated here, there is a sense in which the recent recession does not look so bad, but that may be because of a long-term deterioration in the US economy, i.e. there was a downward level adjustment to the trend.

9. When there are spikes in the interest rate spread, those tend to occur during recessions, i.e. periods when real GDP is below trend. Further, large (small) spikes in the interest rate spread tend to be associated with large (small) negative deviations from trend in real GDP. However, in the 1990-91 recession, there is only a small spike in the interest rate spread, which looks like other random spikes in the spread that have occurred which are not associated with recessions.

10. The three previous declines in housing prices occurred beginning in 1970, 1980, and 1990. In those cases, the percentage declines in relative price of housing were about 15%, 12%, and 15%, respectively. These declines were large, but the decline beginning in 2006 was larger in percentage terms.

Chapter 2
Measurement

■ Teaching Goals

Students must understand the importance of measuring aggregate economic activity. Macroeconomists produce theories that provide useful insights and policy conclusions. To be credible, such theories must produce hypotheses that evidence could possibly refute. Macroeconomic measurement provides such evidence. Without macroeconomic measurements, macroeconomics could not be a social science, and would rather consist of philosophizing and pontificating. Market transactions provide the most simple and direct measurements. Macroeconomists' most basic measurement is Gross Domestic Product (GDP), the value of final, domestically market output produced during a given period of time.

In the United States, the Commerce Department's National Income and Product Accounts provide official estimates of GDP. These accounts employ their own set of accounting rules to ensure internal consistency and to provide several separate estimates of GDP. These separate estimates are provided by the product accounts, the expenditure accounts, and the income accounts. The various accounting conventions may, at first glance, be rather dry and complicated. However, students can only easily digest the material in later chapters if they have a good grounding in the fundamentals.

GDP changes through time because different amounts of goods and services are produced, and such goods and services are sold at different prices. Standards of living are determined by the amounts of goods and services produced, not by the prices they command in the market. While GDP is relatively easy to measure, the decomposition of changes in real GDP into quantity and price components is much more difficult. It is easy to separately measure the number of apples sold and the price of each apple. Because macroeconomics deals with aggregate output, the differentiation of price and quantity is much less easily apparent. It is important to emphasize that while there may be more or less reasonable approaches to this problem, there is no unambiguous best approach. Since many important policy discussions involve debates about output and price measurements, it is very important to understand exactly how such measurements are produced.

■ Classroom Discussion Topics

Much of this material is best learned by example. Rather than simply working through the examples from the text or making up your own, the material may resonate better if the students come up with their own examples. They can start by picking a single good, and by the choice of their numbers they provide their own implied decomposition of output into wage and profit income. Later on, encourage them to suggest intermediate input production, inventory adjustments, international transactions, a government sector, and so on. Such an exercise may help assure them that the identities presented in the text are more than simply abstract constructions.

If many of your students are familiar with accounting principles, it may also be useful to present the National Income and Product Account with the "T" accounts, and highlighting how all income is an expense elsewhere. Make one account for each of the firms, one for the household and one for the government. Add another account for the rest of the world when discussing the example with international trade. This procedure can highlight how some entities can be inferred from others because accounting identities must hold. It makes it also easier to determine consumption for some student Social Security benefits are indexed to the Consumer Price Index. Explain with an example exactly how these adjustments are made. Ask the students if they think that this procedure is "fair." Another topic for concern is the stagnation in the growth of measured real wages. Real wages are measured by dividing (for example) average hourly wages paid in manufacturing by the consumer price index. Ask students if measured changes in real wages confirm or conflict with their general beliefs about whether the typical worker is better or worse off than 10 or 20 years ago. How does possible mis-measurement of prices reconcile any apparent differences between casual impressions and statistical evidence?

The text discusses why unemployment may or may not be a good measure of labor market tightness. Another interpretation of the unemployment rate is as a measure of economic welfare – welfare goes down as unemployment goes up. Ask the students if they agree with this interpretation. Does the unemployment rate help factor in considerations like equal distribution of income? How can the unemployment rate factor in considerations like higher income per employed worker? Discuss possible pros and cons of using unemployment rather than per capita real GDP as a measure of well-being. Can unemployment be too low? Why or why not?

■ Outline

I. **Measuring GDP: The National Income and Product Accounts**
   - A. What Is GDP and How Do We Measure It?
   - B. The Product Approach
   - C. The Expenditure Approach
   - D. The Income Approach
   - E. Gross National Product (GNP)
   - F. What Does GDP Leave Out?
   - G. Expenditure Components
     1. Consumption
     2. Investment
     3. Net Exports
     4. Government Expenditures

II. **Nominal and Real GDP and Price Indices**
   - A. Real GDP
   - B. Measures of the Price Level
     1. Implicit GDP Price Deflator
     2. Consumer Price Index (CPI)
   - C. Problems Measuring Real GDP and the Price Level

III. **Savings, Wealth, and Capital**
   - A. Stocks and Flows
   - B. Private Disposable Income and Private Sector Saving
     1. $Y^d = Y + NFP + TR + INT - T$

2. $S^p = Y^d - C$

C. Government Surpluses, Deficits, and Government Saving

1. $S^g = T - TR - INT - G$

2. $D = -S^g$

D. National Saving: $S = S^p + S^g = Y + NFP - C - G$

E. Saving, Investment, and the Current Account

1. $S = I + NX + NFP$

2. $CA = NX + NFP \Rightarrow S = I + CA$

F. Capital Stock

1. $\mathrm{S} \Rightarrow \Delta\text{Wealth}$

2. $I \Rightarrow \Delta K$

3. $CA \Rightarrow$ Claims on Foreigners

IV. Labor Market Measurement

A. BLS Categories

1. Employed
2. Unemployed
3. Not in the Labor Force

B. The Unemployment Rate

$$\text{Unemployment Rate} = \frac{\text{Number unemployed}}{\text{Labor force}}$$

C. The Participation Rate

$$\text{Participation Rate} = \frac{\text{Labor force}}{\text{Total working age population}}$$

D. The Employment/Population Ratio

$$\text{Employment/Population Ratio} = \frac{\text{Total employment}}{\text{Total working age population}}$$

E. Unemployment and Labor Market Tightness

■ Solutions to End-of-Chapter Problems

1. Product accounting adds up value added by all producers. The wheat producer has no intermediate inputs and produces 30 million bushels at \$3/bu. for \$90 million. The bread producer produces 100 million loaves at \$3.50/loaf for \$350 million. The bread producer uses \$75 million worth of wheat as an input. Therefore, the bread producer's value added is \$275 million. Total GDP is therefore \$90 million + \$275 million = \$365 million.

   Expenditure accounting adds up the value of expenditures on final output. Consumers buy 100 million loaves at \$3.50/loaf for \$350 million. The wheat producer adds 5 million bushels of wheat to inventory. Therefore, investment spending is equal to 5 million bushels of wheat valued

at $3/bu., which costs $15 million. Total GDP is therefore $350 million + $15 million = $365 million.

2. Coal producer, steel producer, and consumers.

(a) (i) Product approach: Coal producer produces 15 million tons of coal at $5/ton, which adds $75 million to GDP. The steel producer produces 10 million tons of steel at $20/ton, which is worth $200 million. The steel producer pays $125 million for 25 million tons of coal at $5/ton. The steel producer's value added is therefore $75 million. GDP is equal to $75 million + $75 million = $150 million.

(ii) Expenditure approach: Consumers buy 8 million tons of steel at $20/ton, so consumption is $160 million. There is no investment and no government spending. Exports are 2 million tons of steel at $20/ton, which is worth $40 million. Imports are 10 million tons of coal at $5/ton, which is worth $50 million. Net exports are therefore equal to $40 million –$50 million = –$10 million. GDP is therefore equal to $160 million + (–$10 million) = $150 million.

(iii) Income approach: The coal producer pays $50 million in wages and the steel producer pays $40 million in wages, so total wages in the economy equal $90 million. The coal producer receives $75 million in revenue for selling 15 million tons at $15/ton. The coal producer pays $50 million in wages, so the coal producer's profits are $25 million. The steel producer receives $200 million in revenue for selling 10 million tons of steel at $20/ton. The steel producer pays $40 million in wages and pays $125 million for the 25 million tons of coal that it needs to produce steel. The steel producer's profits are therefore equal to $200 million – $40 million – $125 million = $35 million. Total profit income in the economy is therefore $25 million + $35 million = $60 million. GDP therefore is equal to wage income ($90 million) plus profit income ($60 million). GDP is therefore $150 million.

(b) There are no net factor payments from abroad in this example. Therefore, the current account surplus is equal to net exports, which is equal to (–$10 million).

(c) As originally formulated, GNP is equal to GDP, which is equal to $150 million. Alternatively, if foreigners receive $25 million in coal industry profits as income, then net factor payments from abroad are (–$25 million), so GNP is equal to $125 million.

3. Wheat and Bread

(a) Product approach: Firm A produces 50,000 bushels of wheat, with no intermediate goods inputs. At $3/bu., the value of Firm A's production is equal to $150,000. Firm B produces 50,000 loaves of bread at $2/loaf, which is valued at $100,000. Firm B pays $60,000 to firm A for 20,000 bushels of wheat, which is an intermediate input. Firm B's value added is therefore $40,000. GDP is therefore equal to $190,000.

(b) Expenditure approach: Consumers buy 50,000 loaves of domestically produced bread at \$2/loaf and 15,000 loaves of imported bread at \$1/loaf. Consumption spending is therefore equal to \$100,000 + \$15,000 = \$115,000. Firm A adds 5,000 bushels of wheat to inventory. Wheat is worth \$3/bu., so investment is equal to \$15,000. Firm A exports 25,000 bushels of wheat for \$3/bu. Exports are \$75,000. Consumers import 15,000 loaves of bread at \$1/loaf. Imports are \$15,000. Net exports are equal to \$75,000 – \$15,000 = \$60,000. There is no government spending. GDP is equal to consumption (\$115,000) plus investment (\$15,000) plus net exports (\$60,000). GDP is therefore equal to \$190,000.

(c) Income approach: Firm A pays \$50,000 in wages. Firm B pays \$20,000 in wages. Total wages are therefore \$70,000. Firm A produces \$150,000 worth of wheat and pays \$50,000 in wages. Firm A's profits are \$100,000. Firm B produces \$100,000 worth of bread. Firm B pays \$20,000 in wages and pays \$60,000 to Firm A for wheat. Firm B's profits are \$100,000 – \$20,000 – \$60,000 = \$20,000. Total profit income in the economy equals \$100,000 + \$20, 000 = \$120,000. Total wage income (\$70,000) plus profit income (\$120,000) equals \$190,000. GDP is therefore \$190,000.

4. Price and quantity data are given as the following.

Year 1

Good	Quantity	Price
Computers	20	\$1,000
Bread	10,000	\$1.00

Year 2

Good	Quantity	Price
Computers	25	\$1,500
Bread	10,000	\$1.00

(a) Year 1 nominal GDP $= 20 \times \$1{,}000 + 10{,}000 \times \$1.00 = \$30{,}000$.

Year 2 nominal GDP $= 25 \times \$1{,}500 + 12{,}000 \times \$1.10 = \$50{,}700$.

With year 1 as the base year, we need to value both years' production at year 1 prices. In the base year, year 1, real GDP equals nominal GDP equals \$30,000. In year 2, we need to value year 2's output at year 1 prices. Year 2 real GDP $= 25 \times \$1{,}000 + 12{,}000 \times \$1.00 = \$37{,}000$.

The percentage change in real GDP equals ($37,000 – $30,000)/$30,000 □23.33%.

We next calculate chain-weighted real GDP. At year 1 prices, the ratio of year 2 real GDP to year 1 real GDP equals g_1 = ($37,000/$30,000) = 1.2333. We must next compute real GDP using year 2 prices. Year 2 GDP valued at year 2 prices equals year 2 nominal GDP = $50,700. Year 1 GDP valued at year 2 prices equals (20 × $1,500 + 10,000 × $1.10) = $41,000. The ratio of year 2 GDP at year 2 prices to year 1 GDP at year 2 prices equals g_2 = ($50,700/$41,000) = 1.2367. The chain-weighted ratio of real GDP in the two years therefore is equal to $g_c = \sqrt{g_1 g_2} = 1.23496$. The percentage change chain-weighted real GDP from year 1 to year 2 is therefore approximately 23.5%.

If we (arbitrarily) designate year 1 as the base year, then year 1 chain-weighted GDP equals nominal GDP equals $30,000. Year 2 chain-weighted real GDP is equal to (1.23496 × $30,000) = $37,048.75.

(b) To calculate the implicit GDP deflator, we divide nominal GDP by real GDP, and then multiply by 100 to express as an index number. With year 1 as the base year, base year nominal GDP equals base year real GDP, so the base year implicit GDP deflator is 100. For the year 2, the implicit GDP deflator is ($50,700/$37,000) × 100 = 137.0. The percentage change in the deflator is equal to 37.0%.

With chain weighting, and the base year set at year 1, the year 1 GDP deflator equals ($30,000/$30,000) × 100 = 100. The chain-weighted deflator for year 2 is now equal to ($50,700/$37,048.75) × 100 = 136.85. The percentage change in the chain-weighted deflator equals 36.85%.

(c) We next consider the possibility that year 2 computers are twice as productive as year 1 computers. As one possibility, let us define a "computer" as a year 1 computer. In this case, the 25 computers produced in year 2 are the equivalent of 50 year 1 computers. Each year 1 computer now sells for $750 in year 2. We now revise the original data as:

Year 1		
Good	**Quantity**	**Price**
Year 1 Computers	20	$1,000
Bread	10,000	$1.00

Year 2		
Good	**Quantity**	**Price**

Year 1 Computers	50	$750
Bread	12,000	$1.10

First, note that the change in the definition of a "computer" does not affect the calculations of nominal GDP. We next compute real GDP with year 1 as the base year. Year 2 real GDP in year 1 prices is now $50 \times \$1{,}000 + 12{,}000 \times \$1.00 = \$62{,}000.$ The percentage change in real GDP is equal to ($62,000 – $30,000)/$30,000= 106.7%.

We next revise the calculation of chain-weighted real GDP. From above, g_1 equals ($62,000/$30,000) = 206.67. The value of year 1 GDP at year 2 prices equals $26,000. Therefore, g_2 equals ($50,700/$26,000) = 1.95. 200.75. The percentage change chain-weighted real GDP from year 1 to year 2 is therefore 100.75%.

If we (arbitrarily) designate year 1 as the base year, then year 1 chain-weighted GDP equals nominal GDP equals $30,000. Year 2 chain-weighted real GDP is equal to (2.0075 × $30,000) □ $60,225. The chain-weighted deflator for year 1 is automatically 100. The chain-weighted deflator for year 2 equals ($50,700/$60,225) × 100 = 84.18. The percentage rate of change of the chain-weighted deflator equals –15.8%.

When there is no quality change, the difference between using year 1 as the base year and using chain weighting is relatively small. Factoring in the increased performance of year 2 computers, the production of computers rises dramatically while its relative price falls. Compared with earlier practices, chain weighting provides a smaller estimate of the increase in production and a smaller estimate of the reduction in prices. This difference is due to the fact that the relative price of the good that increases most in quantity (computers) is much higher in year 1. Therefore, the use of historical prices puts more weight on the increase in quality-adjusted computer output.

5. Price and quantity data are given as the following:

Year 1		
Good	**Quantity (million lbs.)**	**Price (per lb.)**
Broccoli	1,500	$0.50
Cauliflower	300	$0.80

Year 2		
Good	**Quantity (million lbs.)**	**Price (per lb.)**

Broccoli	2,400	$0.60
Cauliflower	350	$0.85

(a) Year 1 nominal GDP = Year 1 real GDP $= 1{,}500 \text{ million} \times \$0.50 + 300 \text{ million} \times \$0.80 =$ $990 million.

Year 2 nominal GDP $= 2{,}400 \text{ million} \times \$0.60 + 350 \text{ million} \times \$0.85 = \$1{,}730.5 \text{ million}$

Year 2 real GDP $= 2{,}400 \text{ million} \times \$0.50 + 350 \text{ million} \times \$0.80 = \$1{,}450 \text{ million}.$

Year 1 GDP deflator equals 100.

Year 2 GDP deflator equals ($1,730.5/$1,450) × 100 = 119.3.

The percentage change in the deflator equals 19.3%.

(b) Year 1 production (market basket) at year 1 prices equals year 1 nominal GDP □$990 million. The value of the market basket at year 2 prices is equal to
$1{,}500 \text{ million} \times \$0.60 + 300 \text{ million} \times \$0.85 = \$1{,}050 \text{ million}.$

Year 1 CPI equals 100.

Year 2 CPI equals ($1,050/$990) × 100 □106.1.

The percentage change in the CPI equals 6.1%.

The relative price of broccoli has gone up. The relative quantity of broccoli has also gone up. The CPI attaches a smaller weight to the price of broccoli, and so the CPI shows less inflation.

6. Corn producer, consumers, and government.

(a) (i) Product approach: There are no intermediate goods inputs. The corn producer grows 30 million bushels of corn. Each bushel of corn is worth $5. Therefore, GDP equals $150 million.

(ii) Expenditure approach: Consumers buy 20 million bushels of corn, so consumption equals $100 million. The corn producer adds 5 million bushels to inventory, so investment equals $25 million. The government buys 5 million bushels of corn, so government spending equals $25 million. GDP equals $150 million.

(iii) Income approach: Wage income is $60 million, paid by the corn producer. The corn producer's revenue equals $150 million, including the value of its addition to inventory. Additions to inventory are treated as purchasing one owns output. The corn producer's costs include wages of $60 million and taxes of $20 million. Therefore, profit income equals $150 million – $60 million – $20 million = $70 million. Government income

equals taxes paid by the corn producer, which equals $20 million. Therefore, GDP by income equals $60 million +$70 million + $20 million = $150 million.

(b) Private disposable income equals GDP ($150 million) plus net factor payments (0) plus government transfers ($5 million is Social Security benefits) plus interest on the government debt ($10 million) minus total taxes ($30 million), which equals $135 million. Private saving equals private disposable income ($135 million) minus consumption ($100 million), which equals $35 million. Government saving equals government tax income ($30 million) minus transfer payments ($5 million) minus interest on the government debt ($10 million) minus government spending ($5 million), which equals $10 million. National saving equals private saving ($35 million) plus government saving ($10 million), which equals $45 million. The government budget surplus equals government savings ($10 million). Since the budget surplus is positive, the government budget is in surplus. The government deficit is therefore equal to (–$10 million).

7. Price controls.

Nominal GDP is calculated by measuring output at market prices. In the event of effective price controls, measured prices equal the controlled prices. However, controlled prices reflect an inaccurate measure of scarcity values. Nominal GDP is therefore distorted. In addition to distortions in nominal GDP measures, price controls also inject an inaccuracy in attempts to decompose changes in nominal GDP into movements in real GDP and movements in prices. With price controls, there is typically little or no change in white market prices over time. Alternatively, black market or scarcity value prices typically increase, perhaps dramatically. Measures of prices (in terms of scarcity values) understate inflation. Whenever inflation measures are too low, changes in real GDP overstate the extent of increases in actual production.

8. Underground economy.

Transactions in underground economy are performed with cash exclusively, to exploit the anonymous nature of currency. Thus, once we have established the amount of currency held abroad, we know the portion of $2,776 that is held domestically. Remove from it what is used for recorded transactions, say by using some estimate of the proportion of transactions using cash and applying this to observed GDP. Finally apply a concept of velocity of money to the remaining amount of cash to obtain the size of the underground economy.

9. "Questionable financial activity" is essentially theft. If someone steals, there is no contribution to GDP as something is simply transferred from one individual to another. Possibly worse, the time and effort of the thief is pure waste for society, as that time and effort could be used in producing goods and services. Some financial activity could be wasteful in the same way. If workers in financial firms spend their time and effort in designing financial products for the purpose of hiding

malfeasance, or to convince ill-informed consumers that such products are something they are not, that time and effort is counted as contributing to GDP, when it should not be.

10. The dollar value of a transaction need not all be a contribution to GDP. Indeed, typically only a fraction of any given transaction in the economy actually represents something we should add to GDP. For example, the production of a given good could involve many stages, with each stage of production done in a different firm. At each stage of production, the intermediate good gets passed on to the next firm in the production process, and a transaction takes place. From this chapter, we know that we only count the value-added at each stage of production toward GDP. Similarly, the financial sector contributes to GDP, but the dollar value of every financial transaction is not counted toward GDP, and rightly so. If the Bank of America makes a payment of $10 million to J.P. Morgan Chase, that payment represents the settlement of a debt between the two institutions. What is actually provided, in terms of financial goods and services, could be very small when measured correctly.

11. $S^p - 1 = CA + D$

(a) By definition:

$$S^p = Y^d - C = Y + NFP + TR + INT - T - C$$

Next, recall that $Y = C + I + G + NX$. Substitute into the equation above and subtract I to obtain:

$$\begin{aligned} S^p - I &= C + I + G + NX + NFP + INT - T - C - I \\ &= (NX + NFP) + (G + INT + TR - T) \\ &= CA + D \end{aligned}$$

(b) Private saving, which is not used to finance domestic investment, is either lent to the domestic government to finance its deficit (D), or is lent to foreigners (CA).

12. The answers to parts (a) and (b) are in the table.

Year	Capital when initial capital = 80	Capital when initial capital = 100
0	80	100
1	82.0	100
2	83.8	100
3	85.4	100

4	86.9	100
5	88.2	100
6	89.4	100
7	90.4	100
8	91.4	100
9	92.3	100
10	93.0	100

In the first case, where the initial quantity of capital was 80, with a constant quantity of investment each period, the quantity of capital increases over time, but at a decreasing rate (note the the increment to the capital stock gets smaller each period). This happens because, as the capital stock grows, the total amount of capital that depreciates each period increases. The quantity of capital appears to be converging to some quantity, but what is this quantity? When the quantity of capital is initially 100, then the capital stock stays at 100 indefinitely, as long as investment is 10 each period. This is because, when the capital stock is 100, the total quantity of depreciation each period when the depreciation rate is 10% is 10, so new investment just replaces the capital that depreciates each period. Here 100 is what we would call the "steady state" quantity of capital. Steady states are useful when we study economic growth in Chapters 7 and 8.

13. Assume the following:

$$\begin{aligned} D &= 10 \\ INT &= 5 \\ T &= 40 \\ G &= 30 \\ C &= 80 \\ NFP &= 10 \\ CA &= -5 \\ S &= 20 \end{aligned}$$

(a)
$$\begin{aligned} Y^d &= S^p + C \\ &= S + D + C \\ &= 20 + 10 + 80 = 110 \end{aligned}$$

(b)
$$\begin{aligned} D &= G + TR + INT - T \\ TR &= D - G - INT + T = 10 - 30 - 5 + 40 = 15 \end{aligned}$$

$$S = GNP - C - G$$

(c) $GNP = S + C + G = 20 + 80 + 30 = 130$

(d) $GDP = GNP - NFP = 130 - 10 = 120$

(e) Government Surplus $= S^g = -D = -10$

$$CA = NX + NFP$$

(f) $NX = CA - NFP = -5 - 10 = -15$

$$GDP = C + I + G + NX$$

(g) $I = GDP - C - G - NX = 120 - 80 - 30 + 15 = 25$

14. First some preliminaries. As the unemployment rate is 5% and there are 2.5 million unemployed, it must be that the labor force is 50 million (2.5/0.05). Thus, the participation rate is 50% (50/100), the labor force 50 million, the number of employed workers 47.5 million (50-2.5), and the employment/population ratio is 47.5% (47.5/100).

Chapter 3

Business Cycle Measurement

■ Teaching Goals

Chapter 3 stresses the importance of observation as a foundation for scientific exploration in macroeconomics. Because there are mountains of data measurements about the macroeconomy, we need to begin to organize these data in a way that we can begin to look for regularities in the economy—regularities that we hope to explain. The cornerstone of business cycle analysis is deviations from trend in real GDP. Students must first understand the difference between long-run trends and deviations from trend in real GDP.

One of the most exciting things about the study of business cycles is the observation that each of these recurring cycles is not unique. Because successive business cycles are more alike than they are different, we have the hope of providing an explanation of business cycles that can consistently be applied to each new cycle we encounter. These business cycle regularities, the "stylized facts" of business cycles, provide us with the first clues about the nature of the typical cycle. Although students may take some time to digest and remember these facts, it is important to be clear about the motivation for cataloging these facts.

The plan of study of this text is to view the business cycle as a puzzle that we hope to solve. Our task is much the same as a detective trying to solve a murder mystery. The first task is to collect clues. The clues in the study of business cycles are the regularities chronicled in this chapter. Later on we will begin to encounter "suspect" causes of business cycles. In order to solve the mystery, we need to deduce the "who," "what" and "why" of our mystery. We cannot begin the deduction process before first collecting the clues. Students need to understand this detective process. Otherwise, the clues presented in this chapter will be nothing more than a laundry list that they must memorize.

■ Classroom Discussion Topics

To get the ball rolling it might be useful to ask the students about whether they have concerns about recessions. Is the economy currently in a recession? When was the economy most recently in recession? How do we date recessions – turning points in macroeconomic activity? Should we be paying attention to only real GDP or to other indicators that might be important for economic welfare – e.g. employment or the unemployment rate?

Macroeconomics is primarily concerned with business cycles and economic growth. Ask the students which of these two topics is most important. A typical comparison is between the possibility of completely eliminating recessions as opposed to increasing the rate of growth by a half of one percent or so. If they could pick only one of these advances, which would they pick? Some simple calculations reveal the apparent dominance of more growth over eliminating business cycles. Ask them if they believe

that there is any other cost of a recession other than the value of lost GDP. In particular, emphasize that GDP fluctuations hide a lot about fluctuations at the household level.

Another potential discussion centers on the murder mystery analogy. If the students were rounding up the usual suspects of business cycle causes, which suspects would they pick? One part of detective work involves theories and hunches about what might have happened. Another less glamorous part of detective work involves ruling out some of the suspects. How can studying the clues eliminate a suspect from consideration? Emphasize the point that much of the organization of the text revolves about the possible elimination of suspected causes of business cycles based on the evidence.

■ Outline

I. Regularities in GDP fluctuations
II. Co-movement
- A. Cyclicality
- B. Lead/Lag Relationships
- C. Variability

III. Components of GDP
- A. Consumption
  1. Procyclical
  2. Coincident
  3. Less Variable Than GDP
- B. Investment
  1. Procyclical
  2. Residential and Inventory Investment Lead GDP
  3. More Variable Than GDP

IV. Nominal Variables
- A. The Phillips Curve
- B. Aggregate Price Level
  1. Procyclical Since World War II
  2. Sometimes Countercyclical
  3. Lags GDP
- C. Money Supply
  1. Procyclical
  2. Leads GDP

V. Labor Market Variables
- A. Employment
  1. Procyclical
  2. Lags GDP
- B. Real Wage Rates
  1. Procyclical
  2. Aggregation Problems
- C. Average Labor Productivity
  1. Procyclical
  2. Coincident
  3. Less Variable Than GDP

VI. Seasonal Adjustment

A. Seasonal Data

■ Solutions to End-of-Chapter Problems

1. In Figure 3.13, after 1980 it appears that real GDP and the nominal money supply are negatively correlated, and it is difficult to discern any lead/lag relationship between real GDP and nominal money. Many people, particularly old-school Monetarists (Milton Friedman included) ascribed much importance to the money-output correlation. The fact that this relationship appears to have disappeared in the last 30 years of data is also important. The reason we observe this could have something to do with changes in the way monetary policy was conducted after 1980.

2. In Figure 3.16, what we tend to see during the last 3 recessions is a quick recovery of average labor productivity prior to real GDP recovering to the point where it is above trend. This is part of the jobless recovery phenomenon. Employment has been very slow to recover during the last three recessions, which makes for higher growth in average labor productivity coming out of the recession. We get this as average labor productivity is the ratio of real GDP to employment, so if employment is not recovering and real GDP is, then the ratio shows a spurt of growth.

3. Both consumption and investment are procyclical and coincident. The key difference is that investment is much more volatile than consumption. Consumer durables provide services over a horizon greater than one year. Some consumer nondurable products, like apparel, provide services well beyond the date of purchase. Services, by definition, are fully utilized at the point of sale. The same kinds of timing considerations that affect business investment are likely to come into play with consumer durables, and to a lesser extent, consumer nondurables. Therefore, it is logical that consumer durable purchases should be more volatile than consumer nondurable purchases and that consumer nondurable purchases should be more volatile than consumption of services.

4. After the 1981-82, the cyclical behavior of the price level varies. From 1980-2000, the price level appears to be countercyclical, but after 2000 it appears to be procyclical. This is important, as alternative types of macroeconomic shocks will move the price level in different directions. As a result, the cyclicality of the price level may be usful in uncovering what shocks are driving aggregate fluctuations at particular dates.

5. One can see that the amplitude of the deviations from the trend is more moderate for prices, as for GDP. It appears also that the price level is becoming less countercyclical. The fact that both GDP and the price level changed their cyclical behavior indicates that any explanation of the Great Moderation needs to look at more than GDP.

Chapter 4
Consumer and Firm Behavior: The Work-Leisure Decision and Profit Maximization

■ Teaching Goals

The microeconomic approach to macroeconomics stresses the notion that economy-wide events are the result of decisions made by individuals. People work so that they may afford to buy market goods. On the other hand, people generally prefer to work less rather than working more. Although discussions in the popular press often refer to the idea that spending is what drives the economy, an economy cannot produce unless people are willing to work. Therefore, the most basic macroeconomic decision is the decision to choose whether, and how much, to work. Production and willingness to work are intrinsically interconnected.

Students often believe that how much a person works is largely determined by the necessities of their circumstances. Students will report that they have to work to survive and pay tuition. Some might point out that some students need not work much or at all because their parents provide more support. However, circumstances need not dictate exactly how much they may choose to work. They may work less if they go to a less costly school. They may sometimes decide to switch to part-time student status and full-time work status if they find a high-paying job. A key message of this chapter is that choice is important and that choice is influenced by changes in circumstances.

This chapter demands the mastery of a large body of structure and yet provides little in the way of immediate insights. Students may need frequent assurances that the mastery of this material eventually pays big dividends in providing hope of understanding the phenomenon of business cycles. This is particularly important as this chapter lays critical foundations for the rest of the book: the use of microfoundations in macroeconomics. Students need to be able to justify macroeconomic relationships with microeconomic arguments, like in this chapter. This requires to some extent some boring drills that they will come to appreciate only later. If for many textbooks the strategy is to teach one chapter a week, spend more time on this one, especially if students have not yet mastered intermediate microeconomics.

Two key points of this chapter are the concepts of income and substitution effects. Often, students are perplexed at the amount of time spent on this material because nothing in practice is purely an income effect or a substitution effect. However, the two most basic insights of microeconomic analysis are that when we become more well-off we generally want more of everything and that we respond to price incentives at the margin.

■ Classroom Discussion Topics

Ask the students about their work choices and the choices of their parents, friends, and relatives. Does everyone work? Does everyone work the same amount of hours? Then ask the students for examples of the kinds of factors that lead people to work more or less. Try to elicit very specific examples. Then ask the students to categorize these factors that lead to more or less work. Some of these factors are actually the by-products of more complex decision making. For example, if they say that they work more or less because they go to school, point out that going to school is a choice. They may also point to circumstances like whether a married couple has children, and if so, the number of children and their ages. Point out that these events are also the results of other choices. Then ask the students to try to categorize the remaining factors as being either primarily an income effect or a substitution effect. Also compare labor choices across countries, as the Macroeconomics in Action feature does.

Ask the students to provide examples of factors other than more labor or capital that can allow some countries to be a lot more productive than others. What factors other than growth in capital and labor allow a given economy to produce more (or less) over time? Explain that these are the kinds of factors that we summarize by the concept of total factor productivity. Insist also on the concept of physical capital and what it measures and what it does not measure.

■ Outline

I. The Representative Consumer

- A. Preferences
  - 1. Goods: The Consumption Good and Leisure
  - 2. The Utility Function
    - a. More Preferred to Less
    - b. Preference for Diversity
    - c. Normal Goods
  - 3. Indifference Curves
    - a. Downward Sloping
    - b. Convex to the Origin
  - 4. Marginal Rate of Substitution
- B. The Representitve Consumer's Budget Constraint
  - 1. Competitive Behavior, Price-takers, Barter Economy, The Time Constraint
  - 2. Real Disposable Income
  - 3. The Budget Constraint Equations
  - 4. A Graphical Representation
- C. Optimization
  - 1. Rational Behavior
  - 2. The Optimal Consumption Bundle
  - 3. Marginal Rate of Substitution □Relative Price
  - 4. A Graphical Representation
- D. Comparative Statics Experiments
  - 1. Changes in Dividends and Taxes: Pure Income Effect
  - 2. Changes in the Real Wage: Income and Substitution Effects

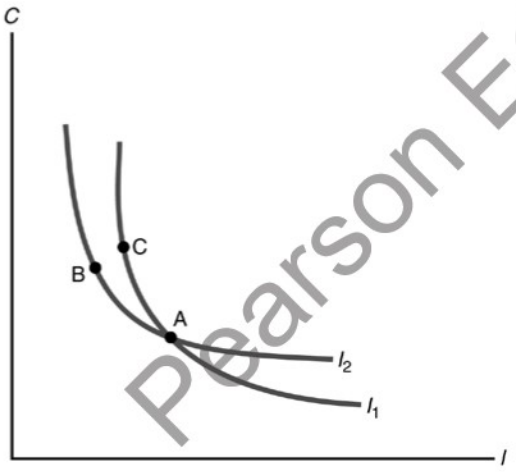
II. The Representative Firm

A. The Production Function
   1. Constant Returns to Scale
   2. Monotonicity
   3. Declining MP_N
   4. Declining MP_K
   5. Changes in Capital and MP_N

B. Profit Maximization
   1. Profits = Total Revenue – Total Variable Costs
   2. Marginal Product of Labor = Real Wage
   3. Labor Demand

■ Solutions to End-of-Chapter Problems

1. Consider the two hypothetical indifference curves in the figure below. Point A is on both indifference curves, I_1 and I_2. By construction, the consumer is indifferent between A and B, as both points are on I_2. In like fashion, the consumer is indifferent between A and C, as both points are on I_1. But at point C, the consumer has more consumption and more leisure than at point B. As long as the consumer prefers more to less, he or she must strictly prefer C to A. We therefore contradict the hypothesis that two indifference curves can cross.

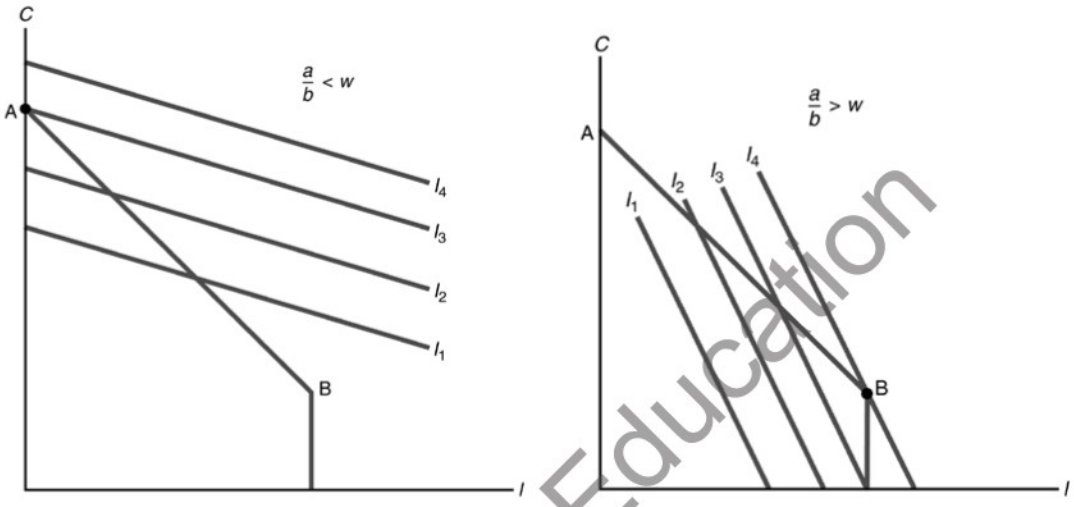


2. $u = al + bC$

   (a) To specify an indifference curve, we hold utility constant at $\overline{u}$. Next rearrange in the form:

$$C = \frac{\overline{u}}{b} - \frac{a}{b}l$$

Indifference curves are therefore linear with slope, $-a/b$, which represents the marginal rate of substitution. There are two main cases, according to whether $a/b > w$ or $a/b < w$. The top panel of the left figure below shows the case of $a/b < w$. In this case the indifference curves are flatter than the budget line and the consumer picks point A, at which $l = 0$ and $C = wh + \pi - T$. The right figure shows the case of $a/b > w$. In this case the indifference curves are steeper than the budget line, and the consumer picks point B, at which $l = h$ and $C = \pi - T$. In the coincidental case in which $a/b = w$, the highest attainable indifference curve coincides with the indifference curve, and the consumer is indifferent among all possible amounts of leisure and hours worked.

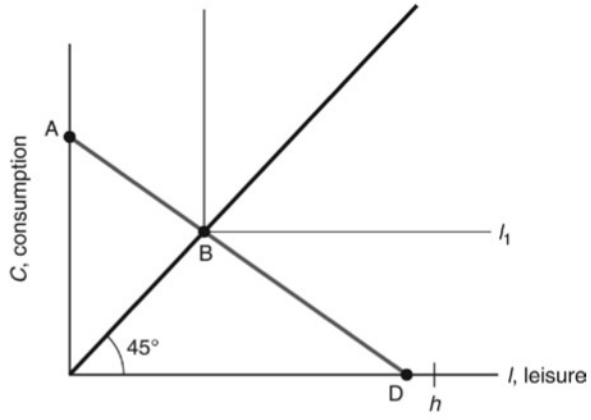


(b) The utility function in this problem does not obey the property that the consumer prefers diversity, and is therefore not a likely possibility.

(c) This utility function does have the property that more is preferred to less. However, the marginal rate of substitution is constant, and therefore this utility function does not satisfy the property of diminishing marginal rate of substitution.

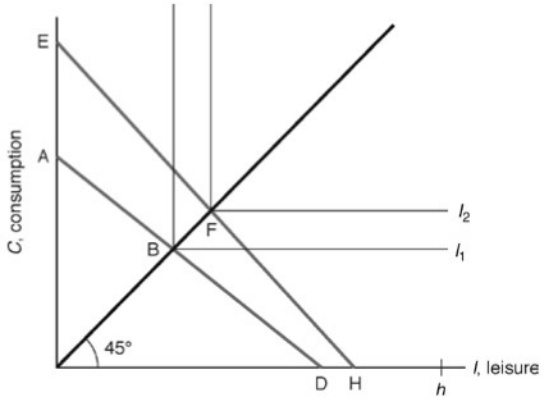
3. (a) Using the formulas in the example from the textbook, one obtains:

$l = C = (0.75 \times 16 - 0.8 - 6)/(1 + 0.75) = 3.89$



Given the numbers given, we can precisely determine the coordinates of the points in the figure above: A is (0,6.8), B is (3.89,3.89), D is (9,07,0), with the slope of ABD being - 0.75.

(b) With the new wage, we obtain: $l = C = (1.5 \times 16 - 0.8 - 6)/(1 + 1.5) = 7.52$



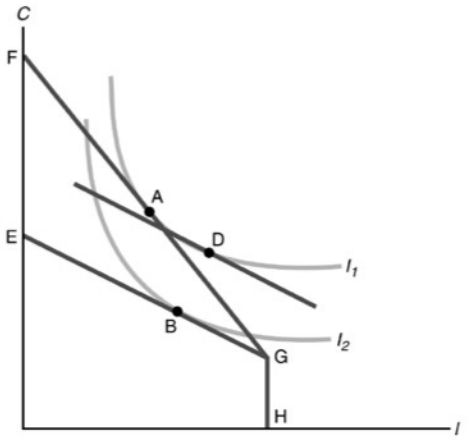
where A, B and D have the same coordinates as above, and E is (0, 12.8), F is (7.52, 7.52), H is (12.53,0), and the slope of EFH is - 1.5. As there are no substitution effects when goods are perfect complements, the entire move from point B to point F is due to the income effect.

4. When the government imposes a proportional tax on wage income, the consumer's budget constraint is now given by:

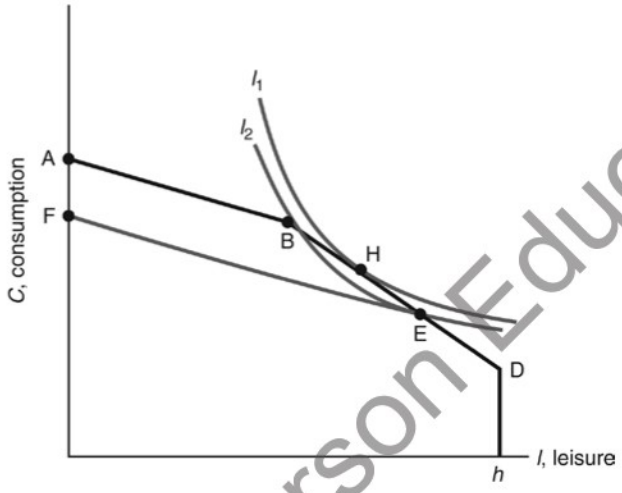
$$C = w(1-t)(h-l) + \pi - T,$$

where t is the tax rate on wage income. In the figure below, the budget constraint for $t \square 0$, is FGH. When $t > 0$, the budget constraint is EGH. The slope of the original budget line is $\neg w$, while the slope of the new budget line is $\square(1 \square t)w$. Initially the consumer picks the point A on the original budget line. After the tax has been imposed, the consumer picks point B. The substitution effect of the imposition of the tax is to move the consumer from point A to point D on the original indifference curve. The point D is at the tangent point of indifference curve, I_1, with a line segment that is parallel to EG. The pure substitution effect induces the consumer to reduce consumption and increase leisure (work less).

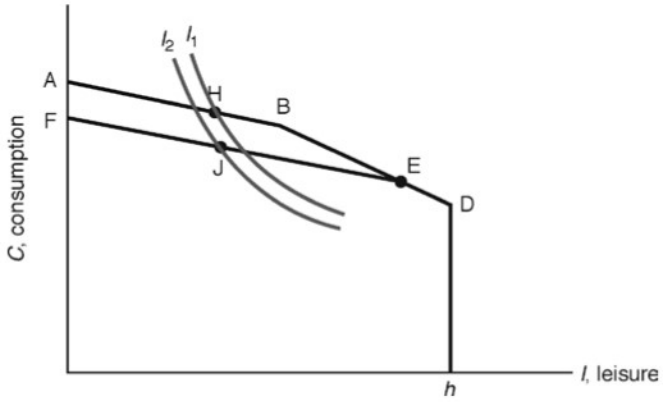
The tax also makes the consumer worse off, in that he or she can no longer be on indifference curve, I_1, but must move to the less preferred indifference curve, I_2. This pure income effect moves the consumer to point B, which has less consumption and less leisure than point D, because both consumption and leisure are normal goods. The net effect of the tax is to reduce consumption, but the direction of the net effect on leisure is ambiguous. The figure shows the case in which the substitution effect on leisure dominates the income effect. In this case, leisure increases and hours worked fall. Although consumption must fall, hours worked may rise, fall, or remain the same.



5. The budget constraint has a kink due to the tax deduction and is represented in the following figures by ABDh. Reducing the tax deduction pushes the budget constraint to FEDh.

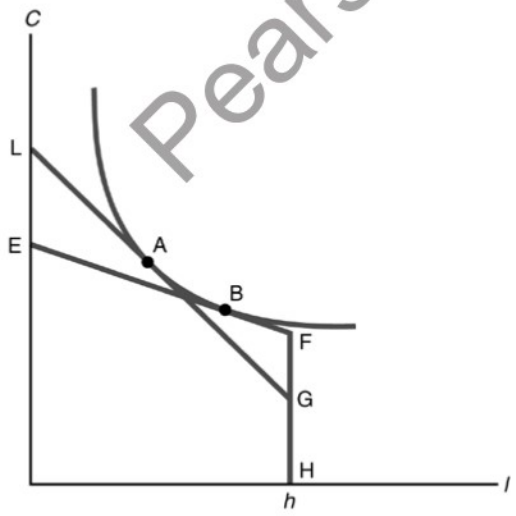


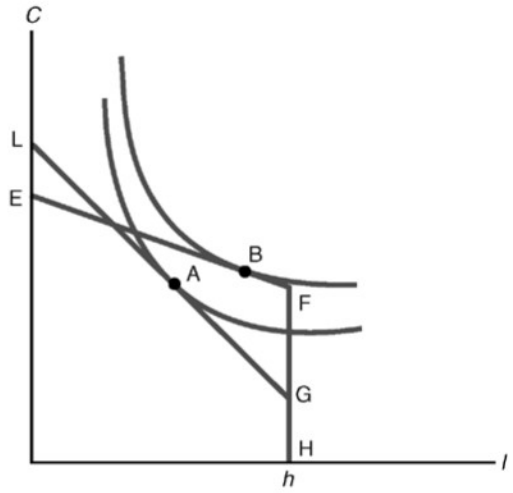
First consider a consumer who does not pay taxes. In the old regime, he would have an optimal bundle somewhere between B and D. Two things can happen. If the bundle is between E and D, there is no change. If it is between B and E, say at H, then the household will reoptimize with the new tax deduction. The new bundle is then either somewhere between E and F, and the MRS equals $w(1 - t)$. Or we obtain a corner solution at E, and the MRS is somewhere between w and $w(1 - t)$. The move from H to E is due to the income effect, and if there is an optimal strictly between E and F, the move from E to that point is due to the substitution effect.

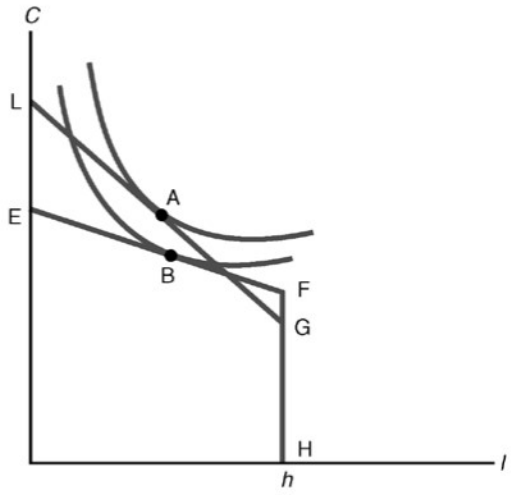


For a consumer who pays taxes, his wage, and thus is MRS does not change. Thus the move from H to J is a pure negative income effect.

6. The increase in dividend income shifts the budget line upward. The reduction in the wage rate flattens the budget line. One possibility is depicted in the figures below. The original budget constraint HGL shifts to HFE. There are two income effects in this case. The increase in dividend income is a positive income effect. The reduction in the wage rate is a negative income effect. The drawing in the top figure shows the case where these two income effects exactly cancel out. In this case we are left with a pure substitution effect that moves the consumer from point A to point B. Therefore, consumption falls and leisure increases. As leisure increases, hours of work must fall. The middle figure shows a case in which the increase in dividend income, the distance GF, is larger and so the income effect is positive. The consumer winds up on a higher indifference curve, leisure unambiguously increases, and consumption may either increase or decrease. The bottom figure shows a case in which the increase in dividend income, the distance GF, is smaller and so the income effect is negative. The consumer winds up on a lower indifference curve, consumption unambiguously decreases, and leisure may either increase or decrease.

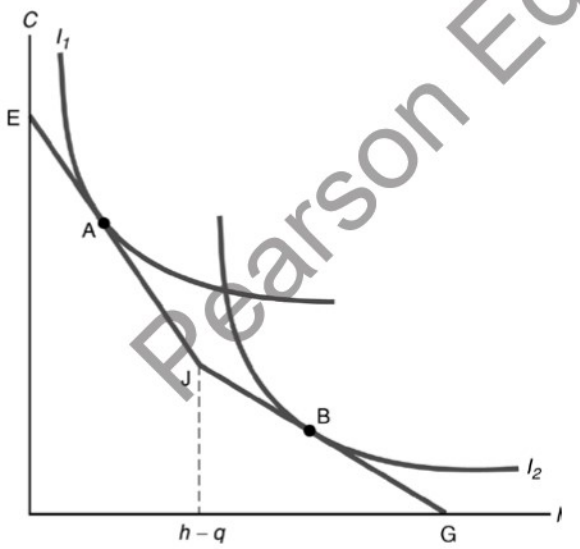






7. This problem introduces a higher, overtime wage for hours worked above a threshold, q. This problem also abstracts from any dividend income and taxes.

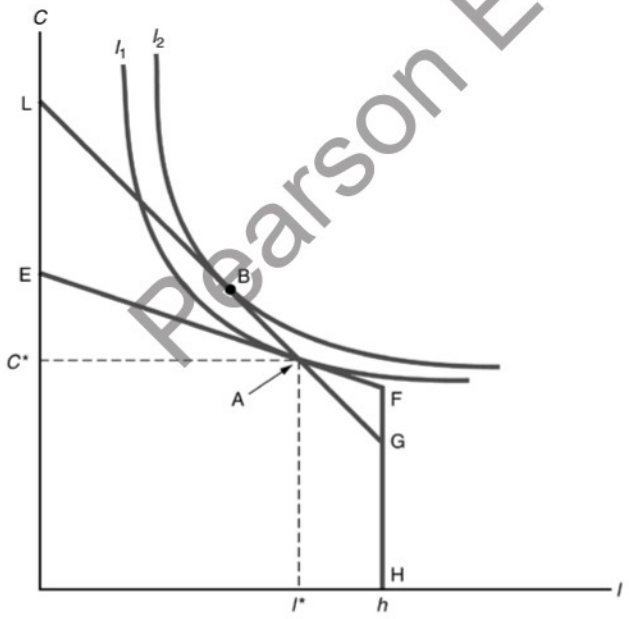
(a) The budget constraint is now EJG in the figure below. The budget constraint is steeper for levels of leisure less than $h - q$, because of the higher overtime wage. The figure depicts possible choices for two different consumers. Consumer #1 picks point A on her indifference curve, I_1. Consumer #2 picks point B on his indifference curve, I_2. Consumer #1 chooses to work overtime; consumer #2 does not.



(b) The geometry of the figure above makes it clear that it would be very difficult to have an indifference curve tangent to EJG close to point J. In order for this to happen, an indifference curve would need to be close to right angled as in the case of pure complement. It is unlikely that consumers wish to consume goods and leisure in fixed proportions, and so points like A and B are more typical. For any other allowable shape for the indifference curve, it is impossible for point J to be chosen.

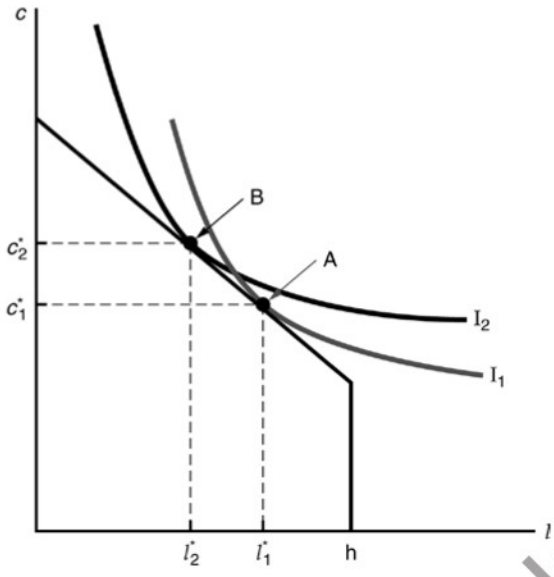
(c) An increase in the overtime wage steepens segment EJ of the budget constraint, but has no effect on the segment JG. For an individual like consumer #2, the increase in the overtime wage has no effect up until the point at which the increase is large enough to shift the individual to a point like point A. Consumer #2 receives no income effect because the income effect arises out of a higher wage rate on inframarginal units of work. An individual like consumer #1 has the traditional income and substitution effects of a wage increase. Consumer #1 increases her consumption, but may either increase or reduce hours of work according to whether the income effect outweighs the substitution effect.

8. Lump-sum Tax vs. Proportional Tax. Suppose that we start with a proportional tax. Under the proportional tax the consumer's budget line is EFH in the figure below. The consumer chooses consumption, C^*, and leisure, l^*, at point A on indifference curve I_1. A shift to a lump-sum tax steepens the budget line. The absolute value of the slope of the budget line is $(1-t)w$, and t has fallen to zero. The imposition of the lump-sum tax shifts the budget line downward in a parallel fashion. By construction, the lump-sum tax must raise the same amount of revenue as the proportional tax. The consumer must therefore be able to continue to consume C^* of the consumption good and l^* of leisure after the change in tax collection. Therefore, the new budget line must also pass through point A. The new budget line is labeled LGH in the figure below. With the lump-sum tax, the consumer can do better by choosing point B, on the higher indifference curve, I_2. Therefore, the consumer is clearly better off. We are also assured that consumption will be greater at point B than at point A, and that leisure will be smaller at point B than at point A.



9. Leisure represents all time used for nonmarket activities. If the government is now providing for some of those, like providing free child care, households will take advantage of such a program, thereby allowing more time for other activities, including market work. Concretely, this translates in a change of preferences for households. For the same amount of consumption, they are now willing to work more, or in other words, they are willing to forego some additional leisure. On the

figure below, the new indifference curve is labeled I_2. It can cross indifference curve I_1 because preferences, as we measure them here, have changed. The equilibrium basket of goods for the household now shifts from A to B. This leads to reduced leisure (from l^*_1 to l^*_2), and thus increased hours worked, and increased consumption (from C^*_1 to C^*_2) thanks to higher labor income at the fixed wage.



10. Supposing that the only options open to the consumer are working q hours and paying a tax T, or working zero hours and receiving an unemployment insurance benefit b, consumption will be $w(h-q)-T$ if the consumer works, and b if the consumer decides not to work. Then, either the consumer prefers not to work, as in the Figure 10.1, where the highest indifference curve is achieved at point A rather than at point B, or the consumer prefers to work, as in Figure 10.2. There is also another case where the consumer is just indifferent between working and not working, but that case is not important.

a) Think of the economy as consisting of many consumers, some of whom are in a situation as in the Figure 10.1 and some as in Figure 10.2. Some consumers do not work, and some choose to work. If the wage goes up, then that will make working preferable for some consumers who formerly did not choose to work. An increase in the wage will not discourage anyone from working, but those who were working already will not choose to vary hours of work (they cannot). But total employment in the economy will increase, as now more people are working. With the constraint on hours of work, there are no issues related to income and substitution effects. A higher wage always increases the total quantity of labor supplied.

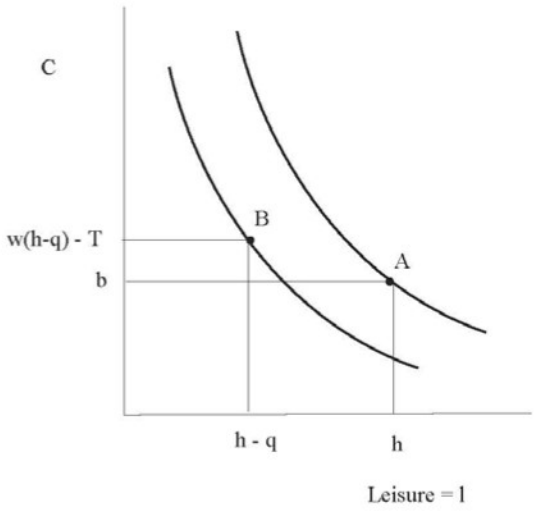


Figure 10.1

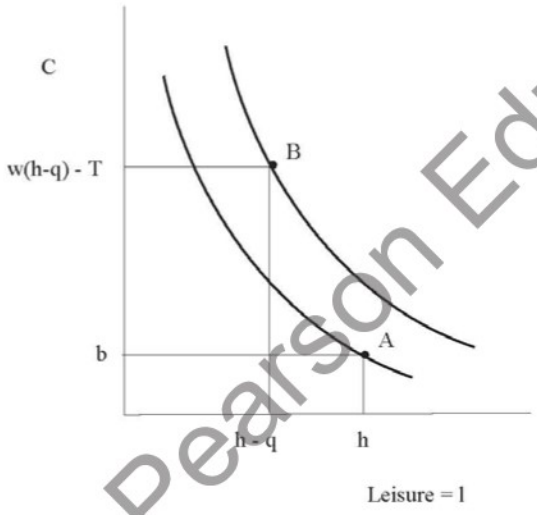


Figure 10.2

b) Similar to part (a), if the unemployment insurance benefit increases, this will make not working preferable to some consumers who were formerly working, and employment will fall. An increase in the unemployment insurance benefit unequivocally reduces the quantity of labor supplied.

11. The firm chooses its labor input, N^d, so as to maximize profits. When there is no tax, profits for the firm are given by

$$\pi = zF(K, N^d) - wN^d.$$

That is, profits are the difference between revenue and costs. In the top figure on the following page, the revenue function is $zF(K,N^d)$ and the cost function is the straight line, wN^d. The firm maximizes profits by choosing the quantity of labor where the slope of the revenue function equals the slope of the cost function:

$$MP_N = w.$$

The firm's demand for labor curve is the marginal product of labor schedule in the bottom figure on the following page.

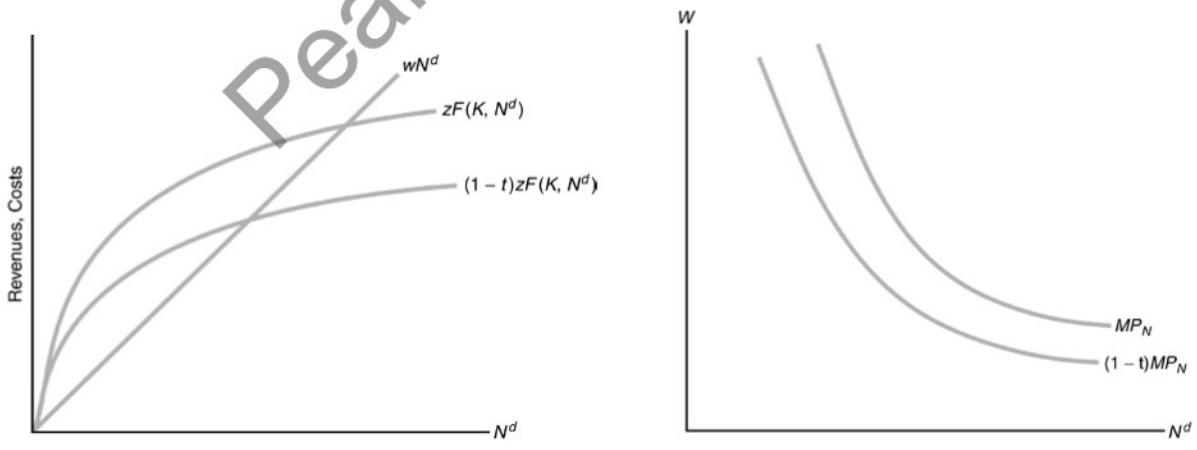
With a tax that is proportional to the firm's output, the firm's profits are given by:

$$\begin{aligned}\pi &= zF(K,N^d) - wN^d - tzF(K,N^d)\\ &= (1-t)zF(K,N^d),\end{aligned}$$

where the term $(1-t)zF(K,N^d)$ is the after-tax revenue function, and as before, wN^d is the cost function. In the top figure below, the tax acts to shift down the revenue function for the firm and reduces the slope of the revenue function. As before, the firm will maximize profits by choosing the quantity of labor input where the slope of the revenue function is equal to the slope of the cost function, but the slope of the revenue function is $(1-t)MP_N$, so the firm chooses the quantity of labor where

$$(1-t)MP_N = w.$$

In the bottom figure below, the labor demand curve is now $(1-t)MP_N$, and the labor demand curve has shifted down. The tax acts to reduce the after-tax marginal product of labor, and the firm will hire less labor at any given real wage.



12. The firm chooses its labor input N^d so as to maximize profits. When there is no subsidy, profits for the firm are given by

$$\pi = zF(K, N^d) - wN^d.$$

That is, profits are the difference between revenue and costs. In the top figure on the following page the revenue function is $zF(K, N^d)$ and the cost function is the straight line, wN^d. The firm maximizes profits by choosing the quantity of labor where the slope of the revenue function equals the slope of the cost function:

$$MP_N = w.$$

The firm's demand for labor curve is the marginal product of labor schedule in the bottom figure below.

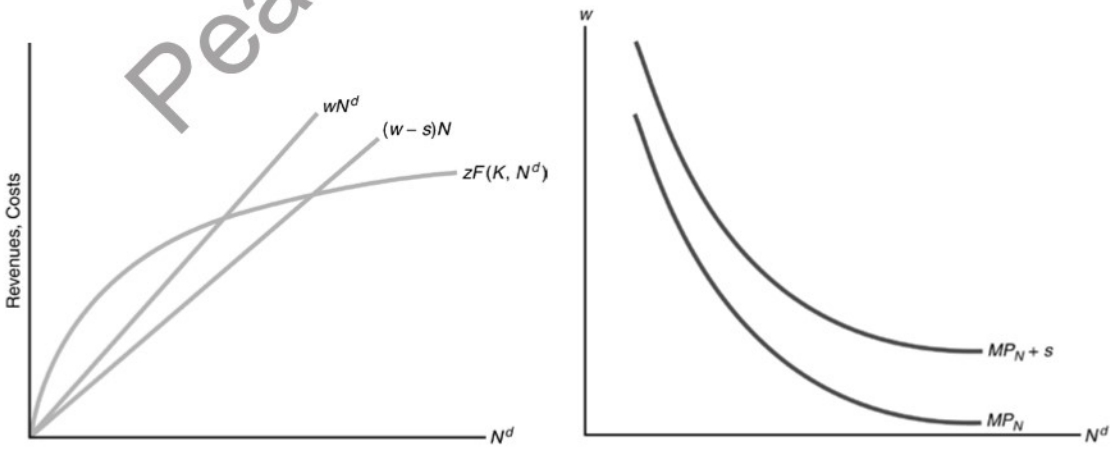
With an employment subsidy, the firm's profits are given by:

$$\pi = zF(K, N^d) - (w - s)N^d$$

where the term $zF(K, N^d)$ is the unchanged revenue function, and $(w - s)N^d$ is the cost function. The subsidy acts to reduce the cost of each unit of labor by the amount of the subsidy, s. In the top figure below, the subsidy acts to shift down the cost function for the firm by reducing its slope. As before, the firm will maximize profits by choosing the quantity of labor input where the slope of the revenue function is equal to the slope of the cost function, $(t - s)$, so the firm chooses the quantity of labor where

$$MP_N = w - s.$$

In the bottom figure below, the labor demand curve is now $MP_N + s$, and the labor demand curve has shifted up. The subsidy acts to reduce the marginal cost of labor, and the firm will hire more labor at any given real wage.



13. In Figure 13.1, given the minimum quantity of employment that the firm requires to operate, the production function (indentical to the total revenue function) follows ABD, and then continues

along the same production function we would have without the minimum quantity of employment. The firm maximizes profits, which implies that, if the market wage rate is greater than w^* the firm will earn negative profits for any quantity of labor input greater than or equal to N^*. Therefore, if $w > w^*$ then $N^d = 0$. If the real wage rate is less than or equal to w^* (so that the firm can earn positive profits for at least some positive quantities of labor input), but larger than MP_N^* (the marginal product of labor when $N^d = N^*$), then the firm will choose $N^d = N^*$ to maximize profits, as is the case in Figure 13.1 when $w = w_1$. That is, choosing $N^d = N^*$ is better than choosing $N^d = 0$ in this case, because the firm will earn positive profits rather than zero profits. However, if the firm increases the labor input above N^*, this will just reduce profits, as $w > MP_N$ when $N^d \geq N^*$. Now, if $w \leq MP_N^*$, then the minimum quantity of employment does not make any difference for what the firm chooses to do. The firm sets N^d so that $w = MP_N$, and the firm will choose $N^d = N^*$, as in Figure 4.14 when the firm faces a market wage w_2 and chooses $N^d = N_2$. Therefore, the labor demand curve is as depicted in Figure 13.2. The interesting feature of the firm's behavior is that labor demand does not change smoothly in response to the real wage. There is a critical wage rate w^* at which the firm is willing to start up, and at that wage it will actually hire more labor than would an identical firm that did not face a minimum employment constraint. In reality, firms may face constraints like this, for example a restaurant needs at least one cook, one waiter, and one cashier to operate, and this may cause employment to increase and decrease by larger amounts in response to changes in market wages than would otherwise be the case.

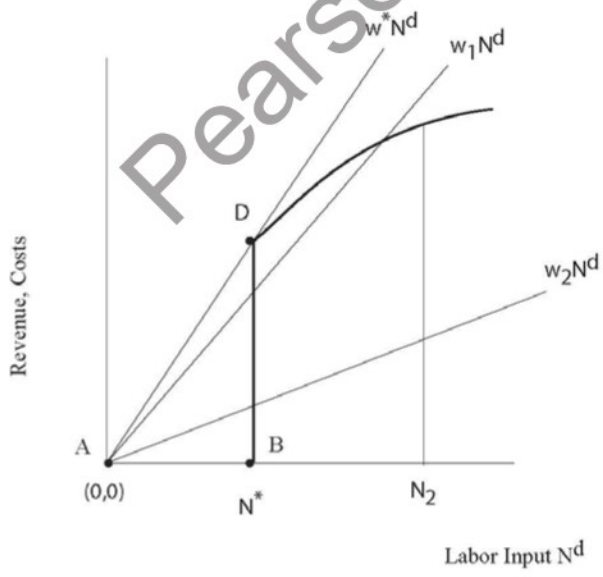


Figure 13.1

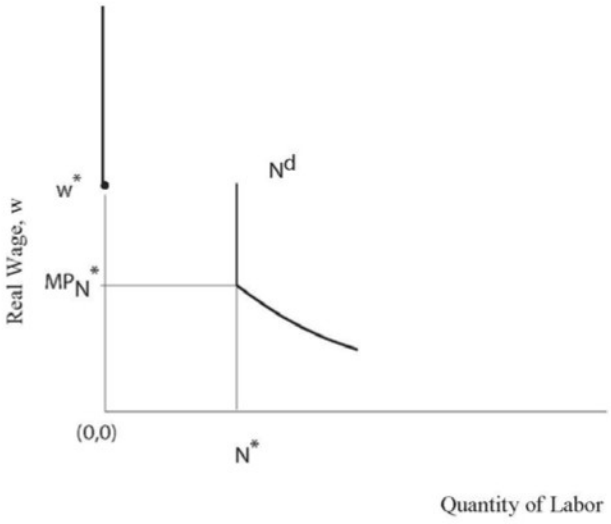
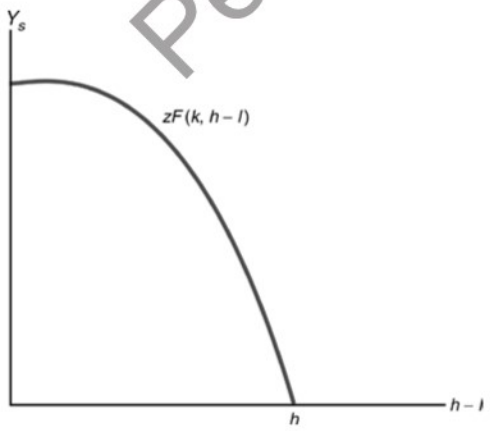


Figure 13.2

14. The level of output produced by one worker who works $h - l$ hours is given by

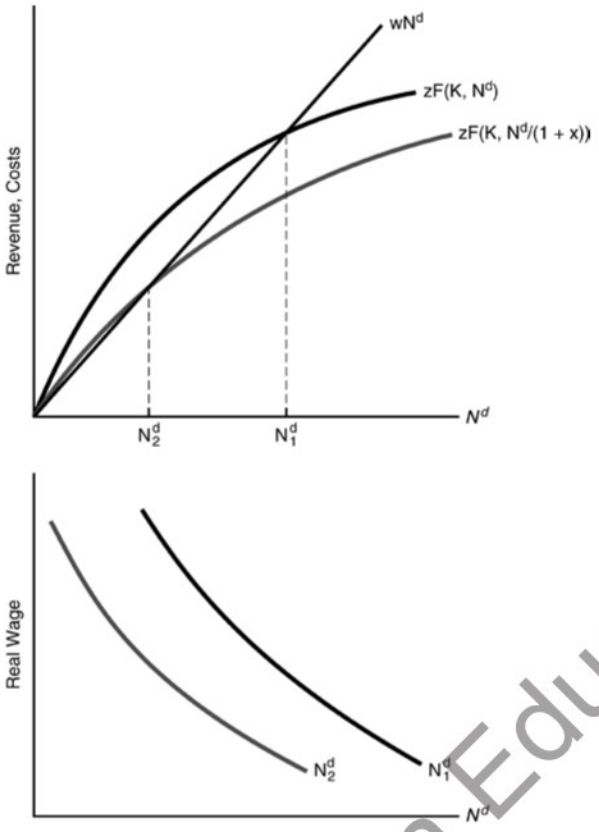
$$Y_s = zF(K, h - l).$$

This equation is plotted in the figure below. The slope of this production possibilities frontier is simply $-MP_N$.



15. As the firm has to internalize the pollution, it realizes that labor is less effective than it previously thought. It now needs to hire $N(1 - x)$ workers where N were previously sufficient. This is qualitatively equivalent to a reduction of z, total factor productivity. The figure below highlights

the resulting outcome: the firm now hires fewer people for a given wage and thus its labor demand is reduced.



16. $Y = zK^{0.3}n^{0.7}$

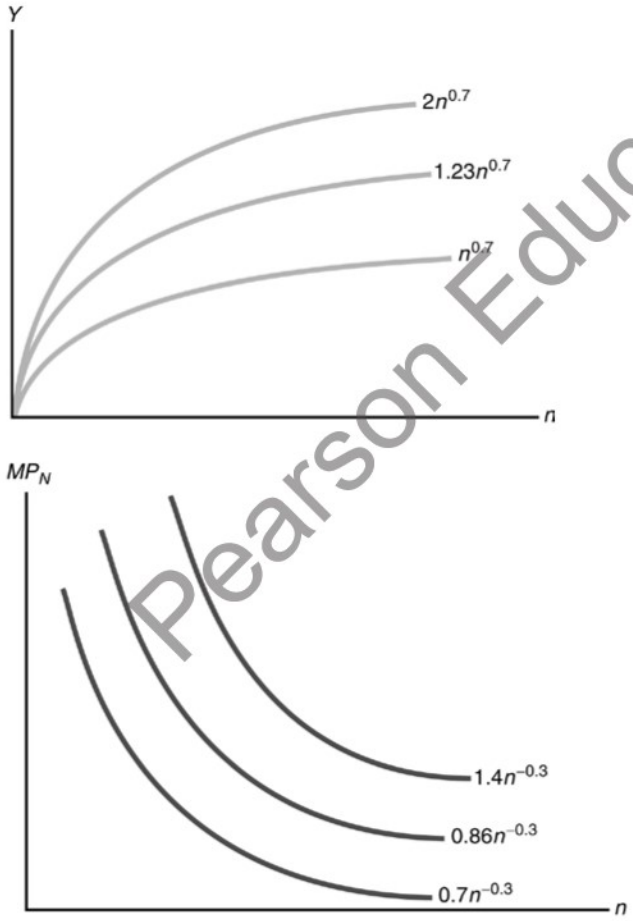
(a) $Y = n^{0.7}$. See the top figure below. The marginal product of labor is positive and diminishing.

(b) $Y = 2n^{0.7}$. See the figures below.

(c) $Y = 2^{0.3}n^{0.7} \approx 1.23n^{0.7}$. See the figures below.

(d) See the bottom figure below.

$z = 1, K = 1 \Rightarrow MP_N = 0.7n^{-0.3}$
$z = 2, K = 1 \Rightarrow MP_N = 1.4n^{-0.3}$
$z = 1, K = 2 \Rightarrow MP_N = 2^{0.3} \times 0.7n^{-0.3} \approx 0.86n^{-0.3}$



17. a) The production function, for fixed K, is shown in Figure 17.1. For any wage w, profits for the firm will increase with N, and there is no limit on how much labor the firm wants to hire. The firm maximizes profits by hiring an infinite amount of labor.

b) This presents problems for competitive equilibrium because supply could never equal demand in equilibrium, as the quantity of labor supplied could not be infinite. Essentially, competitive equilibrium is the wrong modeling approach if there are increasing returns to scale. A more appropriate approach would be to assume a monopoly producer, or at least an oligopoly where firms behave strategically instead of as price takers.

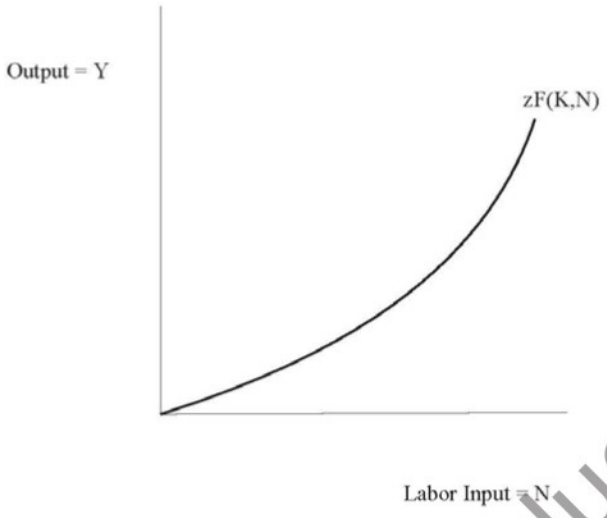


Figure 17.1

Chapter 5
A Closed-Economy One-Period Macroeconomic Model

■ Teaching Goals

There are three key points to be learned from this chapter. The first point is that when we allow the consumers and firms that we studied in Chapter 4 to interact with each other and with the government, the economy is able to achieve equilibrium through price adjustment. In this particular case, the "price" is the relative price of leisure, the real wage. The second important point is that the equilibrium that markets settle upon is a favorable one, in the sense of Pareto optimality. This point is in keeping with Adam Smith's notion that the "invisible hand" of self-interested individuals, meeting in a competitive market, can work for the common good. The third point is that we can directly discover the equilibrium position of a market economy by solving an economic planner problem. Although students may find this point to be somewhat arcane, stress the point that it will be much simpler to solve problems (e.g., exam problems) by working with a planner problem as opposed to directly solving general equilibrium problems. The students, however, need to be aware when this solution method is not applicable. The section about the Laffer curve is a good way to show when social and private optima do not coincide.

Once students have mastered the mechanics of the model, the two problems for which this model is best suited are the analyses of changes in government spending and total factor productivity. In working these problems, stress the applicability of these results to historical applications and as a guide to understanding current events.

A key tactic of the textbook's approach is the critical assessment of the usefulness and credibility of competing models. Therefore, it is important to stress the extent to which models fit the facts. Does this model fit the facts of long-run growth? Does this model fit the facts of the typical business cycle? These kinds of questions come up again and again in the course of macroeconomic study. Stress again and again that scientific study needs to relate to observations, in our case the stylized facts of Chapter 2.

■ Classroom Discussion Topics

An alternative approach to this material is to start with the example of *Robinson Crusoe* (or *Castaway*, *Gilligan's Island*, etc.). Does an isolated individual have any economic choices? What would guide these choices? Would you rather be on an island with a more plentiful food supply? A pure income effect can then be presented in the form of extra food (or a volleyball) washing up on shore, or in the form of "pirates" (government?) demanding tribute. An increase in total factor productivity can be in the form of obtaining a fishing net or a ladder to climb coconut trees. A change in capital can be the consequence of a hurricane, etc.

The next step would be to ask the students about the likely consequences of additional individuals on the island. If they are all identical, and there are no economies to team production, will there be any reason for markets to exist? Could a market improve things? How and why? Typically, markets improve things only

to the extent that people are different. However, these types of differences are what we are willing to ignore when we adopt the fiction of a representative consumer.

■ Outline

I. Competitive Equilibrium

A. A One-Period Model
   1. No Borrowing or Lending
   2. $G = T$

B. Equilibrium Modeling
   1. Endogenous Variables
   2. Exogenous Variables
   3. Hypothetical Experiments

C. Properties of a Competitive Equilibrium
   1. Representative Consumer Maximizes Utility Subject to Budget Constraint
   2. Representative Firm Maximizes Profits
   3. Markets Clear
   4. Government Budget Constraint Satisfied
   5. $w = MRS_{l,C} = MRT_{l,C} = MP_N$

II. Optimality

A. Pareto Optimality

B. Welfare Theorems
   1. 1st Theorem: A Competitive Equilibrium Can Be Pareto Optimal
   2. 2nd Theorem: A Pareto Optimum Can Be a Competitive Equilibrium

C. Inefficiencies
   1. Externalities
   2. Distorting Taxes
   3. Monopoly Power

D. Using the Second Theorem
   1. Pareto Optima Are Easier to Identify
   2. Effects of Disturbances on Pareto Optima

III. Effects of an Increase in Government Spending

A. Impact Effect
   1. Parallel Downward Shift in *PPF*
   2. Pure Income Effect

B. Equilibrium Effects
   1. Reduced Consumption
   2. Reduced Leisure and Increased Hours of Work
   3. Increased Output
   4. Lower Real Wage

C. Crowding-Out

D. Government Spending a Source of Business Cycles?

1. Government Spending Shocks Wrongly Predict Countercyclical Consumption
2. Government Spending Shocks Wrongly Predict Countercyclical Real Wages

IV. Effects of an Increase in Total Factor Productivity

A. Impact Effect
   1. Upward Shift in *PPF*
   2. Steeper *PPF*
   3. Income and Substitution Effects

B. Equilibrium Effects
   1. Increased Consumption
   2. Leisure and Hours Worked May Rise or Fall
   3. Increased Output
   4. Higher Real Wage

C. Productivity and Long-Run Growth
   1. Consumption Grows over Time
   2. Hours Worked Remain about Constant
   3. Output Increases over Time
   4. Real Wages Rise over Time

D. Productivity as Source of Business Cycles?
   1. Consumption Is Procyclical
   2. Cyclical Properties of Hours Worked
      a. Procyclical Hours Worked Is a Business Cycle Fact
      b. Need Strong Substitution Effect to Predict Procyclical Hours
      c. Intertemporal Substitution of Leisure
   3. Increased Output Defines the Cycle
   4. Procyclical Real Wage Rate

V. Income Tax Revenue and the Laffer Curve

A. Tax Revenue
   1. The Tax Base Depends on the Proportional Tax Rate
   2. The Laffer Curve Measures Tax Revenue as a Function of the Tax Rate
   3. Unless the Tax Rate Is Optimal, Two Tax Rates Yield the Same Tax Revenue
   4. Supply-Side Economists Claim the U.S. Economy Is at the Bad Tax Rate
   5. Empirical Evidence Tends to Prove Supply-Side Economists Wrong

VI. A Model of Public Goods: How Large Should the Government Be?

A. Effects of higher GDP on optimal government spending.

B. Better government technology: what happens to optimal government spending and private spending?

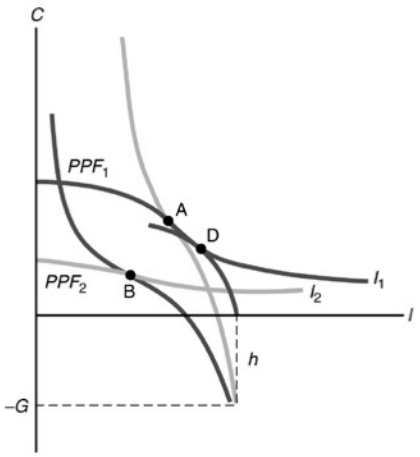
■ Solutions to End-of-Chapter Problems

1. Although we often think about the negative externalities of congestion and pollution in cities, there may also be some positive externalities. A concentrated population is better able to support the arts and professional sports; cities typically have a greater variety of good restaurants, etc. Perhaps a more basic issue is that there may be some increasing returns to scale at low output levels that make industrial production more costly in small towns. There may also be externalities in production in being located close to other producers. One example would be the financial industry in financial centers like New York, London, Tokyo, etc. Another example would be large city medical centers that enhance coordination between primary physicians and specialists.

   One market test of whether productivity is higher in cities would be to look at the wages in cities versus the wages in smaller towns and rural areas. Wages are often higher in cities for individuals of comparable skills. Market efficiency suggests that the higher wages be reflective of a higher marginal product of labor, and that the higher wages compensate those choosing to live in cities for the negative externalities that they face.

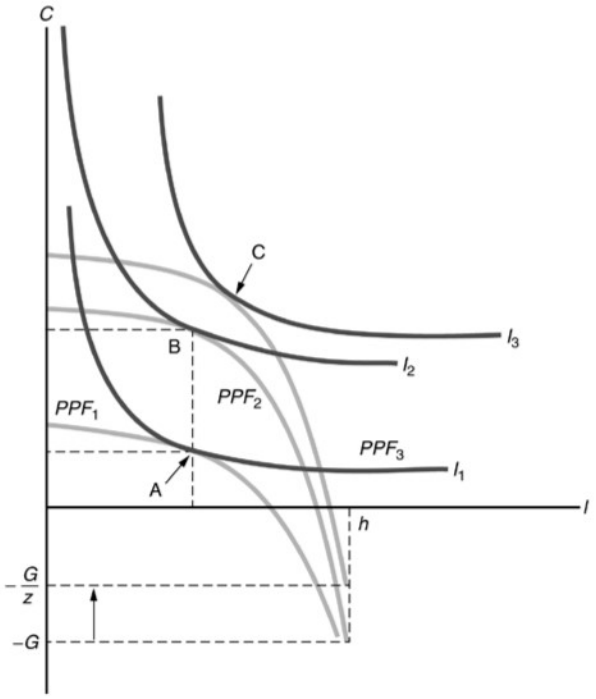
2. In a one period model, taxes must be exactly equal to government spending. A reduction in taxes is therefore equivalent to a reduction in government spending. The result is exactly opposite of the case of an increase in government spending that is presented in the text. A reduction in government spending induces a pure income effect that induces the consumer to consume more and work less. At lower employment, the equilibrium real wage is higher because the marginal product of labor rises when employment falls. Output falls, consumption rises, employment falls and the real wage rises.

3. The only impact effect of this disturbance is to lower the capital stock. Therefore, the production possibility frontier shifts down and the marginal product of labor falls (*PPF* is flatter).
   (a) The reduction in the capital stock is depicted in the figure below. The economy starts at point A on PPF_1. The reduction in the capital stock shifts the production possibilities frontier to PPF_2. Because PPF_2 is flatter, there is a substitution effect that moves the consumer to point D. The consumer consumes less of the consumption good and consumes more leisure. Less leisure also means that the consumer works more. Because the production possibilities frontier shifts down, there is also an income effect. The income effect implies less consumption and less leisure (more work). On net, consumption must fall, but leisure could decrease, remain the same, or increase, depending on the relative strengths of the income and substitution effect. The real wage must also fall. To see this, we must remember that, in equilibrium, the real wage must equal the marginal rate of substitution. The substitution effect implies a lower marginal rate of substitution. The income effect is a parallel shift in the production possibilities frontier. As the income effect increases the amount of employment, marginal product of labor must fall from point D to point B. This reinforces the reduction in the marginal rate of substitution from point A to point D.

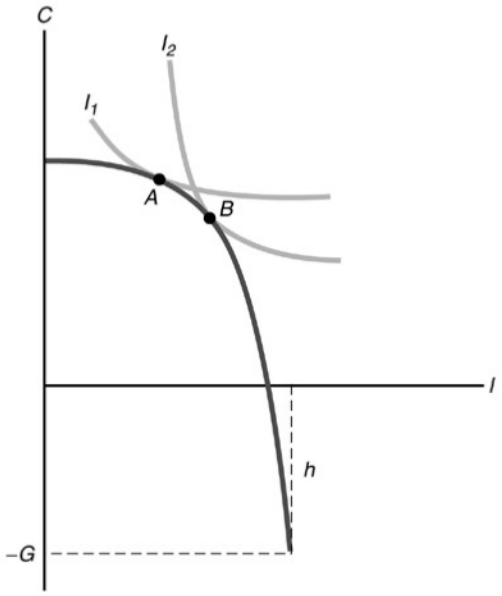


(b) Changes in the capital stock are not likely candidates for the source of the typical business cycle. While it is easy to construct examples of precipitous declines in capital, it is more difficult to imagine sudden increases in the capital stock. The capital stock usually trends upward, and this upward trend is important for economic growth. However, the amount of new capital generated by a higher level of investment over the course of a few quarters, of a few years, is very small in comparison to the existing stock of capital. On the other hand, a natural disaster that decreases the stock of capital implies lower output and consumption, and also implies lower real wages, which are all features of the typical business cycle contraction.

4. Government Productivity. First consider the benchmark case in which $z = 1$, and there is no effect of changes in z on government activities. Now suppose that z increases. This case of an increase in z is depicted in the figure below. The original production possibilities frontier is labeled PPF_1 and the competitive equilibrium is at point A. If the increase in z only affects the economy through the change in $zF(K,N)$, then the new production possibilities frontier is PPF_2. The diagram shows a case in which the income and substitution effects on leisure exactly cancel out, and the economy moves to point B. The equation for the production possibilities frontier is $C = zF(K,h-l) - T$. In the benchmark case, $T = G$ and so we have $C = zF(K,h-l) - G$. For this problem, $T = G/z$, and so the production possibilities frontier is given by $C = zF(K,h-l) - G/z$. When $z = 1$, the two *PPFs* coincide. When z increases, the vertical intercept of the *PPF* increases by $G/\Delta z$. Therefore, the new *PPF* is PPF_3 in the figure below. The competitive equilibrium is at point C. There is an additional income effect that provides an additional increase in equilibrium consumption, and a reinforced income effect that tend to make leisure increase. Therefore, relative to the benchmark case, there is a larger increase in consumption, and either a smaller decrease in leisure or a larger increase in leisure.



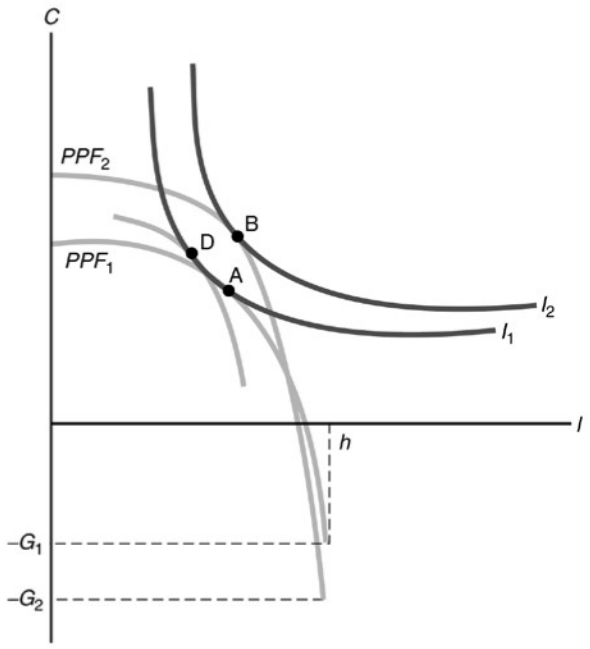
5. Change in preferences.
   (a) At the margin, the consumer decides that leisure is more preferred to consumption. That is, the consumer now requires a bigger increase in consumption to willingly work more (consume less leisure). In more intuitive language, the consumer is lazier.
   (b) To work out the effects of this change in tastes, we refer to the figure below. The production possibility frontier in this example is unchanged. The consumer now picks a new point at which one of the flatter indifference curves is tangent to the production possibilities frontier. That is, equilibrium will shift from point A to point B. Consumption falls and leisure rises. Therefore, the consumer works less and produces less. Because employment has fallen, it also must be the case that the real wage increases.



(c) This disturbance, which some might characterize as a contagious outbreak of laziness, would have the appearance of a recession, as output and employment both fall. The consequent reduction in consumption is also consistent with a typical recession. However, in this case the real wage would rise, which is inconsistent with the business cycle facts. Therefore, this type of preference change is not a cause of recessions.

6. Production-enhancing aspects of government spending.

(a) The increase in government spending in this example has two separate effects on the production possibilities frontier. First, the increase in government spending from G_1 to G_2 implies a parallel downward shift in the production possibilities frontier. Second, the productive nature of government spending is equivalent to an increase in total factor productivity that shifts the production possibilities frontier upward and increases its slope. The figure below draws the original production possibilities frontier as PPF_1 and the new production possibilities frontier as PPF_2. If the production-enhancing aspects of the increase in government spending are large enough, representative consumer utility could rise, as in this figure.



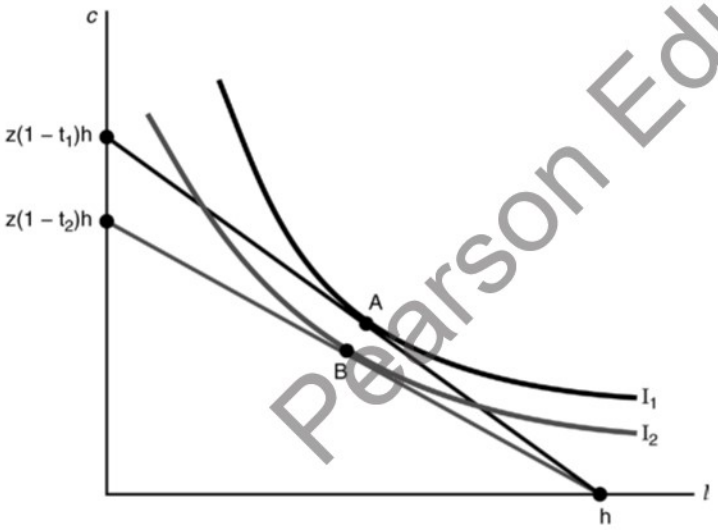
(b) There are three effects at work in this example. First, there is a negative income effect from the increase in taxes needed to pay for the increased government spending. This effect tends to lower both consumption and leisure. Second, there is a substitution effect due to the productive effect of the increase in G, which is drawn as the movement from point A to point D. This effect tends to increase both consumption and leisure. Third, there is a positive income effect from the increase in G on productivity. This effect tends to increase both consumption and leisure. In the figure above, the movement from point D to point B is the net effect of the two income effects. In general, consumption may rise or fall, and leisure may rise or fall. The overall effect on output is the same as in any increase in total factor productivity. Output surely rises.

7. (a) If households dedicate a hours to education today, it reduces the hours available for leisure and work to $h - a$. The PPF has to start form point $(-G, h - a)$. Graphically, this corresponds to the figure in the answer of question 6(b). The consequence is thus a reduction in consumption, leisure, employment, aggregate output, but an increase in the real wage.

   (b) In the future, workers will be more efficient, which corresponds to an increase in total factor productivity. Thus we have the case described in Figure 5.9 of the textbook. There is an increase in future consumption, aggregate output and the real wage. Changes in employment and leisure are ambiguous.

   (c) An increase in education leads to an immediate loss in welfare, as both leisure and consumption are reduced. But this is compensated by an increase in future consumption, and possibly of leisure, too. Whether this is worth doing depends on the preferences of households over current and future utility.

8. We need to analyze each case separately. Start with the good equilibrium. As government expenses increase, more tax revenue needs to be raised, and thus the tax rate needs to be increased. As shown in the figure below, this tilts down the linear *PPF*. The new equilibrium leads to a lower indifference curve. This leads to a negative income effect and a lower wage (remember, it is $z(1 - t)$), thus a substitution effect. The income effect lowers consumption and leisure, the substitution effect decreases consumption and increases leisure. All in all, consumption is lower and leisure is higher, as we know that the substitution effect dominates the income effect. This means that the labor supply is reduced, and thus equilibrium labor and output.



The story is different in the bad equilibrium. To increase tax revenue, one needs to reduce the tax rate. Then all the changes discussed above are exactly in the opposite direction.

9. We know from previous analysis that an improvement in total factor productivity pushes up the *PPF*, and thus leads to an increase in consumption, a decrease in leisure, and thus an increase in the quantity of labor supplied. This increases the tax base, and thus allows a reduced tax rate to achieve the same tax revenue, or in other words, it pushes the left portion of the Laffer curve to the left. The reduction in the tax rate has then a further impact on the variables of interest: as we saw in question 7, first part with a reversal of all signs: consumption increases even more and leisure decrease yet more, leading to an even higher quantity of labor. All in all, as both labor and total factor productivity increase, output increases.

10. a) With perfect substitutes preferences, indifference curves are straight lines with slope $-b$, where b is the marginal rate of substitution. If $b > 1/q$, so that the indifference curves are steeper than the PPF, then the optimal choice for the government is $G=qY$, so that $C = 0$. Thus if b is relatively large (the consumer cares relatively more about public goods relative to private goods) and q is relatively large (the government is relatively efficient), then all production should be carried on by the government. Alternatively if $b < 1/q$, then $G = 0$ and $C = Y$, so that government is inactive. Thus, if b increases or q increases, this makes it more likely that $b > 1/q$ and we have the first case, where all production comes from the government.

b) With perfect complements, indifference curves are as depicted in Figure 10.1, and the initial equilibrium is at point A. If a increases, then the equilibrium shifts from A to B in Figure 10.2. An increase in a represents a greater preference for private goods relative to public goods, and in Figure 10.2, this results in less public goods and more private consumption in equilibrium. If q increases, this shifts the PPF out as in Figure 10.3, and the equilibrium shifts from A to B. Both C and G increase, driven by income effects.

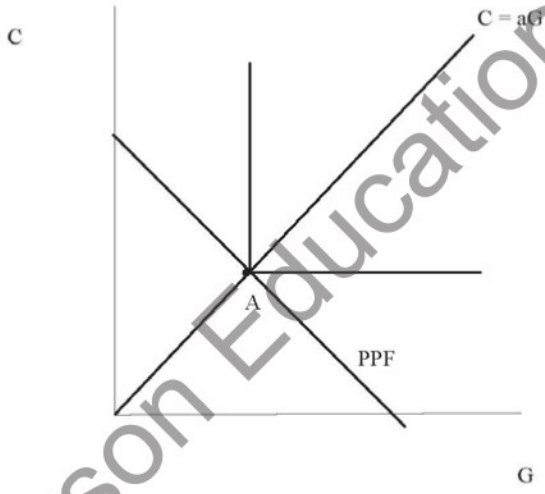


Figure 10.1

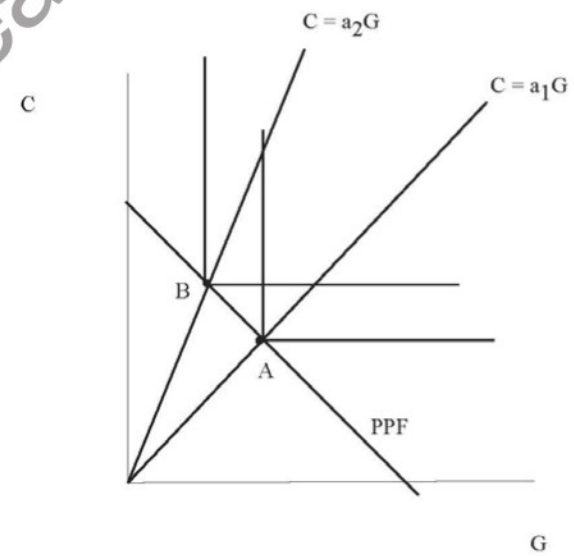


Figure 10.2

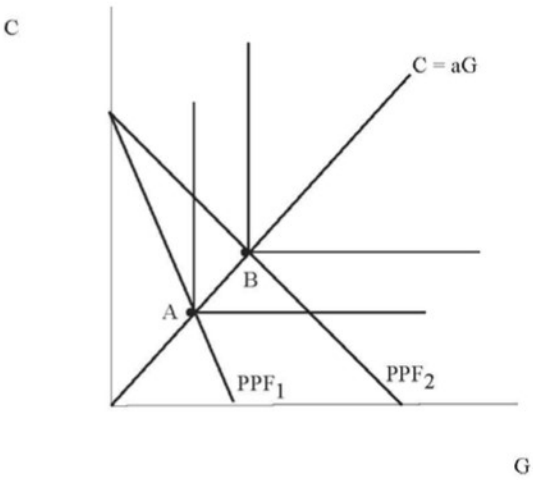


Figure 10.3

11. (a) If public goods and private goods are perfect substitutes, then the consumer always chooses C and l so that $C = dl$, and so given the production possibilities frontier, we must have

$$C = h - \frac{C}{d} - G$$

and so

$$C = \frac{d(h-G)}{1+d}$$

and

$$l = \frac{h-G}{1+d}$$

Therefore, consumption and leisure both decrease when government spending increases – a pure income effect.

(b) However, suppose that public goods and private goods are perfect complements. As in part (a), it is always optimal for the consumer to choose C and l so that $C = dl$. But the consumer faces a tax $T = G$, and the wage is $w=1$. So, if the consumer chooses the $C = dl$ and the budget constraint is satisfied, then

$$C = \frac{d(h-G)}{1+d}$$

and

$$l = \frac{h-G}{1+d},$$

just as in part (a). This is the only optimum if

$$C \leq aG,$$

or

$$G \geq \frac{dh}{a(1+d)+d}$$

But, if

$$G \leq \frac{dh}{a(1+d)+d}$$

Then, it is optimal for the consumer to choose

$$C = aG$$

and

$$l = \frac{aG}{d}.$$

In this case, the consumption bundle of the consumer actually lies inside the production possibilities frontier, and government spending has a Keynesian effect. More government spending implies greater consumption.

Chapter 6
Search and Unemployment

■ Teaching Goals

Including a version of the DMP model in an intermediate macroeconomics text is a novelty. Students should not have difficulty understanding the model, but they may need some additional help, as the approach is somewhat different than what we use in standard competitive equilibrium models, for example in Chapter 5. However, it helps to think of the labor market in terms of demand and supply sides. Then, it is possible to use what a student knows from Chapter 5 to teach them about the DMP model. Workers and firms care about the wage in the same way they do in a competitive model, but now the market "clears" in a different way. Workers care not only about the wage, but the employment insurance benefit (because their job search may be unsuccessful) and labor market tightness (which determines the chances of finding a job). Would-be employers care about labor market tightness and the cost of posting a vacancy, as well as the market wage. The matching function, which determines the number of successful matches as a function of matching efficiency and the numbers of firms and consumers searching, is an important concept. In this case, appeal to what students know about the production function, as the matching function has the same properties. Then, one can appeal by analogy to production so that the student understands how the matching process takes place.

It is important first to understand the labor market data. The DMP model is very nice, as the variables in the model match up almost exactly with the labor market data as measured. The unemployed are those who chose to search but were unsuccessful, the labor force is the number of people who actively searched and found a job (employed) plus the number who actively searched and were unsuccessful (the unemployed), etc.

The experiments in the model – increase in the unemployment insurance benefit, increase in productivity, decrease in matching efficiency – are all useful in understanding recent economic events and less-recent ones.

The "Keynesian DMP Model" comes from ideas in work by Roger Farmer. This is a nice way to understand Keynesian ideas (for starters). With bargaining indeterminacy the wage could be "stuck" at too high a level, with an unemployment rate that is too high. We don't deal with Keynesian economic policies in this chapter, leaving that for later chapters.

■ Classroom Discussion Topics

It should not be hard to get students talking about unemployment. Most of them should know someone who has been unemployed, or they have read about unemployment as it relates to the recent recession. However, students may not understand how unemployment is actually defined, or how economists think about it. An important feature of the DMP model is that there will be unemployment under any circumstances, and students should understand that we cannot make unemployment go away, nor should we want it to.

It will be helpful if students understand why a search-model approach is necessary to understanding unemployment. Get them thinking about what an unemployed person is actually doing, and what is motivating them. Unemployment is an economically measurable activity, and we want to take a scientific approach to thinking about it.

Also, get the students to think about what motivates firms to search for workers to fill job openings. Why is searching for workers costly? What difficulties does a firm face in hiring workers? How does matching between firms and workers take place? Why is the market for labor similar to, and different from, the market for a good or service?

Students should be encouraged to think about government intervention and how it matters for labor market behavior. What will unemployment insurance do? How can the government speed up or slow down the matching process in the labor market?

■ Outline

1. **The Behavior of the Unemployment Rate, the Participation Rate, and the Employment/Population Ratio in the United States**
   a) Unemployment Rate, participation rate, and employment/population ratio: data.
   b) Key determinants of the unemployment rate: aggregate economic activity, demographics, government intervention, mismatch

2. **The Diamond-Mortensen-Pissarides Model of Search and Unemployment**
   a) Consumers
   b) Firms
   c) Matching
   d) Optimization by Consumers
   e) Optimization by Firms
   f) Equilibrium
   g) An increase in the unemployment insurance benefit
   h) An increase in productivity
   i) A decrease in matching efficiency
   j) The Beveridge curve
   k) A Keynesian DMP model

■ Solutions to End-of-Chapter Problems

1. More labor-saving devices has the effect of reducing the payoff to working at home for all consumers, which reduces $v(Q)$ for each value of Q. As a result, the curve in panel (a) of Figure 6.1 shifts up. In equilibrium, Q increases, but j remains unchanged. The unemployment rate and the vacancy rate are unaffected, but the labor force Q increases. Since $j = A/Q$, therefore the number of firms A increases. Aggregate output $Y = Qem(1,j)$, so Y increases, as Q has risen and j is unchanged. Labor saving devices makes searching for work more attractive relative to working at home for consumers. With more consumers in the market, labor market tightness tends to go down, which attracts more firms into the labour market. Ultimately, the number of active firms increases proportionally to the number of consumers searching for work, and there is no change in labor market tightness in equilibrium. Output goes up because there are more successful matches in the labor market.

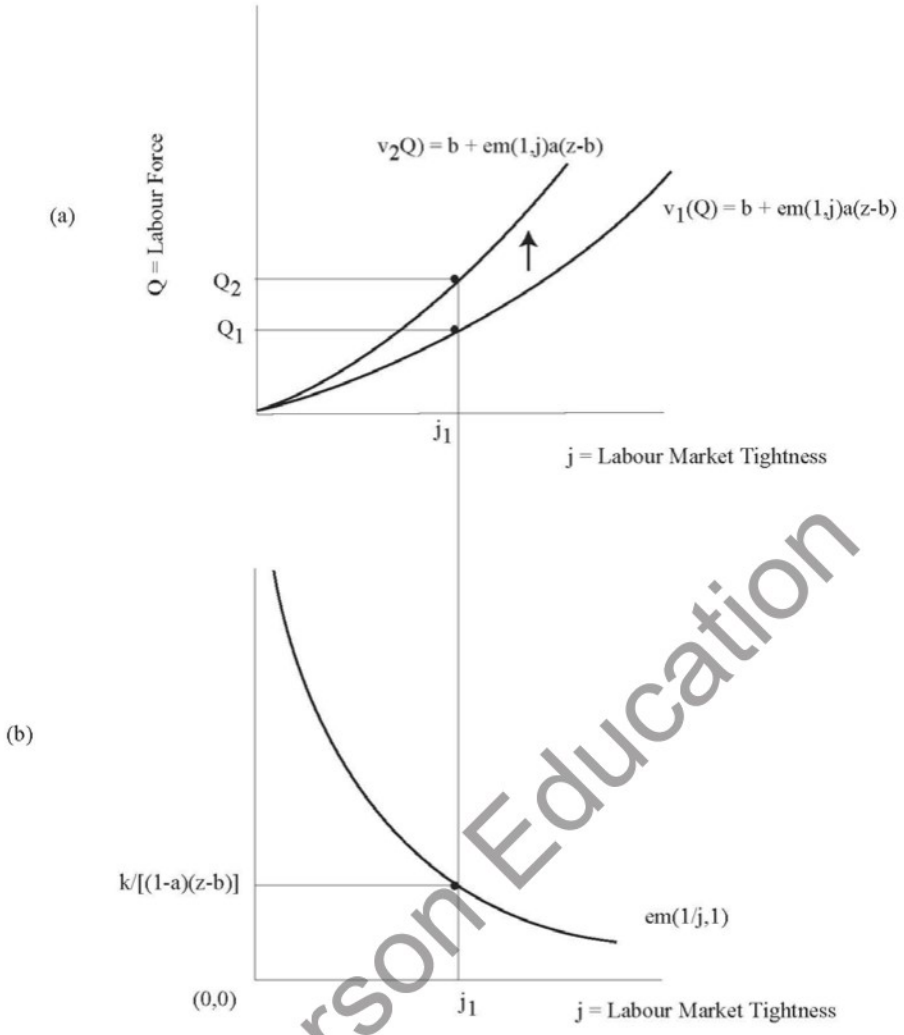


Figure 6.1

2. (i) With a subsidy s to hiring a worker, for a successful match, the surplus of the firm is $z+s-w$, the surplus of the worker is $w-b$, total surplus is $z+s-b$, and the wage (from Nash bargaining) is $w=a(z+s)+(1-a)b$. Then, on the supply side of the labor market, the equation determining the curve in panel (a) of Figure 6.2 is given by

$$v(Q)=b+em(1,j)a(z+s-b),$$

and on the demand side of the market, the equation determining j is

$$(k/((1-a)(z+s-b)))=em((1/j),1)$$

Then, in Figure 6.2, comparing the equilibrium when $s=0$ to one with $s>0$, the subsidy acts to increase labour market tightness, j, and to increase the labor force, Q. The subsidy acts to induce more firms to enter the labor market to search for workers, which makes $j=(A/Q)$ higher. This in turn acts to make

search more attractive for workers, as it is now easier to find a job. As well, the subsidy increases the wage, which further increases the incentive to search for work. The unemployment rate is 1-*em(1,j)*, which falls when *j* increases, so the subsidy reduces the unemployment rate.

(ii) If the government pays would-be workers to stay out of the labor market, this has no effect on the demand side (firms' behavior). However, the supply side of the labor market is now characterized by the equation

$$q+v(Q)=b+em(1,j)a(z+s-b),$$

Therefore, when $q>0$, this shifts the curve in the upper panel of Figure 6.2 to the right. There is no effect on labor market tightness, *j*, and therefore no effect on the unemployment rate. However, *Q* falls. Since *j* does not change, this implies that *A* falls as well, since $j=(A/Q)$. Therefore, this policy has the effect not only of reducing the number of would-be workers looking for work, but it reduces the number of firms searching for workers. The policy has an unintended side effect and has no effect on the unemployment rate.

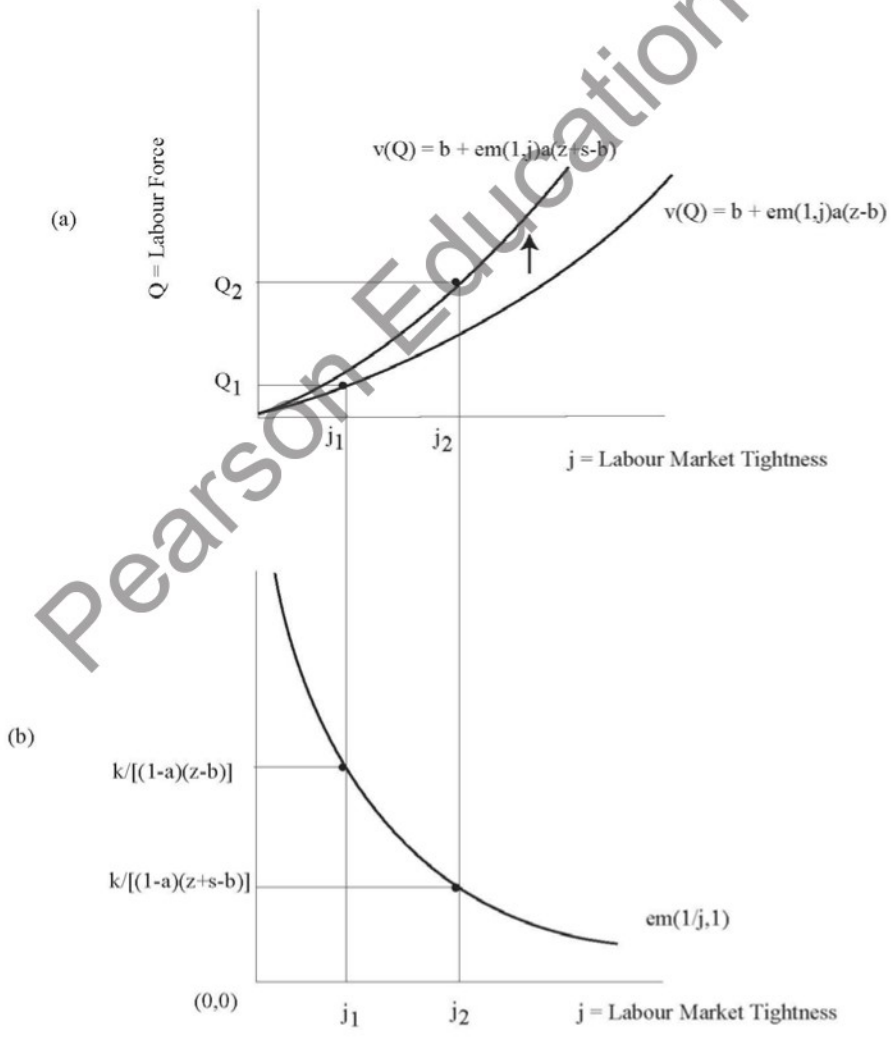


Figure 6.2

3. The lower recruiting cost, k, affects only the demand side of the labor market. In Figure 6.3, labor market tightness increases from j_1 to j_2, and the labor force increases from Q_1 to Q_2. The unemployment rate is *1-em(1,j)*, which decreases because of the increase in j, and the vacancy rate is *1-em((1/j),1)*, which increases. Since *j=(A/Q)*, and since Q and j increase, A also increases. Aggregate output is *Qem(1,j)z*, which increases, as Q and j both increase. Thus, the lower cost of recruiting induces more firms to enter the labor market, which increases labor market tightness, inducing more workers to enter the labor market to search for work, as the chances are now better of finding a job.

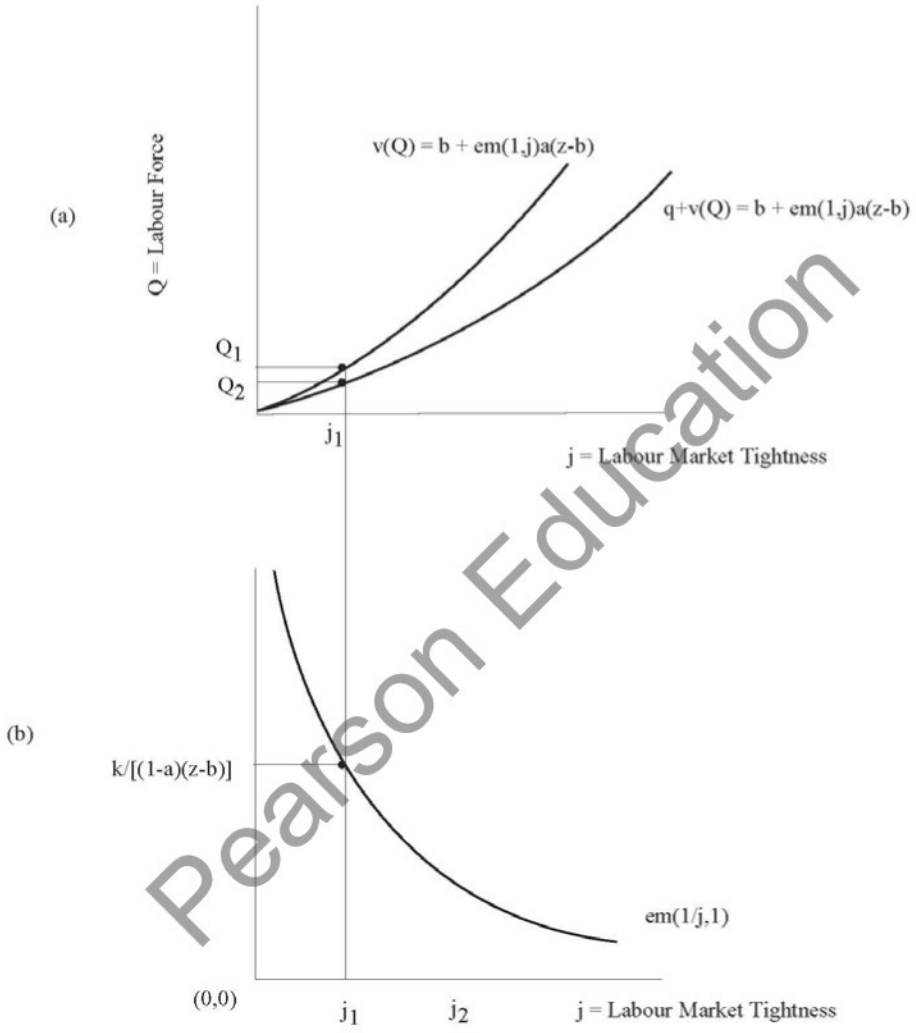


Figure 6.3

4. For this question, re-define labor market tightness as *j = (A+G)/Q*. Then, the diagram we work with looks identical to Figure 6.10 in Chapter 6, and Q and j are determined as in Figure 6.10. Note in particular that G is irrelevant for determining Q and j, so government activity is irrelevant for the size of the labor force and labor market tightness. Further, government activity will not matter for the unemployment rate, the vacancy rate, or aggregate output. However, since j and Q do not change when G changes, $A+G = jQ$ does not change either. But then an increase in G must reduce A by the same amount. Therefore, government activity simply reduces the number of private firms by an equal amount, and there is otherwise no effect on economic activity. The key to this result is that the government was assumed to

be no better or worse at producing output than private sector firms. Therefore, the scale of government activity could not matter for aggregate variables.

5. In the Keynesian DMP model, the wage w is indeterminate and, given w, equations (6.6) and (6.8) solve for Q and j, i.e.

$$v(Q)=b+em(1,j)w, \qquad (1)$$

and

$$(k/(z-w))=em((1/j),1) \qquad (2)$$

Suppose that w is "too high" in equilibrium, which implies that Q and j are too low relative to what is socially efficient. If the government were to subsidize successful matches by paying s to a firm when a match occurs, then equation (2) becomes

$$(k/(z-w+s))=em((1/j),1), \qquad (3)$$

since the firm's surplus from a match (the firm's profit) is now $z-w+s$. In Figure 6.4, this has the effect of increasing j and Q. As long as the government makes s sufficiently large, it can correct the social inefficiency. The subsidy makes it more attractive for firms to enter the labor market to search for workers, which in turn attracts more would-be workers into the labor market as it is now easier to get a job. The labor force increases, the unemployment rate decreases, the vacancy rate increases, and GDP increases. In Keynesian models, there always exists some price distortion - goods and/or labor are mispriced - and this type of inefficiency can be corrected just as we would correct a standard type of inefficiency such as an externality. Typically, we can correct a negative externality with a Pigouvian tax - e.g. a tax on gasoline, as burning gas causes pollution. A positive externality can be corrected with a subsidy. If the government were to subsidize a firm for posting a vacancy, then equation (2) becomes

$$((k-s)/(z-w))=em((1/j),1), \qquad (4)$$

as now the vacancy-posting cost is $k-s$. Qualitatively, this has the same effects as in Figure 6.4, so in that sense it does not matter if the subsidy is aimed at reducing recruiting costs or subsidizing successful matches. In fact, it literally makes no difference to the government which way the subsidy is implemented. Suppose that the government wants to achieve a particular value for labor market tightness, j^*, through a subsidy. If government subsidizes successful matches with a subsidy s_1, then equation (3) gives

$$k=(z-w+s_1)em(1/(j*),1), \qquad (5)$$

and if the government subsidizes recruiting with a subsidy s_2, then equation (4) gives

$$k-s_2=(z-w)em(1/(j*),1). \qquad (6)$$

Then, subtract equation (6) from equation (5) to get

$$s_2=s_1em(1/(j*),1) \qquad (7)$$

But in equation (7), the left-hand side is the cost of the subsidy program per active firm, in the first case, and the right-hand side is the cost of the subsidy program per active firm in the second case. Since $j=j*$ for both programs and Q is the same for both programs, therefore $A=j*Q$ is the same for both programs, i.e. the number of active firms is the same for each program. Therefore, to get the same effect (a given j) each subsidy program has exactly the same cost for the government, so they are identical.

6. If all social welfare programs simultaneously become more generous, suppose that we represent this as a payment p to each person not in the labor force, and an increase by p in the employment insurance benefit. Then, the equation that summarizes behavior on the supply side of the labor market becomes

$$v(Q) + p = b + p + em(1,j)a(z-b-p),$$

or, simplifying,

$$v(Q) = b + em(1,j)a(z-b-p).$$

As well, the equation summarizing demand-side behavior in the labor market can be written as

$$em(1/j,1) = k/(1-a)(z-b-p)$$

Therefore, in Figure 6.4, labor market tightness falls from j_1 to j_2, and the labor force falls from Q_1 to Q_2. As a result, the unemployment rate increases and the vacancy rate decreases. The number of firms is $A=jQ$, so A decreases. As well, output is $Y=zQem(1,j)$, so output falls as well. Consumers are affected by two social programs – one which pays a benefit to people not in the labor force, and one that pays an employment insurance benefit to the unemployed. Since the consumer receives the employment insurance benefit only in the event that search for work is unsuccessful, the increase in generosity of all social programs will on net discourage consumers from searching for work. Further, more generous social programs reduces the total surplus from a successful match, and this discourages firms from posting vacancies. On net, labor market tightness goes down, the labor force contracts, and aggregate output decreases, with the unemployment rate increasing and the vacancy rate decreasing.

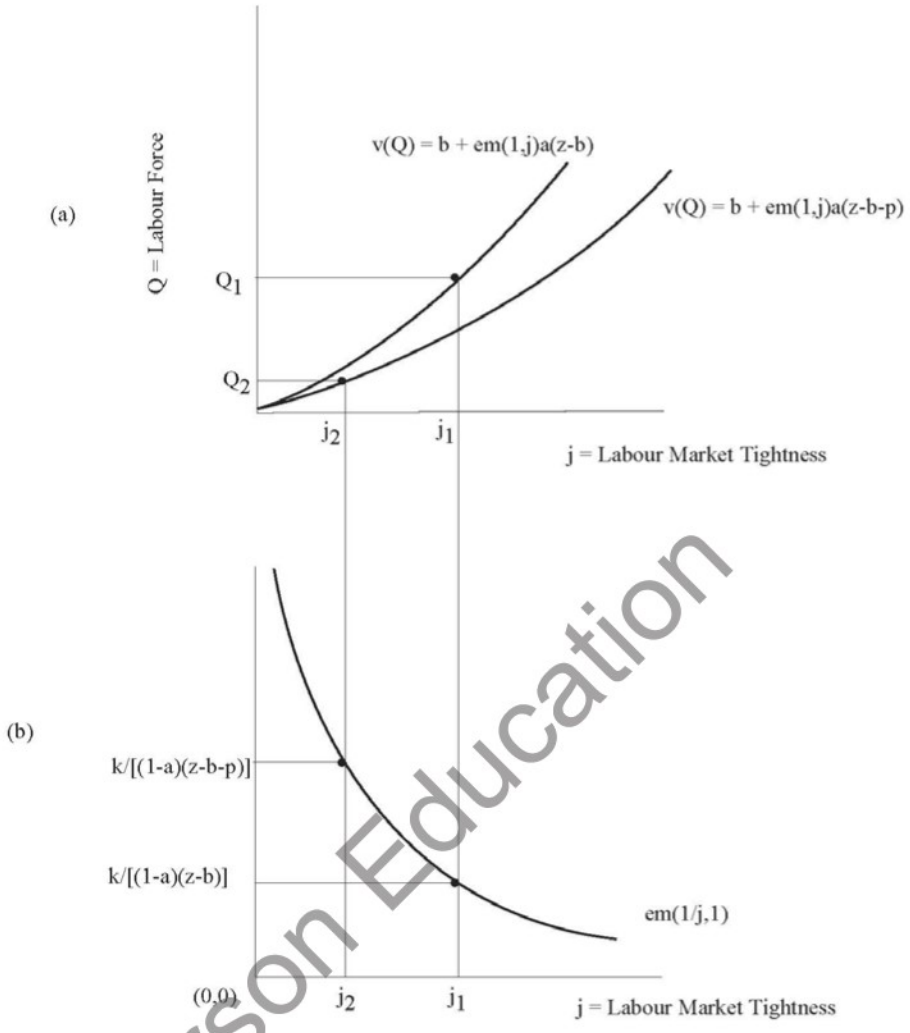


Figure 6.4

Chapter 7
Economic Growth: Malthus and Solow

■ Teaching Goals

Students easily take for granted the much more abundant standard of living of today as opposed to 20, 50, or 100 years ago. Sometimes it is easier to remind students of what their ancestors had to do without, rather than simply referring to per capita income levels over time. Recessions come and go, and yet economic growth swamps the lost output we endure during hard times.

The typical student begins study of economic growth against the backdrop of the recent growth experience of the United States. The current standard of living in the United States vastly surpasses the current standard of living in most countries and would have been unimaginable anywhere in the world before the advent of the industrial revolution. Until about 1800, the world economy produced little more than a subsistence level of income for any but the richest individuals. Growth in per capita income was nonexistent. The Malthusian model of growth explains the tendency of increases in population to dilute any gains in productivity.

The industrial revolution introduced the possibility of sustained growth in per capita income through the accumulation of physical capital. However, growth experience has varied widely around the world. The richer countries have a sustained record of growth. Per capita income in the United States has proceeded at an average rate of about 2% per year. While 2% growth may seem small, it is important for students to realize that such growth transforms into a more than doubling of per capita GDP per generation. Unfortunately, the poorer countries have remained poor. Furthermore, their growth rates have not generally matched growth rates in the richer countries, so that the poor countries fall farther and farther behind. Such differences in standards of living and growth prospects present puzzles that the study of economic growth hopes to solve.

■ Classroom Discussion Topics

Getting students to relate to differences in standards of living can sometimes be difficult. It is easy to take one's own standard of living for granted. An interesting discussion topic is whether students would be willing to travel back in time to 100 or 200 years ago, if they could be one of the richest people of those earlier times. Would the tradeoff be worthwhile? While students typically stress factors like antiquated view about freedom of choice, and racial and gender issues, try to encourage students to divide their concerns into those that are more economic as opposed to social. Also point out that higher standards of living allow societies to be more concerned about issues of equality when mere survival is no longer precarious.

Students often view population growth as the result of cultural factors and personal preferences. Against the abundance of daily living, it is easy to forget economic factors. Ask the students for examples of economic factors that might impact on fertility decisions. The Malthusian model suggests that growth may only be achieved through population control. In the modern economy, the costs of raising children can be formidable, and so there is tendency for such costs to be a disincentive to fertility. Such costs may attribute to the tendency for low fertility rates in advanced economies. In more primitive societies, having a large family can be a private form of Social Security. The more children a family has, the more family members there will be to provide for the parents in old age. Poor public health conditions may actually enhance fertility. If each child has a small chance for survival to adulthood, more births are required to produce a given-sized family.

■ Outline

I. Economic Growth Facts

A. Pre-1800: Constant Per Capita Income across Time and Space

B. Post-1800: Sustained Growth in the Rich Countries

C. High Investment ↔ High Standard of Living

D. High Population Growth ↔ Low Standard of Living

E. Divergence of Per Capita Incomes: 1800–1950

F. No Conditional Convergence amongst All Countries

G. Conditional Convergence amongst the Rich Countries

II. The Malthusian Model

A. Production Determined by Labor and Fixed Land Supply

B. Population Growth and Per Capita Consumption

C. Steady-state Consumption and Population
   1. Effects of Technological Change
   2. Effects of Population Control

D. Malthus: Theory and Evidence

III. Solow's Model of Exogenous Growth

A. The Representative Consumer

B. The Representative Firm

C. Competitive Equilibrium

D. Steady-State Growth
   1. The Steady-State Path
   2. Adjustment toward Equilibrium

E. Savings and Growth
   1. The Golden Rule: $MP_K = n + d$

F. Steady State Effects
   1. Labor Force Growth and Output Per Capita
   2. Total Factor Productivity and Output Per Capita

G. Solow: Theory and Evidence

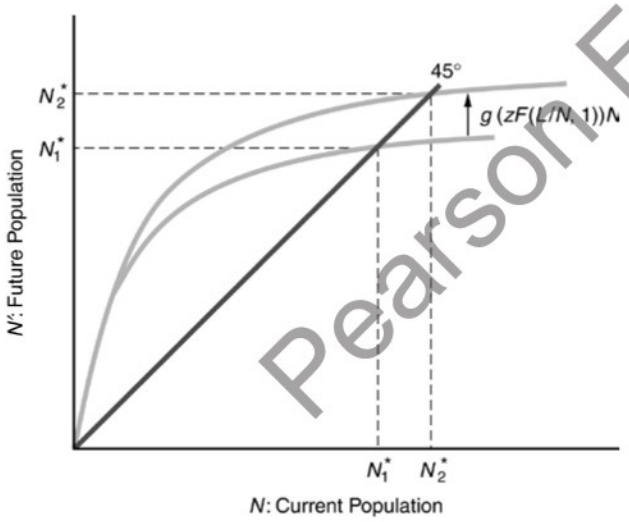
IV. Growth Accounting

A. Solow Residuals

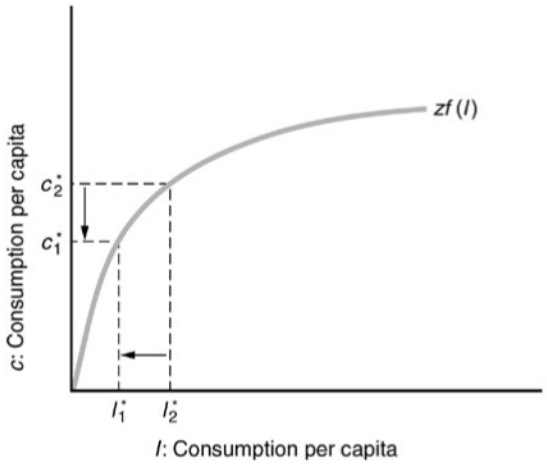
B. The Productivity Slowdown
   1. Measurement of Services
   2. The Relative Price of Energy
   3. Costs of Adopting New Technology

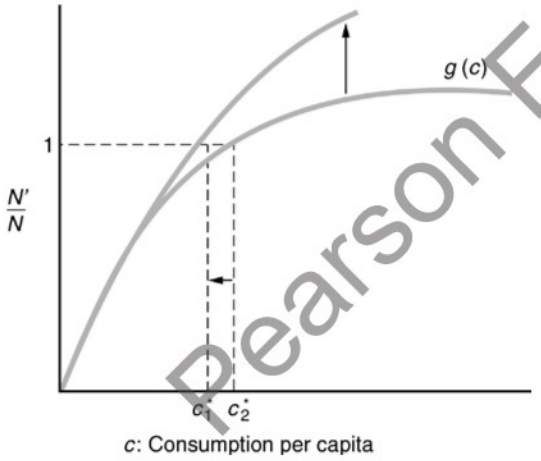
■ End-of-Chapter Problems

1. The amount of land increases, and, at first, the size of the population is unchanged. Therefore, consumption per capita increases. However, the increase in consumption per capita increases the population growth rate, see the figure below. In the steady state, neither c^* nor l^* are affected by the initial increase in land. This fact can be discerned by noting that there will be no changes in either of the panels of Figure 6.8 in the textbook.

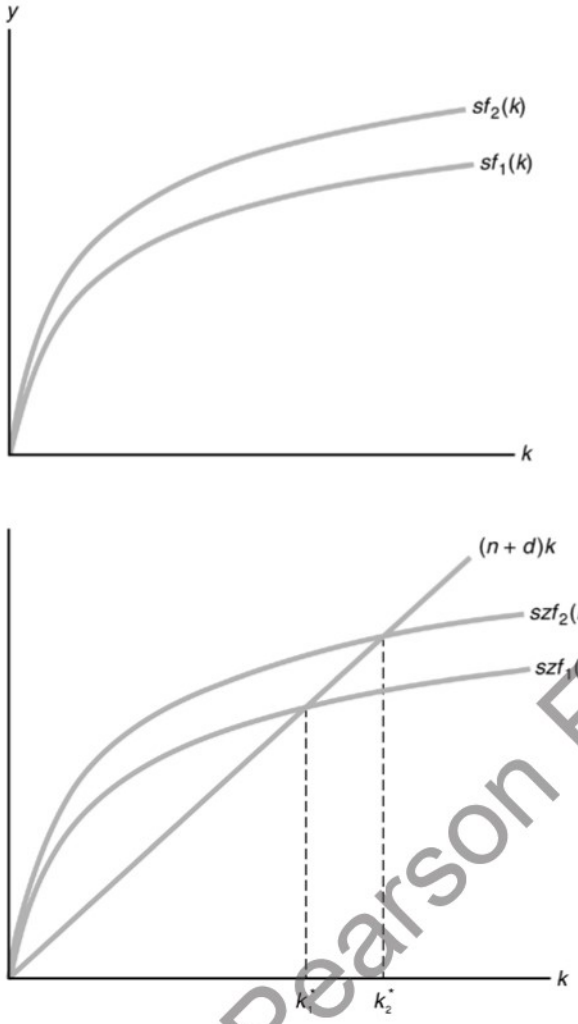


2. A reduction in the death rate increases the number of survivors from the current period who will still be living in the future. Therefore, such a technological change in public health shifts the function $g(c)$ upward. In problem #1 there were no effects on the levels of land per capita and consumption per capita. In this case, the $g(c)$ function in the bottom figure below shifts upward. Equilibrium consumption per capita decreases. From the top figure below, we also see that the decrease in consumption per capita requires a reduction in the equilibrium level of land per capita. The size of the population has increased, but the amount of available land is unchanged.





3. For the marginal product of capital to increase at every level of capital, the shift in the production function is equivalent to an increase in total factor productivity.
   (a) The original and new production functions are depicted in the figures below.

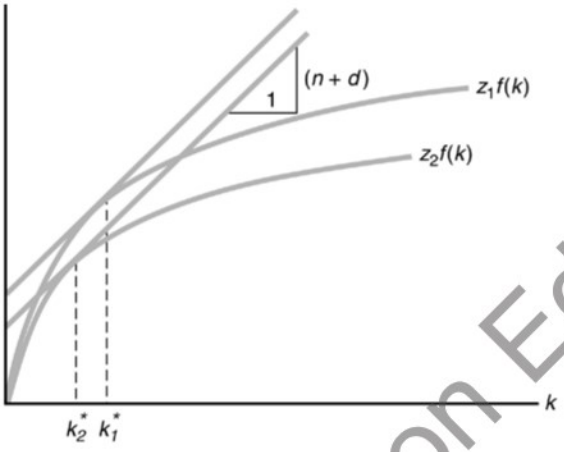


   (b) Equilibrium in the Solow model is at the intersection of $szf(k)$ with the line segment $(n+d)k$. The old and new equilibria are depicted in the bottom panel of the figure above. The new equilibrium is at a higher level of capital per capita and a higher level of output per capita.
   (c) For a given savings rate, more effective capital implies more savings, and in the steady state there is more capital and more output. However, if the increase in the marginal product of capital were local, in the neighborhood of the original equilibrium, there would be no equilibrium effects. A twisting of the production function around its initial point does not alter the intersection point.

4. An increase in the depreciation rate acts in much the same way as an increase in the population growth rate. More of current savings is required just to keep the amount of capital per capita constant. In equilibrium output per capita and capital per capita decrease.

5. A destruction of capital.
   (a) The long-run equilibrium is not changed by an alteration of the initial conditions. If the economy started in a steady state, the economy will return to the same steady state. If the economy were initially below the steady state, the approach to the steady state will be delayed by the loss of capital.
   (b) Initially, the growth rate of the capital stock will exceed the growth rate of the labor force. The faster growth rate in capital continues until the steady state is reached.
   (c) The rapid growth rates are consistent with the Solow model's predictions about the likely adjustment to a loss of capital.

6. A reduction in total factor productivity reduces the marginal product of capital. The golden rule level of capital per capita equates the marginal product of capital with $n + d$. Therefore, for given $n + d$, the golden rule amount of capital per capita must decrease as in the figure below. Therefore the golden rule savings rate must decrease.



7. Government spending in the Solow model.
   (a) By assumption, we know that T = G, and so we may write:

$$K' = s(Y - G) + (1 - d)K = sY - gN + (1 - d)K$$

Now divide by N and rearrange as:

$$k'(1 + n) = szf(k) - sg + (1 - d)k$$

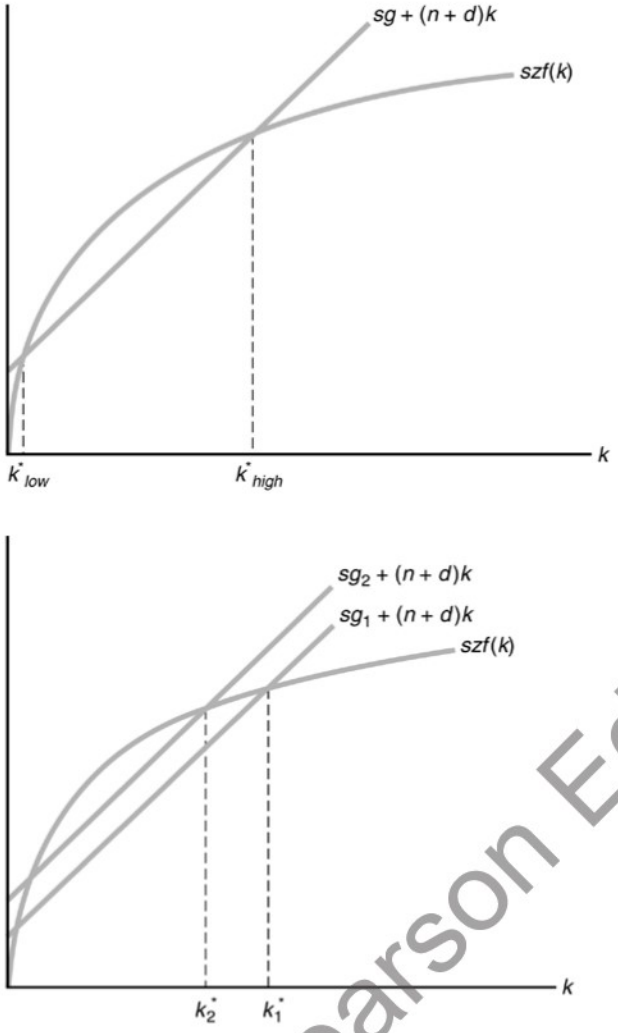
Divide by $(1 + n)$ to obtain:

$$k' = \frac{szf(k)}{(1+n)} - \frac{sg}{(1+n)} + \frac{(1-d)k}{(1+n)}$$

Setting $k = k'$, we find that:

$$szf(k^*) = sg + (n + d)k^*.$$

This equilibrium condition is depicted in the figure below.



(b) The two steady states are also depicted in the figure above.

(c) The effects of an increase in g are depicted in the bottom panel of the figure above. Capital per capita declines in the steady state. Steady-state growth rates of aggregate output, aggregate consumption, and investment are all unchanged. The reduction in capital per capita is accomplished through a temporary reduction in the growth rate of capital.

8. The golden rule quantity of capital per capita, k^*, is such that $MP_K = zf'(k^*) = n + d$. A decrease in the population growth rate, n, requires a decrease in the marginal product of capital. Therefore, the golden rule quantity of capital per capita must increase. The golden rule savings rate may either increase or decrease.

9. a) Given the production function, we can write the per-worker production function as

$$zf(k) = zk^{0.5}$$

Then, from Equation 6.19 the steady state quantity of capital per worker, k, is determined by

$$0.2k^{0.5} = 0.11k,$$

so solving for k we get $k = 3.3058$. Then, income per capita is $(3.3058)^{0.5} = 1.8182$. Finally, consumption per capita is given by $1.8182(1\text{-}s) = 1.4546$.

b)

Period	k	y	c
1	3.96	1.99	1.19
2	4.67	2.16	1.30
3	5.43	2.33	1.40
4	6.25	2.50	1.50
5	7.11	2.67	1.60
6	8.02	2.83	1.70
7	8.98	3.00	1.80
8	9.99	3.16	1.90
9	11.04	3.32	1.99
10	12.14	3.48	2.09

In the new steady state, with $s = 0.4$, calculating the steady state as before, we get $k = 13.22$, $y = 3.64$, and $c = 2.18$. Note that after 10 periods, the economy is much closer to the new steady state than to the old steady state with the lower savings rate. Of particular interest is the fact that consumption per capita actually decreases initially relative to the initial steady state, but consumption per person will actually be higher in the new steady state than in the initial one. This effect occurs because, with a higher saving rate, consumption must initially fall, but as the capital stock rises, the higher level of output tends to increase consumption.

10. (a) First, we need to determine how bN evolves over time:

$$(bN)' = (1+f)(1+n)\,bN$$

Then we just need to redo the analysis of the competitive equilibrium and the steady state as in the book, replacing every N by bN, every $(1+n)$ by $(1+f)(1+n)$, and every n by $f+n$. The new steady-state per efficiency unit capital is then

$$k^{**} = \frac{szf(k^{**})}{(1+f)(1+n)} + \frac{(1-d)k^{**}}{(1+f)(1+n)}$$

All aggregate variables then grow at the rate of $f+n$, while per capita aggregates grow at the rate f.

(b) An increase in f increases the growth rate of per capita income by the same amount, as f is its growth rate. This happens because the exogenous growth in b raises instant capital and income for everyone without a need to invest in capital.

11. Production linear in capital: $\frac{Y}{N} = z\frac{K}{N} = zf(k) \Rightarrow f(k) = k$

(a) Recall Equation (20) from the text, and replace $f(k)$ with k to obtain:

$$k' = \frac{(sz+(1-d))}{(1+n)}k$$

Also recall that $\frac{Y}{N} = zk \Rightarrow k = \frac{1}{z}\frac{Y}{N}$ and $k' = \frac{1}{z}\frac{Y'}{N'}$. Therefore:

$$\frac{Y'}{N'} = \frac{(sz+(1-d))}{(1+n)}\frac{Y}{N}$$

As long as $\frac{(sz+(1-d))}{(1+n)} > 1$, per capita income grows indefinitely.

(b) The growth rate of income per capita is therefore:

$$g = \frac{\frac{Y'}{N'} - \frac{Y}{N}}{\frac{Y}{N}} = \frac{(sz+(1-d))}{(1+n)} - 1 = \frac{sz-(n+d)}{(1+n)}$$

Obviously, g is increasing in s.

(c) This model allows for the possibility of an ever-increasing amount of capital per capita. In the Solow model, the fact that the marginal product of capital is declining in capital is the key impediment to continual increases in the amount of capital per capita.

12. For convenience, normalize by setting $N = 1$, so that per capita variables are the same as levels. First, calculating the steady state capital stock when $z=1$, from equation (7.19),

$$szf(k^*) = (n+d)k^*,$$

So plugging in for $f(k)$ and the parameters assumed in this problem, we have

$$.2(k^*)^{.3} = .1k^*,$$

and solving for k^* we obtain $k^* = 2.69$. This then implies that the steady state quantity of output (or output per capita – the same thing here) is

$$y^* = (k^*)^3 = 1.35$$

Further, savings is equal to investment, or

$$savings = investment = sy^* = 0.27$$

We then start the economy in the first period in this steady state, and consider two alternative scenarios. In the first (part b of the question), we consider a temporary decrease in TFP, with z falling by 10% in period 2, then returning to its previous level forever. In the second case (part c of the question), there is a permanent decrease of 10% in TFP beginning in period 2. Since consumption and investment are proportional to output, it will be sufficient just to show the path of output in the two cases. In Figure 12.1, we show the path of output for the first 30 periods in the case of a temporary and permanent decrease in TFP. With the temporary decrease in TFP, output falls by a large amount for one period. When TFP returns to its previous level in period 3, output returns almost to its former level, but not quite, as the reduction in TFP acts to reduce the capital stock below what it otherwise would have been, and this effect is long-lived. Gradually output returns to the original steady state after the temporary reduction in GDP, but it takes a long time. With a permanent reduction in TFP, output drops by a large amount initially, and then falls gradually to a new, lower, steady state.

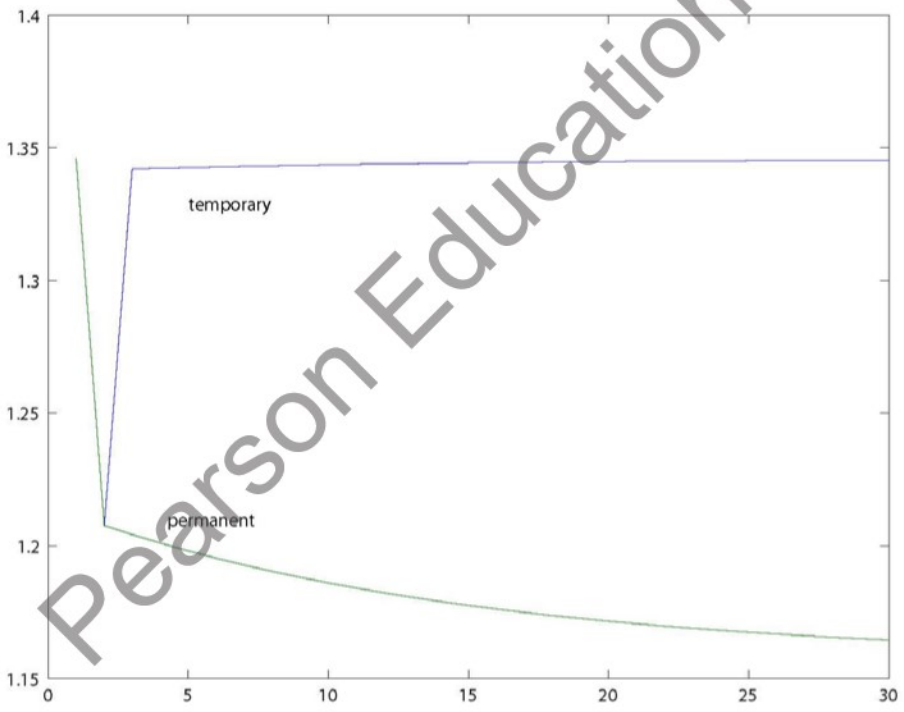


Figure 12.1

13. Solow residual calculations:

Year	Y	K	N	z
1995	9086	31438	124.9	13.85296
1996	9425.8	32338.4	126.7	14.10779
1997	9845.9	33307.7	129.6	14.37701
1998	10274.7	34428	131.5	14.70441
1999	10770.7	35679	133.5	15.08979
2000	11216.4	36999	136.9	15.27264
2001	11337.5	38164	136.9	15.29462

2002	11543.1	39233.9	136.5	15.47502
2003	11836.4	40322.6	137.7	15.64233
2004	12246.9	41471.4	139.2	15.92774
2005	12623	42609.9	141.7	16.08239
2006	12958.5	43836.6	144.4	16.15499
2007	13206.4	44949.2	146.1	16.20738

Growth rate calculations:

Year	Y	K	N	z
1996	3.73982	2.86405	1.441153	1.839552
1997	4.456916	2.997365	2.288871	1.908285
1998	4.355112	3.363487	1.466049	2.277254
1999	4.827392	3.63367	1.520913	2.620862
2000	4.138078	3.699655	2.546816	1.211728
2001	1.079669	3.148734	0	0.143932
2002	1.813451	2.803427	-0.29218	1.179479
2003	2.540912	2.774896	0.879121	1.081146
2004	3.468115	2.849023	1.089325	1.824616
2005	3.070981	2.745265	1.795977	0.970948
2006	2.657847	2.878908	1.905434	0.451426
2007	1.91303	2.538062	1.177285	0.324284

From 1996-2000, growth rates in real GDP are higher on average than from 2001-2007. This reduction in growth rates comes from all sources. The growth rates in inputs (capital and labor) is lower post-2000, as is average growth in TFP. Of particular note is the jobless recovery from the 2001 recession. Growth in employment in 2001-2004 is quite low, but reasonably strong growth in TFP makes up somewhat for the weak employment growth.

Chapter 8
Income Disparity Among Countries and Endogenous Growth

■ Teaching Goals

The Solow model of economic growth provides several testable hypotheses about differences in growth experiences across countries. Countries which are identical, except for initial differences in capital per person, will have the same levels of capital per capita and income per capita in the long run, according to the Solow growth model. Differences in steady state income per capita require differences in savings rates, population growth rates, and levels of technology. While differences in savings rates and population growth rates may account for some differences in the equilibrium levels of income per capita, such differences cannot account for the often dramatic differences we observe in living standards throughout the world. The Solow model predicts that, given the same technology, the poorer countries should be catching up with the richer countries. This prediction is at odds with the facts. For the Solow model to explain persistent, dramatic differences in living standards, we need to believe that the poorer countries face significant barriers to the adoption of new technologies.

Growth miracles may be explained by the sudden removal of barriers to technology. However, some economists have turned their attentions elsewhere to explain the apparent lack of conditional convergence. Endogenous growth models, based upon human capital accumulation, offer potentially better ways of explaining growth. Accumulation of human capital allows for the possibility of choices that affect growth over time. Endogenous growth also explains the persistent differences in standards of living in the poorer countries. Finally, the possibility of endogenous growth brings to the forefront policy choices about education.

■ Classroom Discussion Topics

There is a substantial body of economic analysis that focuses on so-called rent-seeking activities. Loosely speaking, rent seeking refers to the allocation of resources away from productive activities and redirecting resources to attempt to get larger shares of what has already been produced. Encourage the students to come up with examples in which groups attempt to block the introduction of new technologies. Can such activities be privately profitable even while they are socially wasteful?

Students are naturally quite self-interested in issues about the role of government in education. Should primary and secondary education be mainly a responsibility of government? What about government aid to higher education? I like to point to the hypothesis that private markets efficiently allocate educational resources. In the context of the endogenous growth model, is it likely that society will find the best growth path? Are there human capital externalities that might lead to underinvestment in education? Are capital market failures in the student loan market important? Are questions of equity more important than issues of efficiency?

Finally, this chapter addresses some of the most important and pressing issues in the world today: What policies could improve the situation in the poorest countries? The models presented here may help the students reformulate their views on the relevant policy solutions. In particular, they highlight that there is no free lunch, as any long-term improvement implies a short-term cost, unless the latter is covered by foreign aid or substantial loans. These are ideas that students can relate to from other classes or news.

■ Outline

I. Convergence of Growth Experiences

A. Predictions of the Solow Model
   1. Identical Technologies
   2. Technological Differences

B. Convergence: Theory and Evidence
   1. Convergence in Rich Countries
   2. Technological Barriers in Poor Countries
   3. Growth Miracles

II. Endogenous Growth with Human Capital Accumulation

A. Human Capital
   1. Nonrivalry
   2. The Representative Consumer, Efficiency Units of Labor
   3. The Representitive Firm
   4. Constant Returns to Scale

B. Competitive Equilibrium
   1. Steady-State Growth Rates
   2. Choice of Growth Path

C. Convergence
   1. Theory
   2. Evidence
   3. Human Capital Externalities
   4. Education and Growth
   5. Human Capital and Recessions

■ Solutions to End-of-Chapter Problems

1. Differences in population growth rates may account for differences in the equilibrium levels of capital per capita and output per capita across otherwise identical economies. However, once we have isolated this difference, countries well below their equilibrium growth paths should be growing more rapidly than countries that are closer to their equilibrium growth paths. That is, we should observe convergence.

2. We want to solve Equation 6.19 for the given parameter values: $0.25\, zk^3 = (0.01 + 0.02)\, k$. From this we obtain $k = (0.25/0.03)^{(1/0.7)} z^{(1/0.7)} = 20.675 z^{1.43}$. Then $y = zk^3$.

(a) If $z = 1$, then $k = 20.675$ and $y = 2.48$.

(b) If $z = 2$, then $k = 55.708$ and $y = 6.48$.

(c) Country B is producing 160% more output than country A, despite having only 100% more total factor productivity, because differences in z have been amplified by capital accumulation. Differences in TFP are thus an interesting avenue to explain differences across countries.

3. From Figure 7.20 in Chapter 7, per capita capital and per capita income will be higher in the country with higher TFP. From Chapter 4, higher TFP implies that the marginal product of labor will be higher, for given capital and labor inputs. As well, from Chapter 4 higher capital implies that the marginal product of labor is higher. Therefore, in the country with high TFP, the marginal product of capital will be higher in the steady state than in the country with low TFP. Thus, if workers migrate to the country with higher wages, they will choose to migrate from the low-TFP country to the high-TFP country until wages are equalized. In the world, the high-income countries tend to be those with high TFP, and immigration tends to flow from less-developed to more-developed countries. Indeed, high-income countries tend to erect immigration barriers, which prevent wages from equalizing across countries.

4. Because of learning-by-doing, we change the Solow growth model by modifying equation (7-15) on page 239 as follows:

$$Y = C + (1+r)I\,.$$

This implies that we can rewrite equation (7-18) as:

$$k'(1+n) = \frac{szf(k)}{1+r} + (1-d)k$$

Then, in the steady state, with $k' = k = k^*$, we have

$$(n+d)k^* = \frac{szf(k^*)}{1+r}$$

Therefore, an increase in r, the cost of learning-by-doing, has the same effect as a decrease in the saving rate. Thus, as in Figure 7.15 on page 244 (except reverse the experiment) the country with higher r will have a lower level of per-capita capital and lower per-capita income in the steady state. Thus, differences in income per capita across countries could potentially be explained by differences in learning-by-doing, i.e. differences in the ability to assimilate new technologies. These differences could be due to differences in education or differences in the technology for employing new capital equipment.

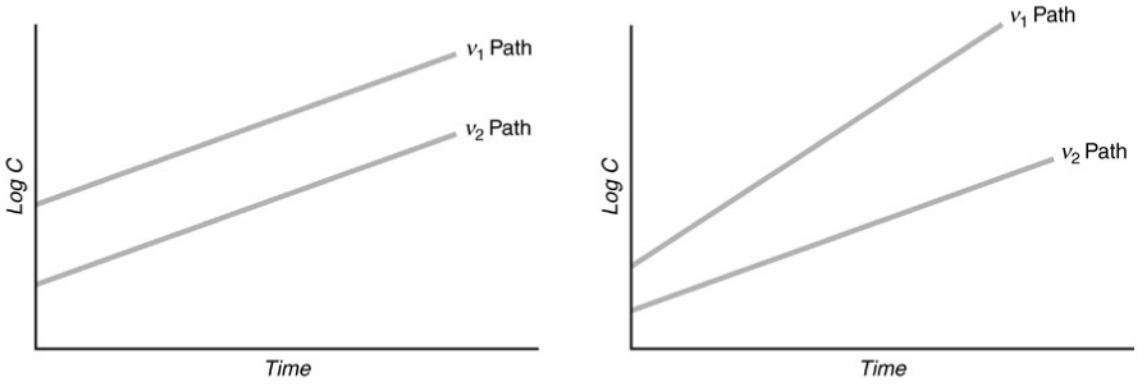
5. An increase in the marginal product of efficiency unit of labor increases the real wage rate, and increases output. However, the increase in z does not change the equilibrium growth rates. The economy has higher paths for consumption and output, but the two paths share the same growth rate.

6. Government activity in the endogenous growth model.

(a) The equation of motion for the economy is now given by:

$$H' = b(1-u-v)H$$

A change in v, holding $u + v$ constant, has no effect on the path of H. Consumption is lower because the time spent working for the government cannot produce consumable goods. The two paths of $\log C$ are depicted in the left figure below.



(b) Holding u constant, an increase in v reduces the growth rate of human capital. The level of consumption falls as workers are taken away from producing consumption goods. The growth rate of consumption also decreases due to the reduction of the growth rate of human capital. The two consumption paths are depicted in the right figure above.

(c) Offsetting changes in u and v change the level of consumption. However, the equation of motion for H is unchanged, so the rate of growth is unchanged. In part c, the growth rate of H is changed, and so is the growth rate of C.

7. The one-time expenditure lowers the growth path of consumption with no change in the growth rate. The increase in b increases the growth rate of the economy. In the short run, the economy gets less consumption. In the long run, the new growth path eventually surpasses the original growth path. Whether such an investment is worthwhile depends on consumers' preferences for current as opposed to future consumption.

8. As there is no interaction between the two groups, we can study them individually and then compare them. There are four relevant cases to analyze:

Case 1: $b_h > b_l$ and $u_h > u_l$. Here, high-skilled people spend less time at school, but are more efficient at accumulating human capital while there. Whether their human capital, and thus their wage, grows faster is not clear, it depends whether $b_h(1 - u_h)$ is larger than $b_l(1 - u_l)$ or not.

Case 2: $b_h > b_l$ and $u_h < u_l$. This means high-skilled people are learning more efficiently and are spending more time at school. Their human capital thus grows faster, therefore their wage grows faster. This can explain the growing wage gap in the United States between high-skilled and low-skilled workers.

Case 3: $b_h < b_l$ and $u_h > u_l$. This is the exact opposite of case 2. Here low-skilled people would eventually overtake high-skilled people and would command a higher wage. This is clearly not what is happening in the United States.

Case 4: $b_h < b_l$ and $u_h < u_l$. This case is similar to case 1 in the sense that the impact on human capital differences depends on whether $b_h(1 - u_h)$ is larger than $b_l(1 - u_l)$ or not.

9. (a) At any moment in time, income per capital in the two countries are $z_r u H_r$ and $z_p u H_p$, and the ratio of these two incomes always stays at $z_r H_r / z_p H_p$. Indeed, the growth rate of income is the same in both: $b(1 - u)$. The real wages in both countries are $z_r H_r$ and $z_p H_p$, and their ratio also stays constant at $z_r H_r / z_p H_p$.

(b) The obvious choice is the rich country, as incomes are higher there and will always be.

(c)-(e) Answers will vary.

10. (a)

t	*H*	*Y*	*C*
1	100.00	70.00	70.00
2	105.00	73.50	73.50
3	110.25	77.18	77.18
4	115.76	81.03	81.03
5	121.55	85.09	85.09
6	127.63	89.34	89.34
7	134.01	93.81	93.81
8	140.71	98.50	98.50
9	147.75	103.42	103.42
10	155.13	108.59	108.59
11	162.89	114.02	114.02
12	171.03	119.72	119.72
13	179.59	125.71	125.71
14	188.56	132.00	132.00
15	197.99	138.60	138.60
16	207.89	145.52	145.52
17	218.29	152.80	152.80
18	229.20	160.44	160.44
19	240.66	168.46	168.46
20	252.70	176.89	176.89

(b)

t	*H*	*Y*	*C*
11	162.89	97.73	97.73
12	171.03	119.72	119.72
13	179.59	125.71	125.71
14	188.56	132.00	132.00
15	197.99	138.60	138.60
16	207.89	145.52	145.52
17	218.29	152.80	152.80
18	229.20	160.44	160.44
19	240.66	168.46	168.46

20	252.70	176.89	176.89

(c)

t	*H*	*Y*	*C*
11	162.89	97.73	97.73
12	239.45	167.61	167.61
13	251.42	175.99	175.99
14	263.99	184.79	184.79
15	277.19	194.03	194.03
16	291.05	203.73	203.73
17	305.60	213.92	213.92
18	320.88	224.62	224.62
19	336.93	235.85	235.85
20	353.77	247.64	247.64

(d)

t	*H*	*Y*	*C*
11	162.89	97.73	97.73
12	205.24	143.67	143.67
13	215.50	150.85	150.85
14	226.28	158.39	158.39
15	237.59	166.31	166.31
16	249.47	174.63	174.63
17	261.94	183.36	183.36
18	275.04	192.53	192.53
19	288.79	202.16	202.16
20	303.23	212.26	212.26

(e) In (a), we see an economy that has a sustained growth in output of 5% a period. In all subsequent cases, there is a one-time drop in employment, call this a recession. The difference is in what the unemployed do. In case (b), the unemployed sit idle. There is a one-time drop in out and consumption compared to scenario (a), but no other changes. Indeed, the accumulation of human capital is unaffected.

In (c) and (d), the unemployed go to school, which triggers a burst in human capital accumulation for one period, and this has an impact over all subsequent periods. In (c), all go to school, which lead to output and consumption being 40% above scenario (a) in period 12 and any thereafter. In (d), only half of the unemployed go to school, and the increase in output is only half as large.

This is an illustration of how recessions can have a positive side in the future if the unemployed take the opportunity to improve their skills.

Chapter 9
A Two-Period Model: The Consumption-Savings Decision and Credit Markets

■ Teaching Goals

This chapter introduces the concept of intertemporal choice. Intertemporal choice concerns decisions that affect the present vs. the future. This chapter focuses on intertemporal consumption choice. Without a credit market, each individual must exactly consume his or her current disposable income in each and every period of time. However, many consumers would prefer to consume more or less than their current disposable income in each period. Credit markets allow consumers to be better off by redistributing consumption over time.

An important first step for students is that they fully understand the meaning of the intertemporal budget constraint. The first key point is that, for given amounts of income, consumption in the present can only be changed if there is a corresponding change in future consumption. At an intuitive level, this point is well understood by students taking out loans for college expenses. However, students are naturally focused on making decisions on current consumption and often lose sight of the fact that current choices effectively preclude alternative future choices. One natural example of choice over time is consumers' responses to lottery winnings. Does the choice of a lump-sum payoff as opposed to a series of annual payments affect current consumption? Does it affect current savings? How would students respond to improved prospects for future employment income?

Students should also understand that there is more to a change in the interest rate than an incentive (substitution) effect acting on the returns to saving. Students should ponder the question of who wins and who loses from changes in interest rates. Can everyone win? Can everyone lose?

The final, and often most challenging issue is Ricardian equivalence. One difficulty is that students find it difficult to conceive of tax changes that do not, at least implicitly, involve changes in current or future government spending. Discussions in the popular press often link tax increases as signaling prospective increases in the size of government, and tax cuts as promoting future spending discipline. While these are valid political possibilities to ponder, they are not the kinds of experiments that shed any light on the validity and relevance of Ricardian equivalence.

■ Classroom Discussion Topics

Ask the students what they think about cultural and religious admonitions against borrowing. Should everyone "neither a borrower nor a lender be"? What about usury prohibitions on charging any interest to borrowers? There are often tales of woe in the popular press about taking on "too much" consumer debt. In the modern economy, no one is forced to borrow or lend. Ask the students if they believe that there would be any benefits of outlawing credit. Ask them if they benefit personally from credit markets. Try to get them to separate the moral arguments and the economic arguments. Also, related to their own experience:

student loans programs allow them to borrow against future income, despite having very little (physical or financial) collateral to show.

Finally, the fiscal policies of recent administrations give ample opportunities for discussion on the impact of various initiatives. There were large tax cuts carried out by both the second Bush administration and the Obama administration, though the motivation for those tax cuts was quite different. George W. Bush appeared to be motivated by long-run considerations, while the Obama tax cuts were part of a stimulus package. If Ricardian equivalence holds, then stimulus by way of tax cuts will not work. So the Obama administration must have thought that that Ricardian equivalence does not hold in practice, or that there is something special about a recession which causes the failure of the Ricardian equivalence theorem. What could those factors be? An important idea to get across is that the Ricardian equivalence theorem is only a starting point in the discussion of why taxes and government debt matter in practice.

■ Outline

I. The Two-period Model

A. Consumer Behavior

1. Consumer's Lifetime Budget Constraint
   a. Present Value
   b. Lifetime Wealth
   c. Endowment Point and the Slope of the Budget Line
2. Consumer's Preferences
   a. More Is Preferred to Less
   b. Consumers Value Diversity
   c. Current and Future Consumption Are Normal Goods
3. Consumer's Optimization: $MRS_{c,c'} = 1 + r$
4. An Increase in Current Income
   a. Effects on Current and Future Consumption
   b. Effects on Savings
      1. Lenders
      2. Borrowers
   c. Excess Variability of Consumption
      1. Credit Market Imperfections
      2. Changes in Interest Rates
5. An Increase in Future Income
   a. Effects on Current and Future Consumption
   b. Effects on Savings
      1. Lenders
      2. Borrowers
   c. Temporary Versus Permanent Increases in Income
      1. Permanent Income Hypothesis
6. An Increase in the Real Interest Rate
   a. Income Effects
   b. Intertemporal Substitution Effect
      1. Lenders
      2. Borrowers
7. Perfect Complements Preferences

B. Government Behavior
   1. Debt Issue
   2. The Government's Present-value Budget Constraint

C. Competitive Equilibrium
   1. Consumers Optimally Choose Consumption and Savings
   2. Government Budget Constraint Is Satisfied
   3. Credit Market Clears

II. Ricardian Equivalence

A. Statement of the Theorem

B. Proof of the Theorem

C. Credit Market Equilibrium

D. The Burden of the Government Debt
   1. The Distribution of Taxes across Different Individuals
   2 The Distribution of Taxes across Different Generations
   3. Distorting Taxes
   4. Credit-market Imperfections

■ Solutions to End-of-Chapter Problems

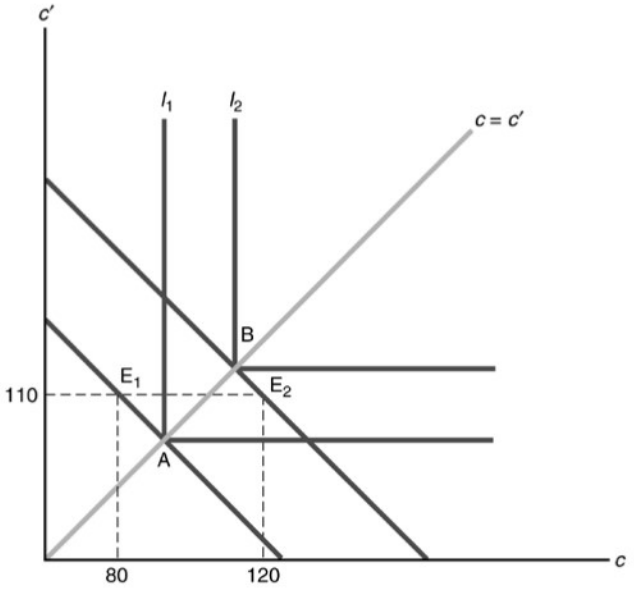
1. Given information:

$$y = 100$$
$$y' = 120$$
$$t = 20$$
$$t' = 10$$
$$r = 0.1$$

(a) To calculate wealth, we compute:

$$w = y - t + \frac{y' - t'}{1 + r} = 80 + \frac{110}{1.1} = 180$$

(b) In the perfect complements case, the indifference curves are like I_1 and I_2 in the figure below.



(c) The consumer's optimal consumption bundle is at point A. Point A simultaneously solves:

$$c = c', \text{ and}$$

$$c + \frac{c'}{1+r} = c + 0.91c' = 180$$

Upon solving, we find that $c = c' = 94.2$. Savings is therefore given by:

$$s = y - t - c = 80 - 94.2 = -14.2$$

The consumer is a borrower. In the figure above, the endowment point is E_1 and the consumer chooses A.

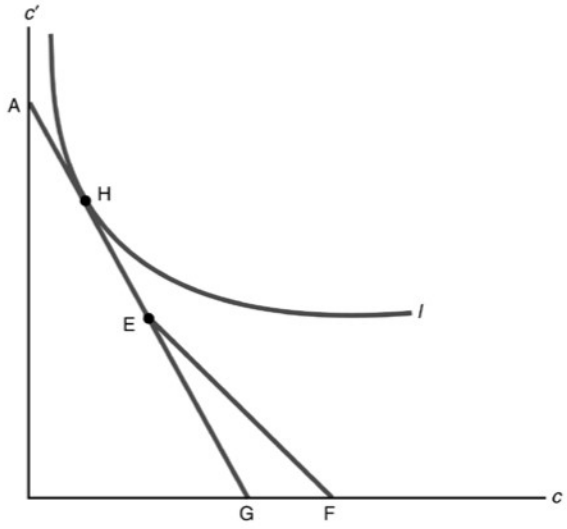
(d) First-period income rises from 100 to 140. We now recompute $w = 220$. Solving as in part (c), we find that $c = c' = 115.2$, and $s = 4.8$. In the figure above, the endowment point is E_2 and the consumer chooses B.

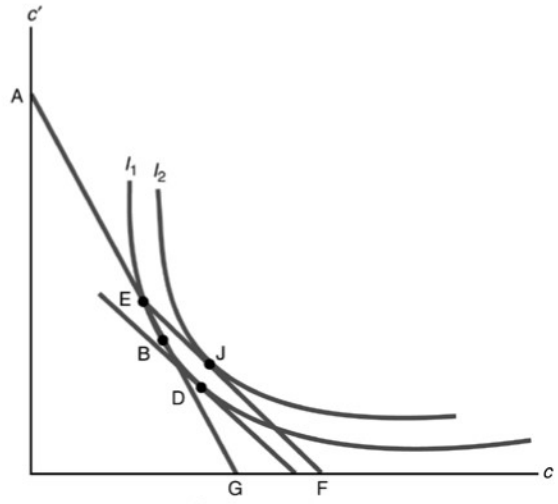
(e) In part (c), the consumer is a borrower. In part (d), first-period income increases and savings has consequently increased enough that the consumer is now a lender.

2. This problem involves a firm's offer to provide an interest-free advance on the consumer's income. If the consumer takes the advance, then his lifetime wealth is given by:

$$we = y + \frac{y'}{1+r} + x\left(1 - \frac{1}{1+r}\right)$$

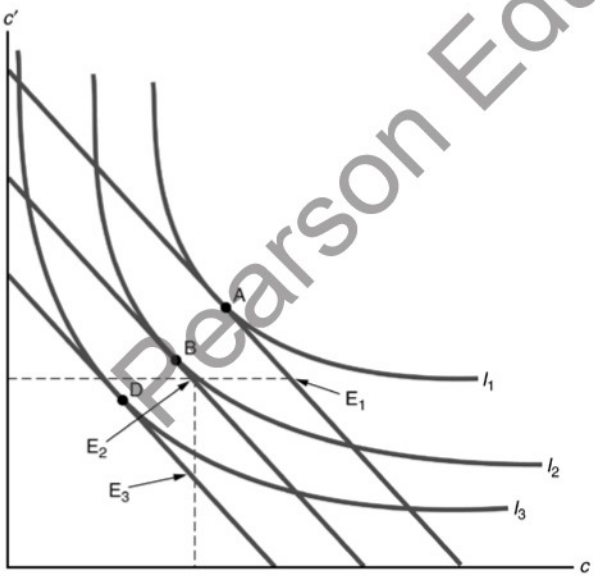
Therefore, provided that $r > 0$, the consumer should take the advance, as any increase in his lifetime wealth makes him better off.





3. Temporary and Permanent Tax Increases.

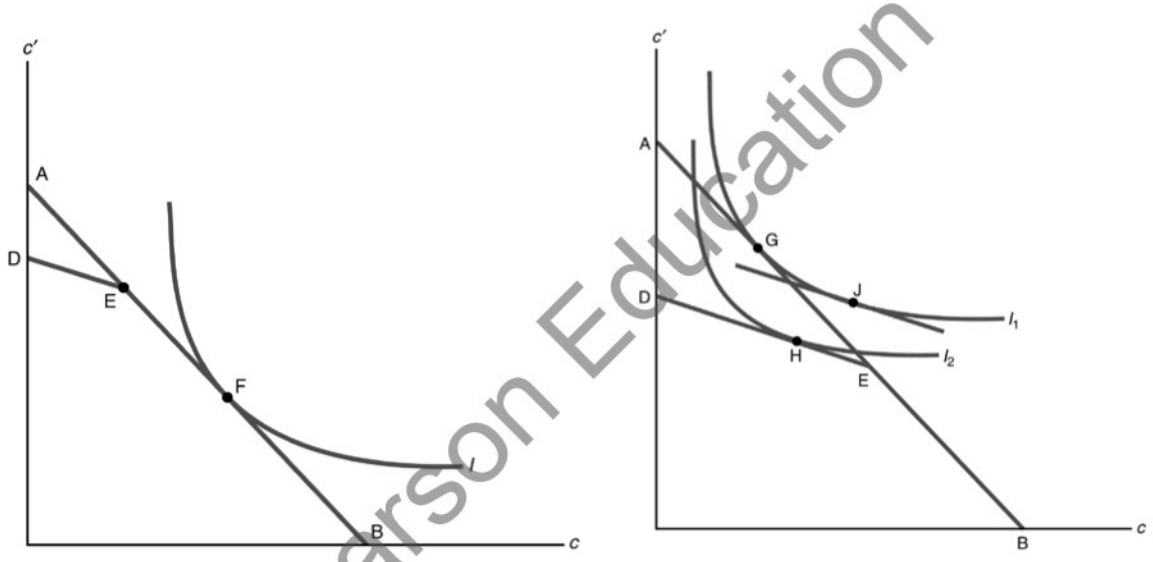
(a) The increase in first-period taxes induces a parallel leftward shift in the budget line. The original budget line passes through the initial endowment, E_1. The new budget line passes through E_2. The consumer reduces both current and future consumption. In the figure below the consumer's optimum point moves from point A to point B. First-period consumption falls by less than the increase in taxes and so savings falls.



(b) Next consider a permanent increase in taxes. A permanent tax increase adds a second tax increase to the first tax increase, the current-period tax increase. The increase in second-period taxes induces a parallel downward shift in the budget line. The new budget line passes through E_2 in the figure above. The second part of the tax increase also reduces both first-period and second-period consumption. The consumer moves from point B to point D. Because the second tax increase reduces first-period consumption holding first-period disposable income fixed, savings must rise. Since the permanent tax increase is the sum of the two individual tax increases, the permanent tax increase reduces both first-period and second-period consumption, but on net, savings may either rise, fall, or remain unchanged.

4. A tax on interest income.

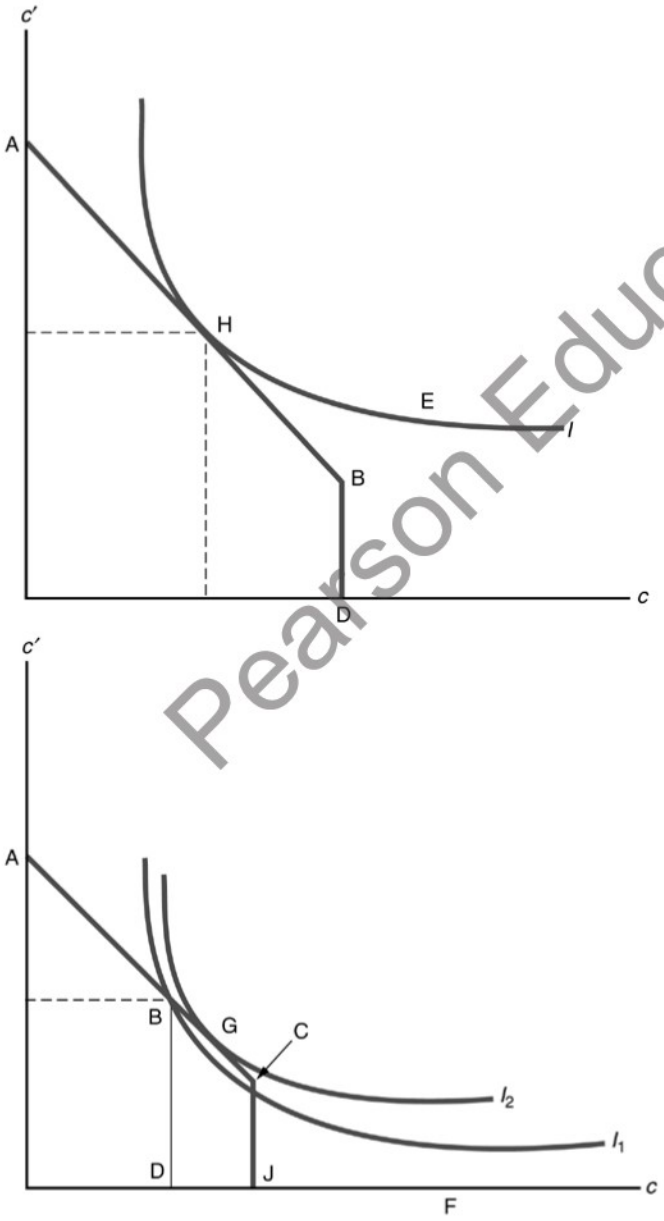
(a) Initially, AB in the first figure below depicts the consumer's budget constraint. The introduction of the tax results in a kink in the budget constraint, since the interest rate at which the consumer can lend, $r(1-t)$, is now smaller than the interest rate at which the consumer borrows, r. The kink occurs at the endowment, E.



(b) The first figure above shows the case of a consumer who was a borrower before the imposition of the tax. This consumer is unaffected by the introduction of the tax. The second figure above shows the case of a consumer who was a lender before the imposition of the tax. Initially the consumer chooses point G, and then chooses point H after the imposition of the tax. There is a substitution effect that results in an increase in first-period consumption and a reduction in second-period consumption, and moves the consumer from point G to point J. Savings also fall from point G to point J. The income effect is the movement from point D to point B, and the income effect reduces both first-period and second-period consumption, and increases savings. On net, consumption must fall in period 2, but in period 1, consumption may rise or fall. The figures above show the case in which first-period consumption increases, which is a case where the substitution effect dominates.

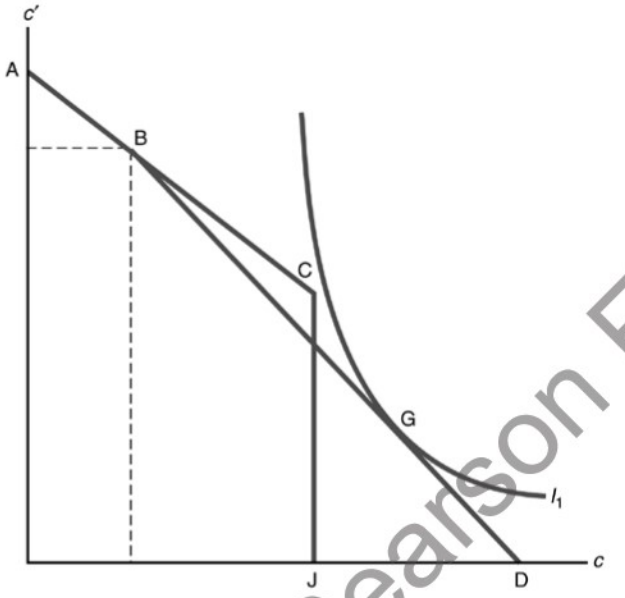
5. The consumer faces a borrowing constraint that places a ceiling on the level of current consumption. The consumer may consume more than the current endowment, $y - t$, but less than the amount of the lifetime endowment, *we*. The consumer's budget line is as in the first figure below. The budget line becomes vertical at $c = x$. An example of such a budget line is depicted in the two panels of the figure as ABD. As one possibility, the constraint is nonbinding as in the figure below. The consumer chooses point H. A change in the level of x has no effect on such a consumer.

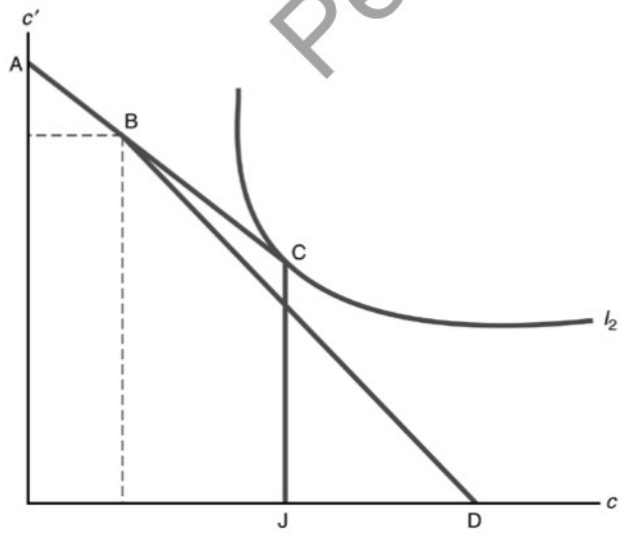
   Alternatively, the consumer depicted in the second figure below originally chooses the corner solution, point B. The consumer achieves the level of utility corresponding to indifference curve, I_1. An increase in x produces the new budget line, ACJ. This consumer now chooses point G. She increases current consumption and decreases both current saving and future consumption. This consumer is able to improve her level of utility to that corresponding to indifference curve, I_2.



6. This problem contrasts two alternative forms of credit market imperfections. As one possibility, consumers may either borrow or lend at the same real interest rate, but face a maximum amount of borrowing. The alternative possibility allows unlimited borrowing, but the interest rate paid on borrowing exceeds the interest rate earned from lending. Clearly, consumers who choose to be lenders are unaffected by such constraints. We therefore only need to be concerned about the behavior of borrowers. In the two figures below, the point B represents the endowment point. The first type of constraint imposes a maximum amount of borrowing. This constraint is depicted as budget line ABCJ in the figures. The second type of constraint imposes a higher interest rate on borrowing. This constraint is depicted as budget line ABD in the figures.

   The first figure below depicts the case of a consumer who prefers to pay the higher interest rate on borrowing. This consumer picks point G, a point that is preferred to any of the points along ACJ. The second figure below depicts the case of a consumer who prefers the maximum borrowing constraint. This consumer picks point C (or alternatively a point along segment BC). Clearly the second consumer prefers point C to any of the points along BD.





7. Let (c_1, c_1') denote the consumption bundle chosen by each consumer under the first tax scheme with tax rate s on savings, and (c_2, c_2') the consumption bundle chosen if the consumer faces the tax scheme with tax rate u on current-period and future-period consumption. Then, since the consumer's budget constraint is satisfied in each case, then

$$c_1 + \frac{c_1'}{1+r} = y + \frac{y'}{1+r} - (y - c_1)s \qquad (1)$$

and

$$c_2(1+u) + \frac{c_2'(1+u)}{1+r} = y + \frac{y'}{1+r} \qquad (2)$$

As well, since tax revenue generated in each case is R, we have

$$c_i + \frac{c_i'}{1+r} = y + \frac{y'}{1+r} - R \qquad (3)$$

for $i = 1, 2$. Then, equations (2) and (3) give

$$u = \frac{R}{y + \frac{y'}{1+r} - R} \qquad (4)$$

As a result,

$$c_1(1+u) + \frac{c_1'(1+u)}{1+r} = \left(c_1 + \frac{c_1'}{1+r}\right)\left(\frac{y + \frac{y'}{1+r}}{y + \frac{y'}{1+r} - R}\right) = y + \frac{y'}{1+r}$$

In the above equation, the first equality follows from equation (4), and the second from (3). Therefore, the consumption bundle (c_1, c_1') is affordable under the second tax system. But that was not the consumption bundle the consumer chose. The consumer chose the consumption bundle (c_2, c_2') which is not the same as (c_1, c_1'), as the consumer's marginal rate of substitution will be different under the two tax systems. As a result, consumers are better off under the second tax system than the first, as the second tax system does not distort the choice the consumer makes over current consumption vs. future consumption – under the second system current and future consumption are taxed at the same rate.

8. Given information:

$$y = 200$$
$$y' = 150$$
$$t = 40$$
$$t' = 50$$
$$r = 0.05$$

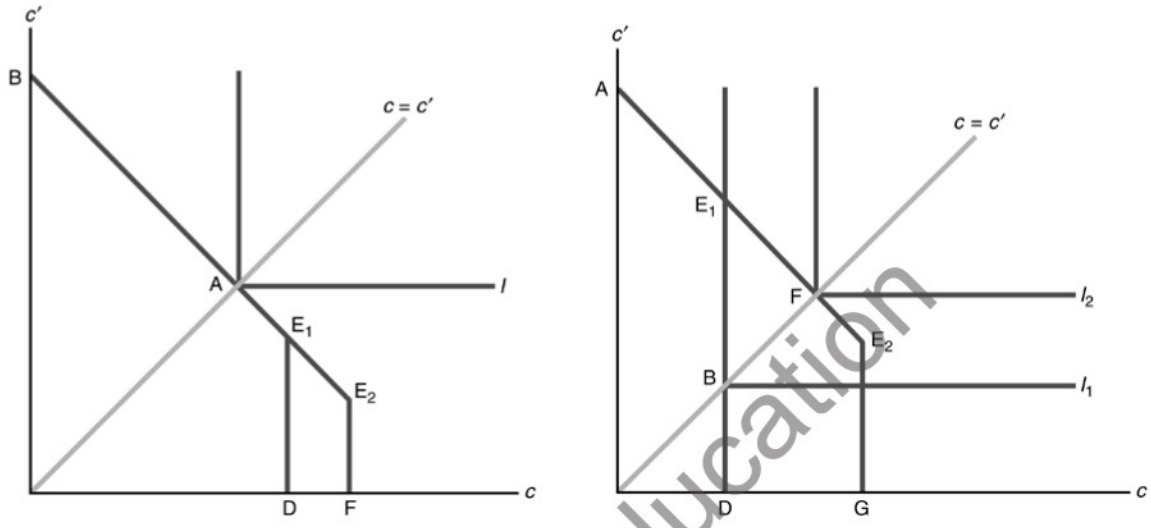
(a) If the consumer could borrow and lend at the real interest rate, $r = 0.05$, then the consumer's lifetime budget constraint would be given by:

$$c + \frac{c'}{(1+r)} = y - t + \frac{y' - t'}{(1+r)}.$$

Plugging in the numbers from this problem, we obtain:

$$c + 0.95c' = 255.2.$$

In the figure below, the initial budget constraint is given by BE_1D. The budget constraint has a kink at the initial endowment point $E_1 = (160,100)$, because the consumer cannot borrow, and therefore cannot consume more than 160 in the first period. Because the consumer has perfect-complements preferences, the indifference curves are kinked at $c = c'$.



(b) With perfect-complements preferences, the consumer picks point A in figure on the previous page. Plugging in $c = c'$ into the budget constraint and solving, we find that $c = c' = 130.7$ and so $s = y - t - c = 160 - 130.7 = 29.3$. In this case, the fact that the consumer cannot borrow does not matter for the consumer's choice, as the consumer decides to be a lender.

(c) When $t = 20$ and $t' = 71$, the consumer's lifetime wealth remains unchanged at 255.2. However, the budget constraint shifts to BE_2F, figure on the previous page, with the new endowment point at $E_2 = (180,79)$. This change does not matter for the consumer's choice, again because he or she chooses to be a lender. Consumption is still 130.7, but now savings is $s = y - t - c = 180 - 130.7 = 49.3$.

(d) Now first-period income falls to 100. Wealth is now equal to $w = 155.2$. In the figure above, the budget constraint for the consumer is AE_1D, so when the consumer chooses the point on his or her budget constraint that is on the highest indifference curve, any point on the line segment BE_1 will do. Suppose that the consumer chooses the endowment point E_1, where $c = 60$ and $c' = 100$. This implies that $s = 0$, and the consumer is credit-constrained in that he or she would like to borrow, but cannot. Now with the tax change, the budget constraint shifts to AE_2G, with the endowment point $E_2 = (80,79)$. Thus the consumer can choose $c = c'$ on the new budget constraint, and solving for consumption in each period using the budget constraint

$$c + 0.95c' = 155.2,$$

we get $c = c' = 79.5$, and $s = 0.5$. Here, notice that first-period consumption increased by almost the same amount as the tax cut, although lifetime wealth remains unchanged at 155.2. Effectively, the budget constraint for the consumer is relaxed. Therefore, for tax cuts that leave lifetime wealth unchanged, lenders will not change their current consumption, but credit-constrained borrowers will increase current consumption.

9. Given information:

$$y = 50$$
$$y' = 60$$
$$t = 10$$
$$t' = 20$$
$$r = 0.08$$

(a) First consider the consumers' budget constraint. All consumers receive identical amounts of income and pay identical amounts of taxes. Therefore, all consumers face:

$$c = y - t + \frac{y' - t' - c'}{1.08} = 50 - 10 + \frac{60 - 20 - c'}{1.08}.$$

For the consumers who consume 60 in the second period:

$$c = 40 - \frac{20}{1.08} = 21.48 \Rightarrow s = 40 - 21.48 = 18.52$$

For the consumers who consume 20 in the second period:

$$c = 40 + \frac{20}{1.08} = 58.52 \Rightarrow s = 40 - 58.52 = -18.52.$$

(b) Aggregate first-period consumption is given by:

$$C = 500 \times 21.48 + 500 \times 58.52 = 40,000.$$

Total GDP for the first period is equal to 50,000. Therefore, $G = 10,000$. Since aggregate disposable income (40,000) is exactly equal to aggregate consumption, aggregate private savings is equal to zero. First-period government spending and first-period taxes are equal, so the government budget deficit is also zero. To satisfy the government budget constraint, second-period government spending must equal second-period taxes minus principle and interest on first-period government debt. The government has no debt to repay, and so second-period taxes and second-period government spending both equal 20,000.

(c) Assuming that consumers do not change their spending plans, we modify the calculation from part (a) to obtain:

$$c = y - t + \frac{y' - t' - c'}{1.08} = 35 + \frac{40 - c'}{1.08}$$

The consumers who save now consume 13.52 in the first period. The consumers who borrow now consume 53.52 in the first period. Disposable income and consumption fall by the same amount, so first-period private savings is unchanged. Since private savings is unchanged, the government continues to issue no debt, and so government spending must equal 15,000.

10. This is case (2) on page 326. In this equilibrium, $1+r=b$, and borrowers consume all of the first-period endowment in the economy as a whole, so current consumption of borrowers is

$$c_b = 2\left(y - \frac{G}{N}\right)$$

and current consumption of lenders is

$$c_l = 0$$

Lenders wish to consume only in the future period, so from a lender's budget constraint, each lender's future consumption is

$$c_l' = b\left(y - \frac{G}{N}\right) + y' - \frac{G'}{N}$$

Since lenders and borrowers must collectively consume $Ny'-G'$ in the future period, future consumption of borrowers must be

$$c_b' = y' - \frac{G'}{N} - b\left(y - \frac{G}{N}\right)$$

In this example, Ricardian equivalence holds, since consumption quantities and the real interest rate do not depend on the timing of taxes, but only on the quantities of government spending.

11. (a) The intertemporal budget constraint is:

$$\frac{(1+s)c + (1+s')c'}{(1+r)} = \frac{y + y'}{(1+r)}$$

(b) The lifetime wealth, which is the present value of all incomes, is independent of s and s', and thus is not affected by changes in tax rates.

(c) Ricardian Equivalence does not hold here because taxation is distortionary. Indeed, changing s' and s' changes the relative price of current and future consumption, which is $(1 + r)(1 + s)/(1 + s')$. With a reduction in s (and increase in s'), current consumption becomes less expensive relative to future consumption, and thus the household will want to consume more now, less later and reduce savings.

12. Government loan program.

(a) There is no government spending in either period. In the first period, the government must collect lump-sum taxes so that $T = L$. In the second period, a lump-sum rebate is given so that $T' = -(1 + r^*)L$, where r^* is the market rate of interest.

(b) The present-value government budget is therefore:

$$T + \frac{T'}{(1+r^*)} = 0$$

(c) The consumers' budget constraint is rewritten as follows.

$$s = y + \ell - c - t$$
$$c' = (1+r)(s + y' - t' - \ell)$$

where ℓ represents the size of the loan that the individual consumer takes from the loan program. Combining, we obtain:

$$c + \frac{c'}{(1+r)} = y + \frac{y'}{(1+r)} - t - \frac{t'}{(1+r)}$$
$$= y + \frac{y'}{(1+r)} - \frac{1}{n}\left(T + \frac{T'}{(1+r)}\right)$$

(d) The size, L, of the loan program, does not change the fact that the present value of tax collections must equal zero. If a consumer originally chose $c = \hat{c}$ and $c' = \hat{c}'$ at r^*, the consumer will continue to choose $c = \hat{c}$ and $c' = \hat{c}'$. Therefore, if $r = r^*$ was originally a competitive equilibrium, it will continue to be a competitive equilibrium.

Chapter 10
Credit Market Imperfections: Credit Frictions, Financial Crises and Social Security

■ Teaching Goals

Credit market frictions and social security may not appear to be related issues, so it is important to stress that this chapter extends the ideas of Chapter 9, by considering instances where credit markets are not perfect. In a world with frictionless credit markets (as considered in Chapter 9), there would be no financial crises or social security, for example.

The first key idea is that credit market frictions are typically reflected, in our two-period model, in a kinked budget constraint for the consumer. The chapter begins by simply considering a kinked budget constraint, where the consumer borrowers at a higher interest rate than he or she receives as a lender, without worrying about why that may be so. Then, asymmetric information is introduced, to show how that leads to the kinked budget constraint, and this leads naturally to issues related to the financial crisis, particularly the increase in interest rate spreads, which in this instance is explained by an increase in credit market uncertainty.

With limited commitment, we again obtain a kinked budget constraint, but now the budget constraint shifts in an interesting way with a decrease in the value of collateral. The drop in housing prices in the United States was a key element of the financial crisis, and the model shows how this can be connected to a decrease in the demand for consumption goods.

Finally, the chapter considers social security systems – pay-as-you-go and fully-funded. The model is a simplification of an overlapping generations model, but the idea is the same. Social security can be welfare-enhancing for everyone, so long as the population grows at a sufficiently high rate. Fully-funded social security is harder to justify economically, however. If this type of program is simply forced savings, then it cannot make anyone better off, as it removes choice. However, social security can always be justified by appealing to commitment, in that people may not save adequately if they know that the government will always be willing to look after them old age.

■ Classroom Discussion Topics

Encourage students to think about the credit market frictions that exist in the world. Individuals cannot borrow all they would like to at market interest rates; we cannot borrow at the same interest rates at which we lend; consumers, firms, and governments sometimes default on their debts; collateral is used in lending contracts; borrowers sometimes have better information than do lenders about their credit-worthiness.

The financial crisis occurred recently, so students may remember some of the key details of what happened. Get the students to recall what was happening in credit markets in the world during the crisis, so

that these details can be related to the models studied in the chapter. Recall that interest rate spreads increased, lending contracted, and there were credit market "freezes" in some segments of the market. Students should be encouraged to think about the implications of this for consumption expenditure.

Students should be familiar with at least the existence of social security programs in the world, and particularly U.S. Social Security system. A discussion could start with the details of U.S. social security and how it is financed. What reasons could we think of for the existence of social security? Is this simply income redistribution, or is there something deeper going on here? Why would private credit markets fail to the extent that social security might be welfare-enhancing?

■ Outline

I. Credit Market Imperfections

A. Consumption
   1. Different Borrowing and Lending Rates
   2. Credit-constrained Consumers
   3. Government Policy

B. Asymmetric Information
   1. Role of the Bank: Intermediate and Diversify
   2. Good and Bad Borrowers
   3. Effect of Increasing Defaults on Spreads and Borrowing

C. Limited Commitment
   1. Collateral to Overcome Limited Commitment
   2. Consumers Face Additional, Collateral Constraint
   3. Loss of Collateral Value Affects Current Consumption

II. Social Security

A. Pay-as-you-go System

B. Fully Funded System

C. Issues
   1. Government Commitment
   2 Low Returns
   3. Moral Hazard

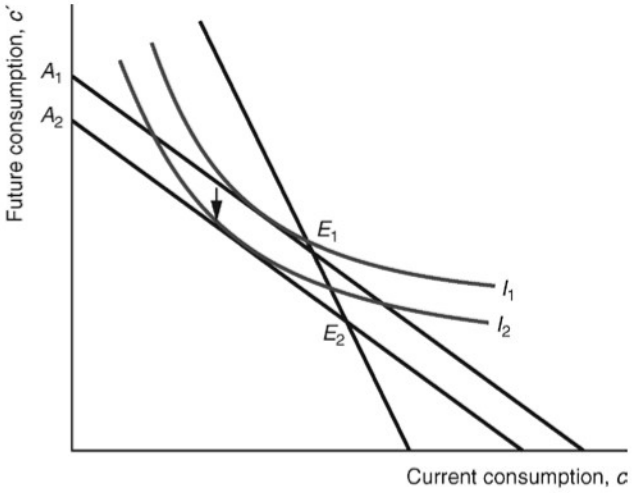
■ Solutions to End-of-Chapter Problems

1. (a) The government intertemporal budget constraint is, assuming both t and t' are positive:

$$\frac{bt + (1-b)at'}{(1+r_1)} = 0$$

(b) We are in a situation where asymmetric information becomes important: the government does not know who will be able to pay the future taxes. The relevant interest rate is the one corresponding to the steeper part of the budget constraint, and the new endowment thus moves the flatter part down. Consumption choices of the first period consumers are thus impacted

through a negative income shock, as they have to pay more taxes to compensate for more unpaid taxes in the future.



(c) The Ricardian equivalence does not apply as the change in timing of taxes has changed some consumption patterns. Indeed, households cannot fully adjust their savings, thus any change in periodic disposable income has an impact at least for some households.

2. (a) The government can only tax in the second period as much as it could get from the collateral:

$$t' \leq pH$$

(b) Now that the government has priority on the collateral, the new collateral constraint is:

$$-s\,(1+r) \leq pH - t'$$

which implies

$$c \leq \frac{y - t + pH}{(1+r) - t'/(1+r)}$$

(c) As we see from the new collateral constraint, Ricardian equivalence holds, as any shifting of taxes across periods does not affect the constraint. The consumer makes the same consumption choice.

3. (a) The bank will be lending so that it will be able to get the loan back in expectation. Thus, the new collateral constraint is

$$-s\,(1+r) \le a\,pH$$

which leads to

$$c \le \frac{y - t + a\,pH}{(1+r)}.$$

This is much like Figure 10.5 in the textbook, simply with a lower collateral value.

(b) If the collateral is more likely to be of no value, banks will lend less. Thus, some household will not be able to borrow as much as they could before, leading for them and in aggregate to a reduction of current consumption and an increase in future consumption. Thus we have exactly the same impact as if we had a reduction in p, as in Figure 10.5 of the textbook.

4. If each good borrower chooses to borrow L, then the cost of deposits for the bank is $(1+r_1)L$. The payoff on each loan to a good borrower is $(1+r_2)L$, and bad borrowers always default, but the bank can have each borrower post A as collateral, so the payoff to the bank on a loan to a bad borrower is the smaller of A or $(1+r_2)L$. Suppose first that $A < (1+r_2)L$. Then, the expected profit for the bank to making a loan is zero in equilibrium, or

$$-(1+r_1)L + a(1+r_2)L + (1-a)A = 0$$

Then, if we solve the above equation for r_2, we obtain

$$r_2 = \frac{1 + r_1 - (1-a)\dfrac{A}{L}}{a}$$

Therefore, the larger is A, the smaller is r_2, the loan interest rate. The larger the quantity of collateral available, the larger the payoff the bank receives when a bad borrower defaults. This increases bank profits, but in equilibrium expected profits are zero for the bank, borrowers benefit from having a higher quantity of collateral with which to secure loans. If A is sufficiently large, i.e. $A \ge (1+r_2)L$, then the bank's payoff on a loan to a bad borrower is $(1+r_2)L$, and so $r_1 = r_2$. Thus, if A is large enough then there is sufficient collateral to eliminate the credit market friction.

5. In this case, the current-period tax is sufficiently low that, in equilibrium,

$$1 + r = \frac{y'}{y},$$

the consumption of borrowers is

$$(c, c') = (2y, 0),$$

and the consumption of lenders is

$$(c, c') = (0, 2y').$$

In this case, changing the current tax has no effect at the margin. Thus, if tax policy has been set so that the borrowing constraint for consumers is relaxed, then Ricardian equivalence holds for any changes in taxes.

6. Since this is case 4, from page 358, we have $1+r=a$. Then, when taxes are zero, a borrower's consumption bundle is

$$(c, c') = \left(y + \frac{v}{a}, y' - v \right),$$

and a lender's consumption bundle is

$$(c, c') = \left(y - \frac{v}{a}, y' + v \right).$$

The optimal tax is

$$t = \frac{v}{a} - y,$$

which will imply that borrowers consume $2y$ in the current period, and lenders consume $2y'$ in the future period.

7. Social Security.
   (a) When the program is first instituted, the current old receive b in benefits and pay nothing. The effect on the current old is as in Figure 10.12 in the text. The current young receive b in benefits when they are old. This effect is also captured by the shift from BA to FD in the text's Figure 10.13. The current young also lend bN to the government in period T and receive $(1+r)bN$ in principal and interest when they are old. In per capita terms, these amounts are $bN/(1+n)N = b/(1+n)$ and $(1+r)bN/(1+n)N = (1+r)b/(1+n)$ respectively. However, this borrowing and lending are represented in Figure 10.13 as movements along the budget line. Unless there is a change in the real interest rate, there is no additional shift in the budget line. Therefore, both these generations unambiguously benefit from the program.
   (b) Once the program is running, it is identical to the pay-as-you-go system in the text. This program benefits a typical cohort as long as $n > r$, as is depicted in textbook Figure 10.13. A special circumstance applies to the cohort born in period $T + 1$. These individuals each receive a benefit per capita of $b/(1 + r)$ in present value terms. However, they pay taxes to support two generations' worth of benefits. They pay taxes to retire the principal and interest on debt incurred in period T. The per capita share of principal and interest on their grandparents' benefits is equal to $(1 + r)b/(1 + n)^2$. The per capita share of their parents' benefits is equal to $b/(1 + n)$. This generation can only benefit if:

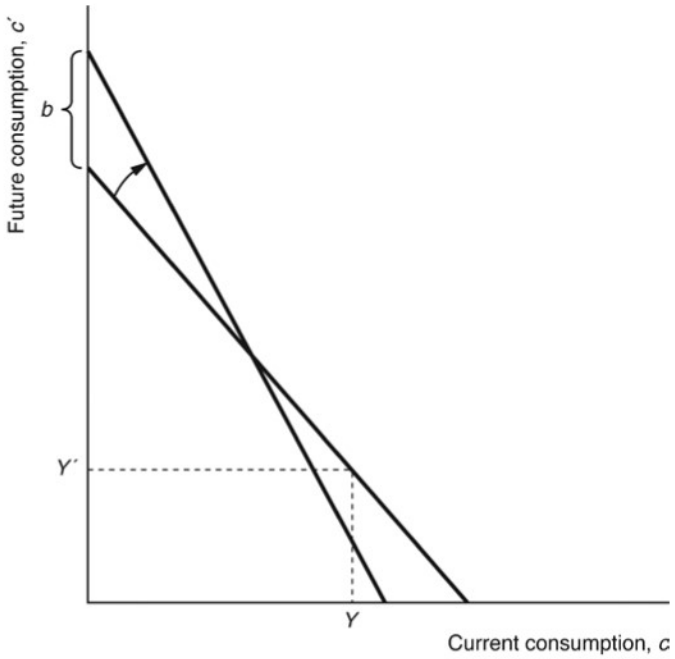
$$1 > \frac{(1+r)}{(1+n)} + \frac{(1+r)^2}{(1+n)^2}$$

   This requirement is obviously more stringent than $n > r$.

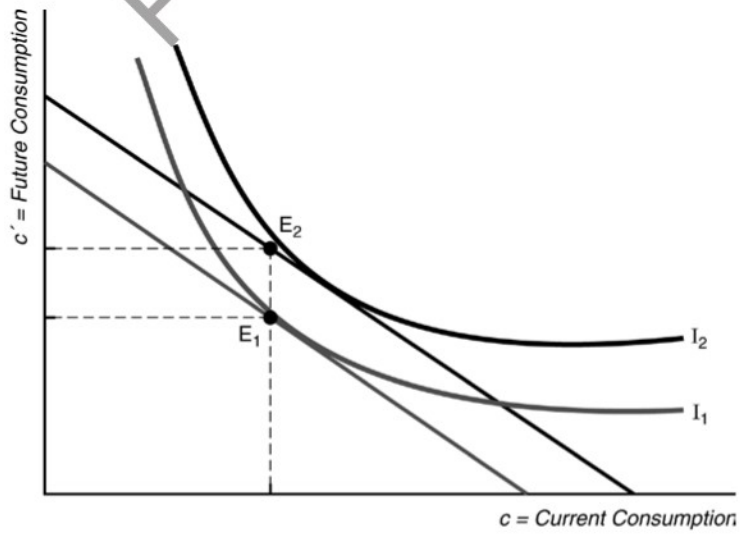
8. Under this regime, disposable income for the young is y, but the price of current consumption is $(1 + s)$. This implies that the intertemporal budget constraint of the household is now

$$\frac{(1+s)\,c + c'}{(1+r)} = \frac{y + y'}{(1+r)} + \frac{b}{(1+r)}$$

   In equibrium, it must be that $sc(1 + n) = b$. Thus whether there is going to be a positive income effect is going to depend on n is larger than r. But the is also a substitution effect coming from the change in relative price between c and c'. This substitution effect has no impact on welfare, though.



9. (a) Consumers born in T are the first ones not to get benefits. The government finances the benefits of the last generation, bN, with bonds D_T. Thus each consumer born in T buys D_T/N' bonds, or $b/(1+n)$ each. In $T+1$, the government has to reimburse principal and interest, $(1+r)D_T$, thus each old consumer at that time obtains $(1+r)b/(1+n)$. This means that for the intertemporal budget constraint in the figure below, the endowment point is shifted $b/(1+n)$ to the left and $(1+r)b/(1+I)$ up. This is on the same budget constraint as before. However, this household is also losing the old-age benefits it was expecting, thus the new endowment point shifts an additional b down. However, this generation does not have to pay, when young, for the benefits of the previous generation, as they are covered by the debt. Thus, the endowment point shifts $b/(1+n)$ to the right. As $r > n$, the new endowment point is now to the right of the old budget constraint, see the figure below, and this household is better of. Essentially, it just the opposite of the situation that made it viable to institute a pay-as-you-go system when $n > r$. The exact same reasoning applies to all future generations.



Chapter 11
A Real Intertemporal Model with Investment

■ Teaching Goals

It is important to emphasize that the possibility of accumulating capital represents a fundamental difference to an economy. In the previous chapter, average consumption must equal per capita total output less per capita government spending. For a given amount of government savings, aggregate private savings is fixed. One consumer may only reallocate consumption across time if another consumer is willing to make the complementary reallocation. Borrowing and lending can improve economic outcomes only to the extent that it can help bridge differences in consumers' allocations of income over time. In particular, if there is a single representative consumer, this consumer is stuck with consuming her gross income (net of government spending) in the current period. The investment process allows the whole economy to effectively reallocate consumption across time.

Many students try to get by with rote memorization of a great many curve shifts and laundry lists of the effects of specific disturbances. However, to really understand this material, students must be able to work out the effects of disturbances on their own. I therefore encourage students to put a good deal of effort into solving problems with the model. Often there may be a specific current political issue to which the model of this chapter may be applied.

■ Classroom Discussion Topics

This material allows the students to explore some interesting issues related to macroeconomic shocks and how they affect the economy, and the effects of government policy. The first issue is the effect of government spending, and it is important to relate this to the fiscal policy responses to the financial crisis. During the last recession, there was a large "stimulus" package, typically motivated by Keynesian economic reasoning. The modelling approach in this chapter can be used to help understand this reasoning. What is a multiplier? How big could it be? These are questions this model can answer. Keynesian models rely on more than just sticky wages and prices—there are implicit assumptions about Ricardian equivalence (or its absence), for example, that should be discussed here.

It is important to relate the experiments in the chapter to current and recent events. The model can show the effects of news (the anticipation of future events), destruction caused by natural disasters, and changes in uncertainty in credit markets, for example. The chapter can be somewhat heavy going, but the investment is important as the model will be used extensively in later chapters. It will help to relieve some of the pain for the students if they can see the applicability of the analysis to events in the world.

■ Outline

I. Consumer Behavior

A. Consumer Choices
   1. Current Work-Leisure Decision
   2. Future Work-Leisure Decision
   3. Consumption-Savings Decision

B. Current Labor Supply
   1. Three Factors of Labor Supply
      a. Current Real Wage Effects
      b. Real Interest Rate Effects—Intertemporal Substitution of Leisure
      c. Lifetime Wealth Effects
   2. Current Labor Supply Schedule

C. Current Demand for Consumption Goods
   1. Real Interest Rate Effects
   2. The Effect of Current Income, the MPC
   3. Changes in the Present Value of Taxes
   4. The Current Consumption Demand Schedule

II. The Representative Firm

A. Firm Choices
   1. Current Production
   2. Future Production
   3. Investment and Capital
   4. Depreciation of Capital

B. Profits and Current Labor Demand
   1. Current Profits
   2. Future Profits
   3. The Present Value of Profits
   4. Current Employment Choice

C. The Investment Decision
   1. The Marginal Cost of Investment
   2. The Marginal Benefit of Investment
   3. The Net Marginal Product of Capital
   4. The Optimal Investment Rule
   5. The Optimal Investment Schedule
      a. Future Total Factor Productivity

   b. The Current Capital Stock
6. Real Interest Rate Effects

III. Government

IV. Competitive Equilibrium

A. The Current Labor Market and the Output Supply Curve
   1. Slope of Output Supply—Real Interest Rate Effects
   2. Shifts in Output Supply
      a. Lifetime Wealth
      b. Current Total Factor Productivity
      c. Current Capital Stock

B. The Current Goods Market and the Output Demand Curve
   1. Slope of Output Demand—Real Interest Rate Effects
   2. Marginal Propensity to Consume and the Multiplier
   3. Shifts in Output Demand
      a. The Present Value of Taxes
      b. Future Income
      c. Future Total Factor Productivity
      d. Current Capital Stock

C. The Complete Real Intertemporal Model
   1. Equilibrium in the Goods Market
   2. Equilibrium in the Labor Market
   3. Comparative Statics Experiments

V. A Temporary Increase in Government Purchases

A. Demand and Total Expenditure Multipliers

B. Impact Effects
   1. Labor Supply
   2. Output Supply
   3. Output Demand and the Multiplier

C. Equilibrium Effects
   1. Goods Market: $Y\uparrow, r\uparrow$
   2. Labor Market: $N\uparrow, w\downarrow$
   3. The Composition of Output: $C\downarrow, I\downarrow$

VI. A Reduction in the Current Capital Stock

A. Impact Effects
   1. Labor Supply
   2. Labor Demand
   3. Output Supply
   4. Output Demand

B. Equilibrium Effects
   1. Goods Market: $Y?, r\downarrow$
   2. Labor Market: $N?, w\downarrow$

3. The Composition of Output: $C \downarrow, I \uparrow$

VII. An Increase in Current Total Factor Productivity

A. Impact Effects

1. Labor Supply
2. Labor Demand
3. Output Supply

B. Equilibrium Effects

1. Goods Market: $Y \uparrow, r \downarrow$
2. Labor Market: N?(likely increases), $w \uparrow$
3. The Composition of Output: $C \uparrow, I \uparrow$

VIII. An Increase in Future Total Factor Productivity

A. Impact Effects

1. Labor Supply
2. Output Demand

B. Equilibrium Effects

1. Goods Market: $Y \uparrow, r \uparrow$
2. Labor Market: $N \uparrow, w \downarrow$
3. The Composition of Output: $C \downarrow, I \uparrow$

C. Credit Market Uncertainty

IX. Credit Market Frictions and the Financial Crisis

A. Impact Effects

1. Labor Supply
2. Output Demand

B. Equilibrium Effects

1. Goods Market: Y falls, r falls.
2. Labor Market: N falls, w rises

X. Sectoral Shocks and Labor Market Mismatch

A. Impact Effects

1. Labor Supply, Labor Demand
2. Output Supply

B. Equilibrium Effects

1. Goods Market: Y falls, r rises
2. Labor Market: N falls, w unchanged

■ Solutions to End-of-Chapter Problems

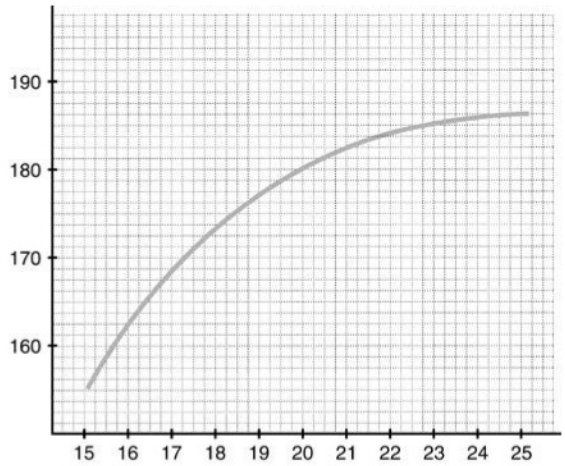
1. There are two effects of an increase in the depreciation rate. First, there is the direct effect, which implies that, given the marginal product of capital in period two, MP'_K, the net marginal product of capital, $MP'_K - d$, will decrease when the depreciation rate increases. For any given real interest rate, this effect lowers investment demand, and so the investment demand schedule shifts to the left. This direct effect is the result of the fact that a higher depreciation rate implies that the scrap value of the capital the firm invests in will be lower at the end of period two.

   In addition to this direct effect, there is also an indirect effect of the depreciation rate on investment. Since $K' = (1-d)K + I$, given the initial capital stock, K, the quantity of capital in period two will be smaller, for any I, if the depreciation rate is higher. Therefore, when d increases, the investment schedule shifts to the right. The direct and indirect effects work in opposite directions, and so, given the real rate of interest, investment may either rise or fall with an increase in the depreciation rate.

2. The problem supplies the following production function, where future output only depends on the level of second-period capital, in this case the number of trees.

Future Trees	Future Output
15	155.0
16	162.0
17	168.0
18	173.0
19	177.0
20	180.0
21	182.0
22	183.8
23	184.8
24	185.2
25	185.4

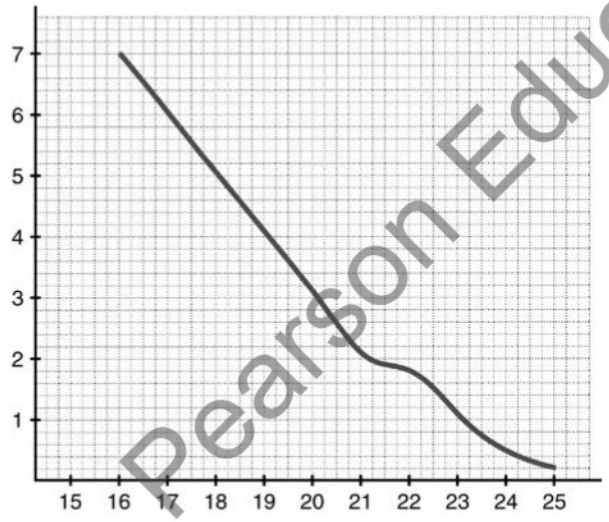
(a) The production function is depicted below.



(b) The marginal product of capital schedule is computed from the previous table. In table form:

Future Trees	Future Output	MP'_K
15	155.0	—
16	162.0	7.0
17	168.0	6.0
18	173.0	5.0
19	177.0	4.0
20	180.0	3.0
21	182.0	2.0
22	183.8	1.8
23	184.8	1.0
24	185.2	0.4
25	185.4	0.2

These data are plotted in the figure below.



(c) Tom's first-year profits are equal to $\pi = Y - I$. The present value of second-year profits is equal to $\pi' = \dfrac{Y' - (1-d)K'}{(1+r)} = \dfrac{Y' - (1-d)K'}{2}$. These calculations are given in the column *V*, below.

(d) The net marginal product of capital is equal to $MP'_K - d = MP'_K - 0.1$. These calculations are also included in the table below.

Future Trees	Future Output	Required I	V	$MP'_K - d$
15	155.0	–3	267.25	—
16	162.0	–2	270.20	6.9
17	168.0	–1	279.65	5.9
18	173.0	0	274.60	4.9
19	177.0	1	276.05	3.9
20	180.0	2	277.00	2.9
21	182.0	3	277.45	1.9
22	183.8	4	277.80	1.7
23	184.8	5	277.75	0.9
24	185.2	6	277.50	0.3
25	185.4	7	276.95	0.1

(e) Tom's optimal level of V is equal to 277.80. To earn this amount of profit, Tom needs to plant 4 new trees. Note that at $I = 4$, $MP'_K - d = 1.7 > r = 1.0$. Planting the 4th tree is therefore profitable. However, at $I = 4$, $MP'_K - d = 0.9 < r = 1.0$. Planting the 5th tree is not profitable. The maximum V is therefore attained at the last tree for which $MP'_K - d > r$.

3. The costs of the output subsidy and the investment subsidy would each require an increase in other (lump-sum) taxes to satisfy the government budget constraint with unchanged government purchases. This increase in taxes reduces consumer wealth and so labor supply shifts to the right and output supply also shifts to the right. This effect tends to increase output and decrease the real interest rate.

   In the case of the output subsidy, the decrease in the real interest rate increases both consumption spending and investment spending to match the increase in output. In the case of the subsidy to investment, there is also a shift to the right in the output demand curve. This effect provides an additional increase in output. Also the increase in the real interest rate (or the smaller-sized decrease in the real interest rate) reduces consumption spending so that more of the increase in output goes to investment spending and less goes to consumption spending. Therefore, the investment subsidy is likely to be more effective in increasing investment.

4. The new second-period profits of the firm are now $\pi' = Y' - w'N' + (1-d)p'_K K$.

   (a) The new marginal benefit from investment is now

$$MB(I) = (MP'_K + 1(1-d)p'_K)/(1+r)$$

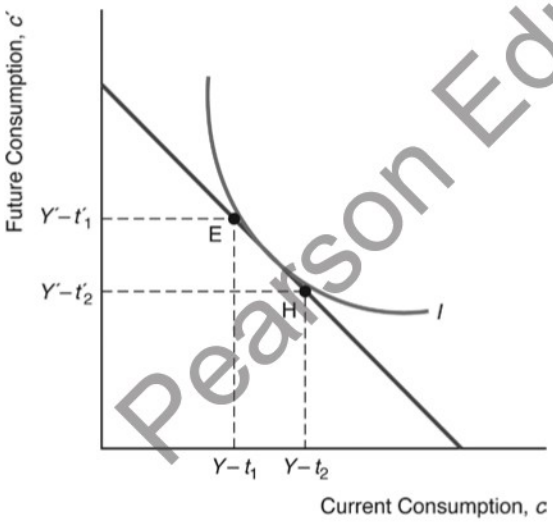
   As the marginal cost from investment remains at one, the new investment rule is then

$$MP'_K = (1+r) - (1-d)p'_K$$

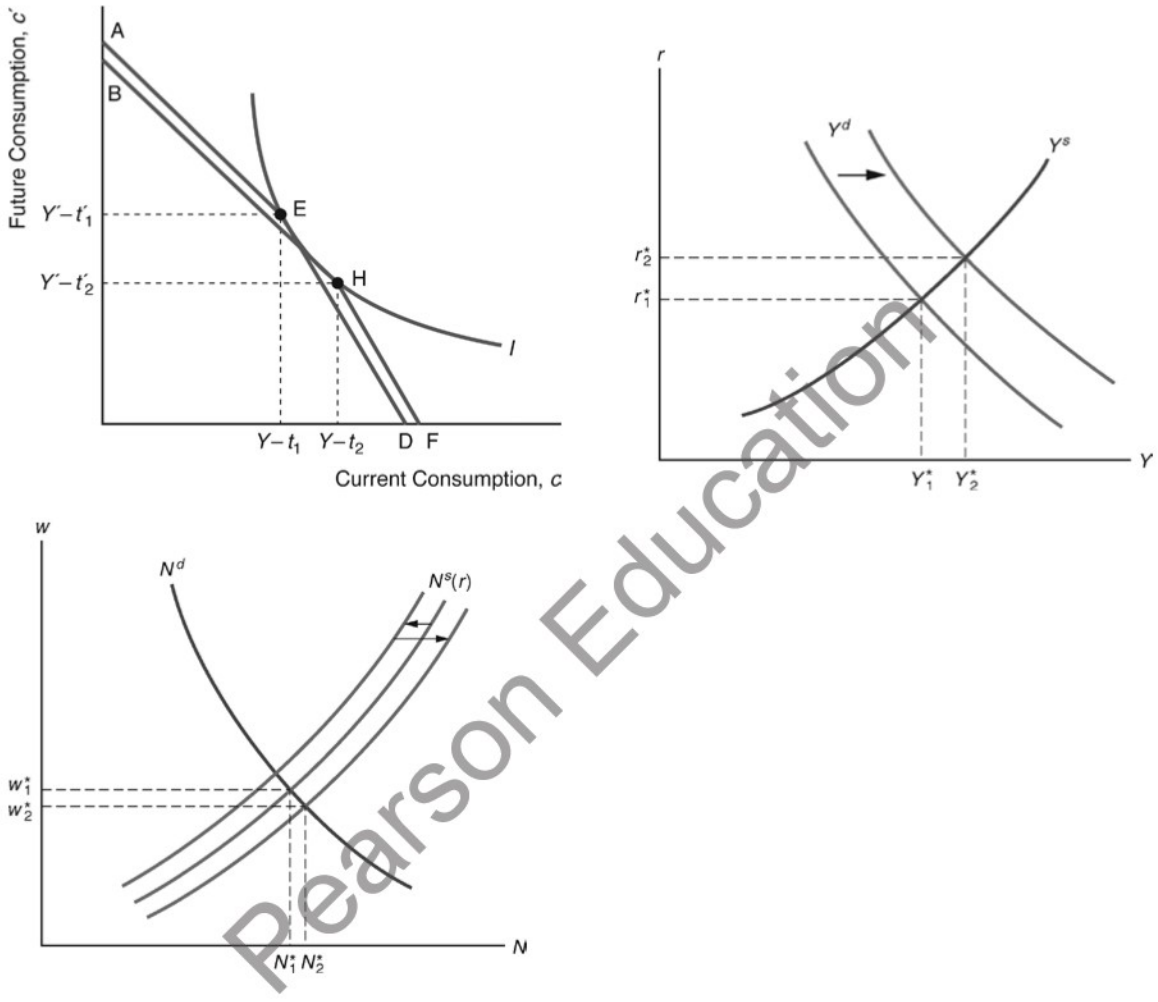
(b) With an increase in p'_K, the marginal product of future capital needs to be reduced, thus more future capital is needed and investment rises. Indeed, as the liquidation value of capital goes up, you want to invest more in capital. Thus investment is positively correlated with stock prices.

5. Slope of the output demand curve.
   (a) A reduction in the real interest rate increases consumption and investment spending. This is the primary reason for the downward slope of the output demand curve. However, as output rises, there is a further increase in consumption spending according to the size of the marginal propensity to consume. The larger the marginal propensity to consume, the flatter is the aggregate demand curve.
   (b) The intertemporal substitution effect on consumption is one of the primary reasons why demand rises at lower interest rates. The larger the sensitivity of consumption spending to the real rate of interest, the flatter is the output demand curve.
   (c) The responsiveness of investment demand to the real rate of interest is one of the primary reasons why demand rises at lower interest rates. The larger the responsiveness of investment demand to the real rate of interest, the flatter is the output demand curve.

6. (a) As government expenses are unchanged, future taxes need to increase to satisfy the intertemporal budget constraint of the government. We are therefore in the context of the Ricardian equivalence. Thus, neither of the real interest rate, aggregate output, employment or the real wage is affected.

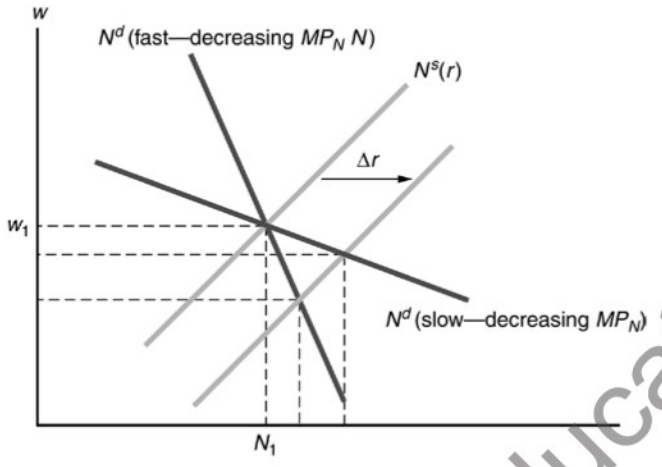


(b) We are now violating the conditions of the Ricardian equivalence. There is potentially an impact. Indeed, the endowment point is moving towards the right, and some borrowers now become lenders, and thus face a lower interest rate. This leads to a positive income effect (and thus an increase in current consumption demand and a decrease in labor supply) and a substitution effect that increases demand for current goods. In then end, consumption demand increases and labor supply decreases.



The implications are that the interest rate increases, thus leading to a second shift in the labor supply, an increase that has to be larger than the initial decrease, as equilibrium out is up. In the end, aggregate output, consumption, labor and the real interest rate are all up, while the real wage is down.

7. Slope of the output supply curve.
   (a) The figure below depicts the effect of an increase in labor supply, due to an increase in the real interest rate, on the equilibrium level of employment. The diagram shows two alternate labor demand curves with differing slopes. Note that the equilibrium level of employment increases more when the marginal product of labor declines at a slower rate with increases in the level of employment. Therefore, when the marginal product of labor declines at a faster rate as the quantity of labor used in production increases, there is a smaller increase in employment and therefore a smaller increase in output supply. The output supply curve is steeper in this case.



   (b) When the substitution effect of an increase in the real rate of interest decreases, there is a smaller effect on equilibrium employment of an increase in the real interest rate. Therefore there is a smaller increase in output supply. The output supply curve is steeper in this case.

8. Labor supply shifts to the right, so output supply also shifts to the right. Consumption demand also increases, so the output demand curve must also shift to the right. Output must increase although the real rate of interest may rise or fall. In light of the increase in output, equilibrium employment must increase. A higher level of employment, in the absence of a shift in the labor demand curve, assures us that the real wage rate must also fall. Investment rises if the real rate of interest declines, and investment falls if the real rate of interest increases. Because output has increased, consumption will rise as long as investment remains the same or declines. Consumption falls only in the case of a decline in the rate of interest of sufficient size to increase investment by more than the increase in output.
   (a) To summarize: $Y\uparrow, N\uparrow, w\downarrow, r?, I?, C?,$ but most likely increases.
   (b) As one possibility, at low levels of nutrition, it may be infeasible for the consumer to work very much (a very high $MRS_{l,C}$). In this case, an increase in nutrition would make the consumer more willing (and able) to work more and consume more. One could also imagine some change in the technology of using leisure that is more goods intensive. In this case the value of leisure is low without a lot of consumption goods.

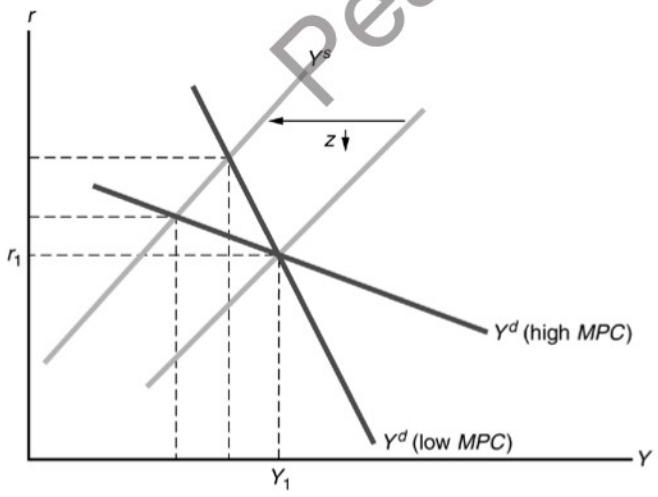
9. A temporary increase in z increases output and employment, raises the real wage, and lowers the real rate of interest. Consumption and investment both increase. An increase in future total factor productivity, z', shifts the current-period output demand curve to the right. Current output and employment increase, and the real interest rate increases. Since the current-period labor demand curve does not shift, the shift in labor supply due to the lower real interest rate causes the real wage rate to decline.

A permanent increase in total factor productivity simply combines the effects of the temporary and permanent changes in z. Current output and employment unambiguously increase. The real wage rate may either rise or fall. The real interest rate may either rise or fall. As long as the direct effect of the increase in MP'_K outweighs any indirect effect due to a possible increase in the real interest rate, then investment will increase. As long as the direct effects of the increases in current and future income dominate any indirect effect of a possible rise in the real interest rate, then consumption will also increase.

10. The increase in z' shifts the output demand curve to the right, but has no effect on the output supply curve. The increase in K shifts the output demand curve to the left, and shifts the output supply curve to the right. The combined effects shift the output supply curve to the right. The shift in the output demand curve is uncertain. An increase in the current capital stock lowers investment spending. An increase in future total factor productivity increases investment spending. As one possibility, suppose that the effect of the prospective increase in total factor productivity is that investment increases. In this case, both the output supply curve and the output demand curve shift to the right. Output rises unambiguously, but the effect on the real interest rate is uncertain.

    If a lack of capital were the only reason for low output in poor countries, then we would expect that the real interest rates in poor countries would be higher than the real interest rates in rich countries. This is not the case. Alternatively, if poor countries are poor both because they have less capital and because they have worse prospects for future investment, then this explanation of the difference between poor and rich countries need not be in conflict with observed differences in real interest rates.

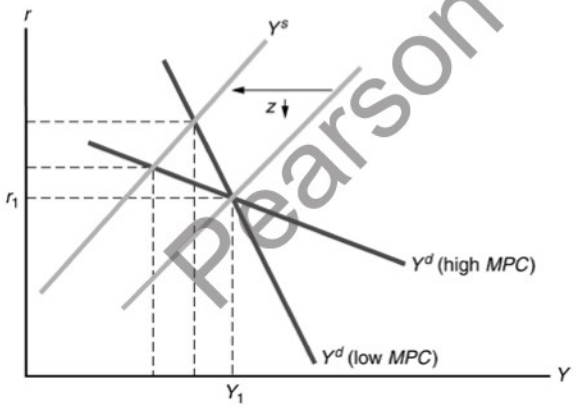
11. A temporary increase in the price of energy is best modeled as a reduction in current-period total factor productivity. Such a disturbance shifts output supply to the left. Therefore, output falls and the real interest rate increases. In question 3, above, we showed that a larger value for the marginal propensity to consume implied a flatter output demand curve. In the figure below, we show the shift in output supply with two alternative output demand curves. When the marginal propensity to consume is high, the output demand curve is flat and the reduction in z results in a large reduction in output and a small increase in the real interest rate. When the marginal propensity to consume is smaller, there is a smaller reduction in output, and a larger increase in the real interest rate.



12. This shock combines Figure 11.23 (a reduction in the capital stock) with Figure 11.28 (an increase in credit market frictions). The net effects on most macroeconomic variables are ambiguous, but we can say that, relative to Figure 11.23, accounting for the effect of a reduction in collateral will give an additional reduction in aggregate output, a decrease in the real interest rate, and a reduction in employment. The increase in credit market frictions produces a scarcity of safe assets, reflected in the decrease in the real interest rate, and under these conditions Ricardian equivalence does not hold. Therefore, a tax cut coupled with an increase in government debt will act to shift the output demand curve to the right, increase aggregate output, increase the real interest rate, and increase economic welfare.

13. A short war is best modeled as a temporary increase in government spending. Such a disturbance shifts the output demand curve to the right because the increase in current-period government spending will be larger than the reduction in consumption demand due to the decline in consumers' lifetime wealth. The output supply curve also shifts to the right because of the reduction in consumers' lifetime wealth. Output and employment unambiguously increase. Because the increase in government spending is only temporary, the effect on lifetime wealth is likely to be small, so the demand curve shifts farther than the supply curve. Therefore, the interest rate most likely increases.

    In order to more clearly see how the size of the intertemporal substitution effect on consumption comes into play, let us assume that the lifetime wealth effect is small enough to be ignored. In this case we need only be concerned with the shift in output demand and not the shift in output supply. The flatter output demand curves correspond to the case in which the interest rate effect on consumption is stronger. As the figure below depicts, the increase in output in this case is smaller. The intuition is as follows. When consumption is very sensitive to changes in the interest rate, it takes a smaller increase in the interest rate to crowd out demand to fit the increased G. With a smaller increase in the real interest rate, there is a smaller shift in labor supply, and so there is a smaller increase in employment and output.



14. This combines Figure 11.30 with Figure 11.22. A sectoral shock occurs which reduces output and employment and increases the real interest rate. The government intervenes by increasing government spending, which acts to increase aggregate output, increase employment, and increase the real interest rate. The government can indeed offset the effects of the sectoral shock on aggregate output, but as a result of the government intervention consumption and investment are lower than they would otherwise be. There is no reason to think that there is an inefficiency implied by the sectoral shock to the economy that the government is equipped to correct.

Chapter 12
Money, Banking, Prices, and Monetary Policy

■ Teaching Goals

Students should obtain a basic understanding of the role of money in the economy and the frictions that monetary exchange helps to overcome. The first part of the chapter deals with traditional roles of money as a unit of account, medium of exchange, and store of value. Then there is an analysis of the relationship among real and nominal interest rates and the inflation rate. Students should understand basic Fisherian principles.

This chapter takes a modern approach to money demand. This is different from traditional Tobin-Baumol approaches to deriving the money demand function, which do not make much sense given modern transactions technologies. The model includes a banking sector which provides transactions services that serve as an alternative to currency. Then, the demand for money is derived from the underlying demand and supply for "credit card balances" which are a stand-in for all alternatives to currency, including debit cards, credit cards, and checks. Ultimately, the demand for money is increasing in income and decreasing in the nominal interest rate, just as with traditional approaches, but the student gains more insight into where this relationship comes from, and why it is not like the demand for a good or service.

An important concept is the neutrality of money, which all economists accept as a long-run proposition. Students need to understand the importance of shifts in money demand, and their role in determining central bank policy. The Friedman-Lucas money surprise model is used as an example of money non-neutrality, though most of the ideas translate into other models in which money is not neutral. There are some key ideas here relating to money targeting, interest rate targeting, other approaches to monetary control, and monetary policy at the zero lower bound.

■ Classroom Discussion Topics

Payments technology has continually advanced over time, but the rate of advance has accelerated in the era of computer technology. Ask students for examples of advances in this technology beyond the routine use of cash and the writing of paper checks. Some obvious possibilities include the use of ATMs, computer and telephone banking, the use of pre-paid phone cards, and other forms of smart card technology. Students are also likely to discuss the existence of credit cards and the ever more sophisticated ways to use credit cards and protect against fraud. As one example, there is the use of credit cards to pay for purchases over the Internet. In discussing these possibilities, it is also important to distinguish payments technology from the proper measurement of the money supply. For example, it is important to distinguish between payment arrangements that are uses of credit, like the use of credit cards, from uses of money, like cash and transaction deposits.

In understanding the economy's transactions demand for money, it might help students to think of their own demand for money. Most of us carry money. How do you determine how much to carry with you and how much to invest or save?

The amount of money an individual carries depends on daily expenses, income, the probability of extra expenses, and the difficulty of obtaining extra money when needed. The college student who lives in a campus residence and whose meals in the residence dining room are part of his room payment has few daily cash expenses. The woman who sits next to him in class may commute to campus and buy her lunch at the local hamburger heaven. She generally will carry more cash so she can pay for her gasoline and hamburger. Students who are on a tight budget are likely to carry only what they can afford to spend. Those who often join their friends for a snack after class or who need to pick up family groceries on the way home from class need more money than those who don't. If you use credit cards and most of the places you frequent take them, you will need less money than if you must pay cash everywhere you go.

What happens if you do not have enough money or money substitutes such as credit cards with you? You forego purchases or you go to acquire money. The former reduces sales in the economy at least temporarily. The latter causes you additional trouble and difficulty, whether it is necessary to borrow from your companions or to find a bank or ATM machine that will allow you to obtain means to pay for the goods or services you want. If sources of additional cash are easily accessible, one is less likely to carry a reserve.

Discussions of Federal Reserve policy can be useful. Get students to think about the problems that the Fed faces. What are its goals? Do those goals make sense? What special problems did the financial crisis present, both in the US and in other countries?

■ Outline

I. Functions of Money
- A. Medium of Exchange
- B. Store of Value
- C. Unit of Account

II. Measuring the Money Supply
- A. The Monetary Base
  1. Currency Outside the Fed
  2. Depository Institution Deposits at the Fed
- B. M1
  1. Currency Held by the Public
  2. Traveler's Checks
  3. Demand Deposits
  4. Other Checkable Deposits
- C. M2
  1. Savings Deposits
  2. Small-Denomination Time Deposits
  3. Retail Money Market Mutual Funds
- D. M3
  1. Large-Denomination Time Deposits
  2. Institutional Money Market Mutual Funds
  3. Repurchase Agreements
  4. Eurodollars

III. Introduction to the Monetary Intertemporal Model

- A. The Need for Money
  - 1. Single Coincidence of Wants
  - 2. Double Coincidence of Wants
- B. Real and Nominal Interest Rates
  - 1. Nominal Bonds
  - 2. The Nominal Interest Rate
  - 3. The Inflation Rate
  - 4. The Fisher Relationship
- C. Banks
  - 1. Facilitation of Transactions
  - 2. Supply and Demand for Credit Card Services
  - 3. Equilibrium in the Market for Credit Card Services
  - 4. Demand for Money
- D. Money and the Government Budget Constraint

IV. Competitive Equilibrium in the Monetary Intertemporal Model

- A. Graphical Apparatus
- B. A Change in the Level of the Money Supply
  - 1. Sources of Changes in the Money Supply
    - a. Helicopter Drops: Taxes/Transfers
    - b. Open-Market Operations
    - c. Seigniorage
  - 2. Classical Dichotomy
  - 3. Neutrality of Money
- C. Shifts in Money Demand
  - 1. Sources
    - a. Information Technology and Banking Costs
    - b. New Financial Instruments
    - c. Government Regulations
    - d. Perceived Riskiness of Banks
    - e. Changes in Circumstances in the Banking System
  - 2. Neutrality vis-à-vis Real Variables
  - 3. Price-Level Effects

V. The Short-Run Non-Neutrality of Money: Friedman-Lucas Money Surprise Model

- A. Graphical Apparatus
- B. Money Supply Targeting and Interest Rate Targeting
- C. Alternative Monetary Policy Rules
- D. The Zero Lower Bound and Quantitative Easing

■ Solutions to End-of-Chapter Problems

1. It is possible that at the market nominal interest rate, $X^*(R) > Y$, which would imply a negative demand for money, which cannot happen in equilibrium. In other words, it is possible that, if the market nominal interest rate is R, and $q = R$, that the banking system would want to

supply. Then, in Figure 12.1, there is some price of credit card services $q_1 < R$, such that, as in Figure 12.1, the equilibrium quantity of credit card services offered is *Y,* so that all transactions services are supplied by banks as credit card services, and no currency is held. Monetary policy is then completely irrelevant, as no one holds the liabilities of the central bank. Such a situation is not inconceivable in practice, and private money systems without central banking existed in past times. In modern times, if the Fed did not exist, we could imagine a financial system where the private banking system supplies all of the transactions services. There may be some problem in such as system in determining a unit of account – it seems important in practice to simplify exchange by having a single object in which we denominate all prices.

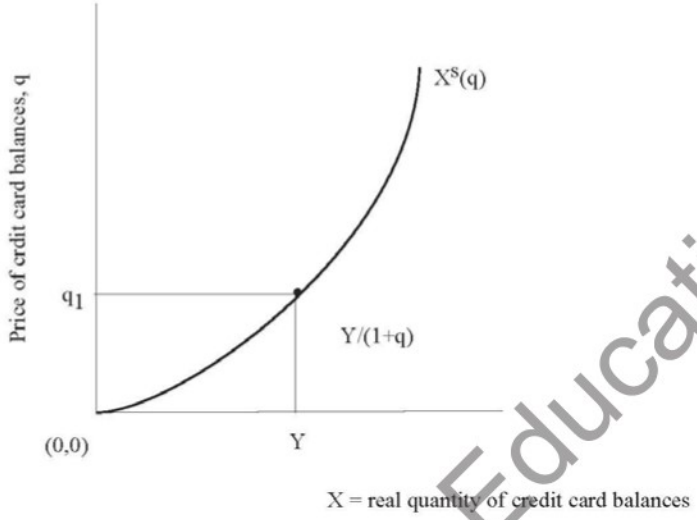


Figure 12.1

2. A tax on credit card balances shifts the demand for credit card balances in Figure 12.2, so that demand is perfectly elastic at $q = R - t$ rather than at $q = R$. Then, for each nominal interest rate, the equilibrium quantity of credit card balances falls, and this shifts the demand for money to the right, just as in Figure 12.12 in the textbook. As a result, the price level will fall. Since money is neutral, this has no effects on any other real variables.

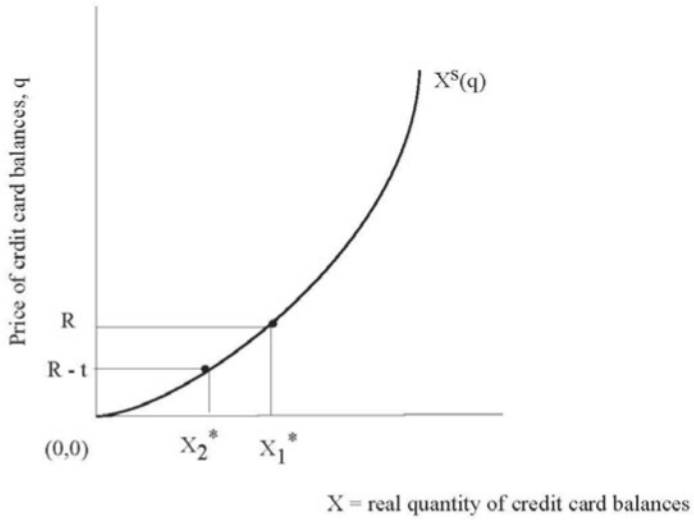


Figure 12.2

3. If the nominal interest rate is zero, then the demand for credit card balances is zero. The nominal interest rate represents the opportunity cost of holding currency for use in transactions, and if this cost is reduced to zero then consumers and firms in the model have no desire to pay a positive cost to use credit cards for transactions. In practice, it seems implausible that a zero interest rate would imply that no one would use alternatives to cash supplied by the banking system. Indeed, after late in 2008, safe interest rates on government debt were essentially zero in the United States, but credit cards, debit cards, and checks were still in wide use. In practice, there is a deterrent to holding cash, which is that it can be lost or stolen (see question 7). Even if the nominal interest rate is zero, there is still a demand for the transactions services offered by banks, as banks provide safekeeping services.

4. The real effects of a decrease in the capital stock are the same as those in the real intertemporal model. The decrease in K leads to an increase in the real interest rate and a decrease in the real wage. The effects on output and employment are uncertain, although it may be somewhat more likely that output will decrease. A decrease in output, along with an increase in the real interest rate, both work to decrease money demand. Therefore, the price level would need to increase to keep money supply and money demand equal.

5. This represents an increase in current total factor productivity (TFP). The real effects are exactly the same as in Chapter 11. But, since real output increases and the real interest rate falls, there is an shift to the right in the money demand function, and the price level falls. The predictions of the model match the key business cycle facts, in that consumption, investment, employment, the real wage, and average labor productivity are procyclical. However, the model predicts a countercyclical price level, but the price level is acyclical in the data, and under TFP shocks the model says nothing about the fact that money is procyclical in the data.

6. The increased presence of ATMs would allow consumers to get by holding less money. Therefore, this disturbance shifts the money demand curve to the left, so the price level would increase to keep money demand and money supply equal.

7. What will work in this case to totally eliminate the confusion for private sector economic agents is the following. First, as long as the central bank does not see a shock to total factor productivity, it should have an interest rate target. Then, if there is a money demand shock, the money supply will respond appropriately so that the price level, real output, and the real interest rate is unchanged. In that case, there will be no response in labor markets, as workers and firms are oblivious to what is going on. However, if there is a shock to total factor productivity, the central bank does nothing in response. Then (see question 5) the price level will change, signaling to workers that there has been a productivity shock. If the price level goes down or up, then workers understand exactly what their actual real wage is, and work the appropriate amount.

8. This works like Figure 12.2 above for question 2, in reverse. Roughly, if there is some chance that currency is stolen, then this increases the opportunity cost of holding money from R to $R + x$, where $x > 0$ captures the positive probability of theft. Given the nominal interest rate, the equilibrium quantity of credit card balances increases, and the demand for money decreases given each nominal interest rate. The demand for money curve shifts to the left and the price level rises in equilibrium. Now, note that, even if the nominal interest rate is zero, there is a positive demand for credit card balances.

9. If the money supply decrease is announced in advance, then the decrease in money is neutral. The price level falls in proportion to the decrease in the money supply. This works as in Figure 12.10 in the textbook, except in reverse. If the money supply decrease is not announced, then this works as in Figure 12.14 in the textbook, except in reverse. Money demand decreases, which offsets the decrease in the price level that occurs. Thus the price level will decrease, but less than in proportion to the money supply decrease, and there is a decrease in output and employment, which is costly. As a result, if the goal of the central bank is to reduce the price level, it should announce the money supply decrease in advance.

10. There are assumed to be no non-neutralities of money. For part (a), from question #5, if there is an increase in total factor productivity, then the price level falls, and real output rises, if the central bank does nothing. Nominal GDP may rise or fall. Therefore, if the central bank is stabilizing nominal GDP, then it may want to increase or decrease the money supply. However, it is guaranteed that the price level will not be stable under productivity shocks, since the price level will have to fall (given nominal GDP targeting) when there is a positive productivity shock. For part (b), if there is a positive shift in the demand for money, then the price level must fall, and there is no effect on real output. In this case, the central bank will increase the money supply if it is stabilizing nominal GDP. With money demand shocks, the central bank does the same thing, whether it is stabilizing the price level or nominal GDP.

Chapter 13
Business Cycle Models with Flexible Prices and Wages

■ Teaching Goals

Chapter 3 demonstrated there are strong regularities associated with the comovements among macroeconomic variables. Though business cycles are remarkably similar, understanding their causes is a difficult task. There are multiple alternative business cycle models, and students need to understand how these models are different – in terms of what causes business cycles in these alternative models, and what the policy prescriptions are. We may not want to totally dismiss any business cycle models. Potentially many models could give us useful insight into what business cycles are about.

The models in this chapter are all based on flexible wages and prices. Sometimes these are called "equilibrium" models, but even models with sticky wages and prices – for example the New Keynesian model in Chapter 14 – have some notion of equilibrium. It is important for students to understand, in spite of the fact that much of Keynesian economics is done with sticky-wage-and-price models, that Keynesian ideas do not depend on sticky wages and prices.

There are three elements in any business cycle model that are important: the impulses (shocks), the propagation mechanism, and the policy conclusions. In the real business cycle (RBC) model, the impulses are shocks to total factor productivity (TFP), these shocks are propagated through the optimizing choices that are made by economic agents, and in the baseline model there is no role for policy. In the Keynesian coordination failure model the impulses are endogenous – self-confirming optimism and pessimism. Propagation occurs in the same way as in the RBC model, but there may be a role for government policy in improving matters. Either model fits the data as well as the other.

The last model in this chapter is a New Monetarist model, which is included to capture specifically some features of the financial crisis, rather than as a general model of business cycles. The novelty is the idea that financial liquidity is important in financial crises, and that this requires a different way of thinking about monetary policy.

■ Classroom Discussion Topics

A key idea in this chapter is that a preliminary evaluation of a model's usefulness involves fitting the data. It would be good to discuss why this is valid. Might we imagine models that did not fit the data well but might nevertheless be useful? Do we want the model to fit *all* the data? Surely a model intended for the study of business cycles need not give good predictions about the price of orange juice ten years from now.

Macroeconomists have been criticized for not foreseeing the financial crisis. Would that have been feasible? Is forecasting all that macroeconomists do? Point out that an important goal in macroeconomics is to design models that can be useful for policy analysis.

Why should we study different business cycle models? Surely they cannot all be correct. Discuss how policymakers use models to make policy decisions. The models need to be simple. There can be many factors at work in the real world, but putting these all in one model may just be confusing.

One could have a discussion about the financial crisis and the last recession, and what the models in this chapter have to say about it. Possibly these approaches missed the boat in various ways. What elements of the models do we want to keep? What should we throw away? Emphasize that we can be wrong, but that does not mean we should throw everything away and start over.

■ Outline

I. The Real Business Cycle Model

A. The Workings of the Real Business Cycle Model
   1. Persistence of the Solow Residual
   2. Effects of a Persistent Change in Total Factor Productivity
   3. Qualitative and Quantitative Replication of the Business Cycle Facts

B. Real Business Cycles and the Behavior of the Money Supply
   1. Cyclical Properties of the Money Supply
      a. Nominal Money Supply Is Procyclical
      b. Nominal Money Supply Leads Real GDP
   2. Endogenous Money
      a. Behavior of Bank Deposit Money
      b. Central Banks and Price-Level Stabilization
   3. Statistical Causality and True Causality

C. Implications of the Real Business Cycle Model for Government Policy
   1. Money Is Neutral
   2. Government Spending Based on Optimal Provision of Public Goods
   3. Other Policy Goals
      a. The Friedman Rule
      b. The Smoothing of Tax Distortions

D. Critique of the Real Business Cycle Model
   1. Measurement of Total Factor Productivity
   2. Labor Hoarding
   3. Real Business Cycle Theory and the "Volker Recession"

II. A Keynesian Coordination Failure Model

A. The Workings of the Model
   1. Coordination Failures
   2. Strategic Complementarities
   3. Multiple Equilibria
   4. Increasing Returns to Scale

B. The Coordination Failure Model: An Example
   1. The Downward-Sloping Goods Supply Curve
   2. Multiple Intersections of Goods Supply and Goods Demand
   3. Sunspots

C. Predictions of the Coordination Failure Model
   1. Properties of "Good" and "Bad" Equilibria
   2. The Coordination Failure Model and the Business Cycle Facts

D. Policy Implications of the Coordination Failure Model
   1. Achieving a Single Equilibrium

■ Solutions to End-of-Chapter Problems

1. The effects in the goods and labor markets are identical to what we considered in Chapter 11. Output increases, the real interest rate rises, consumption and investment fall, employment rises, and the real wage falls. What we need to add to the Chapter 11 analysis are the effects in the money market. Since output increases and the real interest rate falls, money demand may rise or fall, so the price level could fall or rise, respectively. While the model predicts procyclical employment, as in the data, the model also predicts countercyclical consumption, investment, real wage, and average labor productivity, so the model does not match the data in these respects. Further, the price level could be procyclical or countercyclical, so there is no prediction there. Thus, it seems unlikely that shocks to government spending could be important in explaining business cycles.

2. We already know that permanent increases in total factor productivity are consistent with all of the business cycle facts. As developed in the answer to problem 1, above, we noted that temporary increases in government spending were not consistent with several business cycle facts. If both disturbances are combined, the ability to fit the facts depends on which of the parts of the disturbance are stronger. In particular, if the increase in government spending produces a small increase in total factor productivity, then this type of disturbance will not fit the facts very well. For this type of disturbance to fit the business cycle facts, a small increase in government spending would need to generate a large increase in total factor productivity.

3.

a) First consider the fundamental effects of the increase in expected future total factor productivity. Such a disturbance shifts the output demand curve to the right. The effects in the goods and labor markets are the same as considered in Chapter 11. Here, we need to add the effects in the money market. Since output increases and the real interest rate increase, the net effect on money demand is ambiguous, so the price level could rise or fall.

b) From Chapter 11, we know that this shock causes investment to increase, there is an ambiguous effect on consumption (income increases and the real interest rate increases), employment increases, and the real wage falls. Further, average labour productivity falls. As well, the price level could be procyclical or countercyclical. Thus, the model does not match all of the key business cycle facts. Consumption need not be procyclical in the model, and the real wage and average labor productivity are countercyclical in the model but procyclical in the data. .

c) What the central bank should do depends on the direction that money demand moves in – if money demand goes up (down) then the money supply should go up (down).

4. If the money supply were the only variable that shifts the economy between the bad and good states, the monetary authority would need to increase the money supply only if the economy starts out in the bad state. However, once the good state is reached, there is no further need to make any changes in the money supply.

The segmented markets model and the money surprise model studied in Chapter 12 imply that monetary policy should be predictable, which is somewhat related to the conclusion from the coordination failure model under the circumstances specified in this problem. However, predictability is much less specific than having the money supply take on a particular value that everyone agrees inspires optimism.

5. This shock acts to shift the labor supply curve to the right which, when we construct the output supply curve, implies a shift to the left in that curve. As well, because there is an increase in the demand for consumption goods, the output demand curve shifts to the right. As shown in Figure 13.1, output in the good equilibrium increases, and the real interest rate is lower in the good equilibrium. Thus, in the good equilibrium, employment is higher, consumption is higher, investment is higher, and the real wage is higher. However, in the bad equilibrium, output is lower and the real interest rate is higher than before the shock. As a result, employment is lower, consumption is lower, investment is lower, and the real wage is lower. Thus, if we think of the economy as fluctuating between the good and bad equilibria, if this shock is permanent, then volatility in all aggregate economic variables will be higher.

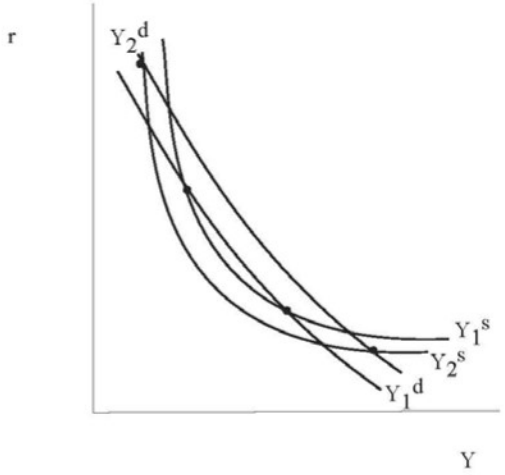


Figure 13.1

6. The effects of the decrease in the capital stock depend on the specific model we are working with. The effect of the decrease in capital in the real business cycle is depicted in Figure 13.2, below.

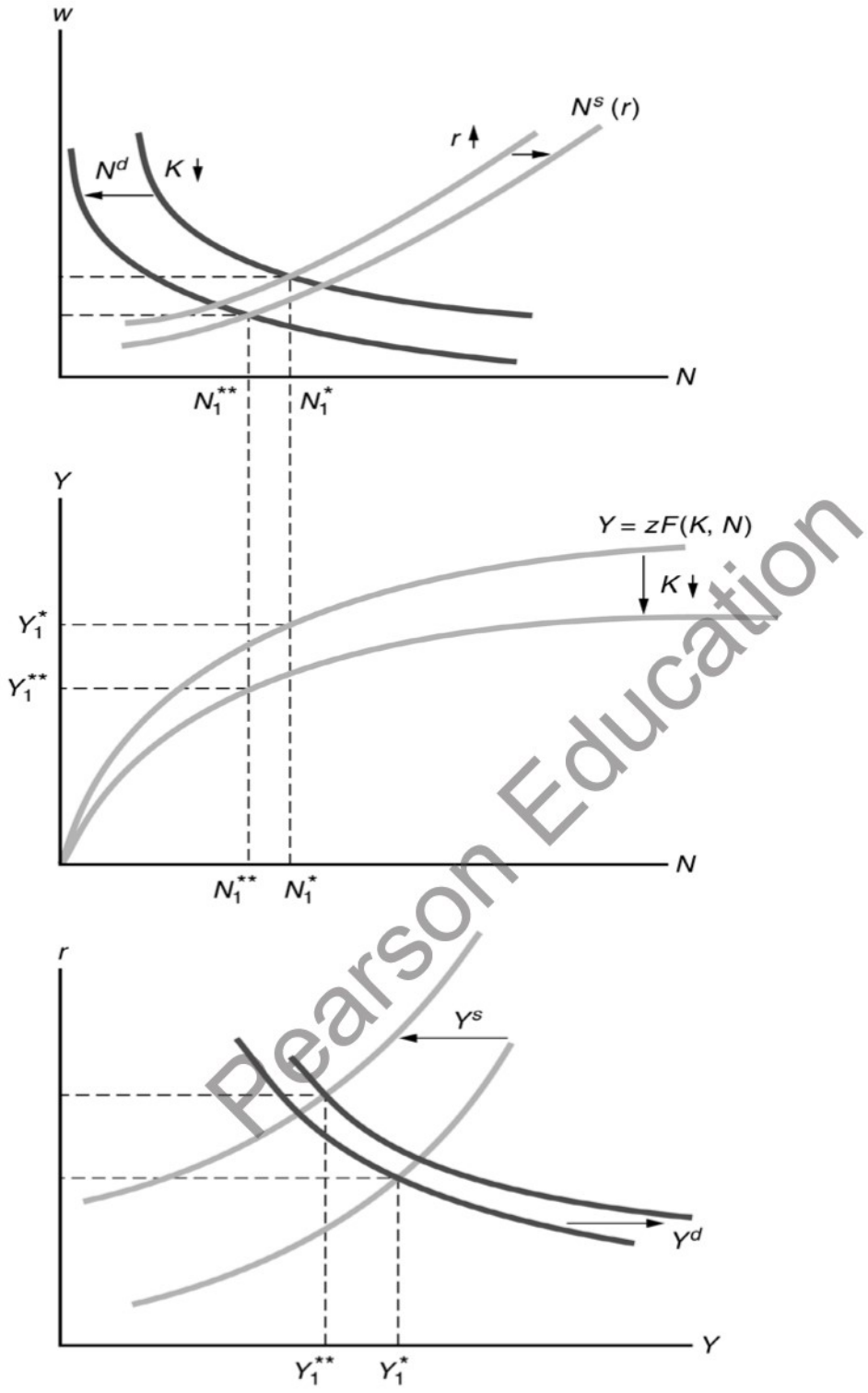


Figure 13.2

The real interest rate unambiguously increases. The diagram depicts a case in which real output decreases. In this case, the demand for money unambiguously decreases, and so a decrease in the money supply is required to maintain price stability. If, on the other hand, the increase in investment demand is strong enough, then the aggregate demand curve may shift to the right by more than the shift to the left in aggregate supply. In this case, real output increases. If real output increases enough, then the demand for money may increase, which would require an increase in the money supply.

7.

a) In the real business cycle model, what the central bank should do in response to a decline in TFP depends on the central bank's goals. If the central bank wishes to stabilize the price level, then it should reduce the money supply, but money is neutral in the real business cycle model, so there is no role for the central bank other than price level control.

b) In the coordination failure model, money is neutral, just as in the real business cycle model, unless money plays the role of a "sunspot" variable. In that case, central bank actions mean something to private sector economic agents, and the central bank needs to take that into account. For example, if private sector economic agents are all optimistic when the money supply increases, then if the central bank detect pessimism that could reduce GDP, the money supply should increase so that there is an optimistic equilibrium. However, if money is not a sunspot variable and the central bank wishes to control the price level, then it should reduce the money supply. In this instance, it does not matter to the central bank whether the correct model is the coordination failure model or the real business cycle model. If price level control is the only goal then a reduction of the money supply is called for in either case.

8. In the New Monetarist model, if there is deficient financial liquidity, then a tax cut financed by an increase in the quantity of nominal government bonds, B, will increase the quantity of liquid financial assets, a. This shifts the output demand curve to the right, as in Figure 13.3, and the real interest rate and output both increase. This mitigates the liquidity deficiency. Therefore, in conditions of deficient financial liquidity, Ricardian equivalence does not hold. Even if the tax cut does not matter for consumption spending because consumers take into account the effect of higher taxes in the future, government debt is important for the functioning of financial markets, so increasing its supply will be beneficial.

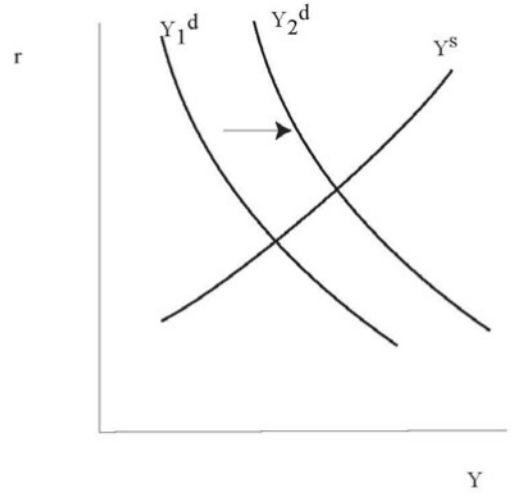


Figure 13.3

9. Whether there is a liquidity trap or not, the tax cut financed by a government bond issue has the same effects as in question #9. Thus, while monetary policy does not work in the liquidity trap case, fiscal policy does.

10. If there is deficient financial liquidity, then quantitative easing – an increase in *M* matched by a decrease in *k(r)* – gives the same effects as in Figure 13.14 in the textbook for a decrease in financial liquidity. The output demand curve shifts to the left, and output and the real interest rate both fall. If there is a liquidity trap and interest on reserves, then the increase in the real quantity of reserves, M_r/P, is matched by an equal and opposite change in the quantity of privately-produced liquid privately-produced assets, *k(r),* so in this case quantitative easing has no effect.

Chapter 14
New Keynesian Economics: Sticky Prices

■ Teaching Goals

It is straightforward to teach this material without making a large investment in doing IS/LM AD/AS analysis. The model is just a simple extension of the monetary intertemporal model, with a fixed price and an interest rate rule for monetary policy. It is important for the students to recognize that the central bank's interest rate target needs to be supported with the appropriate supply of money (which may vary, if there are money demand shocks). Emphasize the concepts "output gap" and "natural rate of interest," particularly as these enter policy discussions.

This model should be subjected to the same rigor as the equilibrium models in Chapter 11. Does it fit the data? Does it make sense? Keynesian thinking is quite ingrained in many textbooks and among policymakers, and students need to have a healthy skepticism about whether or not that is the way to go.

Students should learn how policy works in the New Keynesian model. Policy works because of a market failure—the inability of private markets to clear in the short run. If policymakers are smart, quick, and have good information, they can do better—maybe a lot to ask. There are important differences between fiscal and monetary policy as stabilization tools, particularly in terms of what they imply for the allocation of resources.

The chapter includes a discussion of the debate over the observed response of employment to technology shocks, and how this might allow us to distinguish among theories of the business cycle. There are also interesting boxes relating to policy lags and empirical studies of price stickiness.

A new section is included on the liquidity trap, and there is a new Macroeconomics in Action box covering issues related to quantitative easing, from a Keynesian perspective. These additions are of critical importance for current policy.

■ Classroom Discussion Topics

You might start the discussion by getting students to think about why prices might be sticky in practice. What do we observe about market prices? Which prices seem to be sticky and which are not? Goods are sold in different ways, for example for some goods prices are posted and we cannot bargain, but for other goods we are expected to haggle. Why might prices be sticky? Are there costs to changing prices? What would these costs be? Why do gasoline prices change frequently while the prices of motor oil (sold at the same gas station) do not? What about sales?

Students are indoctrinated with Keynesian economics at an early stage, and this is reinforced by how much of the media thinks about the economy. We typically blame politicians and central bankers for aggregate economic performance, under the belief that they are able to do something about it. These beliefs should

be challenged. Once the students are clear on how the New Keynesian model works, start to take it apart and challenge its assumptions, and think about how it fits the facts.

An important avenue for discussion would be to consider the financial crisis and the responses of fiscal and monetary policy to it. The crisis appears to have had little to do with sticky prices, but nevertheless policymakers use Keynesian beliefs to justify their actions. Was the 2008–09 downturn the result of downward stickiness in prices? Were firms going out of business because they could not bear to reduce the prices of their products?

■ Outline

I. The New-Keynesian Model

A. Sticky Prices In Short Run

B. Menu Costs

C. Goods Market in Disequilibrium

D. Natural Rate of Interest

E. Output Gap

F. Labor Market on Labor Demand

II. Non-Neutrality of Money

A. Keynesian Transmission Mechanism for Monetary Policy

B. Faster Path to Equilibrium Than Long Run

C. Long-Run Money Neutrality

III. Stabilization Policy

A. Monetary Policy: Stabilization With More Consumption and Investment

B. Fiscal Policy: Stabilization With Crowding Out

C. Policy Effective in Presence of Equilibrium Failures

D. But Not If Implementation Lags

IV. TFP Shocks With Sticky Prices

A. Shock Leads to Lower Employment

B. Cannot Be Reconciled With Stylized Facts

V. The Liquidity Trap and Sticky Prices

VI. Criticisms of Keynesian Model

A. Incomplete theory

B. Quantitative Aspects of Menu Costs

■ Solutions to End-of-Chapter Problems

1. An increase in *G* shifts the output demand curve to the right. With a fixed interest rate target, output increases, investment stays constant, consumption increases, employment increases, and the real wage rises. Everything fits the data, except that the price level is acyclical, average labor productivity is countercyclical, and investment is acyclical. It does not look like government spending shocks are a good candidate as a cause of business cycles.

2. a) This acts to shift the output demand curve to the left (just the reverse of what happens in question 1. Output decreases, investment falls, consumption falls, employment falls, and the real wage falls. The output gap rises.
   b) The central bank can lower its interest rate target, supported by decreasing the money supply. Output, investment, and consumption will increase over what they were in part a), employment will increase, and the real wage will rise. An appropriate reduction in the interest rate target reduces that output gap to zero.
   c) Government spending could increase to shift the output demand curve to the right. This also shifts the output supply curve to the right, but with the appropriate increase in *G*, the output gap is reduced to zero. Relative to part a), output is higher, investment is the same, consumption is higher, employment is higher, and the real wage is higher. Relative to part b), consumption may be higher or lower, investment is lower, and output and employment are higher.

3. Given some level of government spending, G_1, this determines the positions of the output demand and supply curves, and determines the equilibrium level of output Y_1, and the equilibrium real interest rate r_1. The central bank would like to keep the price level constant at its current fixed level *P*. Thus, if the central bank sets the money supply so that money supply at $M_1 = PL(Y_1, r_1)$, then the fiscal authority and the monetary authority both achieve their goals. However, the same would be true for any other level of government spending. The fiscal authority chooses the level of spending, which determines the market-clearing level of output and real interest rate, and the monetary authority sets the money supply so that the market-clearing interest rate is its target. To uniquely determine the outcome, the fiscal and monetary authorities have to coordinate.

4. Under the assumption that Ricardian equivalence holds, so that the timing of taxes is irrelevant, the deficit does not matter. What matters in the basic New Keynesian model is the level of government spending. If fiscal policy is the only stabilization tool, then government spending should increase when the output gap is large and decrease when it is small, so government spending should be countercyclical, not the deficit. However, some Keynesians argue that credit market imperfections matter, and this implies that changes in the timing of taxes can affect consumer spending. This would add another stabilization tool, and would tend to imply that the deficit would be countercyclical.

5. a) There should be no change in the target rate. The money supply changes with the shift in money demand, with the target rate unchanged. The output gap therefore is unaffected by the money demand shift.

b) This shifts the demand for investment goods, and shifts the output demand curve to the left. The central bank should reduce its target rate to keep the output gap at zero.
c) This shifts the output supply curve to the right. The central bank should increase its target interest rate, leaving the output gap at zero.

6. Under this monetary policy, whenever TFP increases, the central bank increases its target interest rate to accommodate it. All aggregate variables move just as they would in the real business cycle model, except that the price level does not move—it is acyclical. Further, the money supply is procyclical, just as in the data. In addition, in the real business cycle model, if the central bank were intervening so as to stabilize the price level, then the price level would be constant, just as with the New Keynesian model. Therefore, from the data it would be impossible to tell whether the data was being generated by a New Keynesian model or a real business cycle model.

7. a) No problem. The shift in money demand is accommodated by a movement in the money supply in the same direction. The output gap stays at zero.
b) Output demand shifts to the right, but the central bank holds its interest rate target constant. The output gap becomes negative, so the result here is not what the central bank wants.
c) Output supply shifts right. The output gap increases. Again, the central bank gets a bad result.
d) The interest rate rule is a good one if the very short-run shocks to the economy are money-demand shocks, which happens to be the case in practice. Typically output demand and supply shocks are slower to develop, and the central bank can adjust its target interest rate as evidence is accumulated on these shocks over time.

8. Recall from Chapter 13 that liquid financial assets can be expressed as

$$a = \frac{B}{P} + k(r),$$

with the key difference here being that P is fixed in the New Keynesian sticky price model. An important point to note is that there are now two sources of inefficiency – sticky prices and deficient financial liquidity. Assume here that the central bank intervenes by way of open market operations, so that an increase (decrease) in M is matched by a decrease (increase) in B of the same absolute magnitude. A reduction in r under these circumstances can only by accomplished by an increase in M by the central bank through an open market purchase of government bonds. Therefore, B must decrease, and there is a shift to the left in the output demand curve. In Figure 14.1, output can actually decline under what would conventionally think is accommodative monetary policy. In Figure 14.1, the output gap increases, and the deficiency in financial liquidity is aggravated. However, in Figure 14.2, we depict the case where output increases, so that the the output gap falls, but this case could involve an aggravation in the financial liquidity deficiency. In the case depicted in Figure 14.1, the correct policy would be to increase the real interest rate through an open market sale. This would act to mitigate the deficiency in financial market liquidity, and would also reduce the output gap. In the Figure 14.2 case, there may be a conflict, as a reduction in the real interest rate can close the output gap, but might make the deficiency in financial liquidity worse. In any case, it may not be possible to correct both inefficiencies (the output gap and the deficiency in financial liquidity), as the central bank essentially only has one policy instrument.

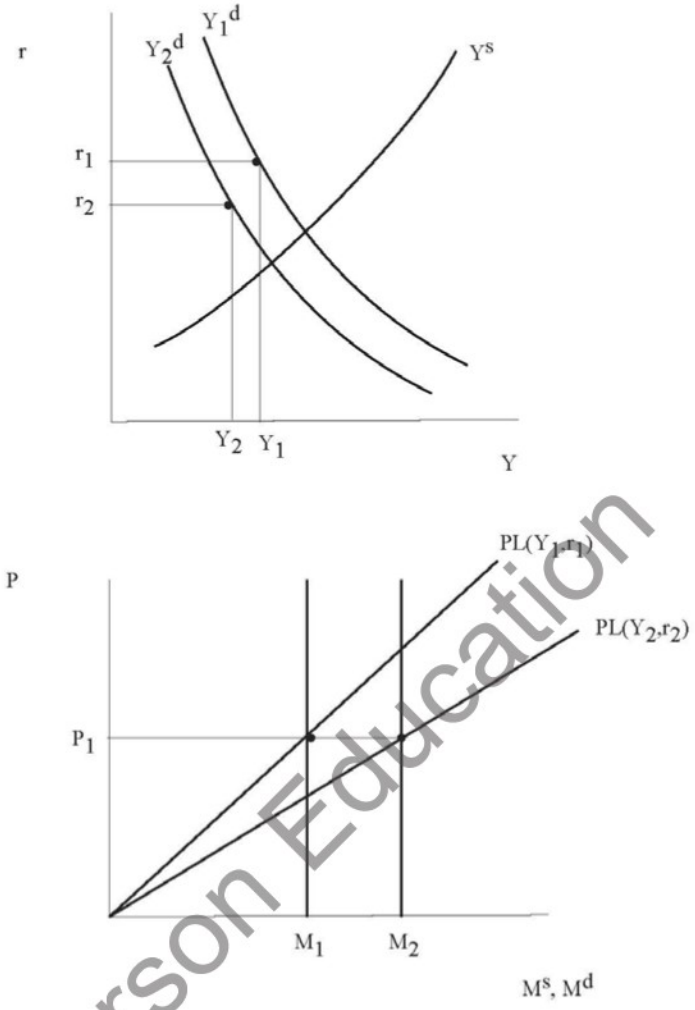


Figure 14.1

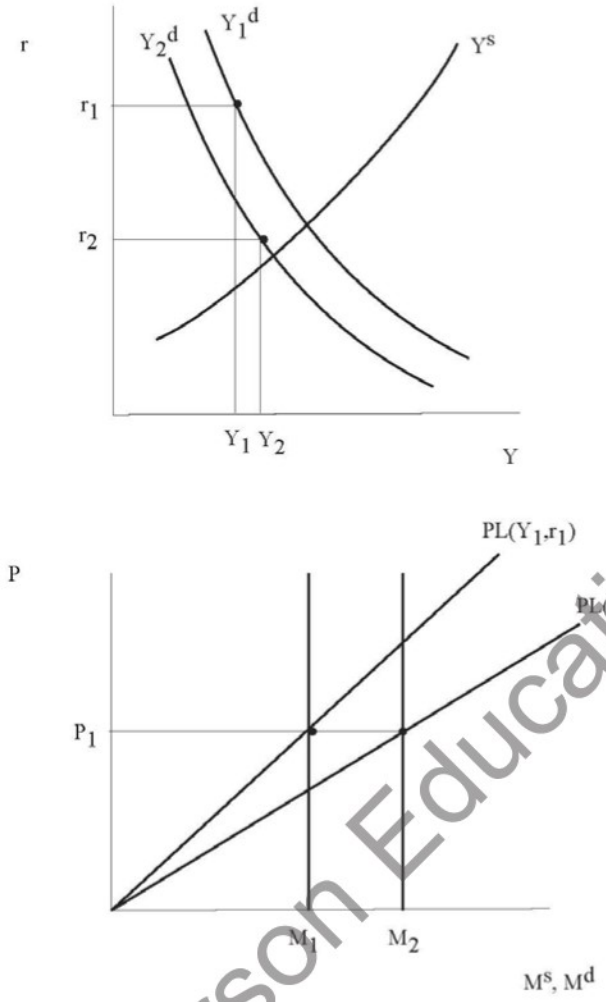


Figure 14.2

9. If consumption and investment expenditures are very inelastic with respect to the real interest rate. This implies that the output demand curve is steeper, which implies that output will increase a smaller amount in response to a decrease in the real interest rate, which makes monetary policy less effective in reducing the output gap. However, it is easy to show that a steeper output demand curve implies that the output gap will be reduced by a larger amount for a given increase in the government spending. This is because the horizontal shift in the output demand curve for a given increase in government spending is always equal to the increase in government spending, as we showed in Chapter 11. If consumption and investment are less elastic with respect to the real interest rate, then this dampens the crowding-out effects of an increase in government spending.

Chapter 15
International Trade in Goods and Assets

■ Teaching Goals

This chapter focuses primarily on international trade in goods and assets, with and without production. A closed economy is required to exactly exhaust its total output in each period among consumption, investment, and government spending. An open economy can use either more or less than the output it produces in each period, and can borrow from and lend to the outside world, just as an individual household borrows and lends. Indeed, the starting point for our analysis of the current account is a model which treats an individual country essentially as an individual.

In an open economy, differences between production and absorption (consumption plus investment plus government spending) occur when the current account is either in surplus or deficit. A common misimpression for students is to think of the current account balance as reflecting competition for sales by firms in different countries. A better insight into the current account balance comes from considering the additional option for consumption smoothing that comes from borrowing and lending activities with those in other countries. One clear case for the benefits of running a current account deficit is for a country that wants to increase its capital stock more quickly than would be possible in the absence of foreign borrowing.

As international trade in assets involves credit market issues, we can use the models in this chapter to think about sovereign debt and sovereign default. The first model considered in this chapter is easily adaptable, using an approach from Chapter 10, to problems associated with international indebtedness.

■ Classroom Discussion Topics

A concern voiced in the popular press relates to the fact that the United States has been running consistent deficits in the current account balance. Are students concerned about the balance of payments? Why or why not? Remind the students that current account surpluses and deficits are equivalent to international borrowing and lending. Is it ever a good idea to try to prevent markets from functioning in a competitive manner? Be sure that they understand that encouraging exports and discouraging imports cannot solve the problems inherent in the desire to smooth consumption and expand investment as long as the marginal product of capital exceeds the world real interest rate.

The global financial crisis brought the issue of international transmission of macroeconomic shocks, and the consequences of international indebtedness to the fore. Get students to discuss how financial events in the United States affected the rest of the world, and the implications of the potential for sovereign default in southern Europe for the United States.

■ Outline

I. A Two-Period Small Open Economy

A. The Intertemporal Budget Constraint

B. Response of the Current Account to Disturbances

1. Current-Period Income and the Current Account
2. Current Government Spending and the Current Account
3. Taxes and the Current Account
4. The Real Interest Rate and the Current Account

C. Credit Market Imperfections and Default

D. The Current Account and Consumption Smoothing

II. Production, Investment, and the Current Account

A. Output Supply and Output Demand

B. Effects of Disturbances

1. An Increase in the World Interest Rate: $Y\uparrow, CA\uparrow$
2. A Temporary Increase in Government Spending: $Y\uparrow, CA\downarrow$
3. An Increase in Current Total Factor Productivity: $Y\uparrow, CA\uparrow$
4. An Increase in Future Total Factor Productivity: $\Delta Y = 0, CA\downarrow$

C. Consumption, Investment, and the Current Account

■ Solutions to End-of-Chapter Problems

1. a) When the real interest rate is 10%, the nation's budget constraint is given by

$$C + G + \frac{C' + G'}{1.1} = 100 + \frac{200}{1.1} = 209.1,$$

and, given perfect complements preferences, $C+G=C'+G'$ is preferred, so solving we obtain $C+G=C'+G'=109.5$. Therefore, the current account surplus, $NX=Y-C-G=-9.5$.
b) If the real interest rate is 20%, then the nation's budget constraint is

$$C + G + \frac{C' + G'}{1.2} = 100 + \frac{200}{1.2} = 200,$$

and so $C+G=C'+G'=109.1$. Therefore the current account surplus is $NX=-9.1$.
c) The increase in the real interest rate caused a decline in total national consumption, and an increase in the current account surplus. In Figure 15.1, since the nation is initially a borrower with a current account deficit, there is a negative income effect from the increase in the real interest rate (no substitution effect with perfect complements preferences), so national consumption declines. With income unchanged, the current account surplus increases (borrowing declines).

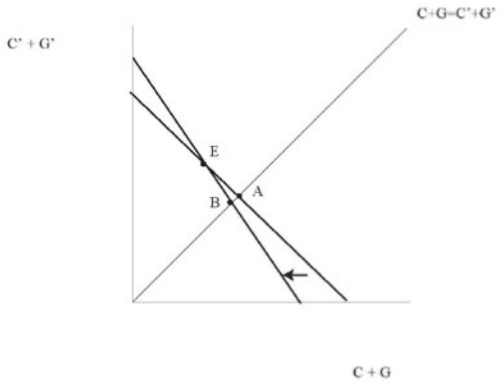


Figure 15.1

In the Figure, E is the endowment point, and the increase in the real interest rate pivots the nation's budget constraint clockwise around E. The consumption bundle shifts from A to B.

2. Figure 15.2 shows the effects of a tax on lending imposed in foreign countries.

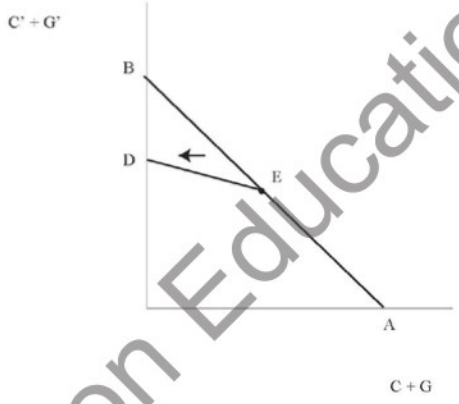


Figure 15.2

In the Figure, E is the endowment point. The initial budget constraint is AB, and it shifts to AED. Thus, the tax introduces a kink in the budget constraint. If the nation were initially a borrower, this would have no effect, as the nation would choose the same consumption bundle on AE. However, if the nation initially had a current account surplus (chose a point on BE), then the consumption bundle would change. There will be income and substitution effects. From the analysis in Chapter 9, $C'+G'$ must increase, but $C+G$ could increase or decrease, depending on the strength of the opposing income and substitution effects. As a result, the current account surplus, $NX=Y-C-G$, could increase or decrease.

3. In these circumstances, it is possible that default in the current period could be chosen, as depicted in Figure 15.3.

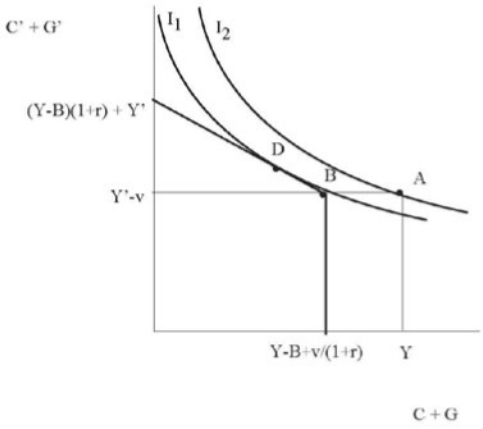


Figure 15.3

In the Figure, the limited commitment constraint does not bind, as in the absence of default point D is chosen. However, point A, where default occurs, is preferable. For A to be preferable to D it is necessary that $B>v/(1+r)$, but that condition is not sufficient for A to be preferable to D.

4. We can draw on Figure 9.5 from the textbook. As the country is collateral-constrained, current consumption must drop as much as the drop in value of the collateral, ΔpK_c, and future consumption is unchanged. We see then a current account surplus increasing by the same ΔpK_c.

5. Current account deficit policies.
   (a) If Ricardian equivalence holds, then the level of lump-sum taxation has no effect on the current account. The first group of advisors would therefore be wrong. A tax on investment shifts the investment demand schedule to the left. The output supply curve is unchanged. The output demand curve continues to pass through the original equilibrium position at the given world real interest rate. Because investment has decreased, absorption decreases, so the current account deficit declines. Therefore, the best advice to take would be to adopt the investment tax.
   (b) The concern with the current account deficit is misguided in this instance. The deficit is being used to finance investment spending. Over time, the increase in investment leads to a larger stock of capital, the output supply curve shifts to the right, and the current account deficit eventually disappears. If the policy is implemented, the stated objective could be met, but welfare would be lower, and the policy would continue to be needed, because it would be difficult for the economy to grow its way out of the situation that caused the deficit.

6. A persistent increase in total factor productivity would shift both the output supply curve and the output demand curve to the right. The supply curve shifts due to higher employment and higher productivity. Investment demand increases due to the increase in expected future productivity. Consumption increases due to the increases in current and future income. The analysis of Chapter 12 argued that the shift in the supply curve would be larger than the combined effects of the changes in investment and consumption, so the current account balance would also increase. At the given world real interest rate, investment increases. At the given world real interest rate, the increase in domestic income increases consumption. These predictions are in line with the typical business cycle. However, this scenario is inconsistent with Figure 14.10 in the text. In the data, the current account is negatively correlated with output. In this example, output and the current account move in the same direction.

7. The effects of an increase in credit market frictions are depicted in Figure 15.4.

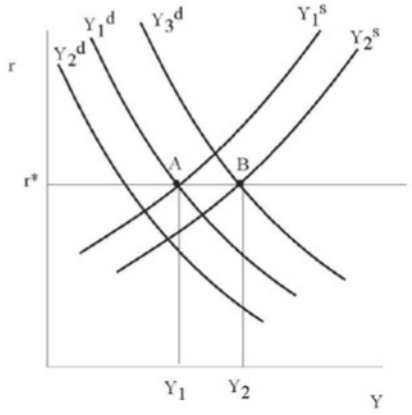


Figure 15.4

As in Chapter 11, the output demand curve shifts to the left from Y_1^d to Y_2^d, and the output supply curve shifts to the right from Y_1^s to Y_2^s. The current account surplus increases, shifting the output demand curve to the right to Y_3^d. Ultimately, output increases, consumption increases, and investment is unchanged. Somewhat surprisingly, greater credit market friction leads to an expansion in output and employment. This is because labor supply increases. The domestic demand for output is indeed smaller, but the increased output is sold abroad, i.e. the current account surplus increases because of the increase in production and the reduction in domestic demand.

Chapter 16
Money in the Open Economy

■ Teaching Goals

The previous chapter covered most of the important issues in open economy macroeconomics with respect to real variables in the economy. This chapter's material covers interactions between real and nominal variables. The most important consequence of the addition of national moneys into the open economy is the need to fully understand exchange rates. A key building block to understanding the material in this chapter is to fully grasp the difference between a nominal exchange rate and a real exchange rate. Although students can easily memorize the equation that relates the two variables, they often become confused on this subject when discussing applications of the theory. The related topic of purchasing power parity is also difficult to fully grasp. The models in the chapter all rely on purchasing power parity, and yet evidence suggests that this relationship is not reliable when dealing with short-horizon developments. In this regard, it is useful to point out that deviations from purchasing power parity are typically due to real, as opposed to nominal factors.

The model is extended to the sticky price case, using what was learned about New Keynesian models in Chapter 14. This extension works much like the conventional Mundell-Fleming model, and has conventional Mundell-Fleming implications, particularly as concerns the effectiveness of monetary and fiscal stabilization under fixed and flexible exchange rates.

■ Classroom Discussion Topics

Many times students are disappointed with economics because the discipline rarely offers strategies for reaping windfall gains. Ask the students if they ever thought of foreign-exchange speculation as a source of livelihood. Can the students work out the proper strategy if they are confident in their ability to predict future movements in nominal exchange rates? Is the possibility of windfall profits limited to the case of flexible exchange rates? Would it be useful to be able to predict devaluations? Remind the students that their ability to forecast must be better than market forecasts. Ask the students about the likely consequences of a widespread change in market expectations about exchange rate movements. Unfortunately, this point brings us back to the difficulties in making quick money from learning about economics.

It is useful to think of the fixed-exchange-rate vs. flexible-exchange-rate choice in terms of countries in the European Monetary Union. EMU members essentially chose a fixed exchange rate among member countries, and this also reflects a choice of a common monetary policy vs. an independent monetary policy, as the models in this chapter show. Students should have encountered media stories about the conflict between Germany and southern European countries in particular, over economic policy. The models in this chapter have a lot to say about this.

■ Outline

I. Basic Concepts

A. The Nominal Exchange Rate

B. The Real Exchange Rate

C. Purchasing Power Parity, The Law of One Price
   1. Nontraded Goods
   2. Mobility of Goods, Labor, and Capital
   3. PPP and the Big Mac Index

II. Flexible and Fixed Exchange Rates

A. Flexible Exchange Rates

B. Fixed Exchange Rates
   1. Hard Pegs
      a. Dollarization
      b. Currency Boards
      c. A Common Currency: The Euro
   2. Soft Pegs, Devaltuations and Revaluations
      a. The European Monetary System
      b. The Bretton Woods Arrangement
      c. The International Monetary Fund

III. A Monetary Small Open Economy: Flexible Exchange Rates

A. Money Market Equilibrium and Exchange Rate Determination

B. The Neutrality of Money under Flexible Exchange Rates: $M\uparrow$
   1. Price-Level Effect
   2. Depreciation of the Domestic Currency

C. A Nominal Shock: $P^*\uparrow$
   1. Insulation of the Domestic Price Level
   2. Appreciation of the Domestic Currency

D. A Real Shock: $r^*\uparrow$
   1. Noninsulation of the Domestic Price Level
   2. Nominal Effects of a Real Shock

IV. A Monetary Small Open Economy: Fixed Exchange Rates

A. The Basics
   1. Foreign-Exchange Transactions by the Government
   2. The Endogeneity of the Domestic Money Supply

B. A Nominal Shock: $P^*\uparrow$
   1. Money Supply Effects: $M\uparrow$
   2. Price-Level Effects: $P\uparrow$

C. A Real Shock: $r^* \uparrow$
   1. Money Supply Effects
   2. Domestic Price-Level Insulation

D. Exchange Rate Devaluation
   1. Reserve Deficiencies
   2. Devaluation and the Current Account

V. Advantages of Fixed vs. Flexible Exchange Rates

A. Advantages of Flexible Exchange Rates
   1. Price-Level Stabilization with Nominal Shocks
   2. An Independent Monetary Policy

B. Advantages of Fixed Exchange Rates
   1. Price-Level Stabilization with Real Shocks
   2. A Commitment Mechanism

VI. Capital Controls

A. The Capital Account and the Balance of Payments
   1. Capital Flows
      a. Inflows and Outflows
      b. Foreign Direct Investment
      c. Portfolio Inflows and Outflows
   2. Balance of Payments: An Accounting Identity

B. Effects of Capital Controls
   1. Insulation from Foreign Shocks
   2. Misallocation of Capital

C. Capital Controls in Practice
   1. Avoidance Activities
   2. Banking System Regulations

VII. A New Keynesian Sticky Price Open-Economy Model

A. Flexible Exchange Rate
   1. Monetary Policy
   2. Fiscal Policy

B. Fixed Exchange Rate
   1. Monetary Policy
   2. Fiscal Policy

■ Solutions to End-of-Chapter Problems

1. Having fixed the foreign exchange market transactions cost, the purchasing power parity relationship is now $P = e(1+a)P^*$, so the equilibrium condition for the money market can now be written as

$$M = e(1+a)P^*L(Y,r).$$

Then, a decrease in a acts to reduce the demand for money, shifting the money demand curve to the left. In the flexible exchange rate regime this acts to increase e, so that the exchange rate depreciates. As well, from the purchasing power parity relationship, the price level must stay constant. In the fixed exchange rate regime, the money supply falls, and given the purchasing power parity relationship, the price level must fall. This is another dimension on which the flexible exchange rate insulates the domestic economy, in that the domestic price level does not change when the transactions cost changes.

2. **A temporary increase in total factor productivity**.

   a) The increase in total factor productivity shifts the goods demand curve to the right. Output increases, absorption is unchanged, and the current account surplus increases. The money demand curve rotates to the right and, under flexible exchange rates, the nominal exchange rate and the domestic price level both decrease.

   b) The real effects are independent of the exchange rate regime. Under fixed exchange rates, the money supply must increase to keep the money market in equilibrium at the fixed exchange rate. There is no change in the domestic price level. A fixed exchange rate is more effective in stabilizing the price level in response to shocks to current total factor productivity.

   c) When the exchange rate is flexible, the money supply does not automatically increase in response to this disturbance. However, if the monetary authority wants to stabilize the price level, the correct policy would be to increase the money supply by the same amount as it would increase under fixed exchange rates.

3. A temporary increase in government spending shifts both the goods demand curve and the goods supply curve to the right, with the demand curve shifting by more than the supply curve. Output increases, absorption increases, and the current account surplus decreases. The increase in real income rotates the money demand curve to the right. Under flexible exchange rates, the nominal exchange rate and the domestic price level both decrease. Under fixed exchange rates, the nominal money supply increases, and both the nominal exchange rate and the domestic price level are unchanged.

4. **A reduction in the domestic demand for money.**

   a) The leftward rotation of the money demand curve increases both the nominal exchange rate and the domestic price level.

   b) To prevent the increase in the price level, the monetary authority would have to reduce the domestic money supply. If the price level were perfectly stabilized, there would be no change in the nominal exchange rate.

   c) Under a fixed exchange rate, the money supply would automatically contract. There would be no change in the fixed exchange rate, and there would be no change in the price level. The endogenous change in the money supply would prevent an increase in the price level in part a), just as occurred in part b). The difference is that with a fixed exchange rate, the necessary change in the domestic money supply is automatic.

5. **An anticipated increase in future total factor productivity**.

a) The increase in future total factor productivity shifts the output demand curve to the right. The output supply curve is unaffected. In the absence of capital controls, output is unchanged, and absorption increases, so the current account moves into deficit. Investment spending increases by the full amount of the rightward shift in the investment demand curve. Because there are no changes in either domestic income or the domestic real interest rate, there is no change in either the nominal exchange rate or the domestic price level.

b) Capital controls, as long as they are effective, keep the current account surplus at zero. Domestic output and absorption must remain equal, so the domestic real interest rate must increase to keep output supply and output demand equal. Output increases in this case. However, because in this case the real interest rate increases, the increase in investment spending will be smaller than in the absence of capital controls. As long as money demand is much more responsive to real income than to the real interest rate, money demand rotates to the right. The nominal exchange rate and the domestic price level both decrease.

In response to the increase in future total factor productivity, capital controls amplify the effects on the nominal exchange rate and the domestic price level. The controls do prevent the current account deficit, but the existence of capital controls lessens the effect of the shock on investment spending. Because the domestic economy may borrow from the rest of the world at the fixed world real interest rate, the efficient increase in investment can only occur in the absence of the controls. The capital controls are not a good policy, because they retard future growth in the economy, and they are ineffective in stabilizing the nominal exchange rate and the domestic price level.

6. As in Chapter 11, an increase in credit market uncertainty results in a shift to the left in the output demand curve, and a shift to the right in the output supply curve. In the small open economy, net exports increase so that the output demand curve shifts to intersect with the output supply curve at the world real interest rate r^*. In equilibrium, output increases in the top panel of Figure 16.1. In the bottom panel, there is an increase in the demand for money, and the demand for money curve shifts to the right from $eL(Y_1,r^*)$ to $eL(Y_2,r^*)$. There is an exchange rate depreciation, and the exchange rate falls from e_1 to e_2. The price level also falls, from purchasing power parity. There is no effect on the real interest rate, which is fixed exogenously at r^*. The model does not capture the effects of the financial crisis, for example in Canada or the United States where, most significantly, output fell. Either the model is missing something, or we need to include other shocks to explain the financial crisis.

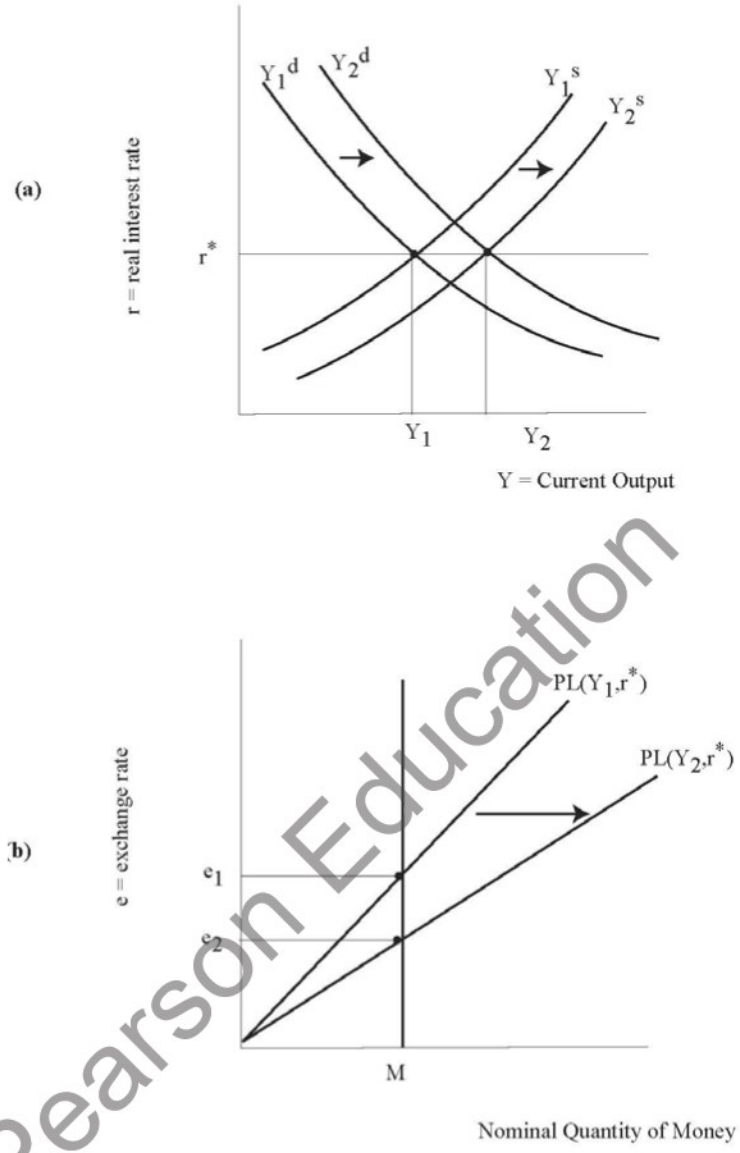


Figure 16.1

6. An increase in the nominal money supply is neutral under flexible exchange rates. The increase in the money supply increases the nominal exchange rate and the domestic price level. The increase in the domestic money supply has no effect on output supply and output demand, so there is no effect on the current account balance. Capital controls do not come into play in response to an increase in the money supply. The size of the change in the nominal exchange rate is independent of whether or not there are capital controls.

7. Suppose for convenience that the current account surplus is initially zero. For a positive productivity shock, the output supply curve shifts right, and this will tend to produce a current account surplus, or a positive capital inflow. However, this is not permitted, so the real interest rate will fall below the world real interest rate. The effects are identical to what would occur in a closed economy with a temporary increase in TFP. For a negative TFP shock, the output supply curve shifts left, which produces a current account deficit, and a capital outflow. This is permitted, so output will decrease more than it would have with constraints on capital outflows.

8. We have here a mixture of an economy without capital controls (when there is a temporary negative shock to total factor productivity) and with capital controls (positive shock). Indeed, when the shock is negative, absorption decreases little but output supply decreases a lot. To decrease the interest rate back to r^*, the economy needs a negative trade balance, in other words it needs capital outflows that are allowed. Figure 16.11 in the textbook is then relevant: output is reduced, the exchange rate goes up, and the interest rate stays at r^*.

   With a positive shock, one would need capital inflows, but they are prohibited. Thus the analysis of Figure 16.12 (with a reversed direction) applies: output increases, but less than it decreased in the other case, the interest rate falls below r^*, and the exchange rate decreases, but less than it increased in the other case.

9. The results are depicted in Figure 16.1.

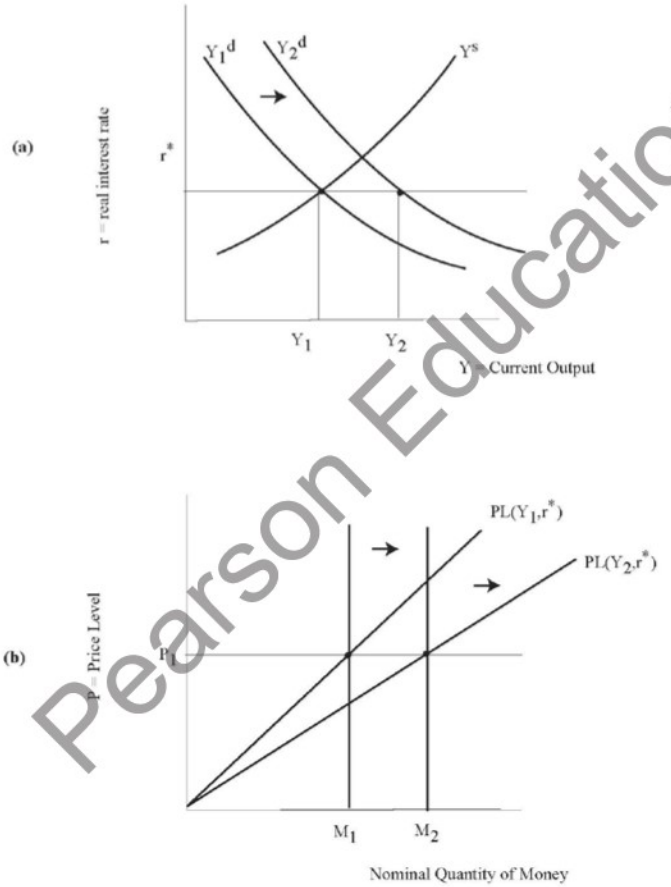


Figure 16.1

In the Figure, an increase in future TFP shifts the output demand curve to the right from Y_1^d to Y_2^d. With a flexible exchange rate, the exchange rate appreciates, reducing net exports and shifting the output demand curve back to its initial position. In equilibrium, output is unchanged, as is consumption. But investment has increased and net exports has fallen by an equal amount. However, if the exchange rate is fixed, then the money supply increases from M_1 to M_2, and output increases from Y_1 to Y_2. In equilibrium net exports are unchanged, as the real exchange rate has not changed, but consumption has increased by the same amount as output.

10. Whether we have the liquidity trap case with $r^*=0$, or the case we have considered in this chapter with $r^*>0$ makes no difference to how policy works. Even in the "liquidity trap" case, monetary policy can still close the output gap under a flexible exchange rate through an exchange rate depreciation, and fiscal policy can close it under a fixed exchange rate by inducing an increase in output.

Chapter 17
Money, Inflation, and Banking

■ Teaching Goals

In the modern world, the use of money as a social contrivance is largely taken for granted. Although the study of the mechanisms of trading may seem rather arcane, it may open some of the students' minds to the value of adopting a uniform medium of exchange. Students should fully understand that a world of rugged individualism in which everyone is self-sufficient is the most likely alternative to a monetary economy.

The level of the money supply is neutral. The growth rate of the money supply has allocative effects on the economy. Continuous growth in the money supply causes inflation. Inflation erodes money's usefulness as a medium of exchange. As inflation worsens, households substitute nonmarket activities, which require no money, for market activities that do require money. Therefore, as the inflation rate increases, output and employment decrease.

Financial intermediation is an important topic for macroeconomists because of the role of financial intermediaries in providing a medium of exchange, and because the interactions between central banks and financial intermediaries is an important component of the money supply process. Financial intermediaries acquire illiquid assets in the form of loans and transform these assets into more liquid assets preferred as media of exchange. The Diamond-Dybvig model is a useful tool that demonstrates how banks might offer insurance against an untimely need for liquidity. The Diamond-Dybvig model is also useful in explaining bank runs and how government-provided deposit insurance may prevent such runs.

■ Classroom Discussion Topics

An important tenet of monetary economics is the dominance of monetary economies over economies without a commonly accepted medium of exchange. Yet we still find the existence of barter clubs. These clubs sometimes arrange direct one-for-one trades between individuals or businesses that have a double coincidence of wants. Sometimes they arrange three-way transactions similar to those depicted in Figure 17.2 in the text. Some of these clubs utilize credits that circulate as a private medium of exchange between members. To find some examples, suggest a Google™ search on the term, "barter." Ask if any of the students have heard of such arrangements or even participated in them. Are the users of these services irrational? Does the existence of such organizations suggest that monetary exchange is becoming outdated?

The widespread use of computer technology has lowered the information costs associated with barter exchange. But such technology also reduces the cost of engaging in monetary transactions. The marketing materials of these exchanges emphasize that they allow businesses to buy necessary products and services without the need for cash. Does this mean that barter exchange can combine credit exchanges with goods and services exchanges? The marketing also promises a source of new business for members. In a perfectly competitive world, there is no need to find more customers. Does this mean that barter transactions are enhanced by the existence of monopolistic competition? The clubs also suggest the importance of personal relationships between buyers and sellers. Is this a solution to informational problems that are inherent in anonymous markets? In any event, the total volume of transactions on such exchanges is a trivial percentage of all transactions. It is not likely that the foundations of monetary theory will become outdated in the near future.

Most of today's students have not had any personal experiences with significant inflation or low confidence in the banking system. Ask the students if they ever worry about inflation or the banking system. There may be students from other countries (Russia, Eastern Europe, the former Yugoslavia, etc.) who have experienced quite a lot of inflation or have heard about hyperinflation in Zimbabwe. Can anyone imagine a set of circumstances that would lead to a serious U.S. inflation problem? Would students find more inflation objectionable? Do the problems that students ascribe to inflation conform to theory, or are they more a figment of confusion between real and nominal variables? There may also be students from countries that experienced the collapse of the banking sector (Argentina, etc.). They can testify how a functioning and confidence-inspiring banking system is essential to the working of a modern economy.

■ Outline

I. Alternative Forms of Money

- A. Commodity Money
- B. Circulating Private Bank Notes
- C. Commodity-Backed Paper Money
- D. Fiat Money
- E. Transaction Deposits at Private Banks

II. Money and the Absence of a Double Coincidence of Wants

- A. Barter and the Absence of a Double Coincidence of Wants
- B. Commodity Money and Trade
- C. Fiat Money and Trade

III. Inflation in the Monetary Intertemporal Model

- A. Real and Nominal Interest Rates
  1. Nominal Bonds
  2. The Nominal Interest Rate
  3. The Fisher Relationship

B. Inflation Effects
   1. The Money Supply Growth Rate
   2. Optimality Conditions
      a. Consumption—Savings Choice: $MRS_{C,C'} = 1 + r$
      b. Current Leisure—Consumption Choice: $MRS_{l,C} = \frac{w}{1+R}$

C. A Change in the Growth Rate of the Money Supply
   1. Output and Employment Effects
   2. The Friedman Rule
   3. Deflation
   4. Hyperinflation
   5. Liquidity Trap

IV. Financial Intermediation and Banking

A. Properties of Assets
   1. Rate of Return
   2. Risk
      a. Diversifiable
      b. Nondiversifiable
   3. Maturity
   4. Liquidity

B. Financial Intermediation
   1. Characteristics
      a. Borrow from One Group and Lend to Another
      b. Diversified
      c. Asset Transformation
      d. Information Processing
   2. Types of Financial Institutions
      a. Insurance Companies
      b. Mutual Funds
      c. Depository Institutions
   3. Problems with Direct Lending
      a. Costly Matching
      b. Difficulty Evaluating Credit Risks
      c. Duplication in Credit Risk Evaluation
      d. Lending to Few Borrowers Is Risky
      e. Loans Are Illiquid
      f. Lenders Prefer Shorter Maturities Than Borrowers

V. The Diamond-Dybvig Model

A. Interrupted Production Processes

B. The Optimal Deposit Contract

C. Equilibria with and without Bank Runs
   1. Banking Panics
   2. The National Banking Era

VI. Deposit Insurance

A. Bank Failures in the Great Depression

B. Moral Hazard

C. Too-big-to-fail policy

■ Solutions to End-of-Chapter Problems

1. In this case, Type I traders would use the commodity money they produce (good 2) to buy good 1 from Type III agents. Type III agents would then use the commodity money to buy good 3 from Type II agents. Type II agents would consume the commodity money.

2. Type I $\begin{cases}\text{Consumes 1}\\ \text{Produces 3}\end{cases}$ Type II $\begin{cases}\text{Consumes 2}\\ \text{Produces 1}\end{cases}$ Type III $\begin{cases}\text{Consumes 3}\\ \text{Produces 2}\end{cases}$

a) Type II agents who produce the commodity money (good 1) use the commodity money to buy good 2 from Type III agents. Type II agents then use the commodity money to buy good 3 from Type I agents. Type I agents consume the commodity money.

b) Type I agents use fiat money to buy good 1 from Type II agents. Type II agents use fiat money to buy good 2 from Type III agents. Type III agents use fiat money to buy good 3 from Type I agents.

3. Suppose that the central bank acquires K units of capital in the current period, and issues M units of money to finance these purchases, so that

$$\frac{M}{P}=K. \qquad (1)$$

Then, in the future period, the central bank earns rK from its holdings of capital, and uses these interest earnings to retire money so that, in the future period

$$rK=-\frac{(M'-M)}{P'} \qquad (2)$$

In equilibrium, the quantity of money stays constant in real terms, so

$$\frac{M'}{P'}=K \qquad (3)$$

So, substituting in equation (2) using (1) and (3), and rearranging, gives

$$rK=-K+\frac{KP}{P'},$$

and solving, we obtain

$$\frac{P'}{P}-1=\frac{1}{1+r}-1\approx -r.$$

Therefore the inflation rate in equilibrium is approximately equal to minus the real interest rate, and we know this is efficient. This is another way for the central bank to run the Friedman rule. If the central bank prints money and uses the money to buy interest-earning assets, then retires the money with the interest it earns on the assets over time, then this will imply an optimal inflation rate in equilibrium.

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4. The fact that inflation alters the real opportunity cost of holding money is the only source of real effects of inflation on the economy. Payment of interest on money eliminates the opportunity cost of money, so inflation is neutral when currency earns interest. The payment of interest on money is therefore equivalent to a decrease (to zero) in the rate of inflation. Output demand and output supply both shift to the right, exactly opposite of the shifts in Figure 15.5 in the text.

5. With the possibility of theft, the Friedman rule is no longer an optimal policy. In this case, the nominal interest rate does not reflect the social cost of holding money, and it should not be reduced to zero. The optimal nominal interest rate will be positive, as this reduces the amount of currency held, and therefore deters thieves. Whether the inflation rate is positive at the optimum depends on how severe the theft problem is.

6. From Chapter 13, we know that in the real business cycle model, fluctuations in TFP cause output and the real interest rate to fluctuate, and that these fluctuations are optimal. Further, the logic of the Friedman rule tells us that the nominal interest rate should always be zero. Under TFP shocks, in a real business cycle model real output will be high, and the real interest rate will be low, when TFP is high. Thus, the demand for money will be high when TFP his high. But the Fisher relation tells us that $R=r+\pi$, i.e. the nominal interest rate is the real rate plus the inflation rate, or in this case the anticipated inflation rate. The question is whether the central bank needs to intervene actively in response to TFP shocks to insure that the nominal interest rate is always zero. It will certainly be the case that, as in this chapter, the money supply should be decreasing on average. But R needs to stay constant at zero, so when r is low (TFP is high) anticipated inflation needs to be high. But when TFP is high, the price level is low, and anticipated inflation is high anyway. Whether it is too high or too low is not clear. In general, some action by the central bank is required in response TFP shocks, but our model cannot determine what it is at this level of analysis.

7. The Friedman rule tells us that, in the long run, a deflation is necessary to eliminate the distortion in private choice. The nominal interest rate should always be zero. But in the New Keynesian sticky price model, the central bank moves the target nominal interest rate in order to affect the output gap. If sticky prices are an important friction in the economy, then the central bank must sometimes trade off the effects of its policies on short term distortions and long-term distortions.

8. **Asset characteristics**.

   i) Works of art typically have a low (financial) rate of return. The only source of a return is appreciation in the market price. Works of art are quite risky and are highly illiquid. The maturity of a work of art is zero because there are no future financial payments. Works of art are stores of value, but not media of exchange or units of account.

   ii) U.S. Treasury Bills have a low rate of return in comparison to other financial instruments. They are almost riskless due to the government's ability to raise taxes to pay principal and interest. They are short-maturity assets and are highly liquid. Treasury Bills are a store of value. Technically, they are not a medium of exchange, although their high liquidity warrants their inclusion in the L definition of the money supply.

   iii) Shares in Microsoft have a high expected rate of return, although they are rather risky, due to fluctuations in price and dividends. The maturity is effectively infinite, because they may

potentially pay dividends into the indefinite future. Shares of stock are very liquid, although perhaps slightly less liquid than Treasury Bills. Shares of stock are a store of value.

iv) Loans to friends generally have a low rate of return as friends generally charge little or no interest on such loans. These kinds of loans are generally high risk, because the need for such loans typically comes from the borrower's inability to borrow at market rates of interest. Such loans are highly illiquid and serve only as a store of value.

v) Loans to General Motors likely have a rate of return in excess of Treasury Bills, but less than the rate of return on shares of stock. As General Motors is an established business with a good credit rating, these loans have little risk. The term to maturity may vary according to circumstance. The loans are relatively illiquid and serve only as a store of value.

9. If the bank can suspend convertibility in this way, then it can always honour all of its second-period commitments. Early consumers never wait to withdraw in the second period because second-period consumption is worthless to them. Therefore, only late consumers will try to withdraw in the second period and so there is no reason for them to panic. Panic would be irrational in this instance.

10. **Production cannot be interrupted.**

a) In the standard model, with no bank, the consumer has no reason not to commit all of her resources to production. If the consumer turns out to be an early consumer, production is interrupted and the consumer has $c_1 = 1$. If the consumer turns out to be a late consumer, production is completed and the consumer has $c_2 = 1 + r$. In no case does the consumer consume less than one.

When production cannot be interrupted, the decision of how much to commit to production becomes important. As long as the good is storable, the consumer can choose to refrain from production, in which case she obtains $c_1 = c_2 = 1$. Now consider devoting the fraction, z, of resources, to production. If the consumer is an early consumer, she consumes $c_1 = (1 - z)$. If the consumer is a late consumer, she consumes $c_2 = (1 + r)z + (1 - z)$. Substituting for z, we obtain $c_2 = 1 + r(1 - c_1)$. Now superimpose the indifference curves; Figure 15.1a depicts optimization for the consumer for interruptible and non-interruptible production. The figure depicts the case of two corner solutions at points A and B. Point B corresponds to the no interruption case with $z = 0$. The indifference curves would need to be considerably flatter for the consumer to choose an interior solution for z. Clearly, the consumer is worse off when production cannot be interrupted.

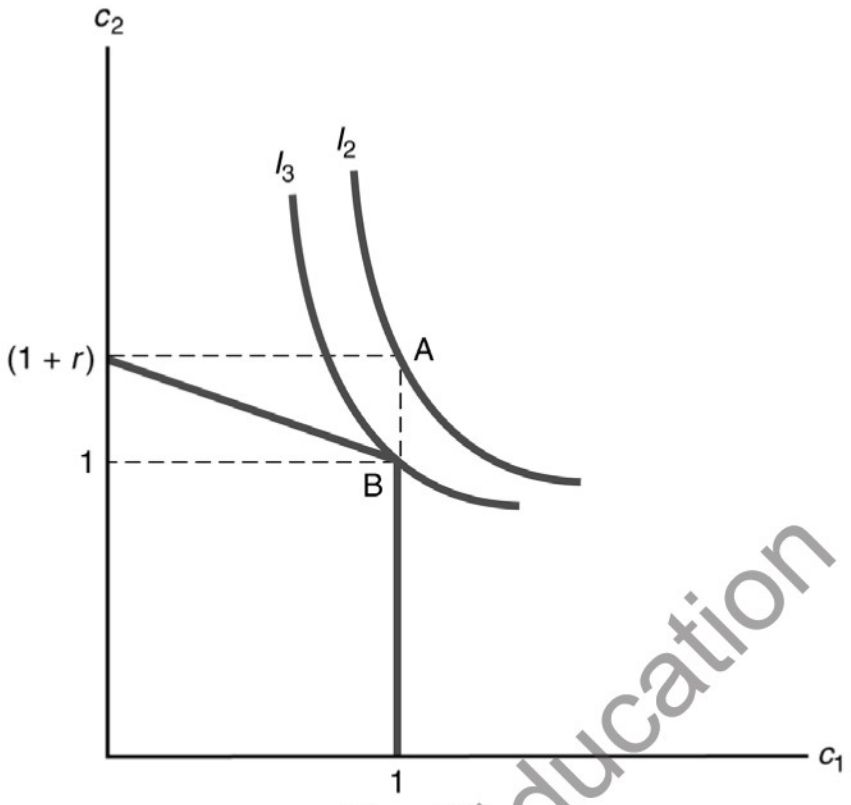


Figure 15.1a

b) As long as banks know the probability of individuals becoming early and late consumers, the need to commit irreversibly to production does not affect the bank. Precommitment does not matter when the bank knows in advance how much it would need to interrupt. Therefore, the optimal bank contract is unchanged. This possibility is added to Figure 15.1b, below. The optimal bank contract is the point c_1^*, c_2^*.

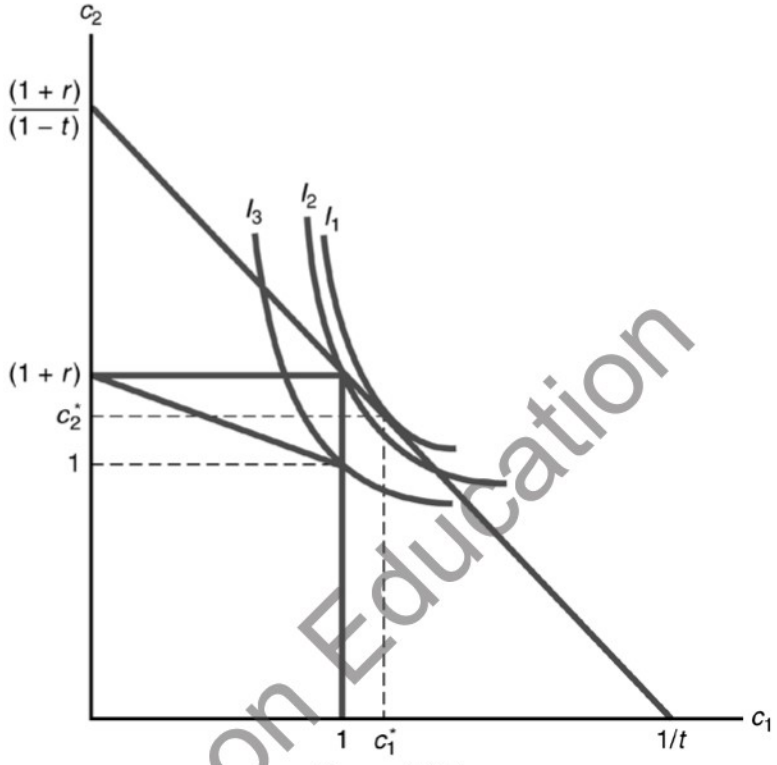


Figure 15.1b

11. Each consumer will invest their entire endowment of 1 unit in the production technology in period 0. In period 1, if an early consumer must choose the fraction of the investment, x, to sell at the price p, and will interrupt the remaining fraction $1 - x$ and consume it. The early consumer then chooses x to maximize $1 - x + px$, and the solution is $x = 0$ if $p < 1$, $x = 1$ if $p > 1$, and the consumer is otherwise indifferent. In period 1, a late consumer chooses y, the fraction of investment to interrupt, to maximize $\frac{y(1+r)}{p} + (1-y)(1+r)$. The solution is then $y = 0$ if $p > 1$, $y = 1$ if $p < 1$, and the consumer is otherwise indifferent. In equilibrium, we have $ptx = (1–t)y$. Therefore, in equilibrium, we must have $p = 1$, which implies that the early consumer consumes 1 and the late consumer consumes $1 + r$, which is the same result as when consumers invest independently. Thus, there is no social benefit from having a share market. Banks are necessary to improve welfare over what the consumers could do on their own.

12. **Moral hazard problems.**

a) The child is more likely to report having trouble because having trouble is rewarded with help.

b) A homeowner with fire insurance is likely to be less careful about smoking and other fire hazards.

c) A volunteer portfolio manager is less concerned about the performance of the portfolio and is less careful about portfolio management.

d) The portfolio manager now need only be concerned about the upside potential of investment choices. The resulting portfolio will therefore be much riskier than it otherwise would be.

Chapter 18
Inflation, the Phillips Curve, and Central Bank Commitment

■ Teaching Goals

Discussion of Phillips curves receded temporarily in the 1980s, but with the advent of New Keynesian models, the Phillips curve is again in fashion. Philips curve language often enters into policy discussions, and appears in FOMC statements, for example. An understanding of Phillips curves is necessary to properly understand the history of Federal Reserve policy since World War II. The most important points are that stable Phillips curves, if they exist at all, are only short-run phenomena, and that policymakers' attempts to exploit the Phillips curve may lead to a permanent increase in inflation and at best a temporary increase in aggregate output.

The primary subject of this chapter is to develop a positive theory of inflation. In the short run, central banks face a given level of expected inflation. Over time, policy behavior affects the future course of expectation formation. The interplay of central bank behavior and the behavior of the public generates the equilibrium rate of inflation. This model can be used to make potentially refutable predictions about the genus of inflation in different times and places.

■ Classroom Discussion Topics

Public discussion periodically focuses on whether the Fed should be given less discretion. This topic was given more attention during the 1970s and early 1980s when the Fed allowed the rate of inflation to get higher than what the public was willing to tolerate. On the one hand, if the Fed is charged only with control of the rate of inflation, and given clear performance standards, theory suggests that the rate of inflation will remain closer to its preferred level. However, discretion may be needed for the Fed to properly respond to macroeconomic disturbances. How do students feel about giving the Fed less discretion? How does the answer to this question depend on the students' judgments about the validity of competing theories of the business cycle? What does the change of leadership at the Fed have to do with rules vs. discretion?

Given the recent behavior of the Fed, has the institution learned the lessons of the 1970s, or are we doomed to repeat history? Is the Fed too concerned with short-term increases in output, at the expense of long-run inflation goals?

■ Outline

I. The Phillips Curve

A. The Work of A.W. Phillips

B. A Theoretical Phillips Curve

C. The Friedman-Lucas Money Surprise Model

1. Central Bank Behavior
2. Time Consistency Problem

II. The Shifting Phillips Curve

A. In Theory

B. As Explained by the Model

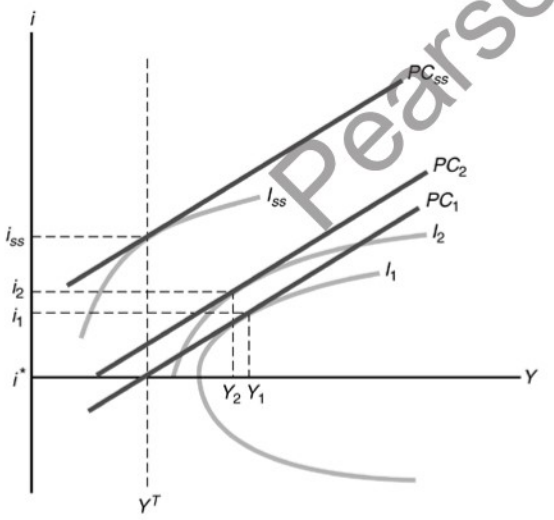
III. The Phillips Curve, Inflation Forecasting, and the Fed's Dual Mandate

A. Phillips curve implies that output gap should predict inflation.

B. It doesn't

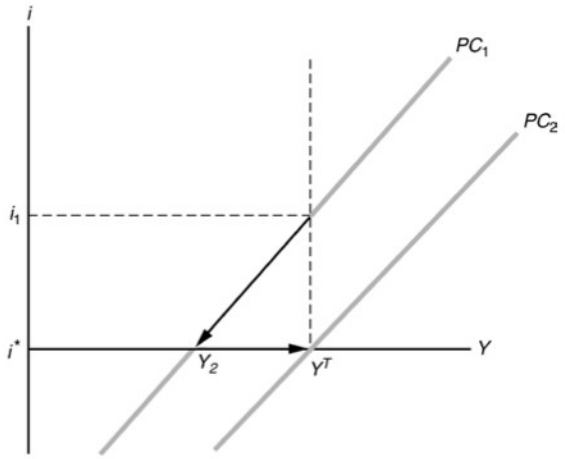
■ Solutions to End-of-Chapter Problems

1. Initially, the inflation rate is equal to i^* and aggregate output is equal to Y^T. The initial Phillips curve is PC_1. To optimally exploit PC_1, the central bank adopts the inflation rate i_1 and the level of aggregate output increases to Y_1. In the next period, the public expects i_1, so the Phillips curve shifts to PC_2, which passes through the point (Y^T, i_1). Now the central bank adopts the inflation rate i_2 to exploit PC_2. This process continues until a steady state is reached at (Y^T, I_{SS}). See the figure below.

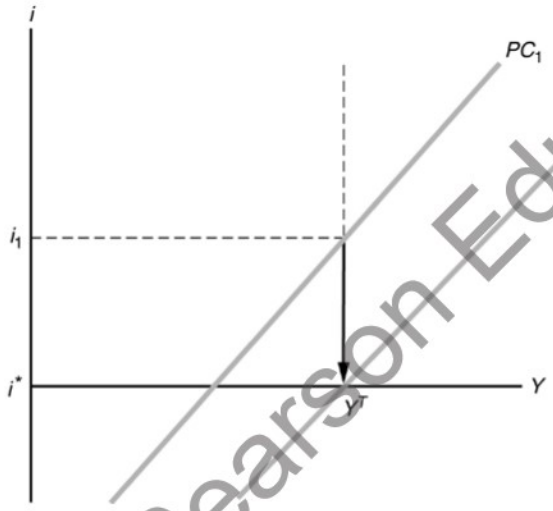


2. Disinflation.

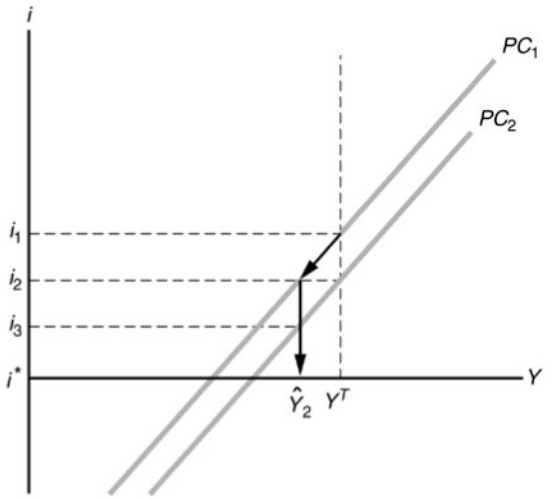
(a) The economy starts at the point (Y^T, i_1) in the figure below. The expected rate of inflation is i_1, and the relevant Phillips curve is PC_1. To immediately reduce inflation to i^*, the central bank moves along PC_1 to the point (Y_2, i^*). Next period, the expected inflation rate is i^*, and the economy is now in long-run equilibrium at (Y^T, i^*).



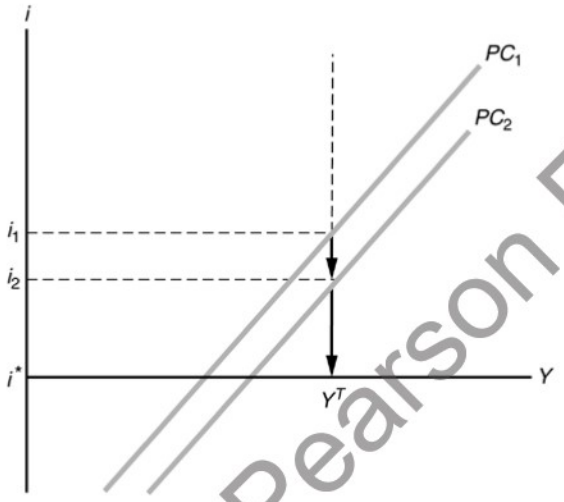
(b) With rational expectations, the expected rate of inflation immediately declines to i^*. The economy immediately moves to the point (Y^T, i^*) in the figure below. Therefore, the economy does not have to endure a period of low output to end the excessive inflation.



(c) The economy starts at the point (Y^T, i_1) in the figure below. If the central bank first reduces the inflation rate to i_2, and expectations are adaptive, output declines to $\hat{Y}_2$, along PC_1. In the next period, the Phillips curve shifts to PC_2. If the central bank sets an inflation rate to maintain the economy at $\hat{Y}_2$, then the inflation rate will fall to i_3. The process continues until the inflation rate is equal to i^*. At this point, output increases to Y^T.



If expectations are rational, then with each gradual step down in the inflation rate, the Phillips curve immediately shifts down to the new inflation rate. Therefore, the level of output is equal to Y^T throughout the gradual reduction in the inflation rate. The path of output is depicted in the figure below.



(d) In the early 1980s, the inflation rate fell dramatically, and there was a large, temporary reduction in aggregate output. This scenario is much like the transition depicted in the first figure of this question. After a relatively long period of inflation, the public at first did not believe that the Fed's attempt to reduce inflation would succeed. Expectations probably behaved in much the same way as the adaptive process described in part (a) of this problem.

3. Central bank credibility.

(a) When the public has confidence that the central bank will follow through on its promise, then expectations are well described as rational. Movement in the economy is as depicted in the second figure of question 2.

(b) When the public does not believe the announcement, then expectations are well described as adaptive. In this case, the path of the economy is like that depicted in the first figure of question 2.

(c) When expectations are slow to adapt, then there is a period of time in which the expected inflation rate lags behind the actual inflation rate. During a period of declining inflation, actual inflation is less than expected inflation, and so there must be a period of low aggregate output. Confidence in the central banks resolve to carry through on its promises is best captured by the assumption of rational expectations. With rational expectations, expected and actual inflation are always equal, so the economy never deviates from trend output.

4. As one option, the central bank could choose the policy of setting $i = i^*$ forever. In this case, the present value of the stream of reward is given by:

$$u_1\left(1+\frac{1}{(1+r)}+\frac{1}{(1+r)^2}+\frac{1}{(1+r)^3}+\cdots\right)=\frac{(1+r)}{r}u_1$$

Alternatively, if the central bank cheats today, it receives the reward of u_2 today. Thereafter, it receives u_3 forever. The present value of this stream of rewards is given by:

$$u_2+u_3\left(\frac{1}{(1+r)}+\frac{1}{(1+r)^2}+\frac{1}{(1+r)^3}+\cdots\right)=u_2+\frac{u_3}{r}$$

(a) The commitment strategy is therefore at least as good as long as:

$$\frac{(1+r)}{r}u_1 \geq u_2+\frac{u_3}{r},$$

or:

$$\frac{1}{r}((1+r)u_1-u_3)\geq u_2.$$

(b) The above expression may also be written as:

$$\frac{(u_1-u_3)}{r}\geq u_2-u_1$$

The right-hand side of this inequality is the gain in the current period of reneging on the central bank commitment. The left-hand side of this inequality is the present value of the loss incurred from cheating, a loss that begins accruing in the second period. As long as the current gain is small relative to the future loss, the central bank will honor its commitment.

(c) Now multiply both sides of the above inequality by *r* and take the limit as *r* approaches zero. The resulting inequality is given by:

$$u_1-u_3\geq 0$$

This relationship is assumed to hold as a part of the set-up of the problem. Without discounting, we incur the loss u_1-u_3 an infinite number of times. The gain u_2-u_1 is only received once.