Chapter 3: Thinking Like an Economist

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Questions

1. Is economics a science?

2. What do economists mean by a *model*?

3. Why do economists use mathematical models so much?

4. What patterns and habits of thought must you learn to successfully think like an economist?

3.1 Understanding Macroeconomics

Every new subject requires new patterns of thought; every intellectual discipline calls for new ways of thinking about the world. After all, that is what makes it a *discipline*: a discipline that allows people to think about some subject in some new way. Economics is no exception.

In a way, learning an intellectual discipline like macroeconomics is similar to learning a new language or being initiated into a club. Economists’ way of thinking allows us to see the economy more sharply and clearly than before. (Of course, it can also cause us to miss certain relationships that are hard to quantify or hard to think of as purchases and sales; that is why economics is not the only social science, and we need sociologists, political scientists, historians, psychologists, and anthropologists as well.) In this chapter we will survey the intellectual landmarks of economists' system of thought, in order to help you orient yourself in the mental landscape of macroeconomics.

3.1 Economics: Is It a Science?

If you are coming to economics from a background in the *natural sciences* you probably expect economics to be something like a natural science, only less so. To the extent that it works, it works more or less like chemistry, though it does not work as well. Economic theories are unsettled and poorly described. Economists' predictions are often wrong.

If you hold these opinions, you are half-right. While economics is a science, it is not a *natural* science. It is a *social* science. Its subject is not electrons or elements, but human beings: people and how they behave. This subject matter has several important consequences. Some of them make economics easier than a natural science, some of them make economics harder than a natural science, and some of them just make it different.

First, because economics is a social science, debates within economics last a lot longer and are *much* less likely to end in a clear consensus than in the natural sciences. The major reason is that different people have different views of what makes a free, a good, a just, or a well-ordered society. They look for an economy that harmonizes with their vision of what a society should be. They ignore or explain away facts that turn out to be inconvenient for their particular political views. People are, after all, only human.

Economists *try* to approach the objectivity that characterizes most work in the natural sciences. After all, what is, is; and what is not, is not. Even if wishful thinking or predispositions contaminate the results of a single study, later studies can correct the error. But economists never approach the unanimity with which physicists embraced the theory of relativity, chemists embraced the oxygen theory of combustion, and biologists rejected the Lamarckian inheritance of acquired characteristics. Biology departments do not have Lamarckians. Chemistry departments do not have phlogistonists. But economics departments do have a wide variety of points of view and schools of thought.

Second, the fact that economics is about people means that economists cannot ethically undertake large-scale experiments. Economists cannot set up special situations in which potential sources of disturbance are reduced to a minimum, then observe what happens, and generalize from the results of the experiment (where sources of disturbance are absent) to what happens in the world (where sources of disturbance are common). Thus the experimental method, the driver of rapid progress in many of the natural sciences, is lacking in economics. This flaw makes economics harder to do, and it makes economists' conclusions much more tentative and subject to dispute.

Third, the subjects economists study--people--have minds of their own. They observe what is going on around them, plan for the future, and take steps to avoid future consequences that they foresee and fear will be unpleasant. At times they simply do what they want, just because they feel like doing it. Thus in economists' analyses the present often depends not just on the past but on the future as well--or rather on what people expect the future to be. Box 3.1 presents one example of this: it describes how people's expectations of the future and particularly their fear that there might be a depression contributed to the coming of the Great Depression of the 1930s.

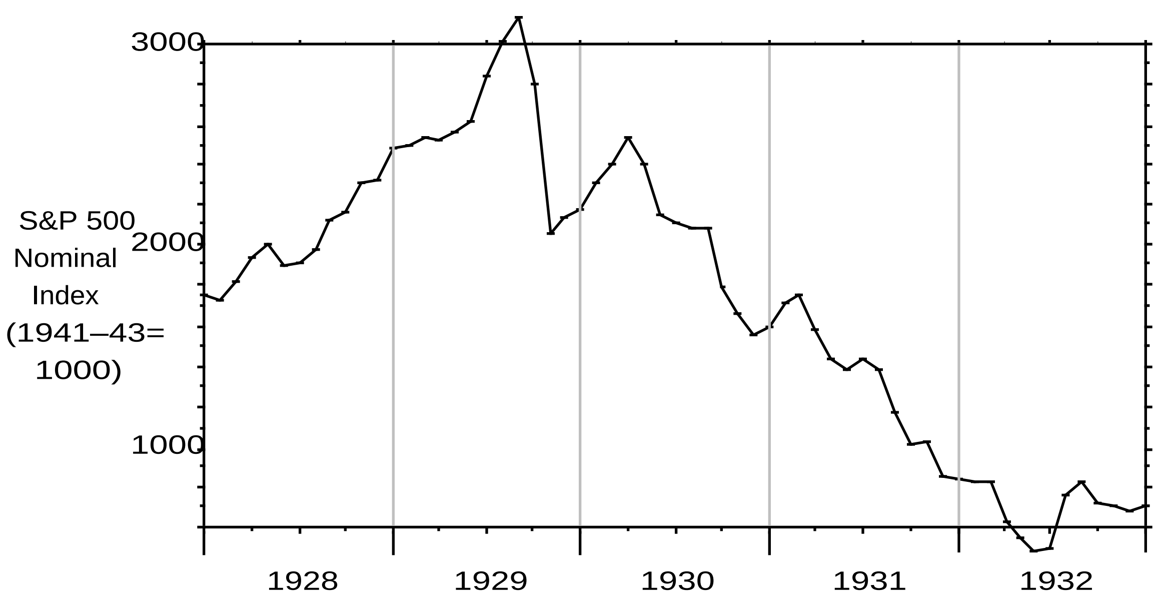
This third wrinkle makes economics in some sense very hard. Natural scientists can always assume the arrow of causality points from the past to the future. In economics people's expectations of the future means that the arrow of causality often points the other way, from the (anticipated) future back to the present.

Box 3.1--Example: Expectations and the Coming of the Great Depression

An important example of how people's expectations can change the course of economic events comes from the stock market crash of 1929. The crash changed what Americans expected about the future of the economy, and the shifts in spending caused by these changes in expectations played a key role in causing the greatest economic depression in American history, the Great Depression.

On October 29, 1929,the price of shares traded on the New York Stock Exchange suffered their largest one-day percentage drop in history. Stock values bounced back a bit initially, but by the end of the week they were down by more than a quarter (see Figure 3.1). Gloom fell over Wall Street. Many people had lost a lot of money.

Figure 3.1: The Stock , 1928-1932



At that time stock ownership was confined to the rich. Middle-class Americans owned little stock. Nonetheless, the crash affected their perceptions of the economy: bad times were coming. Because people expected the economic future to be dimmer, many cut back on spending, especially on big-ticket consumer durables. The 1920s had been the first decade in which consumer credit had been widely available to finance purchases of cars, refrigerators, stoves, and washing machines. With the economic future uncertain, spending on consumer durables collapsed. It made sense to borrow to buy a consumer durable only if you were confident that you could make the payments and pay off the loan. If you thought the economic future might be bad, you had a powerful incentive to avoid debt. And in the short run the easiest way to avoid debt is to not to purchase large consumer durables on credit.

You can probably guess what happened in the months after the crash. Most people simply stopped buying big-ticket items like cars and furniture. This massive drop in demand reduced new orders for goods. The drop in output generated lay-offs in many industries. Even though most people's incomes had not yet changed, their expectations of their future income had.

The drop in demand produced by this shift in expectations helped bring on what people feared, and put America on the path to The Great Depression. The Great Depression happened in large part because people expected something bad to happen. Without that pessimistic shift in expectations triggered by the crash of 1929, there would have been Great Depression.

Reliance on Quantitative Models

In spite of the political complications, the non-experimental nature, and the peculiar problems of cause and effect in economics, the discipline remains a *quantitative* science. Most of the relationships that economists study come quantified. Thus economics makes heavy use of arithmetic and algebra, while political science, sociology, and most of history do not. Economics makes heavy use of arithmetic to measure economic variables of interest. Moreover, economists use mathematical *models* to relate these variables.

The American economy is complex: 130 million workers, 10 million firms, and 90 million households buying and selling $24 trillion worth of goods and services a year. Economists must simplify it. To understand this complex phenomenon, they restrict their attention to a very few behavioral relationships--cause-and-effect links between economic quantities--and a handful of equilibrium conditions--that is, conditions that must be satisfied for economic activity to be stable and for supply and demand to be in balance. They attempt to cappture these behavioral relationships and equilibrium conditions in simple algebraic equations and geometric diagrams. Then they try to apply their equations and graphs to the real world, while hoping that their simplifications have not made the model a distorted and faulty guide to how the real world economy works.

Economists call this process of reducing the complexity and variation of the real-world economy into a handful of equations “building a model.” Using these to understand what is going on in the complex real-world economy has been a fruitful intellectual strategy. But model-bulding tends to focus on those variables and relationships that fit easily into the algebraic model. It overlooks other factors.

An Emphasis on the Abstract

Economics might have developed as a descriptive science, like sociology or political science. If so, courses in economics would concentrate on economic institutions and practices, and the institutional structure of the economy as a whole. But it has not, and has instead become a more abstract science that emphasizes general principles applicable to a variety of situations. Thus a large part of economics is tied up in their particular set of tools: a particular way of thinking about the world that is closely tied up in the analytical tools economists use, a way of thinking about the world that is couched in a particular technical language and a particular set of data. While one can get a lot out of sociology and political science courses without learning to think like a sociologist or a political scientist (because of their focus on institutional description), it is not possible to get much out of an economics course without learning to think like an economist.

The Rhetoric of Economics.

Surrounding the models economists build a special *rhetoric*: a set of analogies and metaphors that economists use to help us grasp the functioning of the macroeconomy. Metaphors and analogies are the basic stuff of human thought: to understand something we do not know, we will often compare to something we do know. Economics is no exception. In economics, curves “shift.” Money has a “velocity." When the central bank raises interest rates and throws people out of work, economists say that it “pushes the economy down the Phillips curve.” Conversely, when the central bank lowers interest rates and the economy booms, economists say that it “pushes the economy up the Phillips curve”--as if the economy were a dot on a diagram drawn on a piece of paper, constrained to move along a particular curve on the diagram called the Phillips curve, and monetary policy really did push this dot up and to the left.

Figure 3.2: The Phillips Curve

Pushing the Economy Up the Phillips Curve

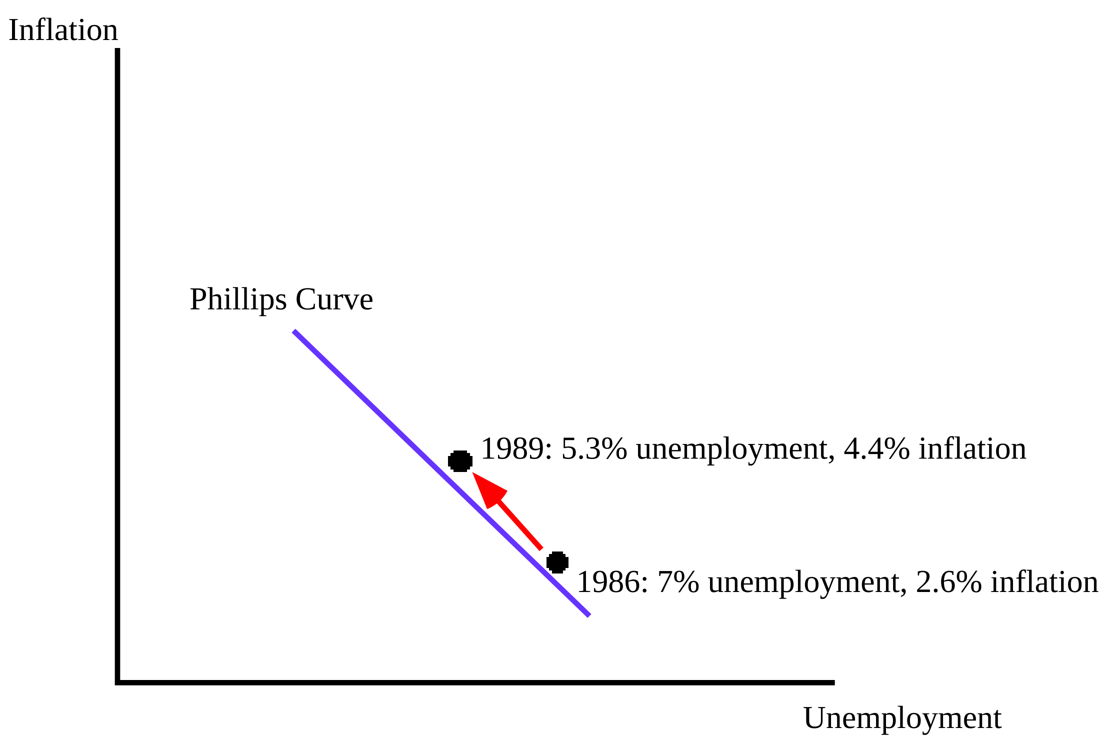


Figure Legend: Between 1986 and 1989 the Federal Reserve's expansionary monetary policy reduced interest rates and increased total spending. Increased total spending meant that unemployment fell from 7% in 1986 to 5.3% in 1989. As unemployment fell, inflation rose from 2.6% in 1986 to 4.4% in 1989.

> Economists talk about this change by saying that "between 1986 and 1989 the Federal Reserve's expansionary monetary policy pushed the economy up and to the left along the Phillips curve" (which describes the short-run relationship between unemployment and inflation).
>
> *Source:* 1999 edition of the *Economic Report of the President.*

As a student you should be conscious of (and a little critical of) the rhetoric of economics for two reasons. First, if you don't understand the metaphors, much of economics may simply be completely incomprehensible. All will become clear… or at least clearer… if you are conscious of the metaphors. For example, there is a central dominant metaphor in macroeconomics, the *circular flow metaphor,* without which discussions of the "velocity" of money are simply incomprehensible. This circular flow metaphor compares the process of spending through the economy to the flow of some liquid. Thus if the total amount of spending increases but the quantity of money does not, then the money must "flow" faster since a fixed quantity of pieces of money must change hands more often. Hence money must have a higher *velocity*. Without the concept of spending as a *circular flow* of purchasing power, references to the "velocity" of money will make no sense.

Much of the rhetoric of economics can be reduced to four dominant concepts. They are:

- The image of the circular flow of purchasing power through the economy—the circular flow of economic activity.

- The use of the word “market” to describe intricate and decentralized processes of exchange--as if all the workers and all the jobs in the economy really were being matched in a single open-air market.
- The idea of “equilibrium”: that economic processes tend to move the economy into some sort of balance, and to keep the economy at this point of balance.
- The use of graphs and diagrams as an alternative to equations and arithmetic in expressing economic relationships. Economists identify equations with geometric curves; situations of equilibrium with points where curves cross; and changes in the economic environment or in economic policy with shifts in the positions of particular curves.

We will look next at the circular flow of economic activity. The market, equilibrium, and the relationship between graphs and equations will be covered in later sections.

3.2 The Circular Flow of Economic Activity

When economists speak of the "circular flow" of economic activity, they have a definite picture in mind. They see paterns of spending, income, and production as liquid flowing through various sets of pipes. In this extended metaphor, categories of agents in the economy-- all businesses, or the government, or all households--are the pools into and out of which the fluid of purchasing power (i.e., money) flows.

Thus economists think of economic activity--the pattern of production and spending in the economy--as a circular flow of purchasing power through the economy. This circular flow metaphor allows them confidently to predict that changes in one part of the economy will affect the whole, and in what ways. It allows them to simplify economic behavior, to understand the entire set of decisions taken by different agents in different parts of the economy by thinking of a few typical decisions taken by abstract representative agents.

The Circular Flow Diagram

Figure 3.3 shows a simplified diagram of this circular flow. It omits the government, and omits international trade. Nevertheless, it is a good place to start. In this figure, money payments flow from firms to households as businesses pay their workers and their owners for their labor and their capital. This is the "income side" of the circular flow: firms buy the *factors of production* capital and labor from the households that own them. Money payments then flow from households to firms as households buy goods. This is the "expenditure side" of the circular flow: households buy *final goods and services* from businesses. Note that these flows balance: the purchasing power that firms earn by selling their goods is the same as the purchasing power that firms spend by buying factors of production; and the incomes of households are then equal to their total expenditures.

Figure 3.3: The Circular Flow Diagram

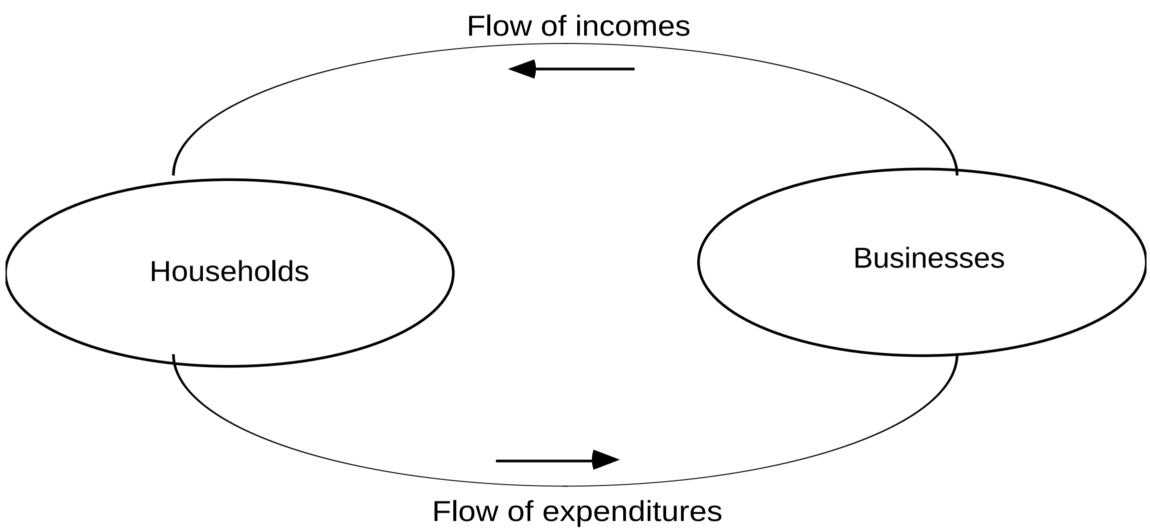


Figure Legend: A version of the *circular flow diagram.* Households spend money buying the products made by businesses, and businesses turn around and spend the same money buying *factors of production*--workers' time and attention, finance, the use of land and other property--from households.

This simplified diagram needs to be elaborated to take account of the role of the government, of financial markets, and of international trade and investment. But the core idea of a balanced circular flow of purchasing power is still there in Figure 3.4. Along the top of the diagram there is still the flow of incomes to households from businesses as they purchase labor and other factors of production from the households that own them. All of these components of business expenditure--rent, wages, salaries, benefits, interest, and profits--become the components of *household income.* To the bottom left of the diagram are the uses of *household -incomes*--consumption spending, savings, and taxes. Consumption spending flows directly to businesses as households purchase consumption goods. Total taxes flow to the government, which uses some of them to make transfer payments--classified here as negative taxes--back to households, uses most of them for government purchases, and sends the remaining *government budget surplus* into financial markets as the government uses its budget surplus to buy back bonds.

Figure 3.4: Circular Flow of Economic Activity

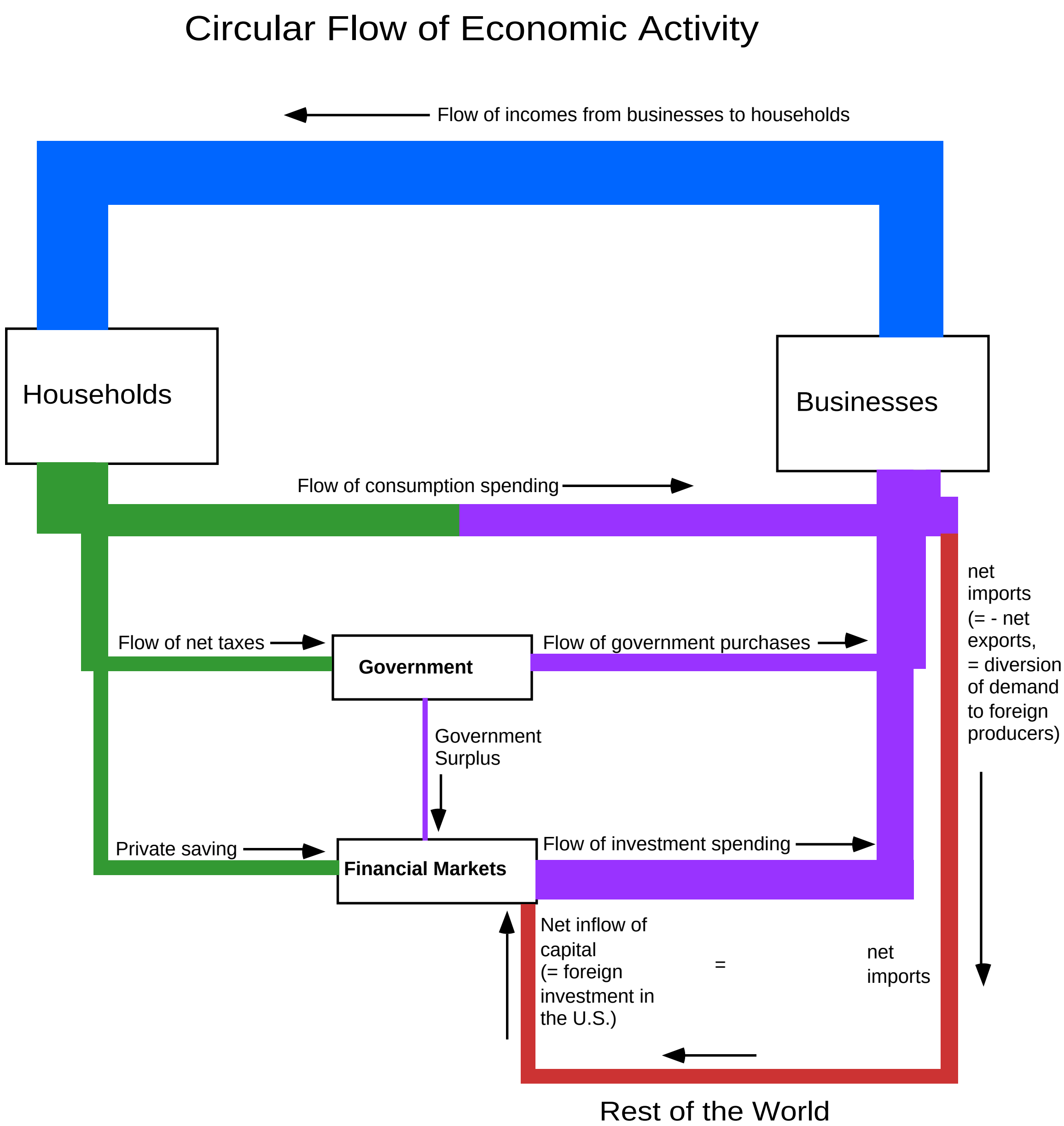


Figure Legend: A more complicated *circular flow diagram.* This version is complicated by the addition of the government and financial markets to the diagram. Not all final goods and services are bought by households. Some are bought by the government, which taxes to raise resources to finance itself. Some are bought by businesses seeking to invest, which raise the needed resources by issuing stock, issuing bonds, and borrowing--all of which take place in *financial markets*. This version is also complicated by its recognizing that there is a world outside: a world outside that buys the products of domestic businesses, and that also invests through domestic financial markets.

Households save what of their incomes is left over after taxes and consumption spending. These savings flow into financial markets as they are put into banks and mutual funds. Businesses seeking to invest draw on the pool of savings to gain financing to purchase capital goods to expand their productive capacity. Exports serve as an addition to (and imports a subtraction from) total demand for domestically-made products.

Thus on the bottom right we have the components of *aggregate demand*: consumption spending, investment spending, government purchases, and net exports (which are in the United States today net imports, a subtraction from GDP, because imports are greater than gross exports).

Within the *business sector,* businesses buy and sell intermediate goods from each other as they strive to produce goods and services and make profits. Within the *household sector*, households buy and sell assets from and to one another. These within-the-business-sector and within-the-household-sector transactions are important components of the economy. But because they net out to zero within the business sector or within the household sector, they are not counted as part of the circular flow of economic activity.

To better grasp the circular flow of economic activity, look at one particular part of the circular flow, a dollar paid out by a business as a dividend to a shareholder. The dollar is payment for use of a factor of production, the capital invested in the business by the shareholder. When the dividend check is deposited, it becomes part of the shareholder's household income. Suppose the household doesn't spend it, but simply keeps the extra money in the bank, thus saving it. The bank will notice that it has an extra dollar on deposit, and will loan that dollar out to a business in need of cash to build up its inventory. That business will then spend the dollar buying goods and services as it builds up its inventory. As soon as the dollar shows up as a component of business investment spending, the circular flow is complete. The dollar's worth of purchasing power has flowed from the business sector to the household sector, then flowed as part of the flow of savings into the financial markets, and finally out of the financial markets and back to the business sector as part of business investment spending.

Different Measures of the Circular Flow

Income, production, and expenditure can be measured at three different points in the circular flow. Economists measure GDP at the point where consumers, exporters, the government, and firms that are making investments purchases goods and services from businesses. This measurement is real GDP, or total output. It is the total economy-wide production of goods and services. It is the "expenditure side" measure of the circular flow.

Economists also measure the level of economic activity at the point in the circular flow where businesses pay households for the factors of production. Businesses need labor, capital, and natural resources, all factors of production owned directly or indirectly by households. When businesses buy them, they provide households with incomes. This measurement is called total income or national income. It is the "income side" measure of the circular flow.

Third, economists measure the level of economic activity at the point where households decide how to use their income. How much do they save? How much do they pay in taxes? How much do they spend on consumption goods? This measure of the circular flow of economic activity is the "uses of income" measure.

The measure used most often is the expenditure-side measure: the Gross Domestic Product produced by firms and demanded by purchasers. It is estimated by counting up the four components of spending (and sales): consumption, government purchases, investment, and net exports. If we compare the expenditure-side measure of GDP with the income-side or uses-of-income-side measure, we will find that aside from differences created by different accounting conventions they are equal (see Box 3.2). They are equal because the circular flow principle is designed into the National Income and Product Accounts (NIPA). Every expenditure on a final good or service is accounted for as a payment to a business. Every dollar payment that flows into a business is then accounted for as paid out to somebody. It can be paid out as income--wages, fringe benefits, profits, interest, or rent, or as an expenditure on goods or services of another business that then in its turn purchases factors of production.

What if you want to withdraw your income from the circular flow? Suppose, for instance, you simply take the dollar bills you receive and use them to buy something old and precious from another household--a bar of gold, say. And suppose you keep the bar of gold in your basement. Doesn't that break the circular flow? The answer is that it does not. You no longer have your income, but the household that you bought the gold bar from does. That household will then either spend it on consumption goods, save it, or have it taxed away.

What if you decided to hide the dollar bills themselves in your basement? Doesn't that break the circular flow? The answer is that it does not. The Bureau of Engraving and Printing will notice that the total number of dollar bills circulating in the economy has dropped. It will print up more dollar bills, and hand them to the Treasury. The government will spend these extra dollar bills, and so replace the ones you have hidden. The net effect would be the same as if you had saved that portion of your income by loaning it out to the government and had bought a Treasury bond. There are only two differences between buying a Treasury bond and your basement storage scheme. The first is that you have a stack of dollar bills in your basement rather than a piece of paper with the words "Treasury bond" written on it. The second is that the government does not pay interest on the dollar bills stacked in your basement, but it does pay interest on its bonds.

In the circular flow diagram, you have saved this portion of your income, and you have saved it in a relatively pointless way by making the government an interest-free loan.

Box 3.2--Tools: Accounting Definitions and Statistical Discrepancies

Because of the technical details of national income accounting, the different measures of the circular flow will not exactly balance. First, there is the *statistical discrepancy.* All pieces of GDP reported by the Commerce Department are estimates. All estimates are imperfect. It is not unusual for $100 billion a year to go "missing" in the circular flow, as Table 3.1 shows happened in the third quarter of 2000.

Measures of the U.S. Circular Flow in the Third Quarter of 2000

	(in billions)
Gross Domestic Product	$8,574
Minus *Depreciation*	-$912
Equals *Net Domestic Product*	$7,662
Minus *Net Factor Incomes Paid Abroad*	-$64
Equals *Net National Product*	$7,598
Minus *Net Indirect Taxes*	-$693
Plus *Net Subsidy to Government Enterprises*	+$25
Plus *Statistical Discrepancy*	-$102
Equals *National Income*	$7,032

Source: National Income and Product Accounts.

Second, different measurements of the circular flow differ because of differences in exact accounting definitions. For example, measures of Net Domestic Product and National Income (NI) exclude depreciation expenditures, but Gross Domestic Product includes them. NI excludes indirect business taxes, but the Product measures include them. Domestic Product measures include and National Product measures exclude incomes earned in the United States by people who are not citizens or permanent residents. And National Product measures include and Domestic Product measures exclude incomes earned abroad by U.S. citizens and permanent residents.

3.3 Rhetoric Continued: Patterns of Economists' Thought

Besides the circular flow of economic activity, three other concepts dominate the rhetoric of economics:

- The idea of the economy as made up of a few very large marketplaces--as if all the workers and all the jobs in the economy really were being matched in a single open-air market.
- The idea of equilibrium: that economic processes tend to move the economy into some sort of balance, and to keep the economy at this point of balance.
- The use of graphs and diagrams as an alternative to equations and arithmetic in expressing economic relationships--the identification of equations with geometric curves; situations of equilibrium with points where curves cross;

and changes in the economic environment or in economic policy with shifts in the positions of particular curves.

Let's look at each of these in turn.

Markets

Economists often speak as if all economic activity took place in the great open-air marketplaces of medieval merchant cities. Contracts between workers and bosses are made in the “labor market.” All the borrowing of money from and the depositing of money into banks take place in the “money market.” Supply and demand balance in the “goods market.” Indeed, in the market squares of pre-industrial trading cities you could survey the buyers and sellers, and form a good idea of what was being sold for how much.

In using the open-air markets of centuries past as a metaphor for the complex processes of matching and exchange that take place in today's modern industrial economy, economists are assuming that information travels fast enough and that buyers and sellers are well informed enough that prevailing prices and quantities are *as if* we actually could walk around the perimeter of the marketplace and examine all buyers and sellers in an hour. In most cases this will be a good intellectual bet to make. But some times (for example, in situations of so-called *structural unemployment*) it may not be.

Equilibrium

Economists spend most of their time searching for the state of *equilibrium*--a point or points of balance at which some economic quantity is neither rising nor falling. The dominant metaphor is of an old-fashioned scale whose two pans are in balance. This search for equilibrium is an attempt to simplify the problem. Economis questions are much easier to analyze if we can identify “points of rest” where pressures for economic quantities to rise and fall are evenly balanced. Once the potential points of rest have been identified, economists can figure out how fast economic forces will push the economy to those points of equilibrium. This search for points of equilibrium, followed by an analysis of the speed of adjustment to equilibrium, is the most common way of proceeding in any economic analysis.

Do not, however, forget that this pattern of thought is merely an aid to understanding economic theories and principles. They are not the theories and principles themselves. the theories and principles, in turn, are just aids to understanding the reality; they are not themselves the reality.

Graphs and Equations

In the seventeenth century, the French philosopher and mathematician Rene Descartes spent much of his life demonstrating that graphs and equations are two different representations of the same reality. Specifically, an algebraic equation relating two variables can also be represented as a curve drawn on a graph. Each of the variables in the equation can be thought of as one of the axes of the graph. The set of points whose x-axis value is the first variable and whose y-axis value is the second—that is, the set of points for which the equation holds—makes up the line or a curve on the graph. That line or curve *is* the equation (see Figure 3.5). Thus the solution to a set of two equations is that point on the graph where the two curves that represent the equations intersect. Moreover, you can just as easily move back in the other direction, by thinking of a curve in terms of the equation that generates it. Today economists make very extensive use of these ideas from Rene Descartes's *analytic geometry*.

Just after the end of World War II Professor Paul Samuelson of M.I.T. discovered that many of his students were much more comfortable manipulating diagrams than solving algebraic equations. With diagrams, they could *see* what is going on in a hypothetical economy. Thinking of how a particular curve would shift was often easier than thinking of the consequences of changing the value of the constant term in an equation.

Figure 3.5: Two Forms of the Production Function

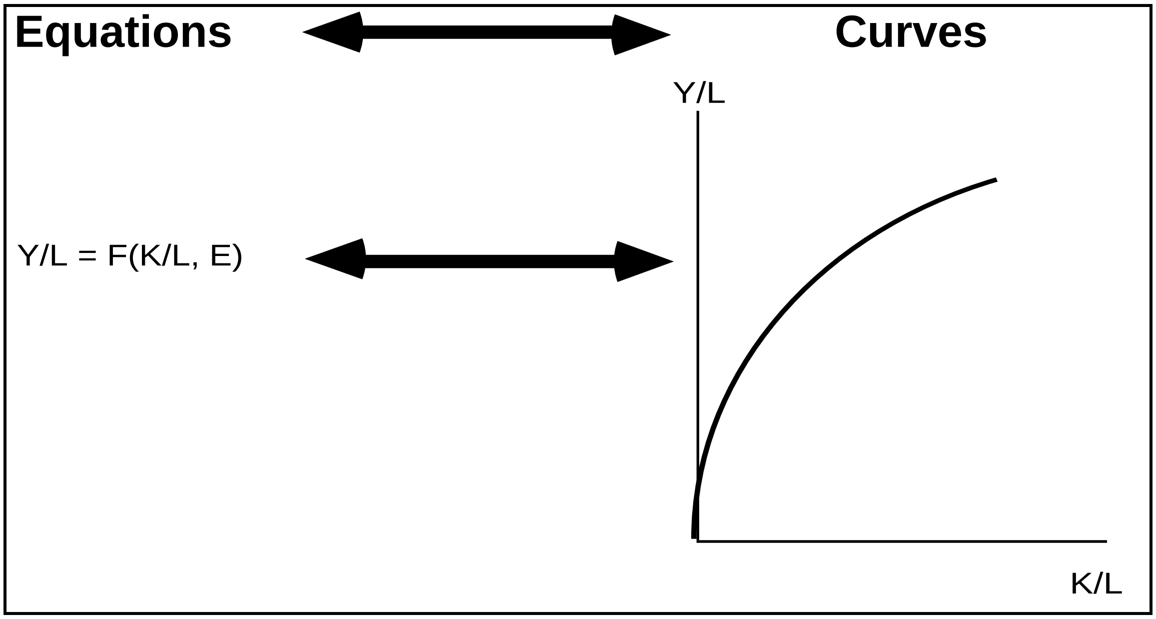


Figure Legend: Economists build their arguments by moving back and forth between equations and diagrams, representing the same relationship. The graph on the right is the geometric representation of the algebraic equation on the left.

When economists translate their algebraic equations into analytical-geometric diagrams, they do two things that may annoy you. First, economists (like mathematicians) think of a "line" as a special kind of "curve" (and it is: it is a curve with zero curvature, after all). So you may find words--in this book, or in your lecture, or in your section--referring to a "Phillips curve," but when you will look over at the accompanying diagram you see that it is a straight line. Do not let this bother you. Economists use the word "curve" to preserve a little generality.

If you find analytic geometry easy and intuitive, then Samuelson's intellectual innovation will make macroeconomics more accessible to you. Behavioral relationships become curves that shift about on a graph. Conditions of economic equilibrium become dots where curves describing two behavioral relationships cross (and thus both behavioral relationships are satisfied). Changes in the state of the economy become movements of a dot. Understanding economic theories and arguments becomes as simple as moving lines and curves around on a graph and looking for the place where the correct two curves intersect. And solving systems of equations becomes easy, as does changing the presuppositions of the problem and noting the results.

If you are not comfortable with analytic geometry, then you need to find other tools to help you think like an economist. Remember that the graphs are merely *tools* to *aid* your understanding. If they don't, then you need to concentrate on understanding and manipulating the algebra, or at understanding and using the verbal descriptions of a problem. Use whatever method feels most comfortable: grab hold of what makes most sense, and recognize that all three are ways of reaching the same conclusions.

Building Models

The American economy is complex: 130 million workers, 10 million firms, and 90 million households all producing $8.5 trillion worth of goods and services a year.

Economists have placed the intellectual bet that the best way to understand this complexity is to simplify. Restrict the problem to a very few behavioral relationships--cause-and-effect links between two sets of economic quantities. Look at only a handful of equilibrium conditions--conditions that must be satisfied for economic activity to remain stable. Capture these few behavioral relationships and equilibrium conditions in simple algebraic equations (and use diagrams to represent those equations). See how the mathematical system made up of those equations behaves. Then apply them back to the real world, and hope that the quantifiying and simplifying have not made the model a bad approximation to reality. Economists call this process of focus and analysis "building a model."

Simplification is the essence of model-building. Economists use simple models for two reasons. First, no one really understands excessively complicated models, and model is of little use if economists cannot understand the logic behind a model's prediction. Second, the predictions generated by simple models are nearly as good as the ones generated by more complex models. While the economic models used by the Federal Reserve or the Congressional Budget Office are more complicated than the models presented in this textbook, at the bottom they are clearly cousins of the models used here.

You may have heard that economics is more of an art than a science. This means that the rules for effective and useful model-building--for omitting unnecessary detail and complexity while retaining the necessary and important relationships--are nowhere written down. In this important respect, economists tend to learn by doing or by example. But there are fundamental steps that almost every successful construction of a macroeconomic model follows. They include the use of representative agents, a focus on opportunity costs in understanding agents' decisions, and careful attention to the effect of people's expectations on events.

Representative Agents

One simplification that macroeconomists--but not microeconomists--invoke constantly is that all participants in the economy are the same, or rather that the differences between businesses and workers do not matter much for the issues macroeconomists study. Thus macroeconomists will analyze a situation by examining the decision-making of a single *representative agent*--be it a business, a worker, or a saver. They will then generalize to the economy as a whole from what would be the rational decisions of that single representative agent.

This use of representative agents makes macroeconomics simpler. Yet it also makes some questions very hard to analyze. Consider unemployment: the key concept is that some workers have jobs but others do not. If one has adopted the simplifying assumption of a single representative worker, how can one worker represent both those who are employed and those who are not?

The assumption of a representative agent is also useless when the relative *distribution* of income and wealth among people in the economy is important. Most of the time our judgments about social welfare are tied up with distribution. Consider an economy in which everyone works equally hard, but a million lucky people received $1,000,000 a year in income and 99 million received $10,000 a year in income. Now consider an economy in which all 100 million people work equally hard and all receive $80,000 a year in income. Almost all of us would think that the second was a better--a happier and a fairer--economy, even though total incomes in the first economy amounted to $10.9 trillion and total incomes in the second economy amounted to only $8 trillion. As noted above, every discipline sees some things clearly and some things fuzzily. Distribution and its impact on social welfare is an area that macroeconomics has trouble bringing into focus.

Opportunity Cost

Perhaps the most fundamental principle of economics is that there is always a choice. But making a choice excludes the alternatives. If you keep your wealth in the form of easily-spendable cash, you pass up the chance to keep it earning interest in the form of bonds. If you keep your wealth in the form of interest-earning bonds, you pass up the capability of immediately spending it on something that suddenly strikes your fancy. If you spend on consumption goods, you pass up the opportunity to save. Economists use the term *opportunity cost* to refer to the value of the best alternative that you forego in making any particular choice.

At the root of every behavioral relationship is somebody's decision. In analyzing that decision, economists will always think about the decision maker's *opportunity costs.* What else could the decision maker do? What opporutnities and choices does the decision maker foreclose by taking one particular course of action? Many students make economics a lot harder than it has to be by not remembering that this opportunity cost way of thinking is at the heart of every behavioral relationship in an economic model.

The Focus on Expectations

Much of the time the *opportunity cost* of taking some action today will be not an alternative use of the same resources today, but a foregone opportunity to save one's resources for the future. A worker trying to decide whether to quit a job and search for another will be thinking about future wages after a successful search. A consumer trying to decide whether to spend or save will be thinking about what interest rate savings will earn in the future.

No one, however, knows the future. At best people can form rational and reasonable expectations of what the future might be. Hence nearly every behavioral relationship in macroeconomic models depends on *expectations of the future*. Expectations formation is a central, perhaps the central piece of macroeconomics: every macroeconomic model must explain the amount of time people can spend thinking about the future, the information they have available, and the rules of thumb they use to turn information into expectations.

Economists tend to consider three types of expectations:

- Static expectations, in which decision makers simply don't think about the future.
- Adaptive expectations, in which decision makers assume that the future is going to be like the recent past.

- Rational expectations, in which decision makers spend as much time as they can thinking about the future, and know as much (or more) about the structure and behavior of the economy as the model builder does.

The behavior of an economic model will differ profoundly depending on what kind of expectations economists build into the model.

Solving Economic Models

Behavioral Relationships and Equilibrium Conditions

When economists are trying to analyze the implications of how people *act*--say, how the overall level of production would change with a larger capital stock--they will almost always write an equation that represents a *behavioral relationship*. This behavioral relationship states how the effect (the total level of production) is related to the cause (the available capital stock). The economist will usually draw a diagram to help visualize the relationship, and write it down verbally: "A larger capital stock means that the average employee will have more machines and equipment to work with, and will increase total production per worker. But increases in capital will probably be subject to *diminishing returns to scale,* so that the gain in production from increasing the capital stock per worker from $40,000 to $80,000 will be less than the gain in production from increasing the capital stock per worker from $0 to $40,000." Box 3.3 fleshes out this example of a behavioral relationship, in this case the *production function*.

Box 3.3-- The Production Function: An Example of a Behavioral Relationship

One of the key behavioral relationships in macroeconomics is the *production function*, which specifies the relationship between the economy's productive resources. The production function relates:

- the economy's capital-labor ratio (how many machines, tools, and structures are available to the average worker), written K/L ("K" for capital and "L" for labor).
- the level of technology or efficiency of the labor force, written E.
- the level of real GDP per worker, written Y/L, (Y" for real GDP or total output and "L" for the number of workers in the economy).

An economist could write the production function in this general, abstract form:

$$Y/L = F(K/L, E_t)$$

This formula states that the level of output per worker is some *function*, F(), of K/L and E; that is, the level of output per worker depends in a systematic and predictable way on the capital-labor ratio and the efficiency of labor. But this abstract form does not specify the particular form of this systematic and predictable relationship.

Alternatively, an economist could write the production function in a particular algebraic form, for example the Cobb-Douglas form:

$$Y/L = (K/L)^{\alpha} \times E_t^{1-\alpha}$$

This equation states: "Take the capital-labor ratio, raise it to the exponential power α, and multiply the result by the efficiency of labor E_t raised to the exponential power (1- α). The result is the level of output per worker that the economy can produce." While this equation is more particular than the abstract, general form Y/L = F(K/L, E_t), it remains flexible: the parameter α could have any of a wide range of different values, and the efficiency of labor E_t could have any value. This Cobb-Douglas algebraic form still stands for a whole family of possible production functions. The values are chosen for E and α will tell us exactly which production function is the real one, and thus what the behavioral relationship is between the economy's resources and its output. For once we know the values of E and α, we can calculate what output per worker will be for every possible value of capital per worker.

Why do economists choose to write down the production function in this particular algebraic form? Truth be told, economists often use this form of the production function because it makes a lot of calculations *much* simpler and more straightforward than other forms. Ease of use is the key reason.

Box 3.4-- Tools: Working with Exponents

What is the point behind the use of the Cobb-Douglas production function, with all of its exponents?

$$Y/L = (K/L)^{\alpha} \times E_t^{1-\alpha}$$

Recall that exponents greater than one are a way of repeated multiplication: 2^1 is two times itself once: that is, 2. 2^2 is two times itself twice: that is, 2 x 2 = 4. 2^3 is two times itself three times: that is, 2 x 2 x 2 = 8. Recall that exponents between one and zero are a way of taking roots. $2^{(0.5)}$ is the square root of two. $2^{(1/3)}$ is the cube root of two.

Whenever the Cobb-Douglas production function is used, the *parameters* that are the exponents will be between zero and one. In fact, in most applications of this production function the parameter α will be something like 1/2. Raising the capital-labor ratio to the *a* power will be something like taking the square root of the capital-labor ratio. So the production function will state that output per worker is proportional to the square root of the capital-labor ratio. This function (a) is easy to calculate or look up for particular cases, (b) is one with which we have a lot of experience, (c) is an increasing function (so it fits intuitive requirement that more capital is useful, and (d) is a function with diminishing returns--the higher the capital stock, the less valuable is the next investment in expanding the capital stock still further. Thus a lot of features that economists would like a sensible behavioral relationship between the capital-labor ratio and output per worker to have are already built into the Cobb-Douglas production function.

Moreover, there is an additional advantage to using the Cobb-Douglas production function. It makes calculating growth rates easy. Recall from Chapter 2 the rule of thumb for calculating the growth rate of a quantity raised to a power: *The proportional changes of a quantity raised to a power is equal to the proportional change in the quantity, times the power to which it is raised.*

Output per worker is proportional to the capital-output ratio raised to the power α. Thus if nothing else is changing, and if we know the growth rate of the capital-labor ratio, we can immediately calculate the growth rate of output per worker. If a is 1/2 and if the capital-labor ratio is growing a 4% per year, then output per worker is growing at:

1/2 x 4% = 2% per year.

Besides *behavioral relationships*, economists also consider *equilibrium conditions*--conditions that must be true if the economy is to be in balance. If an equilibrium condition does not hold, then the state of the economy must be changing rapidly, moving toward a state of affairs in which the equilibrium condition *does* hold. In microeconomics the principal equilibrium condition is that supply must equal demand. If not, then buyers who find themselves short are frantically raising their bids (and prices are rising) or sellers who find themselves with excess inventory are frantically trying to shed it (and prices are falling). Only if supply equals demand can the price in a market be stable. In macroeconomics, supply must equal demand equilibrium conditions are just as important, but there are other important equilibrium conditions too. Box 3.5 provides an example of one such: the equilibrium condition required for *balanced growth*.

Box 3.5—Example Equilibrium Condition: The Capital-Output Ratio

An important equilibrium condition in part of macroeconomics that is not of the form that supply-must-equal demand is the equilibrium condition for *balanced growth*, which plays a big part in Chapter 4. This equilibrium conditon relates the following economic variables:

- The share of total income in the economy saved and invested, written *s*.
- The proportional rate of growth of the labor force, written *n*.
- The proportional rate of growth of the efficiency of the labor force, written *g*.
- The depreciation rate--the rate at which capital wears out--written δ (Greek lowercase letter delta).

Growth will be *balanced* if and only if the ratio of the economy's stock of capital K to its level of output Y is constant. This equilibrium condition holds if and only if the capital-to-output ratio K/Y is equal to:

$$\frac{K}{Y} = \kappa^* = \frac{s}{n + g + \delta}$$

The capital-output ratio must be equal to the economy's savings rate *s*, divided by the sum of the population growth rate n, the labor efficiency growth rate g, and the depreciation rate δ.

If the capital-output ratio is lower than this value, it will grow because net investment will be high relative to the capital stock. If the capital-output ratio is higher than this value, it will shrink because net investment will be low relative to the capital stock. In either case, the capital-output ratio will converge to its *balanced growth equilibrium* level over time.

Thus this balanced-growth capital-output ratio equation satisfies the two requirements to be an equilibrium condition. If the economy does not satisfy the equilibrium condition, it will be heading toward it. If the economy satisfies the equilibrium condition, it will remain in the same place.

As we have seen, economists solve models by combining behavioral relationships with equilibrium conditions. If the equilibrium conditions are not satisfied, then the economy cannot be stable. Someone's expectations must turn out to be false, or someone's plans for what to buy and sell must be unsatisfied. If the behavioral relationships are not satisfied--well, the behavioral relationships *must* be satisfied, or they are not behavioral relationships. Economists hope that the simplified behavioral relationships of the model are a good enough match to actually behavior. And they hope that the *actual* economy moves rapidly to equilibrium rapidly enough that the only situations they need consider are those in which the equilibrium conditions hold.

Boxes 3.6, 3.7, and 3.8 give three views of how economic models are put together. All three of them show how to solve an economic model: how to combine the behavioral relationship of the production function with the balanced-growth equilibrium condition to determine the value of steady-state output per worker in the economy. But they do so in three different ways. Box 3.6 uses arithmetic to arrive at a particular solution for a particular production function determined by particular parameter values. Box 3.7 uses algebra to derive a more general solution that holds for a wide range of parameter values.

And Box 3.8 uses graphical techniques--Descartes's idea that anything that can be done with equations can also be done by drawing curves on a graph.

Box 3.6--Using Arithmetic to Determine Steady-State Output per Worker

Using simple arithmetic, we can combine the production function (a behavioral relationship) with the balanced-growth equilibrium condition to calculate the economy's equilibrium level of output per worker.

Suppose the efficiency of labor E is $10,000 a year, the diminishing-returns-to-investment parameter α is 1/2, the savings rate s is 25% of total output, the population growth rate n and the labor efficiency growth rate g are each 1% per year, and the depreciation rate δ is 3% per year. In that case the balanced-growth capital-output ratio K/Y will be:

$$\kappa^* = \frac{s}{n+g+\delta} = \frac{25\%}{1\% + 1\% + 3\%} = 5$$

If K/Y = 5, then K = 5 x Y, and K/L = 5 x Y/L. Thus in this economy, the equilibrium capital stock per worker will be five times output per worker:

K/L = 5 x Y/L

Given the current efficiency of labor, the production function is:

$$Y/L = (K/L)^{\alpha} \times E_t^{1-\alpha}$$
$$Y/L = (K/L)^{(0.5)} \times 10000^{(0.5)} = \sqrt{(K/L)} \times 100$$

What is the equilibrium? In equilibrium, both the behavioral relationship and the equilibrium condition hold. To solve these two equations together, substitute one into the other:

$$K/L = 5 \times Y/L = 5 \times \sqrt{(K/L)} \times 100$$
$$K/L = 500 \times \sqrt{(K/L)}$$
$$\sqrt{(K/L)} = 500$$
$$K/L = 250{,}000$$
$$and \;\; so:$$
$$Y/L = \sqrt{(K/L)} \times 100$$
$$Y/L = 50000$$

In its balanced-growth equilibrium the level of output per worker is $50,000 a year, and the balanced-growth level of the capital stock per worker is $250,000.

Box 3.7--Using Algebra to Determine Steady-State Output per Worker

Box 3.6 showed how to use arithmetic to calculate the economy's steady-state growth equilibrium level of output per worker for particular values of the parameters E and α (E = $10,000 a year, and α = 1/2). But if we wanted to find out the answer for another set of values of these two parameters, we have to do the whole process all over again and repeat all our work. We can save a lot of work in the long run if we are willing to use algebra instead arithmetic.

Once again start with the behavioral relationship:

$$Y/L = (K/L)^{\alpha} \times E^{1-\alpha}$$

This equation states the influence of the capital-labor ratio K/L on output per worker Y/L. But our equilibrium condition doesn't address the capital-labor ratio K/L, it is phrased in terms of the capital-output ratio K/Y. So we need to rewrite the equation using the fact that K/L = K/Y x Y/L--that is, the capital-labor ratio is equal to the capital-output ratio times output-per-worker. We proceed as follows:

$$Y/L = \left((Y/L)\times(K/Y)\right)^{\alpha} \times E^{1-\alpha}$$

Dividing both sides of this equation by $(Y/L)^{\alpha}$, we obtain:

$$(Y/L)^{1-\alpha} = (K/Y)^{\alpha} \times E^{1-\alpha}$$

And raising both sides to the $1/(1-\alpha)$ power produces an equation that we can work with:

$$(Y/L) = (K/Y)^{\left(\frac{\alpha}{1-\alpha}\right)} \times E$$

There is an important general principle here: if a behavioral relationship and an equilibrium condition refer to different variables, the first step is to rewrite one or the other so that both refer to the same thing.

Now we can determine the balanced-growth equilibrium level of output per worker by substitution of the equation for the balanced-growth equilibrium condition into our reworked equation for the production function:

$$(Y/L) = \left(\frac{s}{n+g+\delta}\right)^{\left(\frac{\alpha}{1-\alpha}\right)} \times E$$

Thus if the efficiency of labor E_t is \$10,000 a year, the diminishing-returns-to-investment parameter α is 1/2, the savings rate s is 25% of total output, the population growth rate n and labor efficiency growth rate g are both 1% per year, and the depreciation rate δ is 3% per year, we can calculate the equilibrium level of output per worker as:

$$\left(\frac{Y_t}{L_t}\right) = \left(\frac{.25}{.01+.01+.03}\right)^{\left(\frac{.5}{1-.5}\right)} (\$10{,}000) = 5^1 \times \$10{,}000 = \$50{,}000$$

Notice that this is the same answer we arrived at using arithmetic in Box 3.6. But now we have a general equation that can be used with any set of parameter values. To answer the question: "What would output per worker be if everything else was the same, but the efficiency of labor were doubled?" we could simply substitute the new parameter values into our algebraic answer:

$$(Y/L) = \left(\frac{s}{n+g+\delta}\right)^{\left(\frac{\alpha}{1-\alpha}\right)} \times E$$

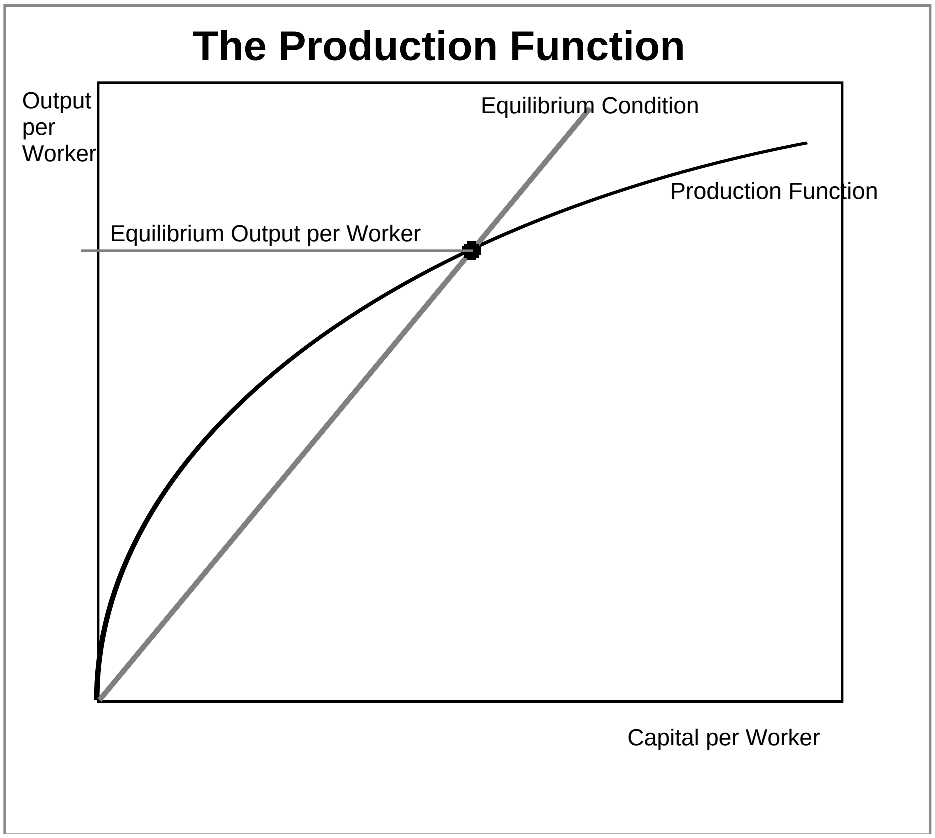
And immediate say "Output per worker doubles."

Box 3.8--Using Graphs and Geometry to Determine Steady-State Output per Worker

To avoid using algebra to solve the problem in Box 3.7, or just to understand what our algebraic manipulations are telling us, we can turn to Rene Descartes's tools and use analytic geometry. We can think about our behavioral relationship, the production function, as a curve on a graph, with output per worker on the vertical and capital per worker on the horizontal axis (see Figure 3.6). This curve always slopes upward: increasing the amount of capital per worker increases the amoujlevelnt of output per worker. However, as capital per worker increases the curve's slope decreases: diminishing returns to scale mean that each new increase in capital yields less additional output than the one before.

On the same graph, our equilibrium condition--that the capital-output ratio K/L be equal to the steady-state value of $s/(n+g+\delta)$ in terms of the parameters of the economy--is simply a line with a constant slope, for which capital per worker is the appropriate constant multiple of output per worker. Diminishing returns to capital guarantee that eventually the slope of the production function curve will fall below the slope of the equilibrium condition line. Thus the two curves must cross. The point where they cross is the equilibrium.

Figure 3.6: Equilibrium Output per Worker



If we knew the parameter values and had a steady hand, we could solve for the balanced growth value of output per worker simply by finding the point on the graph where the curves cross, and reading off the x-axis and y-axis values.

Even if we don't have a steady hand and don't know the parameter values, the diagram is still worth drawing. Diagrams allow for qualitative if not quantitative predictions. For example, consider an increase in the equilibrium capital-output ratio. It will reduce the slope of the equilibrium condition line. You can immediately draw an equilibrium condition line with a lesser slope on Figure 3.6, and see that such a change pushes the equilibrium point up and to the right along the production function. Diagrams allow us to visualize the effect of a change in a way that the equations do not.

The Advantages of Algebra

Model building is a powerful way of thinking, if the details that you omit are indeed unnecessary, and if the factors emphasized are the most important factors. Algebraic equations *are* the best way to summarize cause-and-effect behavioral relationships in economics. Because so many economic concepts are easily quantified, arithmetic might seem a more natural choice, but arithmetic quickly reaches its limits. For example, to know what the level of output per worker would be for each of a great number of possible levels of the capital stock per worker and the efficiency of labor, you would need to carry around a huge table. Table 3.2 shows just a tiny part of what would be required. Much better to remember and to work with a single algebraic equation, like this one:

$$Y/L = (K/L)^{0.5} \times (\$10{,}000)^{1-0.5}$$

Table 3.1: A Small Part of a Very Large and Cumbersome Table

Output per Worker	Capital per Worker	Efficiency of Labor
$0	$0	$5,000
$7,071	$10,000	$5,000
$10,000	$20,000	$5,000
$12,247	$30,000	$5,000
$14,142	$40,000	$5,000
$15,811	$50,000	$5,000
$17,321	$60,000	$5,000
$18,708	$70,000	$5,000
$20,000	$80,000	$5,000
$21,213	$90,000	$5,000
$22,361	$100,000	$5,000
$0	$0	$10,000
$10,000	$10,000	$10,000
$14,142	$20,000	$10,000
$17,321	$30,000	$10,000
$20,000	$40,000	$10,000
$22,361	$50,000	$10,000
$24,495	$60,000	$10,000
$26,458	$70,000	$10,000
$28,284	$80,000	$10,000
$30,000	$90,000	$10,000
$31,623	$100,000	$10,000

Algebra, moreover, has another advantage. It allows us to think about the consequences of a host of different possible systematic relationships by replacing the fixed and known coefficients like $10,000 and 0.5 with unspecified and potentially varying *parameters*, in this case E and α:

$$Y/L = (K/L)^{\alpha} \times (E)^{1-\alpha}$$

Using algebra to analyze this single equation allows us to manipulate and analyze all at once, in shorthand form, all the systematic relationships corresponding to different parameter values, and all of the tables that they summarize.

Do you want to analyze a situation in which boosting capital per worker raises output per worker at almost the same rate indefinitely? You can do that with a value of α that is near one. Do you want to analyze a situation in which boosting capital per worker beyond an initial minimal level does little to raise potential output per worker? You can do that with a value of α near zero. Do you want to analyze an intermediate case? You can do that, too, with an intermediate value of the parameter α that tunes how quickly a diminishing marginal product to investment sets in. Do you want to analyze a productive economy, in which output per worker is high? Then pick a high value of the parameter E which represents the efficiency of labor. Do you want to analyze a poor economy, close to subsistence levels, in which even mammoth amounts of capital per worker would not create an affluent society? Then pick a low value of the parameter E. Figure 3.7 shows some of the results of manipulating both α and E in the production function.

Figure 3.7: A Single Equation, a Host of Relationships…

$$\left(\frac{Y_t}{L_t}\right)=\left(\frac{K_t}{L_t}\right)^{\alpha}(E_t)^{1-\alpha}$$

$$\left(\frac{Y_t}{L_t}\right)=\left(\frac{K_t}{L_t}\right)^{0.25}(E_t)^{0.75}$$

Output per Worker	Capital per Worker	Efficiency of Labor
$9,306	$60,000	$5,000
$10,000	$80,000	$5,000
$10,574	$100,000	$5,000
$15,651	$60,000	$10,000
$16,818	$80,000	$10,000
$17,783	$100,000	$10,000
$21,213	$60,000	$15,000
$22,795	$80,000	$15,000
$24,103	$100,000	$15,000

$$\left(\frac{Y_t}{L_t}\right)=\left(\frac{K_t}{L_t}\right)^{0.50}(E_t)^{0.50}$$

Output per Worker	Capital per Worker	Efficiency of Labor
$17,321	$60,000	$5,000
$20,000	$80,000	$5,000
$22,361	$100,000	$5,000
$24,495	$60,000	$10,000
$28,284	$80,000	$10,000
$31,623	$100,000	$10,000
$30,000	$60,000	$15,000
$34,641	$80,000	$15,000
$38,730	$100,000	$15,000

$$\left(\frac{Y_t}{L_t}\right)=\left(\frac{K_t}{L_t}\right)^{0.75}(E_t)^{0.25}$$

Output per Worker	Capital per Worker	Efficiency of Labor
$32,237	$60,000	$5,000
$40,000	$80,000	$5,000
$47,287	$100,000	$5,000
$38,337	$60,000	$10,000
$47,568	$80,000	$10,000
$56,234	$100,000	$10,000
$42,426	$60,000	$15,000
$52,643	$80,000	$15,000
$62,233	$100,000	$15,000

Figure Legend: A single algebraic equation can represent a host of different relationships between capital per worker and output per worker. Each of those relationships in turn represents a host of possible values of capital per worker and the efficiency of labor, and the resulting values of output per worker.

It is easy moving back to the specific when you want to consider a particular case with a particular set of parameter values. Just substitute the numerical values for that particular case ($10,000, and 0.5) for the abstract parameters (E and α).

Figure 3.8: Changing Parameter Values and the Shape of the Cobb-Douglas Production Function

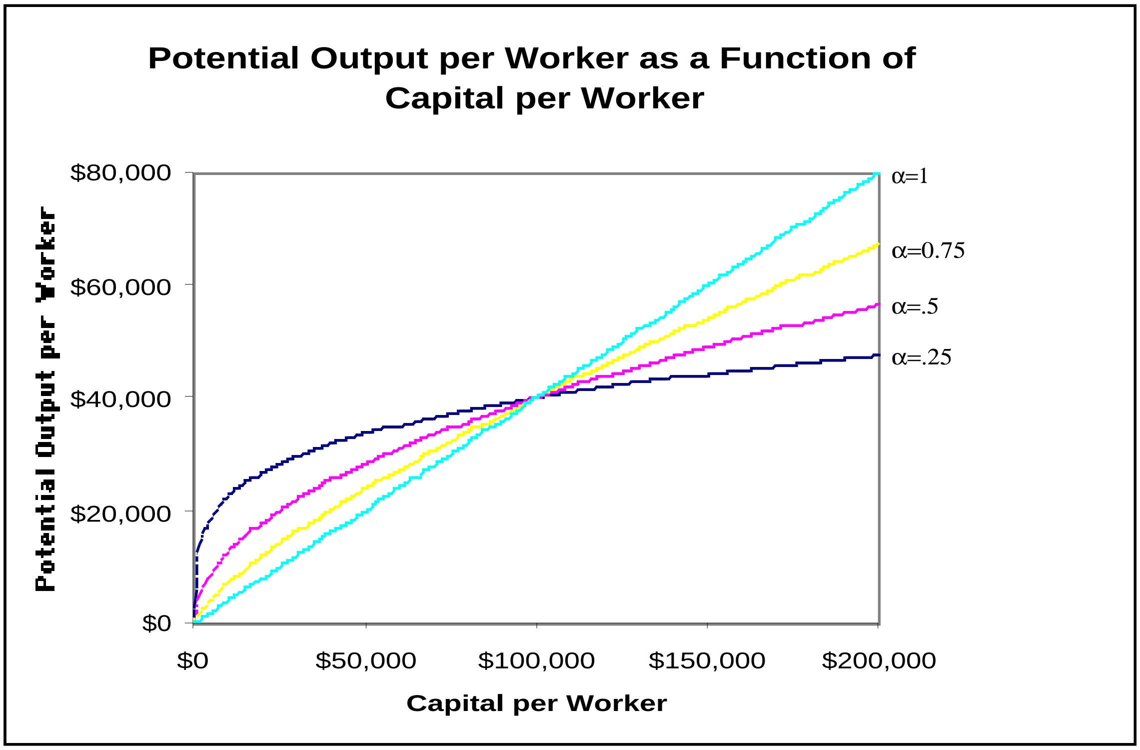


Figure Legend: Changing the parameter α--the exponent of (K/L) in the production function changes the curvature of the production function, and thus changes the point at which returns to increases in capital per worker begin to diminish.

Figure 3.9: The Effect of Changes in the Efficiency of Labor on the Shape of the Production Function

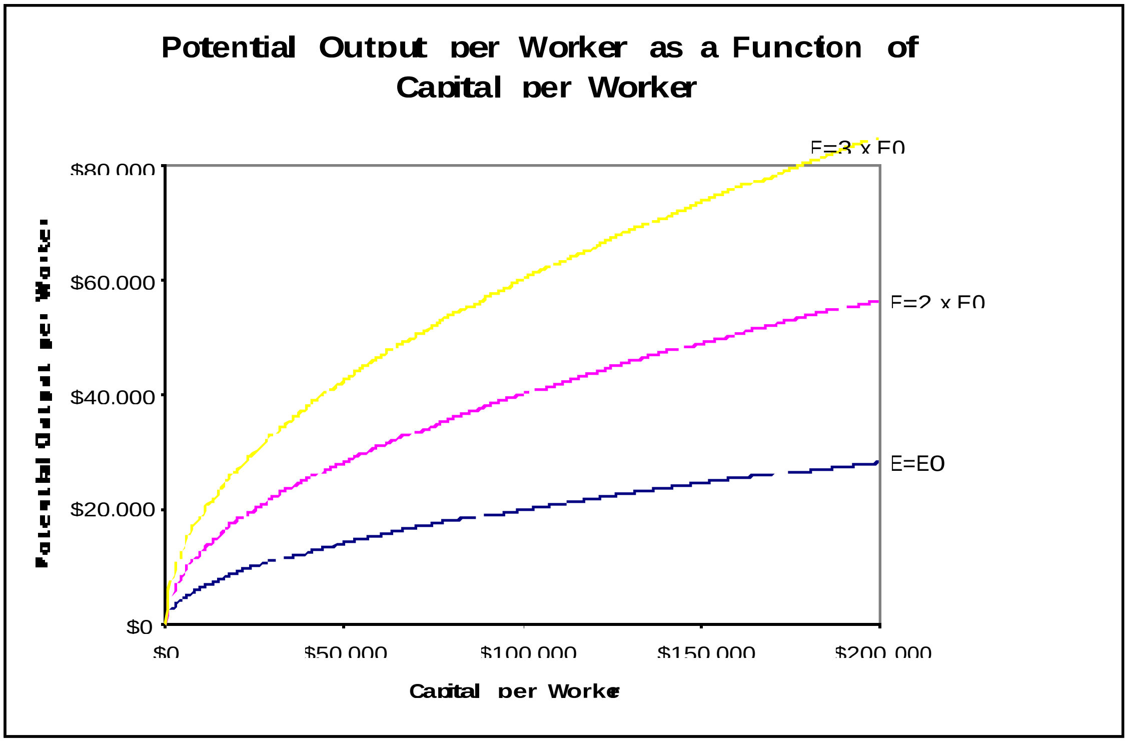


Figure Legend: A high value of E_t corresponds to a highly productive economy; a low value to one in which even mammoth increases in the capital per worker level will not create an affluent society.

It is possible to pass--even do well in--a macroeconomics course without feeling comfortable with all the algebra. In this book we generally go through each topic three times: once in words, stating the logic of the argument and telling which quantities influence which others; once in algebra; and once in diagrams that represent the algebraic and verbal relationships. Figures 3.8 and 3.9, for example, show in graphs the same flexibility of the production function in response to different parameter values as Figure 3.7 showed in algebra. If you don't understand a concept the first time it is presented, you have two more chances. Recognize, however, that words, equations, and diagrams are simply three ways of presenting the same material. They should agree. So a disconnect between your understanding of the algebra, the diagrams, and the words, is a sign that something is wrong with your understanding.

3.4 Chapter Summary

Main Points

1. Don’t be surprised to find economists’ ways of thinking strange and new--that is always the case when you learn any new intellectual discipline.

2. Don’t be surprised to find economics more abstract than you had thought. Today’s economics courses focus more on analytic tools and chains of reasoning and less on institutional descriptions.

3. Economics is a relatively mathematical subject because so much of what it analyzes can be measured. Thus economists use arithmetic to count things, and use algebra because it is the best way to analyze and understand arithmetic.

4. When macroeconomists build models, they usually follow four key strategies:

- Strip down a complicated process to a very few economy-wide behavioral relationships and equilibrium conditions.
- Simplify--ignore differences between people in the economy
- Look at opportunity costs as ways to understand behavioral relationships.
- Focus on expectations of the future, and how such expectations affect the present

Important Concepts

Science

Model

Analytic Geometry

Equilibrium

Circular Flow

Expectations

Behavioral Relationships

Equilibrium Conditions

Opportunity Costs

Representative Agents

Analytical exercises

1. What do you think a "science" is? Write down five characteristics that you think that a science *must* have. Which of these does economics satisfy?

2. Write down five characteristics that you think that a science *must not* have? Which of these does economics satisfy?

3. Why does the fact that economic agents take actions today that depend on their expectations of the future make economics an extra-hard subject?

4. What do economists mean when they say that it is time to "build a model" of a situation or a problem?

5. Write down four metaphors that you have heard people use in talking about the economy that are now--or were at the time--obscure to you.

6. In what sense can a line on a graph "be" an equation?

7. What advantage do models with symbolic parameters (that can later be varied or specified) have over models in which the parameters are specific numbers hard-wired into the equations of the model?

8. What are behavioral relationships? List five behavioral relationships that you have encountered in previous economics courses.

9. What are equilibrium conditions? List some equilibrium conditions that you have encountered in previous economics courses.

10. Which do you think is the best measure of the circular flow of economic activity: GDP, NDP, NNP, or national income? Why?