MBA MACROECONOMICS

William Neilson
Marianne H. Wanamaker

Department of Economics
University of Tennessee – Knoxville

January 2010

CHAPTER 1
MACRO DATA

The media regularly reports on the macroeconomy, and it does so with a large number of different measures including such things as GDP, CPI measures of inflation, unemployment rates, and so on. Each of these variables has an explicit definition, and an understanding of the definitions aids greatly in the understanding of the economy.

1. PRODUCTION AND INCOME

The first macroeconomic variable we consider measures a country's output. **Gross Domestic Product (GDP)** is defined as follows:

> GDP is the value of all final goods and services newly produced in a country during a given time period.

In essence, GDP measures the total productive activity of the country's economy. Each phrase in the definition is important, though.

- **value** – We want to add up the total amount produced, but that requires adding apples and oranges. You learned in elementary school that you must never add apples and oranges. Nevertheless, macroeconomics is the discipline where we have to add apples and oranges, and we do so by adding up the dollar value of all the apples, oranges, and everything else.
- **final** – We want to add up the value of everything produced. But, if we include a can of Pepsi, and also the can itself (if produced in America), as well as the aluminum (if produced in America) used to make the can, we count the aluminum three times. But, the value of the aluminum is included in the value of the final can of Pepsi, so we can avoid double or triple counting by just counting final products. GDP does not count inputs.

- **goods and services** – We want to count everything produced in the country. This includes tangible goods like cans of Pepsi, cars, or fish tacos, but it also includes services like haircuts, brokerage services, and legal services. Note that many goods (such as Dell computers) come with services (the retail services provided by Best Buy).
- **newly produced** – A used 2005 GMC Yukon was counted in 2005 GDP when it was produced. If it is sold again in 2009, it should not be counted again in 2009 GDP. We avoid counting it again by requiring that all goods and services be newly produced. Note, however, that any retail and financial services involved in the sale of the used car do contribute to 2009 GDP, since those services are newly produced.
- **in a country** – The nationality of the producer does not matter, as long as production takes place in the country. So, Nissan's assembled in Tennessee count for US GDP, not Japan GDP. Two decades ago the government switched from reporting GNP (gross national product) to reporting GDP. GNP counted everything produced by a country's assets, so the Nissan's assembled in Tennessee would have counted for Japan but not for the US. GDP better reflects the global nature of the economy.
- **in a given time period** – The US reports GDP quarterly, but the number reported is for an entire year's worth of production.

To see how the definition works, consider whether the following items are included in 2009 GDP.

1. Milk sold to consumers in 2009? Yes, it is a final good.
2. Milk sold to cheese producers in 2009? No, it is an input.
3. The sale of a 10-year old house? No, it is not newly produced. The various legal, financial, title, broker, and other fees do count, however.
4. A new building for Aubrey's restaurant? Yes. It is not an input, because it is not used up in the production of Aubrey's food.
5. Wheat grown by US farmers and sold to a Jamaican brewery? Yes. It was produced in the US, and is a final good from the perspective of the US. It is an input in Jamaica.
6. Illegal meth produced and sold in a garage in Raleigh, NC? Yes, but it is difficult to count.

One can think about GDP in three different ways. One is as a country's total *output* during a year, an interpretation that coincides with the definition given above. A second interpretation is as the total amount of *income* a country earns in a year. To see the link between output and income, think about the following process. A farmer grows apples and sells them to a cider-maker. The

amount of this transaction is the farmer's income. The cider-maker transforms the apples into cider and sells it from the back of his pickup truck. The price of the cider less the price of the apples is the cider-maker's income from the transaction. The final good is the cider, and its price gets added to GDP. The price was split between the cider-maker and the farmer, so the entire price became someone's income. Thus, GDP = income.

The third interpretation of GDP is as *spending*. The link between output and spending is relatively simple: if someone produces it someone else has to buy it. GDP adds up the total value of new final goods and services sold on the market. If everything is sold (we'll get to inventories soon), then total output = total spending.

For what we are going to do in the next several chapters, the interpretations of GDP as income and spending are vital. The interpretation as output is the one used to actually compute GDP.

The spending interpretation can lead to a further breakdown into components, and these are listed in Table 1.1.

TABLE 1.1
SPENDING COMPONENTS OF GDP
($ BILLIONS, 3RD QUARTER 2009)

GDP	**$14,302**	
CONSUMPTION	**10,152**	
Durable goods		1,056
Nondurable goods		2,244
Services		6,852
INVESTMENT	**1,579**	
Business fixed investment		1,366
Residential fixed investment		361
Change in inventories		(147)
GOVERNMENT SPENDING	**2,958**	
Federal		1,164
State and local		1,794
NET EXPORTS	**(388)**	
Exports	1,563	
Goods		1,038
Services		525
Imports	1,951	
Goods		1,573
Services		378

By far the largest spending component is consumption, which is defined as spending by households on everything except new housing. Consumption comprises about 70% of GDP, and it has held this share for a very long time. Consumption can be broken down further into three categories: durable goods, nondurable goods, and services. Durable goods are things like cars and appliances, many of which consumers finance through borrowing. Services are things like haircuts, repairs, movies at theaters, and food at restaurants. American households spend most of their money on services. Durable good purchases are the most volatile and respond the most to changes in the economy.

Investment is spending on new final goods and services by businesses, and also spending on new housing by consumers. In addition, investment includes changes in inventories, to account for the possibility that a business produces something in one year but sells it in a later year.

Government spending is spending by the government on new, final goods and services. About a third of government spending comes at the federal level, and about 70% of that was spent on defense. State and local governments spend on education, law enforcement, and so on. It is important to note that federal spending contribution to GDP is *not* the same as the federal government's budget expenditures. For example, the federal budget for FY 2009 was $3.1 trillion, which did not include expenses on the war(s). Much of this spending was not on new goods and services, and instead was on transfer payments (from one taxpayer to another) or interest on the debt. It just so happens that the total government spending component of GDP is about the same as the federal government's budget, but that is just a coincidence (and one that has persisted for a long time).

The final spending component of GDP is net exports, defined as exports minus imports. Exports are goods that are produced in the US but consumed abroad, so they should be included in GDP. Imports are goods that are purchased in the US but not produced in the US, so they should not be included in GDP. However, some of the goods and services bought by consumers (like TVs) are imports, so imports are counted in the other spending components.

2. PRICES AND INFLATION

Inflation is a measure of how prices change over time. The issue for the data people is that different prices change at different rates and different times. So, the data collectors must come up with a way to summarize all of the price changes.

The best-known way to do this is by using the **Consumer Price Index (CPI)**. To compute the CPI, the Bureau of Labor Statistics (BLS) has identified a bundle of goods and services consumed by a "typical" family in a "typical"

month. Every month the BLS sends teams out, all over the country, to record the prices of these goods and services. The total price of the bundle of goods and services is the consumer price index.

Inflation is the growth rate of the CPI. For example, the CPI was 208.9 in October 2007 and 216.6 in October 2008. The growth rate is

$$\frac{216.6 - 208.9}{208.9} \times 100\% = 3.7\%,$$

and this is the **inflation rate** for the year. The inflation rate shows that it costs consumers an average of 3.7% more to buy the same bundle of goods a year later.

In general, the formula for a growth rate is

$$\text{growth rate} = \frac{\text{new value} - \text{old value}}{\text{old value}} \times 100\%.$$

Recall that GDP is the value of all final goods and services newly produced in a country during a given time period. The value of the goods and services could rise for two reasons, an increase in the quantity of the goods and services, and an increase in the price of the goods and services. If we want to measure changes in economic activity, we want to concentrate on changes in the amount produced, and not changes in the underlying prices. To do this we use **real GDP**.

Real GDP is the value of all final goods and services newly produced in a country during a given time period, just like regular GDP (called *nominal* GDP), but this time the prices used to measure value are not the current prices, but instead are the prices from some base year. A *really* simple (some might say *lame*) example shows what is going on. Table 1.2 shows the data for an economy that produces only two goods, food and clothing. The table shows both the prices and the quantities.

TABLE 1.2
ECONOMIC DATA FOR A LAME ECONOMY

Year	Product	Quantity	Price
2008	Food	500	6
	Clothing	200	30
2009	Food	600	5
	Clothing	150	60

The first step is to calculate nominal GDP for the two years. For 2008, this is

$$2008 \text{ GDP} = (500)(6) + (200)(30) = 9{,}000$$
$$2009 \text{ GDP} = (600)(5) + (150)(60) = 12{,}000.$$

These are nominal GDP figures, and it looks like the economy grew by a third during the year. But also notice from the table that the price of clothing doubled during the year, so it may be that the growth was all inflation and not actual growth. To find out, compute *real* 2009 GDP using 2008 base-year prices. That is, multiply the 2009 quantities by the 2008 prices to come up with real 2009 GDP:

$$2009 \text{ real GDP} = (600)(6) + (150)(30) = 8{,}100.$$

Using 2008 prices, 2008 output was worth \$9,000, and 2009 output was worth \$8,100. Real GDP shrank during the year, even though nominal GDP grew.

The important point here is that real GDP reflects actual economic activity, while nominal GDP reflects both activity and inflation. Figure 1.1 shows how real GDP has changed over the years. The figure shows that real GDP rises, but does not lend much detail.

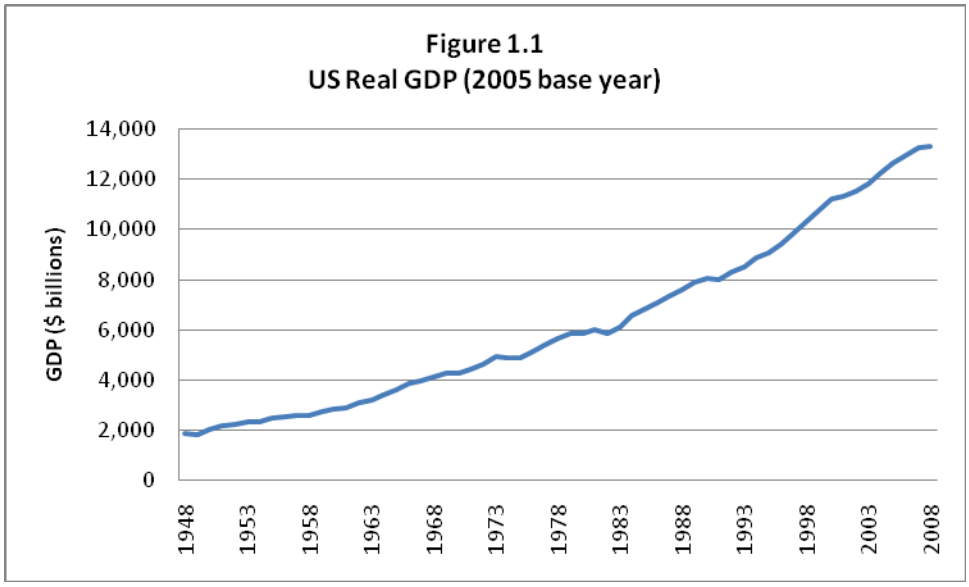
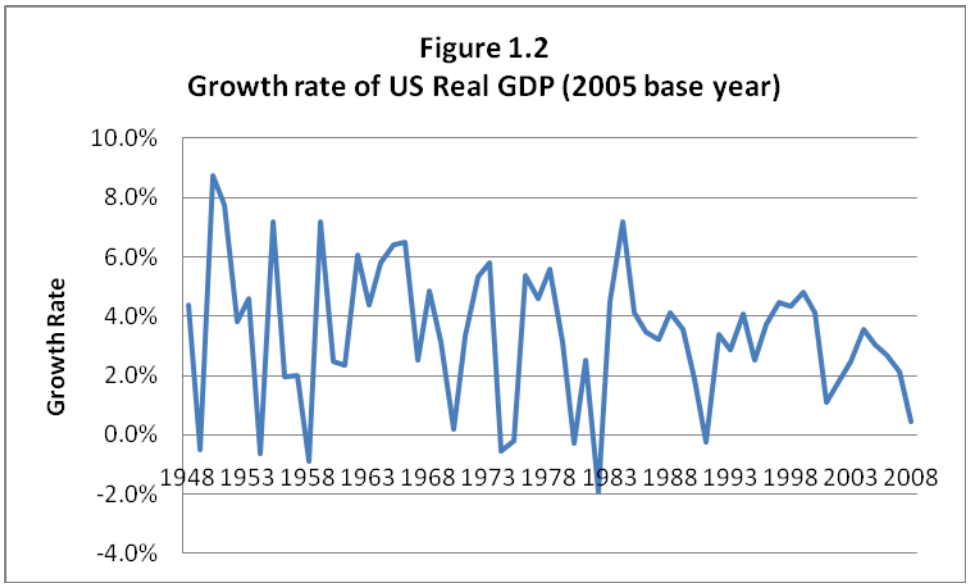
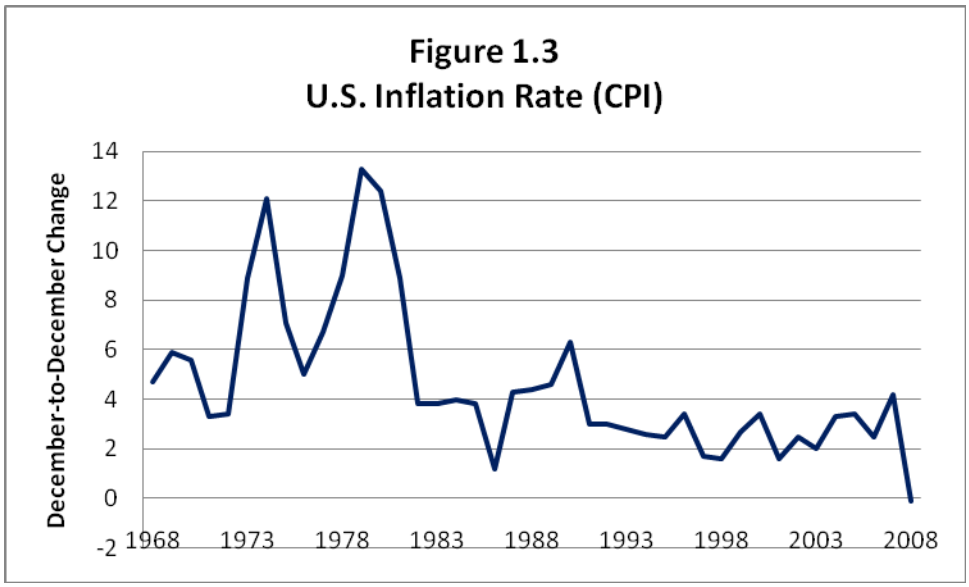


Figure 1.2 shows the annual growth rate of GDP, which is more informative.



As you can see from the figure, the growth rate of real GDP fluctuates quite a bit. Low growth rates are associated with recessions (although technically a recession requires two consecutive quarters of *negative* growth), and high growth rates are associated with expansions. The periods that stand out in the last 50 years or so are the mid 70s with the recession caused by high oil prices, the early 80s with the recession caused on purpose for reasons discussed in later chapters, and the early 2000s with the recession caused by the September 11 attacks. Periods of high growth occurred during Reagan's second term (mid 80s) and Clinton's term (mid to late 90s).

Figure 1.3 shows the inflation rate through the same period. Inflation has been low throughout the period except for the 1972-84 period when oil prices rose dramatically.



Compared to many other countries, the US has low inflation. In contrasts, some countries have experienced annual inflation rates above 100% or even above 1000%. An extreme case is going on right now in Zimbabwe. Inflation hit 231 million percent in July 2008, and December 2008 estimates suggested that the inflation percentage was an 8 followed by 18 zeros. Such cases of hyperinflation can shut down an economy because no one wants to hold onto the country's currency. Think about it. You get paid $4000 at 2:00 on Friday. By 4:00 that same day your pay is only worth $1000. So what would you do? You would spend that $4000 the instant you got it. Or, more likely, you would not find it worthwhile to work for the $4000 at all, preferring instead to work somewhere that paid you in tradable commodities like food instead of non-tradable ones like cash. In effect, the economy as we know it shuts down. In fact, schools in Zimbabwe have shut down because teacher salaries no longer cover the bus fare to work.

Deflation, or falling prices, is also bad. When prices are falling, especially if they are falling rapidly, people wait to buy to take advantage of the lower prices. If everyone is waiting, no one is buying, and once again the economy comes to a halt.

Not everyone loses from inflation. Borrowers, for one, are better off when prices go up. The reason is that the money they pay back is worse less than the money they borrowed. For the same reason, lenders are hurt because the money they get paid back is worth less than the money they lent. Deflation has the opposite impact, helping lenders and hurting borrowers.

3. UNEMPLOYMENT

Like GDP, the unemployment rate has a very specific meaning. To get to it, there are several useful intermediate steps, summarized in Table 1. 3. The population is everyone in the US. Of these, we discard from consideration people under 16, in the military, and in prison, because these people cannot enter the civilian work force. Not everyone wants to work, though, because some are in school, some are retired, and some want to stay home. The people who are eligible to work and want to work at the going wage comprise the **labor force**. To be in the labor force an individual must either be employed or actively seeking employment. It may surprise you to see that in a country with more than 300 million people only about half of them are in the civilian labor force. The **participation rate** is the fraction of work-eligible people who want to work.

The **unemployment rate** is the fraction of people in the labor force who cannot find jobs. Or, put differently:

> The unemployment rate is the fraction of individuals who are allowed to work in civilian jobs and want to work at the market wage but cannot find jobs.

In November 2009 the unemployed constituted 10.0% of the labor force, so that is the unemployment rate. Figure 1.4 shows historical data.

TABLE 1.3
UNEMPLOYMENT DATA, NOVEMBER 2009
(MILLIONS OF PEOPLE)

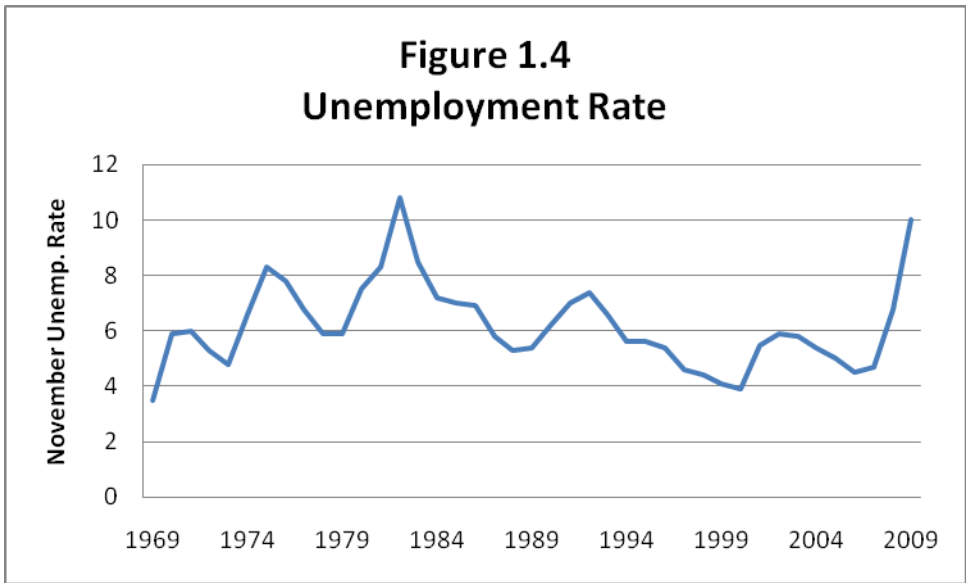
Population	308.0	
Civilian, non-institutionalized, over 16	236.8	
Labor force	153.9	
Participation rate		65.0%
Employed	138.5	
Unemployed	15.4	
Unemployment rate		10.0%

One of the important phrases in the definition of unemployment is *at the market wage*. Presumably everyone would want to work if the wage was high enough. For example, a new stay-at-home mom might be willing to go back to work for $10,000 per hour. But the market wage is not $10,000 per hour, so that is irrelevant.

There are two ways for the unemployment rate to get smaller. One is for more people in the labor force to find jobs. The other is for people to leave the labor force, essentially giving up on trying to find a job. The unemployment rate is simply a fraction given by

$$\text{unemployment rate} = \frac{\#\text{unemployed}}{\#\text{in labor force}}.$$

When someone gets a job the numerator goes down but the denominator stays the same. When someone without a job leaves the labor force both the numerator and the denominator fall. Either way the unemployment rate falls.



There is an obvious link between unemployment and real GDP. Real GDP measures the amount of stuff that the economy produces. In order to produce this stuff, firms need to employ workers. So, the more workers are employed, the more stuff can be produced and the higher real GDP is, and lower unemployment rates correspond to higher levels of real GDP.

You will notice in Figure 1.4 that the unemployment rate seems to have cycles. These cycles reflect what is known as the **business cycle**, and much of we will discuss in the next several chapters is a model of the business cycle. Cycles move around something, and from the graph above it seems that, except for the recessionary periods of the late 70s and early 80s, the unemployment cycle has fluctuated around a number in the range of 5.0 – 6.0%. This number, although not explicitly determined, is called the **natural rate of unemployment**, and it

plays a key role in analyzing the economy. It also makes the unemployment rate the simplest gauge of the health of the economy.

The argument is worth spelling out. It begins by restating the definition:

> The natural rate of unemployment is the unemployment rate that occurs when labor markets clear, so that there is neither upward nor downward pressure on wages. The natural rate is somewhere between 5.0 and 6.0 percent.

When the unemployment rate is below 5.0%, the labor market is tight and employers must offer higher wages to attract workers. This, in turn, places upward pressure on output prices, and leads to inflation. When the unemployment rate is above 6.0%, the labor market is slack and job applicants are easy to find. Firms can actually offer new employees lower wages, leading to downward pressure on wages and prices.

If the unemployment rate is below the natural rate, the economy is booming. If it is above the natural rate, the economy is struggling. The economy may or may not be in recession because of the technical definition of recession (two consecutive quarters of negative real GDP growth), but an unemployment rate above 6% means an unhealthy economy.

When the unemployment rate is at the natural rate, the economy can produce a specific level of output. The level of real GDP coinciding with the natural rate of unemployment is called **potential GDP**. It is the level of output when all inputs, including labor, are fully employed to the extent that there is neither upward nor downward pressure on prices.

4. MONEY

As with GDP and unemployment, money has a very specific definition. Money is what we use to pay for things. We can use cash or we can write a check. We can also use a credit card, but that is simply borrowing, and then the credit card bill is paid either with cash or a check. The macroeconomic definition of money is based on how we pay for things. In particular, the most common measure of money, called **M1**, is the total of currency and checking account balances.

In December 2009, M1 was $1.68 trillion. Of this, $860 billion was currency. Think about this: $860 billion in currency amounts to over $2600 in currency per person in the US. Where is it? The answer is that most of it is overseas. Many countries have unstable currencies, and for their citizens the best place to keep their savings was in US dollars instead of local banks. So, while

inflation ate away the value of the local currency, the dollar was still worth, well, a dollar. Most of this money being held abroad is in fifty and hundred dollar denominations.

Is it a good thing or a bad thing that foreigners hold so much of our currency? It might be a good thing. The way they got the currency was by selling Americans a good or service. In exchange for the good or service, the foreigner accepted a piece of paper with a picture of a prominent American on it. While the foreign country provided Americans with valuable goods and services, the US did not have to provide any goods and services in exchange. In essence, we got those goods and services for free, and they will remain free as long as the foreigners are willing to hold onto US dollars. This is **seigniorage**, a case in which the government makes a profit from the printing of money. In this case the profit came from foreigners taking the currency out of circulation.

The government also profited from the issuing of the 50 state quarters. About 150 million people began collecting the coins, taking them out of circulation. In essence they "bought" quarters for 25 cents each. Each quarter cost about 10 cents to make, and the government has earned over $5 billion in seigniorage so far.

The amount of money in the economy is controlled by the Federal Reserve Bank, commonly referred to as the Fed. The Fed does not simply print money and inject it into the economy. Instead, it does a dollar-for-dollar asset exchange. If the Fed decides that it wants to increase money supply, it purchases US Treasury Bonds from the public. This removes T-bills from public holdings, but increases the amount of money held by the public. No one is made richer or poorer from the transaction, it is simply a change in the types of assets people hold. Similarly, if the Fed decides to decrease money supply, it sells US Treasury Bonds to the public, so that the public holds more T-bills but less money.

When the media reports a change in monetary policy, it talks about the Fed raising or lowering interest rates. There are actually two relevant interest rates here. The federal funds rate is the interest rate at which banks lend reserves to other banks overnight. The discount rate is the rate at which banks can borrow reserves from the Fed overnight. When the Fed increases money supply, both of these interest rates fall, making loans cheaper. So, when the media reports that the Fed is lowering interest rates, it means that the Fed is increasing money supply.

Figure 1.5 shows how the federal funds rate has changed over time. If you compare the last four graphs presented in this chapter, you can note the following patterns. First, the federal funds rate was high when inflation was high. This occurs because inflation rates and interest rates tend to move together. Second, the federal funds rate tends to go down when the unemployment rate goes up and GDP growth falls. These relationships will be explained in later chapters.

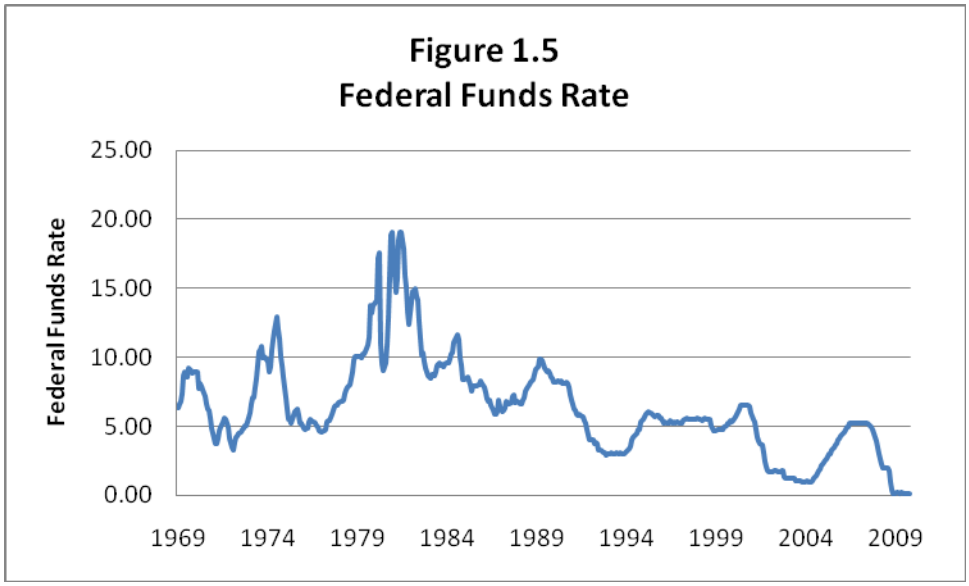


Figure 1.5
Federal Funds Rate
Federal Funds Rate
25.00
20.00
15.00
10.00
5.00
0.00
1969
1974
1979
1984
1989
1994
1999
2004
2009

CHAPTER 2
MACRO MODELS

A large part of what macroeconomists do is make models of the economy. The purpose of this chapter is to describe what is meant by a "model" of the economy, identify the features good models share, and explain why models are important.

1. WHY A MODEL?

Models are used in many different fields. For example, architects create scale models of the buildings they design and the surrounding areas so that clients can see how their property will look after the project is complete. Automobile engineers create scale models of cars and use them to test everything from aerodynamics to consumer response. Washing machine and dishwasher manufacturers build clear models of their products so that consumers can see the features of the machines in operations. All of these models serve the same two purposes: understanding and prediction. Continuing one of the examples, the purpose of the automobile model is to understand more about how the different features of the exterior design of the car contribute to aerodynamics, and to predict how it will handle.

A **macro model** is a mathematical structure that describes the economy. A *mathematical structure* is a set of equations. So, when we construct a macro model, we will be writing down a set of equations that describe the economy. The set of equations can then allow us both to understand the economy more fully and to predict what will happen to it.

Macroeconomists construct models for the same two reasons that other professionals construct them: understanding and prediction. Each equation reflects some important part of the economy, and when put together the equations describe the entire economy. By fine-tuning the equations in the model, macroeconomists learn more about how the economy works. At the same time, they become better able to predict how the economy will respond to changes. What's more, if their predictions are good enough, they can even try to manipulate the economy to counteract the effects of any changes.

In this course the macro model serves three purposes. First, it introduces you to what macroeconomists do. Second, it provides a way for you to understand how the economy works. Third, it enables you to predict how the economy will respond to changes, and how policymakers try to counteract those changes.

2. WHY A MATHEMATICAL STRUCTURE?

Not everyone likes math. So, why are we using a mathematical structure to describe the economy? To answer this question, we must first determine what the alternative is. More precisely, if we do not use mathematical equations, what would we use?

The only real alternative to mathematical equations is stories, or verbal descriptions of how the economy works. Verbal descriptions are good alternatives to mathematical ones when the arguments are simple. As they become more complex, mathematical equations become increasingly more useful for at least three reasons. First, when arguments become complex it is easy to leave parts of them out. With mathematical equations it is much harder to forget things. Second, working through the mathematical equations gives you an answer in which you can be confident. This is not always the case with verbal arguments. Third, mathematical equations sometimes lead to conclusions that you never would have looked for with verbal arguments. An example is given in Section 4.

Accuracy and confidence are not the only reasons to use a mathematical structure. A third reason for using equations is that policy makers, such as the Fed, the Office of Management and Budget (which oversees the creation of the budget that the President submits to Congress), and the Congressional Budget Office (which provides the analysis used by Congress in legislating the budget) use systems of equations to describe the economy. They use more equations than we will, and their equations are more complex than ours will be, but we will still be using the same general process that they use.

3. THE FEATURES OF A GOOD MACRO MODEL

As we have already said, a macro model is a set of equations that describe the economy. We do not want just any set of equations, though. There are some further requirements that make the model a good one:

FEATURES OF A GOOD MACRO MODEL

1. It should include the variables that we want to predict.
2. It should capture the most important factors whose effects we want to determine.
3. Its equations should be consistent with the way the variables are defined and measured.
4. Its equations should be easily defended.
5. It should make predictions that are qualitatively in line with the real world.
6. It should be easy to use.

These six features can be discussed one-by-one.

1. *The model should include the variables that we want to predict.*

In the five preceding chapters we learned about several macro variables that are meaningful indicators of how the economy is doing, specifically GDP, inflation, and unemployment. GDP measures the total output of the economy, and also its total income. Inflation measures how fast prices are rising. Unemployment measures how many people who would like to work cannot find jobs. Since these are the primary variables used to indicate the health of the economy, any good model of the economy should allow us to predict how these variables will change over time. So, the model should include these three variables.

There is one more variable that should be included, although it is one that did not get a separate discussion in earlier chapters. Interest rates are important to the economy in many ways. They determine both borrowing and lending, and can make or break the decision of whether or not a business undertakes a new project or a family purchases a new house or a new car. The model should be able to predict interest rates along with the other three.

2. *The model should capture the most important factors whose effects we want to determine.*

Several variables can impact the economy. Some of them are controlled by government agencies, and some are not. We should at least be able to determine the effects of the government-controlled changes. These are changes in government spending, changes in taxes, and changes in the money supply. Government spending and taxes are controlled through the budget process, which for the federal government involves both the White House and the Congress. State governments also impact spending and taxes, and these are important

considerations, too. Money supply is determined by the Fed, which is independent of the White House and Congress.

Another factor deserves some attention, primarily because it receives considerable attention in the media. Every month the media reports consumer confidence, which is related to how much consumers spend on durable goods. The idea is that if consumers are confident that the economy will do well and their incomes will be high, they will go ahead and buy the expensive durable goods, but if they expect the economy to do poorly they will postpone those purchases. So, we add consumption patterns to our list of factors whose effects the model should determine.

3. *The model's equations should be consistent with the way the variables are defined and measured.*

We have spent considerable effort providing precise definitions of GDP and unemployment. We have also spent some time discussing how they and the other variables are measured. Part of the reason for doing this was so that you would understand the numbers that are reported in the media. The rest of the reason is so that these variables can be used correctly in the model. After all, if a model used the variables incorrectly, then its predictions would have very little to do with how the measured economy turned out, and they would have very little to do with the numbers that are reported in the media. The only way that the model has any relevance is if it uses the same variables that are measured by the government.

4. *The model's equations should be easily defended.*

This is a rather cryptic statement. It means that each individual equation should stand on its own, and there should be a reasonable explanation of why the equation is written the way it is. The equations will capture relationships between the variables, and the relationships should be reasonable.

For example, one equation will relate consumption, which is spending on final goods and services by households, to income. It should be pretty apparent that if incomes rise, households will spend more. They might also save more, but they should spend more, too. An equation that captures this relationship between consumption and income would be easily defended.

5. *The model should make predictions that are qualitatively in line with the real world.*

All of the features are important, but this one is especially so. Part of the reason for building a model of the economy is to show you what macroeconomists do. The rest of the reason is to provide you with an

understanding of the economy and an ability to make your own predictions. If the model doesn't match the real world, then it fails to meet these last two goals.

We want the predictions to be **qualitatively** in line with the real world. This means that when the model predicts that a variable will change, it predicts a movement in the right direction. A **quantitative** prediction would also predict how much the variable would move. Getting quantitative predictions requires that we somehow fit the data to the model, which requires sophisticated and difficult statistical techniques. Happily, for almost everyone it is sufficient to just be able to predict the directions of changes accurately.

6. *The model should be easy to use.*

Given that the model is based on mathematical equations, if it is difficult to use you will spend all of your time struggling to handle the math, without ever having much time to spend learning the economics. Furthermore, if it is difficult to use, you will never use it on your own. To be truly useful, the model should be easy.

It may seem contradictory to have a mathematical model that is easy to use, but it can be done. We do it by transforming the equations into graphs. We will eventually compact the model into two graphs, and once you learn how to use the graphs, you will be able to predict the qualitative effects of changes in government spending, taxes, money supply, and consumption patterns on GDP, inflation, unemployment, and interest rates.

4. AN EXAMPLE OF A MACRO MODEL

To show you what is meant by a macro model, and to show you the advantages of the mathematical approach, let's look at a simple model. It is not a particularly good model, and it does not have all six of the features of a good macro model. Even so, it serves its purposes of illustrating what a macro model is. In future chapters we will construct the model carefully, equation by equation. This time, though, we will just put down the entire model first and then discuss it and work with it.

A SIMPLE SAMPLE MODEL

The model has two equations:

$$Y = C + I + G$$
$$C = 0.9(Y - T)$$

where

Y = income (GDP),
C = consumption (spending by households),
I = investment (spending by businesses or spending on new housing),
G = government spending, and
T = taxes.

The first equation comes directly from the definition of GDP and the way it is measured. Recall that GDP is a measure of output, a measure of income, and a measure of spending. Furthermore, when it is thought of as spending it can be broken down into four components corresponding to who is doing the spending: consumption, investment, government spending. So, the left-hand side of the first equation is income, the right-hand side is spending, and both sides are equal to GDP. (Net exports are left out of the model to keep it simple. We will put net exports in a more complete model in the next chapter.)

The second equation is also easily defended. It relates consumption to income and taxes. Think about a typical household's spending decision. Someone gets a paycheck. The top line of the paycheck shows the household's income, and then it shows how much the government took out for taxes. What is left is **disposable income**, or income minus taxes. The household must decide how much of this disposable income to spend and how much to save. That spending is part of consumption. The second equation states the households spend 90% of their disposable income and save the rest.

Our model consists of two easily defended equations. Let's move on to see if it can be used to make some predictions. Suppose that the government decides to spend \$2000 and collect \$2000 in taxes, and that investment is equal to \$900, where all of these quantities are in billions to make them realistic. In terms of the variables, $G = 2000$, $T = 2000$, and $I = 900$. Using these numbers, we can determine the size of GDP by solving for Y.

To do this, rewrite the two equations inserting the values of the variables just given.

$$Y = C + I + G = C + 900 + 2000$$
$$C = 0.9(Y - T) = 0.9(Y - 2000)$$

Now substitute the formula for C into the first equation:

$$Y = [0.9(Y - 2000)] + 900 + 2000.$$

All that remains to do is solve for Y. Multiply out $0.9(Y - 2000)$ and collect terms on the right-hand side:

$$Y = 0.9Y + 1100.$$

Subtract $0.9Y$ from both sides to get:

$$0.1Y = 1100.$$

Finally, solve for Y to get

$$Y = 11{,}000.$$

We have now answered the first question. The value of GDP is \$11,000. (Since these numbers are in billions, we have calculated that GDP is \$11 trillion.)

What makes the model really useful and interesting is to see what happens to GDP when one of the other variables changes. In the past several years there have been many tax cuts. Let's see what happens if taxes fall by \$100 from \$2000 to \$1900. This time we will combine a few of the steps. First write down the new equations:

$$Y = C + I + G = C + 900 + 2000$$
$$C = 0.9(Y - T) = 0.9(Y - 1900)$$

Now substitute the formula for C into the first equation and multiply out $0.9(Y - 1900)$:

$$Y = 0.9Y - 1710 + 900 + 2000.$$

Collect terms:

$$Y = 0.9Y + 1190.$$

Subtract $0.9Y$ from both sides and reduce to get:

$$0.1Y = 1190.$$

Finally, solve for Y to get

$$Y = 11{,}900.$$

When taxes were 2000, GDP was \$11,000. When taxes fell to \$1900, GDP rose to \$11,900. This tells us two things. First, a tax cut leads to an increase in GDP. This is in line with the real world, as many people supported tax cuts in 2001-2003 because they wanted GDP to grow. The second thing we learn is that the increase in GDP is larger than the original tax cut.

We could have figured out that GDP rises when taxes are cut from a verbal argument. It would go like this: when taxes are cut, disposable income rises. Households then spend more, increasing consumption, which increases GDP. But, it would be much harder for a verbal argument to determine that GDP rises by more than the tax cut. This is one reason why the mathematical approach is so useful.

The following examples get more out of the model.

EXAMPLE 2.1: AN INCREASE IN GOVERNMENT SPENDING

Suppose that taxes return to 2000, but government spending rises to 2100. What happens to GDP?

Follow the same approach. This time the explanations are left out.

$$Y = C + 900 + 2100$$
$$C = 0.9(Y - 2000)$$

Substitute and solve:

$$Y = [0.9(Y - 2000)] + 900 + 2100.$$
$$Y = 0.9Y + 1200.$$
$$0.1Y = 1200.$$
$$Y = 12{,}000.$$

When government spending rises by \$100, GDP rises by \$1000. So, an increase in government spending also cause GDP to rise.

EXAMPLE 2.2: CUTTING GOVERNMENT SPENDING AND TAXES TOGETHER

Suppose that both G and T are both 1900 instead of 2000.

$$Y = C + 900 + 1900$$
$$C = 0.9(Y - 1900)$$

Substitute and solve:

$$Y = [0.9(Y - 1900)] + 900 + 1900.$$
$$Y = 0.9Y + 1090.$$
$$0.1Y = 1090.$$
$$Y = 10{,}900.$$

When government spending and taxes are cut by the same amount, GDP contracts.

This is a useful lesson to learn. When Congress wants to cut taxes, and "pays" for the tax cut by cutting government spending, GDP falls. So, even though a tax cut boosts GDP, a spending cut of equal magnitude causes GDP to fall by a larger amount.

EXAMPLE 2.3: A BOOST IN INVESTMENT

Suppose that something happens to cause investment to rise from its original \$900 up to \$1100. What is the effect on GDP?

$$Y = C + 1100 + 2000$$
$$C = 0.9(Y - 2000)$$

Substitute and solve:

$$Y = [0.9(Y - 2000)] + 1100 + 2000.$$
$$Y = 0.9Y + 1300.$$
$$0.1Y = 1300.$$
$$Y = 13{,}000.$$

A \$200 boost in investment leads to a \$2000 increase in GDP.

IS THE MODEL A GOOD MACRO MODEL?

A good macro model has the six features listed in the box in Section 2.3. To determine if our simple model is a good one, we can just go down the list and see if the model has all of the features.

1. *The model should include the variables that we want to predict.*

While the model predicts the value of GDP, it has nothing to say about interest rates or inflation. The model is incomplete.

2. *The model should capture the most important factors whose effects we want to determine.*

We can use the model to determine the effects of changes in government spending and taxes, but it is useless for finding the effects of money supply changes, among other things. The model is incomplete along these lines, as well.

3. *The model's equations should be consistent with the way the variables are defined and measured.*

As explained in Chapter 1, GDP has four spending components: consumption, investment, government spending, and net exports. The first equation of the model says that GDP has only the first three of these spending components. It omits net exports. Except for this, the first equation is based on the way that GDP is defined and measured. The second equation is consistent with the definition of consumption as spending by households. The model comes close on this criterion.

4. *The model's equations should be easily defended.*

We defended the two equations immediately after presenting them, so the model also has this feature.

5. *The model should make predictions that are qualitatively in line with the real world.*

The examples showed that GDP increases when taxes are cut, government spending increases, or investment increases. All of these are in line with the real world.

6. *The model should be easy to use.*

The model only has two equations, and we solved it several times with some simple algebraic manipulations. The model is easy to use.

The only problem with our simple model is that it is incomplete. The next several chapters build a complete model of the economy that has all six of the features.

CHAPTER 3
IS-LM AND THE ECONOMY IN THE SHORT RUN

We will build our model of the macroeconomy in the following stages:

1. IS-LM model: Used for determining GDP and interest rates in the short run. It cannot handle either inflation or exchange rates.
2. AD-AS model: Used for determining GDP and the price level in the long run. It is a model of the business cycle, and in company with IS – LM can also be used to determine interest rates. But it cannot handle exchange rates.
3. An open economy model for use in determining exchange rate fluctuations.

The reason for building the model in stages is that each component has its own interest, and separating the full model into components makes it easier to digest. This chapter develops the IS-LM model, the next chapter develops AD-AS, and Chapter 5 does IS-LM-BP.

The IS-LM model is boils down to two curves, the IS curve and the LM curve. We introduce them separately, and then put them together to begin analyzing macroeconomic fluctuations and policy.

1. THE IS CURVE

The IS curve arises from the following equations:

IS equations

$$Y = C + I + G + X \quad (3.1)$$

$$C = a + b(Y - T) \quad (3.2)$$

$$I = e - dR \quad (3.3)$$

Fabulous, don't you think? Interpretation would probably help.

Let's start by giving names to the letters. You already know some of them, and they are listed on the next page. An **endogenous variable** is a variable whose value is determined by the system, and so the purpose of the IS-LM model is to tell us the values of the endogenous variables. An **exogenous variable** is a variable whose value is determined outside of the system, or, put more simply, taken as given. In general we want to see how the endogenous variables change when the exogenous variables change. **Parameters** are values that make the equations fit the data. When you studied multiple regression last semester, you were looking at ways of estimating these parameters.

All of the endogenous variables are measured in real terms, that is, corrected for inflation. This is important.

There are two key exogenous *policy* variables in the IS equations: G and T. Congress sets the values of these variables, and when Congress attempts to stimulate the economy either by increasing spending or cutting taxes, it is known as a **fiscal policy**. The IS curve captures fiscal policy. It should be pretty clear by now that, for the federal government at least, tax revenue and spending need not be equal, and the model allows G and T to move independently of each other.

Variables for the IS curve

Endogenous variables
Y = GDP = income
C = consumption
I = investment
R = interest rate

Exogenous variables
G = government spending
T = taxes
X = net exports

Parameters
a, b, e, d
(all parameters are positive)

Net exports is an exogenous variable in this model. We will make it endogenous in Chapter 5. For now, leaving it exogenous simplifies the analysis.

Equation (3.1) says that GDP is the sum of consumption, investment, government spending, and net exports. This has to be true. To see why, look back at Chapter 1. There we said that GDP measures output, income, and spending. The left-hand side of equation (3.1) is income, and the right-hand side is spending. These must be equal. Also, income = spending is the reason it is called the IS curve. The spending side of the equation is broken up into the four spending components.

Equation (3.2) tells us how consumption relates to income:

$$C = a + b(Y - T).$$

Since Y is income and T is tax revenue, $Y - T$ measures after-tax income, or **disposable income**. Equation (3.2) states that when disposable income rises, so does consumption, or spending by households on goods and services. This makes sense. Furthermore, when disposable income rises by \$1, consumption rises by \$$b$. The parameter b is called the **marginal propensity to consume**, and it tells how much consumption rises when disposable income rises by \$1. It makes sense for $0 < b < 1$, so that when disposable income rises by \$1, consumption rises by some amount but not by more than \$1. This restriction on b is going to come up later, so I am going to offset it for future reference:

$$0 < b < 1.$$

Equation (3.3) tells us how investment relates to interest rates:

$$I = e - dR.$$

Recall that investment is spending by businesses and spending by households on new housing. As you hopefully learned in a finance class, businesses choose to spend on new capital if the net present value of the project exceeds the opportunity cost. Net present value is determined in part by the interest rate: the lower the interest rate, the higher the net present value of the project. Therefore, when the interest rate falls, businesses find more projects profitable and undertake more investment. On the other hand, when interest rates rise, fewer projects are profitable and businesses undertake less investment. The minus sign in front of the dR term in equation (3.3) tells us that when interest rates rise investment falls. The parameter d is positive and measures how sensitive investment is to interest rate changes.

It is important here to keep in mind that we are using the macroeconomic definition of investment, and not the popular, Charles Schwab definition of investment. The latter refers to the purchasing of stocks and bonds, in which case the interest rate is related to the yield on stocks and bonds. When the yield goes up, people put more of their assets into stocks and bonds. But this would give you the wrong sign for equation (3.3), so it is important to think about the right definition of investment here.

You may have noticed that consumption depends on income but not interest rates, while investment depends on interest rates but not income. Let me defend these two notions. Regarding consumption, people spend more when their incomes rise. They also save more, and for each additional dollar of disposable income they spend \$$b$ which is less than \$1, and they save \$$(1 - b)$, which is more than \$0. It might be tempting to say that when the interest rate rises they save more. We could work this into equation (2) by letting the parameter b be a

function of R, but that makes the math messy and we really don't want messy math. Also, whether or not saving increases when the interest rate increases depends on what people are saving for. If people are saving for college and the interest rate increases, they no longer have to save as much to have the same amount available when it comes time to pay the tuition bill. On the other hand, if people are saving for retirement and the interest rate rises, they might save more because they get more bang for their buck when interest rates rise. So it could go either way, and ultimately becomes an empirical question. The data suggest that the two effects wash out, and interest rate changes have no systematic effect on consumption or saving.

Investment is determined by financial decision within the firm, and the arguments above show why they depend on interest rates. It may be that the return on capital is higher when income is higher, because when income is higher demand is higher for many goods. This may be the case but the effect is small, and the model is simpler without income in the investment equation.

The effect of interest rate changes is a bit trickier. When the US interest rate rises, US financial assets such as treasury bills become more attractive compared to financial assets from the rest of the world, and individuals in the rest of the world would like to adjust their financial portfolios to hold more US assets. In order to do this they must obtain dollars, and to obtain dollars they must sell goods and services in the US. From the US perspective these are imports, so when the US interest rate rises imports rise and net exports fall.

Variables for the LM curve

Endogenous variables
Y = income
R = interest rate

Exogenous variables
M = money supply
P = price level

Parameters
h, k
(all parameters are positive)

2. THE LM CURVE

The LM curve is based on the fact that money demand equals money supply. It has only one equation:

LM equation

$$M/P = hY - kR. \tag{3.4}$$

The initials L and M stand for liquidity and money.

The LM equation contains one exogenous policy variable, M, which is the *nominal* money supply. As discussed in Chapter 1, money supply is determined by the Fed. The variable P is the price level which, in this chapter, is treated as exogenous. It will become endogenous in the next chapter. The quantity M/P is the money supply divided by the price level, which is the **real money supply**.

The left-hand side of equation (3.4) is real money supply. The right-hand side is real money demand. Recall that money is the sum of currency and checking account balances. We want to determine how people's demand for currency and checking account balances depend on their income and the interest rate. Start with income.

When income goes up, people want to buy more goods and services. In order to make these transactions people need more money. Consequently, when real income Y increases, demand for real money increases, which is reflected in the hY term in the equation.

Currency and most checking accounts balances do not earn any interest. When interest rates rise, people would like to adjust their financial portfolio to take advantage of the higher interest rates, and they do this by moving assets out of cash and checking accounts and into interest bearing accounts. Put differently, they hold less money and more interest-bearing assets. So, when interest rates rise demand for money falls. This is reflected in the $-kR$ term in equation (3.4).

3. IS-LM

Let's put the IS and LM equations together:

IS equations

$$Y = C + I + G + X \quad (3.1)$$
$$C = a + b(Y - T) \quad (3.2)$$
$$I = e - dR \quad (3.3)$$

LM equation

$$M/P = hY - kR. \quad (3.4)$$

This is a system of four equations. Government agencies, financial companies, academic researchers, and others interested in forecasting the economy use systems of equations, too, but their systems have hundreds of equations, not just five. But we can get a really good, seat-of-the-pants model of the economy with just five equations.

Life will be easier (trust me on this one) if we do two things to the system of equations. First, we want to collapse the first four equations into just one equation. That new equation is

$$\begin{aligned} Y &= C + I + G + X \\ Y &= [a + b(Y - T)] + [e - dR] + G + X. \end{aligned} \tag{3.5}$$

Notice that when I do this the endogenous variables C, I, and X disappear, and the only endogenous variables in (3.5) are Y and R.

The next step is to rearrange equations (5) and (6) so that R is by itself on the left-hand side. Rearranging equation (6) yields

$$\begin{aligned} Y &= [a + b(Y - T)] + [e - dR] + G + X \\ Y &= [a - bT + e + G + X] + bY - dR \\ dR &= [a + e + X + G - bT] - (1 - b)Y \end{aligned}$$

$$R = \frac{a + e + X + G - bT}{d} - \frac{1 - b}{d} Y. \tag{3.6}$$

Rearranging (3.4) yields

$$\begin{aligned} \frac{M}{P} &= hY - kR \\ R &= -\frac{1}{k} \cdot \frac{M}{P} + \frac{h}{k} Y. \end{aligned} \tag{3.7}$$

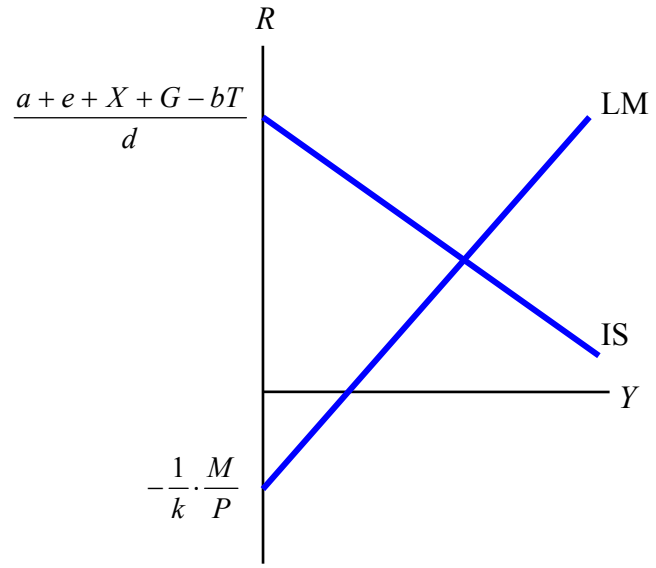
Equation (8) is the equation of the LM curve.

Okay, so we've done a lot of math with nothing to show for it. I realize that, but we're almost to the point where we can do something with our model. What we want to do is graph equations (3.6) and (3.7). Both equations are lines in slope-intercept form, so the work we have done makes drawing the graph pretty straightforward. Once we have the graph we can address policy issues in a very simple way. So, the idea here is to do the hard stuff to make later work easier.

Equation (3.6) is the equation of the IS curve, which is graphed in Figure 3.1. The graph has R on the vertical axis and Y on the horizontal axis, and equation (3.6) is the equation for a line in slope-intercept form, which you may remember from your high school algebra classes. The intercept is the first term on the right-hand side of (3.6), and the slope is the thing multiplying Y on the right-hand side. First note that the slope term in equation (3.6) is negative, so the

IS curve is downward sloping. The intercept is shown in the graph, and it is useful for figuring out how the IS curve shifts.

FIGURE 3.1
IS-LM



Recall that we have two fiscal policy variables, government spending G and tax revenue T. An increase in G causes the intercept term, which is

$$\frac{a+e+X+G-bT}{d},$$

to increase, which shifts the IS curve upward (and to the right). An increase in T causes the intercept term to decrease, which shifts the IS curve downward (and to the left). Although it is not a policy variable, and increase in net exports X behaves just like an increase in government spending, shifting the IS curve upward (and to the right).

Equation (3.7) for the LM curve is also in slope-intercept form. This time the slope coefficient, h/k, is positive and the red LM curve is upward sloping. The intercept turns out to be negative, but that is not a big deal. What matters is how it shifts. The intercept is

$$-\frac{1}{k}\cdot\frac{M}{P},$$

and it contains one exogenous monetary policy variable, the money supply M, and also one other exogenous variable we care about, the price level P. When M increases, the fraction M/P becomes larger, so the intercept term becomes more negative. That means that the LM curve shifts downward (and to the right) when money supply increases. The opposite occurs when the price level rises, with the LM curve shifting upward (and to the left).

Table 3.1 summarizes how the IS and LM curves shift when our key policy variables change.

TABLE 3.1
SHIFTING THE IS AND LM CURVES

Change in variable	Impact on IS	Impact on LM
Increase gov't spending	Shift right	No shift
	Shift left	No shift
Increase taxes	Shift right	No shift
Increase net exports	No shift	Shift right
Increase money supply	No shift	Shift left
Increase price level		

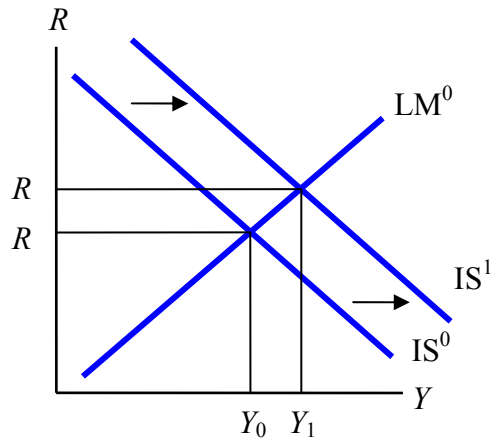
4. IS-LM AND FISCAL POLICY

We now have the tools we need to begin analyzing the economy. The economy begins with GDP at Y_0 and the interest rate at R_0, which is where the original IS and LM curves, labeled IS^0 and LM^0, meet. The intersection is the right place to look for the following reasons: (1) By definition income equals spending, so we must be somewhere on the IS curve, and (2) in equilibrium the money market clears, meaning that money demand equals money supply, and so we must be somewhere on the LM curve. The only point where we are on both curves is the intersection point, where income is Y_0 and the interest rate is R_0.

Now suppose that the government increases spending, perhaps by building new highways. From Table 3.1 we know that the increase in government spending causes the IS curve to shift to the right. The new intersection point has higher income, Y_1, and higher interest rates, R_1. The increase in government spending is an **expansionary fiscal policy**, expansionary because it increases GDP, and fiscal because it concerns either government spending or taxes. As shown by the graph, expansionary fiscal policies lead to higher interest rates.

Figure 3.2 also works for a *decrease* in taxes. A tax cut also leads to a rightward shift in the IS curve, leading to an increase in GDP and higher interest rates.

FIGURE 3.2
INCREASE IN GOVERNMENT SPENDING OR DECREASE IN TAXES



The discussion above concerns two of the endogenous variables, Y and R. These are not the only endogenous variables, though, so we should take some time to look at the effects of expansionary fiscal policies on consumption C and investment I. Consumption rises when income rises, and expansionary fiscal policies cause income to rise. So, expansionary fiscal policies lead to increased consumption. Investment rises when interest rates fall, but expansionary fiscal policies lead to higher, not lower, interest rates. Consequently, expansionary fiscal policies lead to lower investment.

Increases in government spending lead to increases in GDP, and so do decreases in taxes. Which one has the bigger effect? This question matters because Congress might like to enact a budget-neutral policy, either raising spending and taxes by the same amount or cutting taxes and spending by the same amount. Which of these two budget-neutral policies is expansionary? To figure this out we must determine which way the IS curve shifts when G and T increase by the same amount. We do so by looking at the intercept as shown in Figure 3.1, which is

$$\frac{a+e+X+G-bT}{d}.$$

Suppose we add 100 to both G and T, so that our policy is to increase government spending by \$100 and pay for it with \$100 in new taxes. The intercept becomes

$$\begin{aligned}\frac{a+e+X+[G+100]-b[T+100]}{d} &= \frac{a+e+X+G-bT+[100-100b]}{d} \\ &= \frac{a+e+X+G-bT}{d}+[1-b]\frac{100}{d}.\end{aligned} \tag{3.8}$$

The left-hand term in the last line of equation (3.8) is the original intercept shown in Figure 3.1. The right-hand term in the last line is $[1 - b]100/d$, which is positive because $0 < b < 1$. This means that the new intercept is higher than the old intercept, and the IS curve shifts upward (and to the right). When both government spending and taxes increase by the same amount, the IS curve shifts to the right. By the same token, when both government spending and taxes decrease by the same amount, the IS curve shifts to the left.

We can now rephrase our results on fiscal policy in terms of deficit spending. Government deficits, whether caused by spending increases or tax cuts, are expansionary. Surpluses are contractionary. Some uninformed people think that recessions are caused by high deficits, and that the key to getting out of recessions is to reduce the deficit. Quite the opposite is true, and bigger deficits actually help get countries out of recessions. As for budget-neutral policies, tax cuts are expansionary if the are not financed through spending cuts, and spending increases are expansionary even if they are paid for with tax increases. During the most recent presidential election one party (you can probably figure out which one) said that you never want to increase taxes during a recession to counter the other party's proposal to raise taxes to fund new spending. You can now hold an informed opinion about the merits of those competing proposals.

As of the time of this writing (December 15, 2008), President-elect Obama has discussed using a huge increase in government spending to help get us out of the current recession. This spending program would involve highway construction and repair, the development of green technologies, and the development of alternative fuels. The graph shows that such a policy would be expansionary, although it would lead to higher interest rates. Franklin Roosevelt's New Deal program was similar, although on a much larger scale, in an effort to get the country out of the Great Depression. Also, recall from Chapter 1 that GDP and unemployment are inversely related, so that when GDP rises, unemployment falls. Thus, expansionary fiscal policies create jobs.

Earlier in 2008 the Bush administration undertook a different fiscal policy, a tax cut in the form of tax rebates to most households. This fiscal policy had little impact on the economy. The reason comes from the marginal propensity to consume, *b*, which you will remember is the additional consumption that follows from a $1 increase in disposable income. A tax cut increases disposable income, so it should lead to more consumption. However, people seem to have a different value of *b* for temporary income changes and permanent income changes. When an income change is temporary, people tend not to adjust their spending habits and end up saving the additional income, or paying off their debts (which is the same thing as saving). When an income change is permanent, people tend to change their consumption patterns and end up consuming more. Evidence has shown that the value of *b* is close to one when the income change is permanent but close to zero when the income change is temporary. The 2008 tax rebate program led to a temporary drop in taxes, which meant a small value of *b*, which meant a small shift in the IS curve. The temporary tax cut did little to expand the economy.

5. IS-LM AND MONETARY POLICY

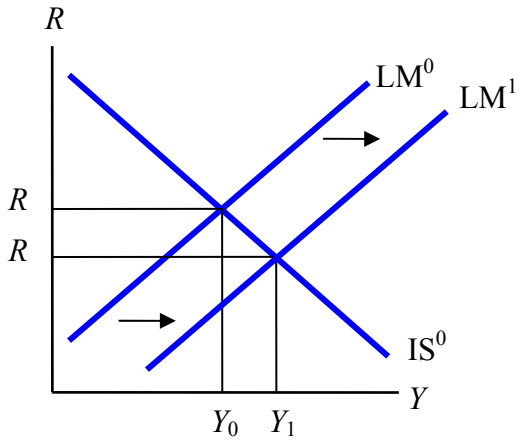
When the Fed changes money supply (reported as the Fed changing interest rates), the Fed undertakes a monetary policy. Figure 3.3 shows the impact of a money supply increase. The LM curve shifts to the right, as suggested by Table 3.1, GDP rises, and interest rates fall.

The most natural result from this exercise is that interest rates fall. When the Fed increases money supply, the media reports that the Fed lowered interest rates. As you can see from the graph, interest rates do, in fact, fall. The reason for the monetary policy is now clear. The Fed increases money supply and lowers interest rates because it believes that GDP is too low (or growing too slowly), and the policy it undertakes is an **expansionary monetary policy**. By the same logic, when the Fed believes that GDP is too high (or growing too fast), it undertakes the contractionary monetary policy of cutting money supply and raising interest rates.

Fed actions are fairly predictable, and they can be predicted pretty well with a single piece of data. Recall that the natural rate of unemployment is the level of unemployment consistent with full employment and no change in inflation. In Chapter 1 we said that it is somewhere in the neighborhood of 5.0 to 6.0 percent. When the unemployment rate is below 5.0 percent the economy is growing strong, and if the Fed conducts a monetary policy it will undertake one to slow down the economy. In other words, when unemployment is below 5.5% the Fed tends to reduce money supply and raise interest rates. On the other hand,

when unemployment is above 6.0% the Fed tends to undertake expansionary policies, increasing the money supply and reducing interest rates.

FIGURE 3.3
INCREASE IN MONEY SUPPLY OR DECREASE IN PRICES



Inflation, or an increase in the price level P, has same effect as a monetary *contraction*. When the price level rises the LM curve shifts to the left, GDP falls, and interest rates rise.

As for the other endogenous variables, an increase in money supply leads to an increase in consumption because of the increase in income. The money supply increase also leads to increased investment because of the lower interest rates.

CHAPTER 4
AS-AD AND THE ECONOMY IN THE LONG RUN

The IS-LM model of the last chapter is useful for many things. For example, it is easy to manipulate. Also, it tells us what happens to GDP and interest rates and, by extension, unemployment, consumption and investment. However, it is far from a complete model. In particular, it is missing two key components: inflation and time. This chapter expands on the IS-LM model to allow for a discussion of how inflation arises and how the economy adjusts over time.

1. THE AD CURVE

When drawing graphs, the axes are important. The IS-LM diagram has Y on the horizontal axis and R on the vertical axis. This makes IS-LM the appropriate tool for talking about interest rate changes. This chapter, though, concerns price level changes. The obvious way to talk about price level changes is to have the price level on one of the axes of the graph.

That is exactly what we are going to do. We will draw a graph with the price level P on the vertical axis and GDP on the horizontal axis. We can't draw IS and LM curves with these axes, though, because they require interest rates on the vertical axis. So we have to rethink the curves.

The IS-LM equations are still valid, and they are repeated here:

IS equations

$$Y = C + I + G + X$$
$$C = a + b(Y - T)$$
$$I = e - dR$$

LM equation

$$M/P = hY - kR.$$

In Chapter 3 we manipulated these equations in the following ways. First we collapsed the four IS equations into a single equation, and then we rearranged this new equation and the LM equation to isolate R on the left-hand side. This gave us the equations of the lines we graphed for IS-LM analysis. Bear with me while I repeat those equations, too.

IS line

$$R = \frac{a + e + X + G - bT}{d} - \frac{1 - b}{d} Y$$

LM line

$$R = -\frac{1}{k} \cdot \frac{M}{P} + \frac{h}{k} Y$$

The way we worked with these equations was we graphed them. This gave us two lines and we looked at the intersection. We can also find the intersection mathematically instead of graphically simply by noting that at the intersection both equations give us the same value of R. So, we can set the right-hand sides of the two equations above equal to each other. This gives us

$$\frac{a + e + X + G - bT}{d} - \frac{1 - b}{d} Y = -\frac{1}{k} \cdot \frac{M}{P} + \frac{h}{k} Y .$$

Don't bother trying to make sense of this equation. All I want you to do with it is notice that it contains Y and P but not R. That makes it perfect for graphing with Y on the horizontal axis and P on the vertical axis.

One could solve for P, but that would lead to a really ugly equation, even by my standards. So let's think our way through it instead. Figure 4.1 has two panels. The upper panel has P on the vertical axis and Y on the horizontal axis, so it is our new graph. The lower panel has R on the vertical axis and Y on the horizontal axis, so it is an IS-LM graph. Let's fix an IS curve and see what happens when the price level changes. The lower panel shows LM curves corresponding to three different price levels, $P_1 < P_2 < P_3$. When the price level rises the LM curve shifts to the left, reducing GDP and raising interest rates. The upper panel of the matches the price levels to the corresponding GDP levels, showing that when the price level rises GDP falls. This is the **aggregate demand**, or **AD** curve.

Table 4.1 tells how the AD curve shifts with various policy variables. When government spending increases the IS curve shifts right, leading to higher GDP for every price level. This means that the AD curve shifts to the right. A tax increase shifts the IS curve to the left, and also shifts the AD curve to the left.

A money supply increase shifts the LM curve to the right, leading to higher GDP at every price level, and therefore shifting the AD curve to the right. An increase in the price level shifts the LM curve to the left, but has no impact on the AD curve because the price level is on the axis of the AD curve. So, when the price level increases we move upward along the AD curve without shifting it.

FIGURE 4.1
CONSTRUCTING THE AGGREGATE DEMAND (AD) CURVE

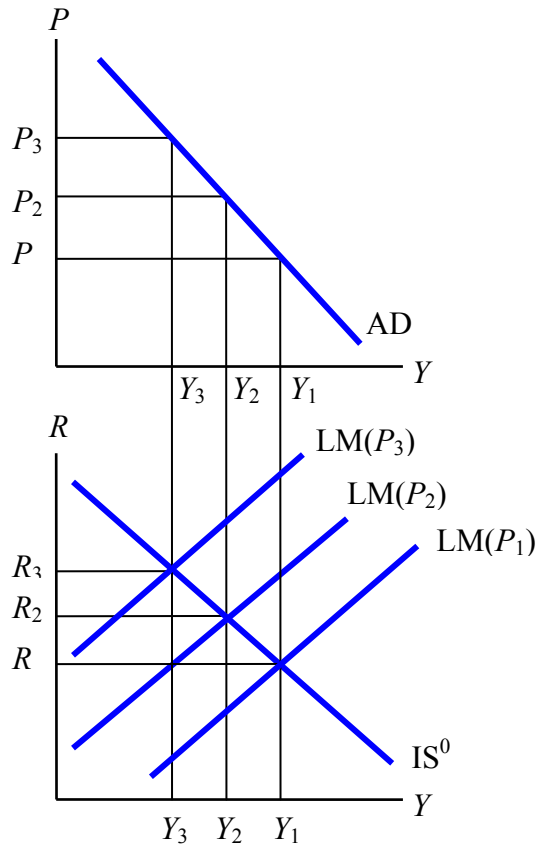


TABLE 4.1
SHIFTING THE AD CURVE

Change in variable	Impact on AD
Increase gov't spending	Shift right
Increase taxes	Shift left
Increase net exports	Shift right
Increase money supply	Shift right
Increase price level	No shift

2. THE AS CURVE

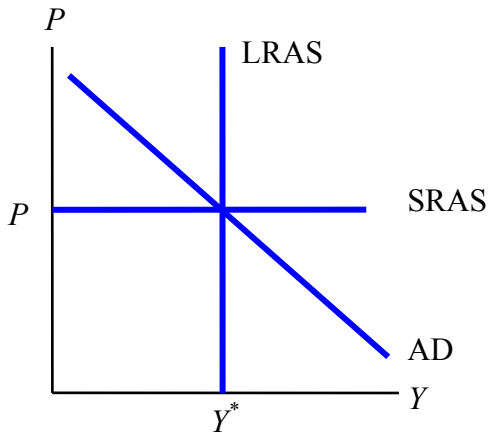
Our notion of aggregate supply is built around two key ideas: price level adjustment and potential GDP. To get there, recall some definitions from Chapter 1. The *natural rate of unemployment* is the unemployment rate that occurs when labor markets clear, so that there is neither upward nor downward pressure on wages. If the unemployment rate is below the natural rate, employers must offer higher wages to get additional workers to take the job, putting upward pressure on wages. If the unemployment rate is above the natural rate, an excessive number of people are unemployed and employers can offer lower wages and still get people to take the jobs. This puts downward pressure on wages. The natural rate is the unemployment rate at which neither of these things happen.

Potential GDP is the level of real GDP that coincides with the natural rate of unemployment. At that level of output all inputs are fully utilized and there are no upward or downward pressures on input prices. This in turn means that there are no upward or downward pressures on output prices. So, potential GDP is the level of GDP at which there is no pressure for the price level to change, either up or down.

When GDP differs from potential the economy is out of equilibrium. In the long run the economy will adjust to equilibrium, so in the **long run**, that is, after prices have had sufficient time to fully adjust, real GDP must equal potential GDP. Let Y^* denote potential GDP.

The **short run** is a period of time too short for prices to adjust at all. Therefore, in the short run the price level is fixed.

FIGURE 4.2
AN ECONOMY IN LONG-RUN EQUILIBRIUM



This gives us two aggregate supply curves. The **short-run aggregate supply** curve **SRAS** is horizontal at whatever price level pertains at the time. The **long-run aggregate supply** curve **LRAS** is vertical where GDP equals potential GDP. Figure 4.2 shows an AS-AD diagram for an economy at long-run equilibrium, so that the AD curve, the SRAS curve, and the LRAS curve all intersect at the same point.

3. BUSINESS CYCLES

Figure 4.2 shows an economy in long-run equilibrium. In contrast, the upper panel of Figure 4.3 shows one that is not in long-run equilibrium. The initial price level is P_0 and the corresponding short-run aggregate supply curve is $SRAS_0$. The short-run outcome is point *A*, where GDP is above potential, that is, $Y_0 > Y^*$. We know that *A* is the short-run point because it is the intersection of the AD and $SRAS_0$ curves.

Point *A* is not a long-run equilibrium because it is not on the LRAS curve. That means that prices will adjust. The long-run equilibrium point is point *B*, the intersection of the AD and LRAS curves. The economy moves from point *A* from point *B* because the price level rises, otherwise known as inflation. The price level rises from P_0 to P_1, and P_1 is the new long-run equilibrium price level. This new price level corresponds to a new short-run aggregate supply curve, labeled $SRAS_1$. During the adjustment GDP falls from Y_0 to Y^*.

The lower panel of Figure 4.3 shows what happens to interest rates using an IS-LM diagram. As the price level rises the LM curve shifts to the left, and the interest rate rises.

There are two lessons from Figure 4.3. One is that the economy is self-correcting in the sense that any departures from potential GDP eventually disappear. The second is that having GDP too high introduces inflationary pressures. Given that high GDP corresponds to low unemployment, the economy always faces a tradeoff between inflation and unemployment. One can gain temporary periods of low unemployment but at the cost of inflation.

FIGURE 4.3
AN ECONOMY WITH INFLATIONARY PRESSURE

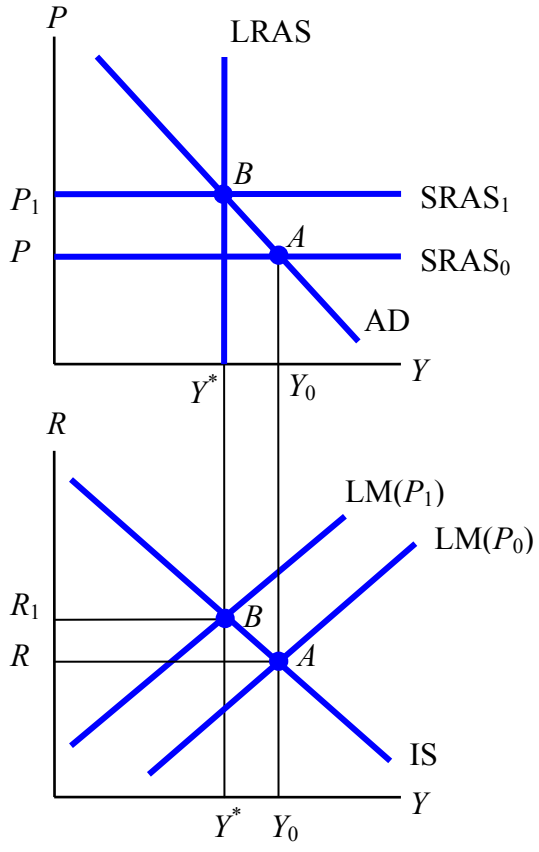
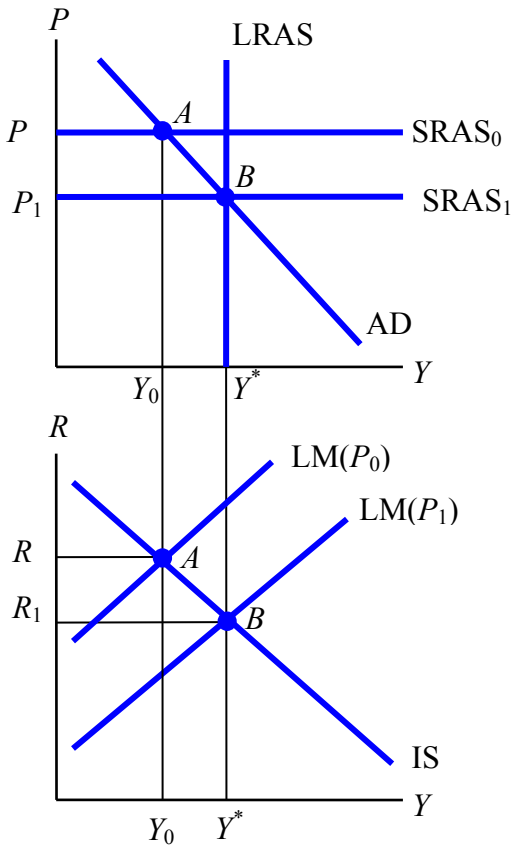


Figure 4.4 concerns the opposite case, the one in which GDP starts off below potential and unemployment is higher than the natural rate. This case puts downward pressure on the price level as the economy adjusts back to potential, and interest rates also fall. As one can see, the economy's self-correcting mechanism works in both directions.

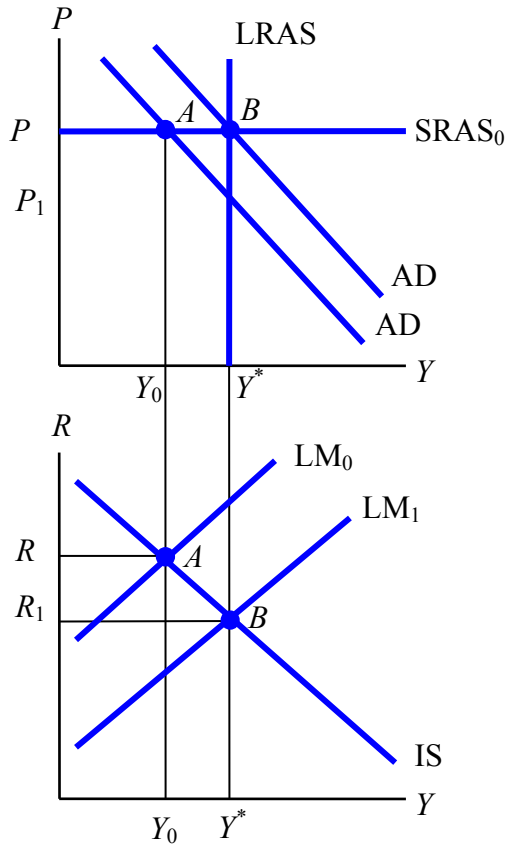
FIGURE 4.4
AN ECONOMY WITH DEFLATIONARY PRESSURE



4. POLICY RESPONSES TO BUSINESS CYCLES

As of this writing the US economy is in a recession, which means that we are in a situation similar to the one depicted in Figure 4.4. As the figure shows, the economy will naturally correct itself, GDP will eventually return to potential, and unemployment will eventually return to the natural rate. It will just take some time. But what if policy makers don't want to wait that long?

FIGURE 4.5
MONETARY POLICY RESPONSE TO A RECESSION



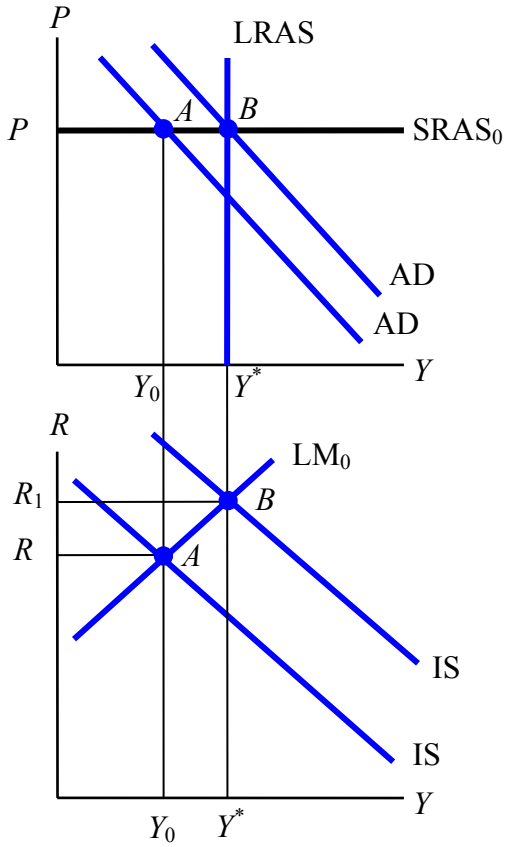
The usual party to act first in conducting policy to combat a business cycle is the Fed. If it does so correctly, the economy looks the one depicted in Figure

4.5. The Fed increases money supply and lowers interest rates, stimulating the economy by shifting the LM curve to the right. If the Fed gets it exactly right, the new LM curve intersects the IS curve exactly at potential GDP, so that no further adjustment is necessary. As described in Table 4.1, the increase in money supply also causes the aggregate demand curve to shift to the right. Again, if the Fed does this exactly right the new AD curve intersects the short-run aggregate supply curve $SRAS_0$ exactly at potential GDP, so that no further adjustments are necessary.

Fiscal policy responses are also possible. Figure 4.6 shows such a policy response, and it can be either a government spending increase or a tax cut. If the policy response is exactly right, prices do not have to adjust, but interest rates rise.

FIGURE 4.6

FISCAL POLICY RESPONSE TO A RECESSION



Everything works the same way if GDP starts off above potential, and you should be able to work these out for yourselves. The appropriate monetary policy response is to reduce money supply and raise interest rates, and the appropriate fiscal policy response is to raise taxes or cut government spending.

5. ISSUES WITH POLICY RESPONSES

Figures 4.3 – 4.6 paint a rosy picture. The economy adjusts by itself if we are patient. If not, we can always use an appropriate monetary or fiscal policy to speed the process up. So, business cycles shouldn't be a big deal.

There are some problems with these scenarios. First, the self-adjustment process could take a long time. The Great Depression began in 1929 and was not fully resolved until World War II. Also, the two policy graphs assumed that the policy makers got things exactly right. That's a lot to expect from a government agency.

Think about enacting monetary policy. The Fed first has to determine that the economy is sufficiently far from potential to warrant some action. Given that they can only look at past data, by the time they figure it out some of the damage is already done. Then the Fed must decide how large a money supply adjustment to undertake. This again takes some time. Once they make the monetary policy adjustment, it takes time for the economy to respond to the additional money. It does not happen overnight, and the full effects of a monetary adjustment have been estimated to take about 12 months. But all this time the economy is adjusting on its own, so the Fed must be careful not to overadjust because then the economy moves from one side of potential to the other.

Fiscal policy is even more difficult, because it requires actions by Congress. It takes longer for Congress to notice a problem, because the state of the economy is a primary concern of the Fed but only one of many concerns of Congress. Then Congress must pass a bill, either a spending bill or a tax bill. This must go through several committees and both houses, and is subject to amendments that change the original amount of the policy initiative. And fiscal policies take longer to reach their full impact than monetary policies, with estimates suggesting that effects might linger for 2 – 3 years. This makes overadjustment very likely, and fiscal policy is the right response only in extreme circumstances.

CHAPTER 5
THE OPEN ECONOMY AND EXCHANGE RATES

We now have a model that can be used to predict many things. It tells how GDP, unemployment, interest rates, and inflation all react to macroeconomic shocks, how policy makers respond to those shocks, and how the variables react to those policy responses. The model is somewhat complicated, but so is the economy.

One thing we have not yet covered is net exports and exchange rates. To do so we must add one more feature to the model, which will make it complete.

1. EXCHANGE RATES, TRADE, AND CAPITAL FLOWS

Exchange rates can be measured in two ways, foreign currency per dollar, or dollars per unit of foreign currency. The day I am writing this a dollar is worth 0.71 Euros, which means a euro is worth 1/0.71 = 1.41 dollars. We can talk about exchange rates either in terms of 0.71 euros per dollar, which is the price of a dollar, or 1.41 dollars per euro, which is the price of a euro. When I want to talk about the American economy I will choose Euros per dollar so that I am talking about the foreign price of the domestic currency. I will refer to this as the euro/dollar exchange rate.

Like any other price, the exchange rate is determined by supply and demand. In the case of the euro/dollar exchange rate, the demand for dollars comes from Europeans wanting to obtain dollars so that they can buy either American goods or American financial assets (like stocks and bonds), and the supply of dollars comes from Americans wanting to obtain euros so that they can purchase either European goods or European financial assets. In addition, petroleum is traded worldwide in dollars, creating further demand for dollars.

When the euro/dollar exchange rate rises, American goods become more expensive for Europeans, and so they buy less of them. At the same time, European goods become cheaper for Americans, so we buy more of them. This strong dollar makes US exports fall and US imports rise, increasing the US trade

deficit. On the other hand, when the dollar weakens US imports fall and US exports rise, making the US trade deficit smaller.

As discussed in Chapter 1, the US trade deficit is about $700 billion in 2008. This means that we import $700 billion more goods and services than we export. There is a net inflow of goods and services into the U.S. To pay for them, there is a net outflow of dollars. When you think about it, this means that foreigners are collecting $700 billion that they do not want to spend on US goods and services. So what do they do with the dollars?

Some people keep them because the dollar is more stable than their own domestic currency, and many black markets around the world operate around transactions in dollars instead of the domestic currency. However, most of the exporters who sell goods and services in the U.S. do not just collect pieces of paper with pictures of presidents on them. Instead, they buy other things from the US, especially financial assets like stocks and bonds. This means that the dollars are returning home, but shares of our corporate and national debt, and ownership shares of our companies, are going abroad.

As stated above, when the dollar becomes stronger, the US imports more and exports less. This makes the trade deficit larger, which means that foreigners have more dollars to spend on US financial assets. So, a stronger dollar means increased foreign ownership of US assets, and a weak dollar means decreased foreign ownership of US assets. So who benefits from a stronger dollar? US consumers clearly like a stronger dollar because they pay fewer dollars for the same foreign goods and services. Importers also like it for the same reason. Exporters are hurt, because now their goods and services are more expensive, and less competitive, in foreign markets. Financial investors in the US like it because of the influx of foreign capital into US financial markets, driving up prices.

What we want to do with this chapter is formulate a model that can be used to predict exchange rate movements.

2. PURCHASING POWER PARITY

The theory of **purchasing power parity (PPP)** says that in the long run exchange rates should adjust to equate purchasing power. It is related to a different economic idea, the *law of one price*, which states that identical goods should sell at identical prices. In other words, a twelve pack of Diet Coke (the elixir of life) should cost the same everywhere. Obviously, this is not true. Nevertheless, the idea of purchasing power parity has some traction, so we should spend some time on it.

PPP states that exchange rates should adjust so that individuals in different countries are able to purchase the same things with their incomes. To test this, it

would be nice if there was a single good, identical throughout the world, whose price could be used for comparison purposes. Fortunately, there is, a McDonald's Big Mac. The magazine *The Economist* regularly computes what it calls the Big Mac Index, which is the local price of a Big Mac converted into dollars. According to PPP, this should be the same all over the world. As Table 5.1 shows, however, this is not the case. Big Macs cost $3.57 in the US, but as much as $7.88 in Norway and as little as $1.70 in Malaysia. In some countries the theory seems to work, though, and in Argentina a Big Mac costs about the same as it does in the US.

TABLE 5.1
LOCAL BIG MAC PRICES CONVERTED INTO DOLLARS

Country	Big Mac price	
	in local currency	in dollars
United States	3.57	3.57
Argentina	Peso 11.0	3.64
Britain	Pound 2.29	4.57
China	Yuan 12.5	1.83
Euro area	Euro 3.37	5.34
Malaysia	Ringgit 5.50	1.70
Norway	Kroner 40.0	7.88
UAE	Dirhams 10.00	2.72

Source: *The Economist*, July 24, 2008
http://www.economist.com/finance/displaystory.cfm?story_id=11793125

Let's think about this a little more deeply. According to PPP, exchange rates should adjust to equate purchasing power across countries. The data show that current exchange rates fail to do so. Therefore, exchange rates should adjust in the future. In particular, they should adjust, over the long term, to make a Big Mac cost the same everywhere. Let's see where this takes us. The price of a Big Mac in China is 12.5 yuan, which converts to $1.83. This implies an exchange rate of $0.146/yuan, because

$$\frac{12.5 \text{ yuan}}{\text{Big Mac}} \times \frac{0.146 \text{ dollars}}{\text{yuan}} = \frac{1.83 \text{ dollars}}{\text{Big Mac}}.$$

PPP says that the Chinese price of a Big Mac should rise until it equates with the US price, which means that the dollar/yuan exchange rate must rise. In other

words, the Chinese yuan should appreciate relative to the dollar, and the dollar should weaken against the yuan, so that it takes more dollars to buy a yuan. Assuming that the US price of a Big Mac holds steady at $3.57, the dollar/yuan exchange rate should double to $0.286/yuan.

The world contains some clever people. One of them thought of the Big Mac. One of them thought of using the Big Mac to test PPP. And another one thought of an even better use of the Big Mac. Table 5.2 shows how long someone must work to earn enough to buy a Big Mac at the local wages and local Big Mac prices. The table also shows how much someone must work to buy a kilogram of bread or a kilogram of rice. These measures allow us to compare the purchasing power of labor across countries.

There are huge global disparities in the purchasing power of labor. It takes a worker in London five minutes to earn enough to buy a kilogram of rice, but it takes 36 minutes for a worker in Jakarta, Indonesia. It takes 13 minutes to earn a Big Mac in New York City, but 97 in Bogotá, Columbia.

3. THE IS-LM-BP MODEL

Purchasing power parity is amusing, but not terribly informative for predicting how exchange rates will change. A more useful model can be built off of our IS-LM model.

What we are going to do is use our old IS-LM framework but add a curve that reflects the current exchange rate. This curve, called the **BP curve** for *balance of payments*, is the set of combinations of income Y and interest rate R that lead to the same exchange rate. To figure out its slope, pick any point, such as A in Figure 5.1. Now increase the domestic interest rate from R_A to R_B. This makes US financial assets more attractive relative to foreign ones, and so foreigners want to move more of their assets into American capital markets. In order to do so, they need dollars, and bid up the price of the dollar, which is the exchange rate.

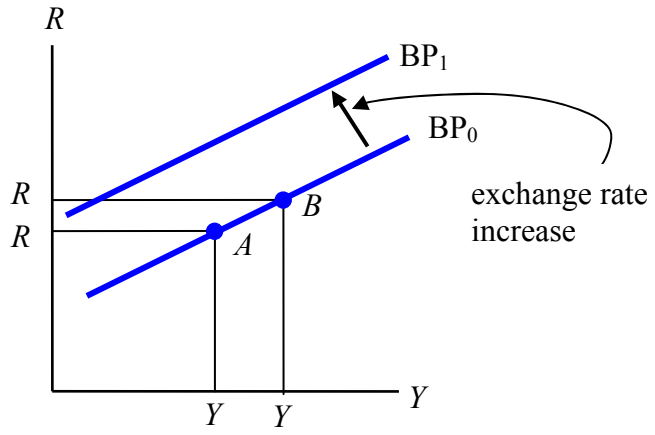
TABLE 5.2
COMPARING PURCHASING POWER ACROSS COUNTRIES

	Minutes of work required to buy		
	a Big Mac	**1 kg bread**	**1 kg rice**
Bangkok	67	49	22
Barcelona	21	16	10
Beijing	44	42	29
Bogotá	97	59	25
Bucharest	69	31	25
Budapest	48	14	24
Delhi	59	22	36
Dubai	25	11	12
Frankfurt	16	9	17
Geneva	16	10	7
Hong Kong	17	26	11
Istanbul	48	14	36
Jakarta	86	47	36
Johannesburg	30	12	11
Kuala Lampur	33	21	9
Lima	86	37	19
London	16	5	5
Manila	81	64	29
Mexico City	82	53	22
Montreal	17	17	9
Moscow	25	12	12
Mumbai	70	14	32
Nairobi	91	32	33
New York	13	16	8
Oslo	18	14	6
Rome	25	23	19
Santiago de Chile	56	32	21
Seoul	29	28	13
Sydney	14	15	5
Taipei	20	18	11
Tokyo	10	16	12
Vienna	16	13	10
Warsaw	43	17	18

Source: UBS: *Prices and Earnings*, 2006 edition
http://www.ubs.com/1/ShowMedia/wealthmanagement/wealth_management_research/prices_earnings?contentId=137705&name=P+L_0601_e.pdf

But the BP curve keeps the exchange rate fixed. So something must happen to income Y to put countervailing downward pressure on the exchange rate. The change we need is an increase in Y. When Y increases people, businesses, and governments in the US buy more goods and services, and some of these goods and services are imported from abroad. When they buy these new imports they exchange dollars for goods and services, increasing the supply of dollars to foreigners, and alleviating the upward pressure on the exchange rate. So, the new point on the BP curve has higher income, such as at point B in Figure 5.1.

FIGURE 5.1
THE BP CURVE



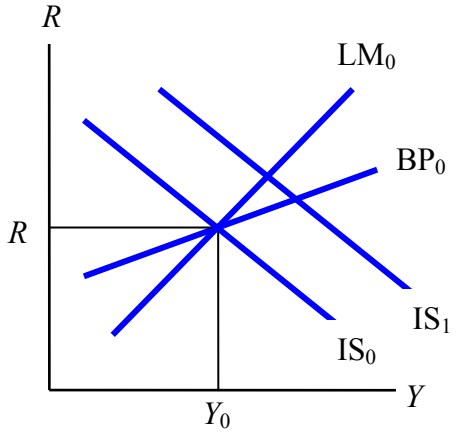
The BP curve shifts when the exchange rate changes. We should figure out the direction. Suppose that the exchange rate rises, so that the foreign price of a dollar rises. This means that people in the US will import more because the dollar now buys more goods and services, and foreigners will import less from the US because their currency buys fewer goods and services. US imports rise, US exports fall, and US GDP falls. Consequently, we get a reduction in Y. Thus, an increase in the exchange rate shifts the BP curve to the left (and upward).

Figure 5.2 shows the full IS-LM-BP model. We have three curves, and in the figure they all intersect at the same point. This is an equilibrium of the model. Also, in the figure the BP curve is shallower than the LM curve. This is true of countries that have no limits on international flows of capital, which would be

most industrialized countries. Some countries place limits on flows of capital into and out of their countries, and for these nations the BP curve might be steeper than the LM curve, which would make a difference. The model shown here is the right one for the US and most countries with which you would do business.

As a prelude to what is coming, Figure 5.2 also shows the IS curve shifting to the right, which is what happens with a fiscal expansion. Now there are two intersection points, one with IS and LM, and one with IS and BP. Which one is the right one? It turns out that it depends on whether the country is following a floating exchange rate regime or a fixed exchange rate regime. The US uses a floating exchange rate regime, so we will look at that case first.

FIGURE 5.2
THE IS-LM-BP MODEL



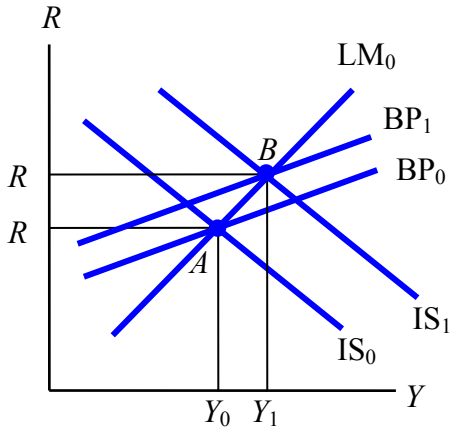
4. FLOATING EXCHANGE RATE REGIMES

The US and most other industrialized nations allow their exchange rates to float freely in response to market forces. This section tells how the IS-LM-BP model can be used to predict these exchange rate movements.

Operationally, freely-floating exchange rates means that the BP curve adjusts to wherever the IS and LM curves intersect. Figure 5.3 shows what happens in response to a fiscal stimulus. The economy begins at point *A*, where IS_0, LM_0, and BP_0 all intersect. An expansionary fiscal policy moves the IS curve rightward from IS_0 to IS_1. The new (short run) equilibrium point is where the new IS curve intersects the LM curve, which is point *B*. The BP curve must shift to

pass through this point, which means that it shifts upward and to the left. This shift is caused by an increase in the exchange rate, so the expansionary fiscal policy makes the exchange rate rise.

FIGURE 5.3
FISCAL EXPANSION WITH FLOATING EXCHANGE RATES



There are two things to learn here. One is that in a floating exchange rate regime, the addition of the BP curve to the model does not change anything about how we do IS-LM analysis. All we do is move the BP curve in order to figure out which direction exchange rates will move. In this case the BP curve shifted upward, which means that the exchange rate rises.

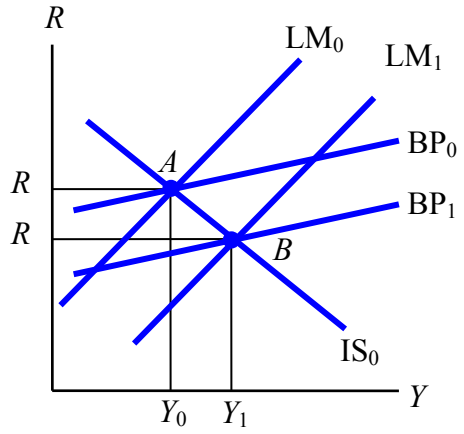
The second thing to learn is that fiscal expansions strengthen the dollar. This might seem counterintuitive. After all, the fiscal expansion raises income, which increases our imports, thereby increasing demand for foreign currency and increasing supply of dollars. This should put downward pressure on the exchange rate. But, and this matters, the fiscal policy also raises interest rates, attracting capital to the US, and raising the foreign demand for dollars so that foreign entities can buy US financial assets. This puts upward pressure on the exchange rate. The model shows us which of these two forces on exchange rates, the downward pressure from increased imports or the upward pressure from increased foreign demand for US assets, dominates. It's the pressure from the changing demand for US assets.

The mechanical nature of the model clearly helps here. If you were trying to reason it out on your own you could have come up with a rationale for rising or falling exchange rates. The model tells you which one really holds.

Figure 5.4 shows the effects of a rightward shift in the LM curve, which could arise from either an increase in domestic money supply or a decrease in the domestic price level. The economy again starts at point *A* where IS_0, LM_0, and BP_0 all intersect. The LM curve shifts rightward to LM_1, and the new equilibrium point is point *B* where IS_0 and LM_1 intersect. The BP curve must shift to pass through this point, which means that it must shift downward. Thus, exchange rates must fall.

FIGURE 5.4

MONETARY EXPANSION WITH FLOATING EXCHANGE RATES



The reason for the drop in exchange rates in Figure 5.4 is that the monetary expansion lowers interest rates, which makes US financial assets less attractive abroad, which reduces exchange rates. The increase in GDP puts upward pressure on the exchange rate, but the pressure from interest rate changes outweighs the pressure from income changes.

Table 5.3 summarizes the workings of the IS-LM-BP model in a floating exchange rate regime. Recall that a variable is endogenous if its value is determined by the system, and exogenous if its value is determined outside of the system. We can use the same terms to discuss curves instead of variables. In a floating exchange rate regime the IS and LM curves are given by the problem, but

the BP curve shifts to where it has to go. This makes the BP curve endogenous, while the IS and LM curves are exogenous.

TABLE 5.3
SUMMARY OF THE FLOATING EXCHANGE RATE MODEL

	IS curve	LM curve	BP curve
Exogenous or endogenous?	Exogenous	Exogenous	Endogenous
Increase gov't spending	Shift right	No shift	No shift
Increase taxes	Shift left	No shift	No shift
Increase money supply	No shift	Shift right	No shift
Increase price level	No shift	Shift left	No shift
Increase exchange rate	No shift	No shift	Shift up

5. FIXED EXCHANGE RATE REGIMES

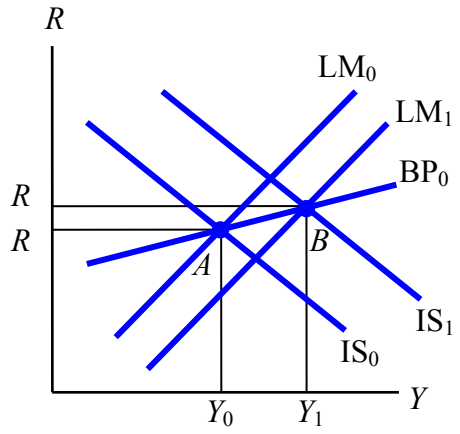
For most of the 20th century exchange rates were fixed, with most countries making an effort to peg their currency to the dollar. One famous system was the Bretton Woods system, negotiated by 44 countries at a hotel in Vermont in 1944. That system identified narrow bands within which exchange rates were allowed to fluctuate, and the original 1944 agreement also established the International Monetary Fund as well as an organization that is now part of the World Bank. That system finally collapsed in 1971 when the US ended the convertibility of dollars to gold. Even so, there are still many countries that fix their exchange rates, although the US and most of the major economies allow their interest rates to float. The purpose of this section is to analyze a country that tries to keep its exchange rate fixed.

Before we change the model, we must first figure out the mechanism by which a country keeps its exchange rate fixed. To do this we need a country and a currency. Let's choose the Latvian lat, and suppose that Latvia wants to fix the dollar/lat exchange rate at $2/lat. Suppose that there is increased demand for lats by US importers. This would ordinarily put upward pressure on the exchange rate, since the exchange rate is the price of a lat and demand for lats has risen. To remove this upward pressure, the Latvian central bank must provide these additional lats, which it can do by exchanging them for dollars on the open market. In essence, the central bank expands the Latvian money supply by buying dollars instead of Latvian government bonds.

Note from this story that if the Latvian central bank wants to control the exchange rate, it cannot control the money supply. This makes the exchange rate an exogenous policy variable in the model and makes money supply an endogenous variable. In terms of the IS-LM-BP model, fixing the exchange rate makes the BP curve exogenous and the LM curve endogenous.

Figure 5.5 shows the story. The economy begins at point *A*. An expansionary fiscal policy shifts the IS curve from IS_0 to IS_1. The new equilibrium point is *B*, where IS_1 crosses BP_0. The economy remains on BP_0 because the exchange rate is not allowed to adjust. The LM curve must shift to pass through point *B*, which means that it must shift to the right. The central bank increases money supply, which it does by exchanging the local currency for foreign currency.

FIGURE 5.5
FISCAL EXPANSION WITH FIXED EXCHANGE RATES

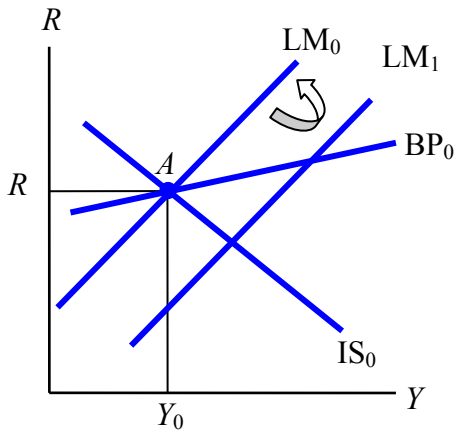


Comparing Figures 5.3 and 5.5, the fiscal expansion has a greater impact on GDP and a smaller impact on interest rates in the fixed exchange rate regime than in the floating exchange rate regime.

Figure 5.6 shows what happens when the LM curve shifts to the right because of, say, a money supply increase. Neither the IS nor the BP curves move, so the equilibrium stays at point *A*. The LM curve then shifts leftward back to its original spot. There is no change in the economy, and monetary policy is completely ineffective in a fixed exchange rate regime.

Currency crises occur because of fiscal downturns. Look at Figure 5.7, where the IS curve shifts left from IS_0 to IS_1, and then left again to IS_2. To keep the exchange rate fixed the central bank must contract money supply by selling from its stock of foreign currency, and then shrink it again by selling more foreign currency. This cannot go on forever because the central bank must eventually run out of foreign currency to sell. At this point the central bank can no longer artificially prop up the exchange rate, and it has no choice but to devalue the currency, shifting the BP curve downward to BP_3. This devaluation is actually good for the economy, allowing GDP to increase. bank runs out of foreign currency

FIGURE 5.6
MONETARY EXPANSION WITH FIXED EXCHANGE RATES



The lesson of Figure 5.7 is that in a prolonged fiscal downturn a fixed exchange rate regime actually makes things worse, and currency devaluations actually help. Also, currency devaluations might be forced by circumstances when the central bank runs out of foreign currency and can no longer prop up the artificially high exchange rate.

FIGURE 5.7
CURRENCY CRISIS WITH FIXED EXCHANGE RATES

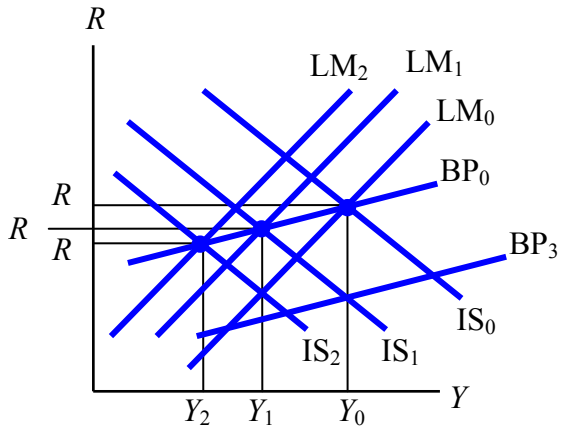


Table 5.4 summarizes the workings of the fixed exchange rate model. The term "ineffective" for the LM curve captures the idea of Figure 5.6: the LM curve shifts one way but then shifts right back to where it started.

TABLE 5.4
SUMMARY OF THE FIXED EXCHANGE RATE MODEL

	IS curve	**LM curve**	**BP curve**
Exogenous or endogenous?	Exogenous	Endogenous	Exogenous
Increase gov't spending	Shift right	No shift	No shift
Increase taxes	Shift left	No shift	No shift
Increase money supply	No shift	Ineffective	No shift
Increase price level	No shift	Ineffective	No shift
Increase exchange rate	No shift	No shift	Shift up

CHAPTER 6
ECONOMIC GROWTH

One might think that a chapter called "Economic Growth" would be about what makes economies grow. One would be mistaken. The subject of economic growth is really about what makes an economy rich, not growing. So, this chapter is about what makes economies prosper.

To put it in perspective, everything we have done up to now is about how an economy fluctuates. Now we want to look at why some economies are rich and advanced and so on, and why some just suck. So, this chapter takes sort of a long-run, cross-sectional view. We are going to look at broad, institutional factors, and changing these factors is a very long term process. On the other hand, if one looks across countries, one can determine which nations have pro-prosperity factors in place, and which have anti-prosperity factors. Business is likely to be better in the pro-prosperity countries. Consequently, this chapter can be thought of as addressing the issue of where to do business.

1. SOME NUMBERS

The very first thing we need to do is measure prosperity. Several measures are possible, but the one we will use is per capita income. Finding it is easy. We know by now that GDP measures income, so we just divide GDP by population to get our measure of prosperity.

Figures 6.1 – 6.3 use data from across several countries to show how per capita GDP correlates with some other variables. All data come from the Penn World Table 6.2 (http://pwt.econ.upenn.edu/php_site/pwt_index.php). Figure 6.1 looks at the saving rate, and the line is the standard regression line. The figure shows an upward trend, so that countries that save more tend to have higher per capita GDP. Figure 6.2 shows that countries that invest more, that is, that devote more of their income to purchasing new plants and equipment, also tend to be richer. Figure 6.3 shows that countries with higher population growth rates tend to be poorer.

By the way, the vertical axis of the three figures is the natural logarithm of per capita GDP. The reason for using the logarithm is that it compresses the

vertical axis, and compresses more at the top then at the bottom, so that not all of the data points are at the bottom of the graph. Also, it allows the regression line to give a better fit. But don't worry about it. This paragraph is just for full disclosure.

The figures show some clear trends. What we want to do now is formalize it through a model. We can then use the model to identify the factors that make countries wealthy. For the model to be a good one, though, it must fit the data, so it must imply that increased saving and increased investment both lead to higher per capita GDP, and higher population growth rates lead to lower per capita GDP.

Figure 6.1
Savings and per capita GDP

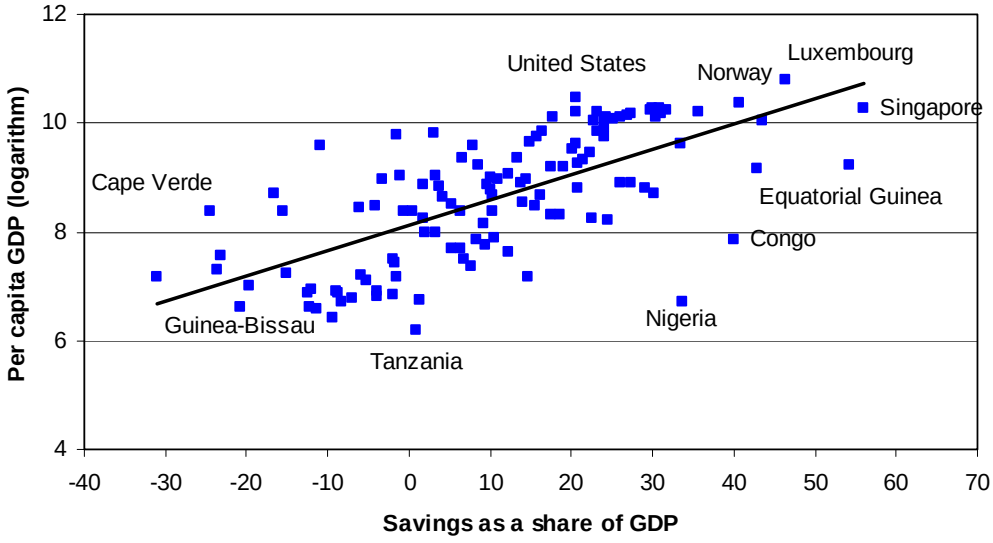


Figure 6.2
Investment and per capita GDP

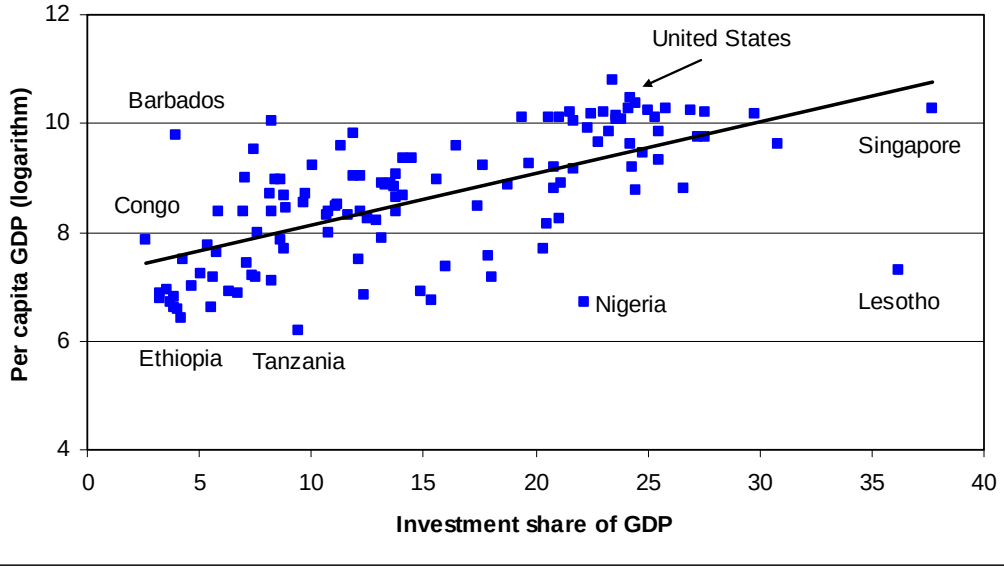
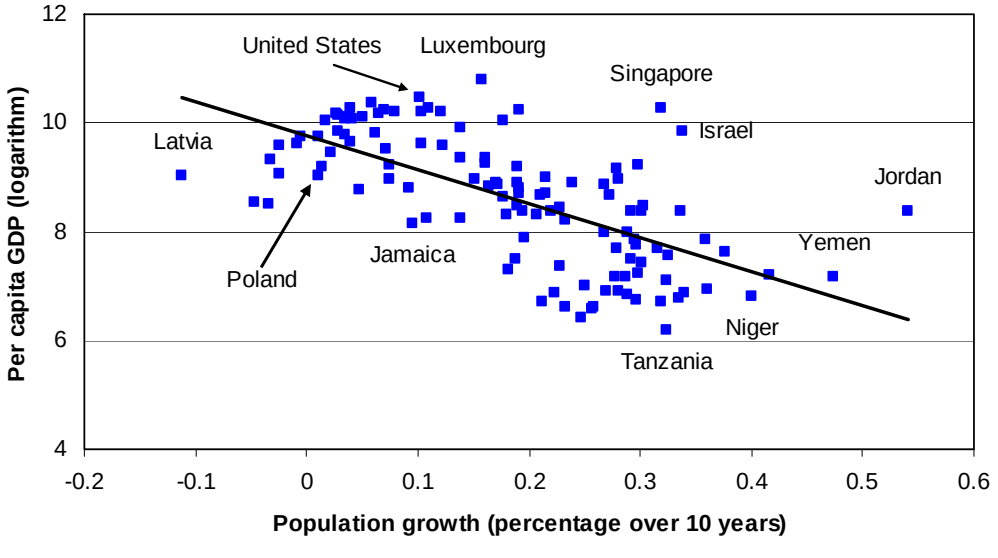


Figure 6.3
Population growth and per capita GDP



2. THE SOLOW GROWTH MODEL

The model we will use is a classic, and it earned Robert Solow of MIT a Nobel Prize. It's also very simple, built upon three basic ideas. These are

1. Investment = saving.
2. Agents save a fixed proportion of their output.
3. Investment provides more capital, which makes workers more productive.

We will cover these in turn.

First, the fact that investment and saving are equal comes directly from our division of GDP into components. Let's go through some arithmetic manipulations:

$$\begin{aligned} Y &= C + I + G + X \\ Y - C - G - X &= I \\ [Y - T - C] + [T - G] + [-X] &= I. \end{aligned} \tag{6.1}$$

As before, Y is income, C is consumption, G is government spending, X is net exports, and T is tax revenue. Look at the first term in brackets in equation (6.1). Y is income, and $Y - T$ is disposable income, or the amount households have to spend. They spend C on consumption, so the leftover is $Y - T - C$, which is saving by households. The second term in brackets is $T - G$. Tax revenue is the government's income, and G is the government's spending, so $T - G$ is government's saving. Finally, X is exports minus imports, so $-X$ is imports minus exports. Our imports provide income for individuals in other countries, and our exports are spending by individuals in other countries. Imports minus exports, then, is saving by the rest of the world.

Summarizing all of this, equation (6.1) becomes

$$[Y - T - C] + [T - G] + [-X] = I$$

[saving by households] + [saving by gov't] + [saving by rest of world] = investment

This is what we wanted to show, that saving equals investment.

Now suppose that overall saving is a fixed percentage of output. Let y denote per capita income, which is also per capita GDP. Also, let k denote per capita capital, which is the amount of equipment and machinery the average

worker has available for use in producing output. Workers use this capital to produce output, and the production function is

$$y = Af(k),$$

which is shown in Figure 6.4. There are two things to note. First, the production function is increasing but at a decreasing rate. This means that additional capital makes the average worker more productive, but each additional unit of capital adds less to his or her productivity than the previous units did. In other words, there are diminishing returns to capital. Second, an increase in A causes the production function to rotate upward. The parameter A captures technical progress, so an increase in technology makes capital and workers more productive.

From the graph, it is apparent that there are two ways that the average worker can earn more income. One is to use more capital, which means moving rightward along a production function. The other is to have a technological advance, which means shifting to a higher production function.

The big assumption of the model is that individuals save a fixed fraction of their incomes. Call this fraction s. Then savings is

$$\text{Savings} = sAf(k),$$

and it is shown in Figure 6.5. Remember that investment equals savings, so this is also the investment curve. For reasons that might become clear soon, I am going to label this the **available investment (AI) curve**. The height of the AI curve is simply the fraction s times the height of the production function.

FIGURE 6.4
PRODUCTION FUNCTION

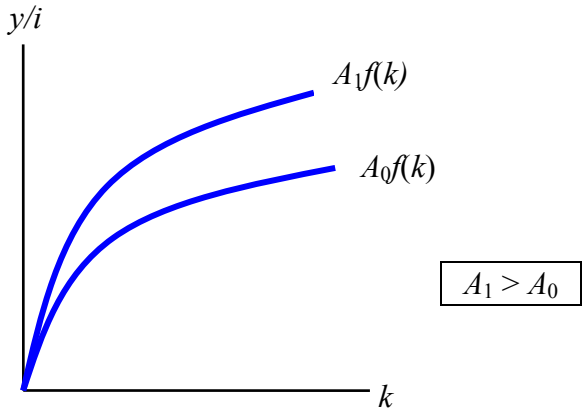
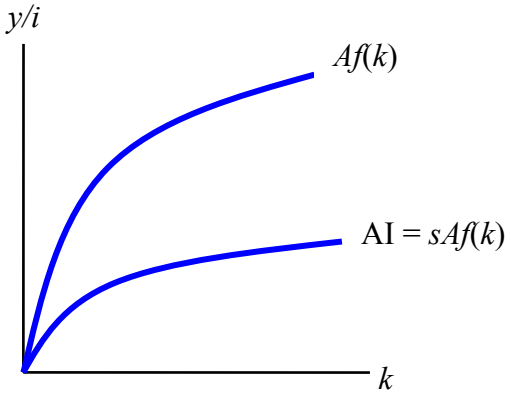


FIGURE 6.5
AVAILABLE INVESTMENT (AI) FUNCTION



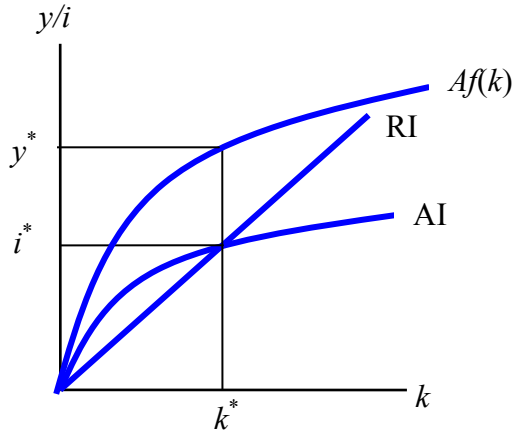
We have now covered the ideas that (1) investment equals saving and (2) individuals save a fixed fraction of their incomes. We now include the third idea, that (3) investment provides additional capital. Recall from Chapter 1 that

investment is spending by businesses on new plants and equipment. According to this definition, investment is the purchase of new capital.

However, there are two countervailing factors that naturally reduce the amount of capital available to the average worker. One is that capital depreciates, so some investment is required to replace the depreciated capital. A second is that as the population grows the same total stock of capital is being spread over more workers, meaning that each worker has a smaller amount of per capita capital to work with. Some investment is required to outfit the new workers.

Figure 6.6 has an additional curve, the **required investment (RI) curve**. This curve shows the amount of per capita investment needed to keep the level of capital per worker constant in the face of depreciation and a growing labor force. It is an upward sloping curve, since maintaining a higher level of capital requires a higher level of maintenance investment. A higher depreciation rate and a higher population growth rate both mean that more investment is required to maintain the same amount of capital per worker, so increases in the depreciation and birth rates shift the RI curve upward.

FIGURE 6.6
SOLOW GROWTH MODEL



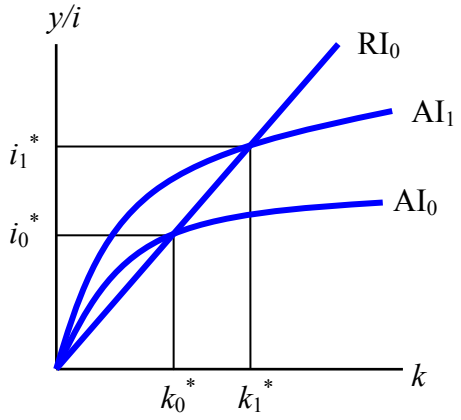
Combining the AI and RI curves into one graph gives us our growth model. The workings of the model are summarized in Table 6.1, which tells how the curves shift. Before we shift the curves, though, let's look closely at the model, because there is a lot going on. First of all, the curve shows us the outcome y^*, which is the equilibrium level of per capita GDP, which is also per capita income. So, the model shows us how well off the average worker is. But,

it also shows us k^*, which is the equilibrium level of capital per worker. Remember that investment is new capital, so the total capital stock is just accumulated investment. But investment equals saving, so the capital stock is also accumulated saving. The usual term for accumulated saving is wealth, so k^* is the equilibrium value of per capita wealth. The model gives us two measures of a country's well-being, per capita income and per capita wealth.

TABLE 6.1
SHIFTING THE AI AND RI CURVES

Change in variable	Impact on AI	Impact on RI
Increase depreciation rate	No shift	Shift up
Increase pop. growth rate	No shift	Shift up
Increase saving rate	Shift up	No shift
Technological advance	Shift up	No shift

FIGURE 6.7
INCREASED SAVING RATE OR TECHNOLOGICAL ADVANCE



Now let's shift some curves. Begin with an increase in the saving rate. The data in Figure 6.1 show that higher saving rates are associated with higher levels of per capita GDP. According to Table 6.1, an increase in the saving rate shifts the AI curve upward, which moves i* upward and k^* to the right, as shown in Figure 6.7. An increase in the saving rate leads to higher income (an increase

in y* associated with the increase in k*) and more wealth, consistent with the data.

This result, that higher saving rates lead to higher income and higher wealth, are pretty intuitive. It certainly works on a personal level. Think about Warren Buffett. He has extremely high income but very low spending, and has amassed a huge personal fortune. The model shows that the same thing works nationwide. If a country saves more of its income, it not only accumulates more wealth, but it ends up earning more income.

Figure 6.7 also works for technological advances, since they also shift the AI curve upward. So, technological advances raise per capita income and also make workers wealthier, even holding the saving rate constant.

FIGURE 6.8

INCREASED POPULATION GROWTH OR DEPRECIATION RATE

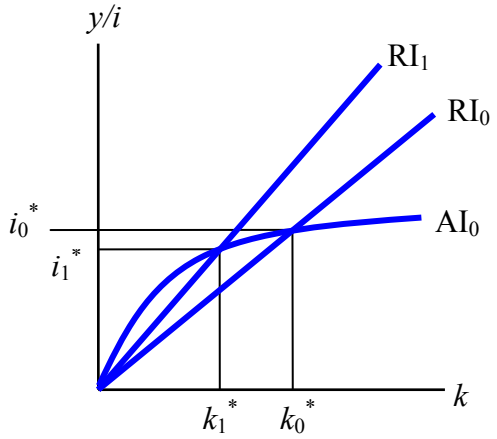


Figure 6.8 analyzes shifts in the RI curve. Suppose that there is an increase in the population growth rate. According to Table 6.1, this shifts the RI curve upward, since more investment is required to outfit the new workers with capital. The outcome is lower per capita GDP and lower wealth per worker. This fits what we saw in Figure 6.3, where countries with higher population growth tended to have lower per capita GDP.

Faster capital depreciation also reduces per capita income and per capita wealth.

3. KEYS TO A PROSPEROUS ECONOMY

The growth model of the preceding section pointed out three keys to a prosperous economy:

- High saving rates
- Continued technological advances
- Low population growth

This information on the three keys to a prosperous economy can be used in two ways. One is to govern policy. After all, policy should make us more prosperous, not less prosperous. We will look at policy initiatives in the next section. The other way to use the keys is to determine whether a country is a good one in which to do business.

The first key is a high saving rate. Recall from equation 6.1 that saving has three components – household saving, government saving, and saving by the rest of the world. The first two of these are important. A country with a high saving rate could get it from frugal households, or from a government that avoids deficit spending.

The second key is technological advances. An environment that favors technological advances has several pieces. First, whoever makes the advances must be able to keep the proceeds from the advancement. This entails both intellectual property rights protection, such as copyrights and patents, and low taxes. Second, legal institutions that make contracts enforceable are vital, because contract breaches also keep those who make the advances from profiting from their work. Third, education can be thought of as a technological advance, because a more educated work force is more productive with the same physical capital. A good education system is paramount, and there are reasons for education to be publicly provided.

The third key is low population growth. Anti-growth policies are difficult at the national level, and usually take the form of immigration restrictions. Anti-growth policies are much more common at the municipal level, with fast-growing communities taking steps to inhibit new people from coming into the community. Nevertheless, population growth is what it is, and slower-growing populations are more likely to prosper than faster-growing populations.

4. PRO-GROWTH POLICIES

Within the United States there are several measures that make sense for promoting prosperity in the long run, although they are painful in the short run. We will go through these in the order of the three keys to a prosperous economy.

There are two obvious ways to increase saving in the US. One is to reduce the deficit spending by the federal government, whether by cutting services or raising taxes. The other is to reform Social Security. Right now Social Security transfers money from workers to retirees. There is no actual saving, so there is no actual investment. However, the payroll taxes reduce worker disposable income, and the promise of future Social Security benefits means they need not save as much for retirement. Both of these make workers save less. A more pro-growth system would involve workers actually saving for retirement.

Many pro-technological growth pieces are already in place in the US. We have good intellectual property protection and a strong body of contract law. However, education, especially higher education, is primarily left to the states and private entities, and so the nation may be under-investing in education, leading to a work force with less human capital.

During the most recent presidential campaign much was made of promoting technological advances, primarily in the energy and environmental sectors. Such programs, if they came about, and if they made workers more productive, would aid prosperity. Those are big ifs, though.

Population growth policies have been in the news, too, primarily in the form of immigration controls. By limiting the amount of investment required to outfit new workers, these policies, if effective, could make the country more prosperous, but with obvious social costs.

All of these policies have something in common. We pay now for benefits much later. Cutting government deficits hurts now, but helps growth. Increasing educational spending costs us now, but leads to a more productive future workforce. Limiting immigration has social costs now, but can make us more prosperous in the future.

A useful metaphor is to think about a country that only produces one good, which we will call cake. Workers produce cake, which they also eat. The part that they don't eat can be used to increase their future cake production. However, they have to go hungry now to be better off in the future. Pro-growth policies are the ones that keep us from eating all of the cake now.