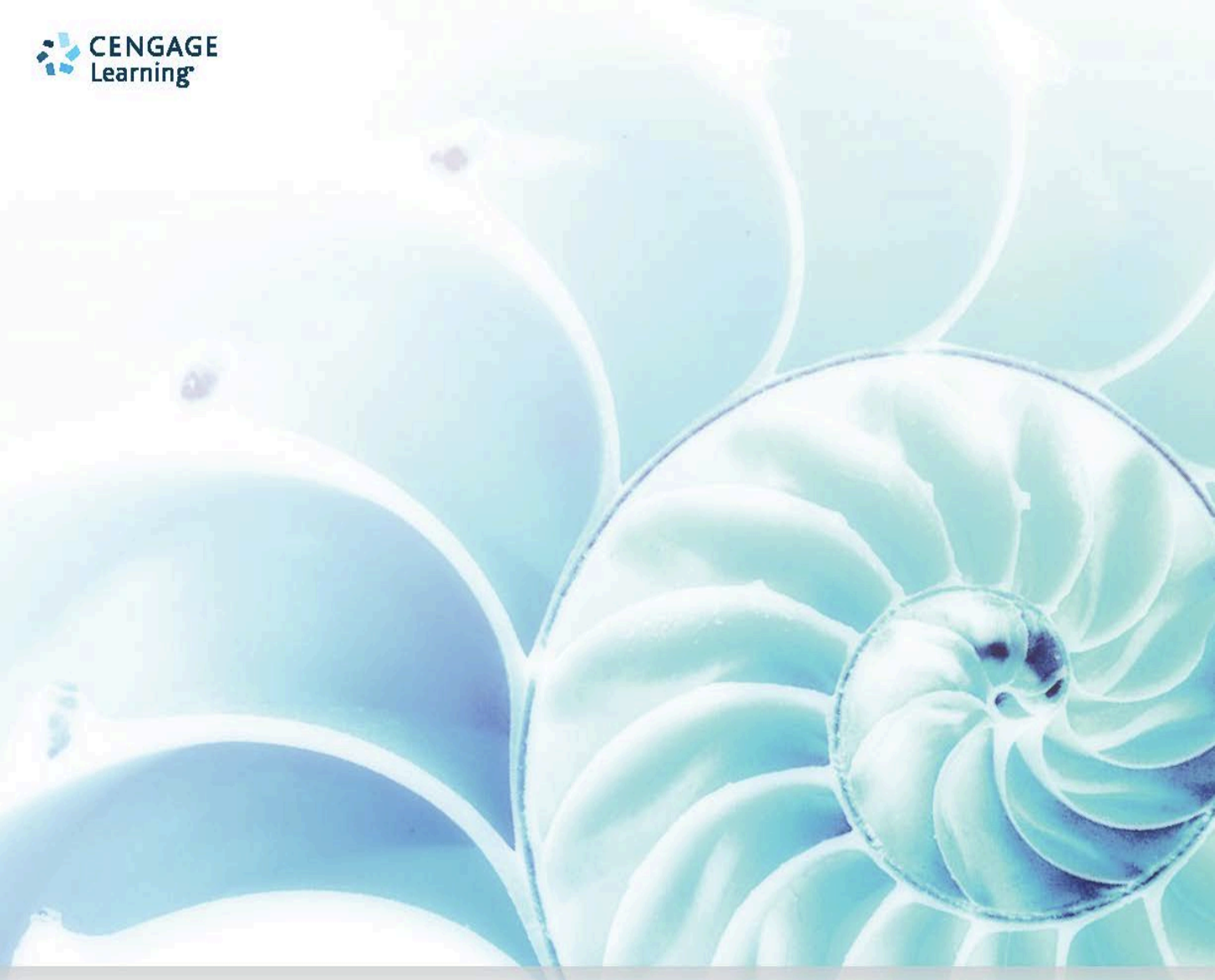

Intermediate Macroeconomics

Robert J. Barro
Angus C. Chu
Guido Cozzi

FIRST EDITION

CENGAGE Learning

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Intermediate Macroeconomics, 1st Edition

Robert J. Barro, Angus C. Chu and Guido Cozzi

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Robert J. Barro: To Rachel, Zac and Wiggles.
Angus C. Chu: To Amanda, Alvin and Alice.
Guido Cozzi: To Silvia, Diana and Aurelio.

Brief contents

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Preface

Sound theory and a unified approach

Macroeconomics and microeconomics are the two pillars of economics. Yet, there is a wide gulf between the two pillars in the undergraduate curriculum. Micro courses teach material that is easier but basically consistent with the content taught to graduate students and used by economists in their research. In contrast, macro courses often bear little resemblance to graduate courses or academic research. Undergraduate macro textbooks and courses seem frequently to compromise good economics for presentations that are breezy, closely linked to arguments found in the popular press and not very intellectually challenging. But sacrificing solid economics to capture student interest is not necessary – sound theory can be clearly written with vivid examples to reinforce it.

This dissatisfaction with the textbook environment motivated Barro to write his first intermediate macro textbook in 1984. That book appeared in five editions, and he likes to think it had a positive impact – directly and also indirectly – in terms of influencing the subject matter and approaches of competitor works. Yet, there have been tremendous advances in macroeconomic theory and evidence over the last 30 years, and much of this research was left out of his earlier books. Hence, we decided to put our energies into this new book, *Intermediate Macroeconomics*, which is an adaptation of Barro's earlier book, *Macroeconomics: A Modern Approach*, with new materials and new data.

In addition to providing a more accurate presentation of the current state of macroeconomic thought, this text provides a unified approach that most macro textbooks lack. Rather than presenting a completely new model when shifting from a discussion of long-run theory to short-run theory, this book develops short-run and long-run models that build on one another in a natural, comprehensible and elegant way. And all this is done *without* ignoring the important differences between the economy in the long run and the short run. Similarly, we bring in the Keynesian idea of sticky prices as a new idea, but one that builds coherently on the structure of the basic equilibrium model.

Organizational structure

LONG-TERM GROWTH

Part I begins with long-run macroeconomics; that is, with the determinants of long-term economic growth. Great advances in theory and empirical analysis have taken place in this area since the late 1980s. Fortunately, it is possible to convey these important findings to undergraduates in a manageable and interesting way. In fact, as can be seen from Part II, students can understand the exciting results (in Chapters 3–5) without having, first, to master the details of the underlying microeconomic foundations (which come in Chapters 7 and 8). This early consideration of results with important policy implications helps to drive home the impact and relevance of macroeconomics.

THE EQUILIBRIUM BUSINESS-CYCLE MODEL

In Chapter 6, we begin Part III by reviewing some traditional Keynesian models that often appear in many macroeconomic textbooks. However, a complete microeconomic framework is more important for satisfactory analyses of economic fluctuations. Therefore, we apply the micro foundations from Chapters 7 and 8 to the development of an equilibrium business-cycle model in Chapters 9 and 10. This model generalizes the real business-cycle model, which has become a centrepiece of macroeconomic research since the mid-1980s. In Parts IV and V, Chapters 11–15

extend the equilibrium model to allow for money and inflation, and for the government sector (expenditure, taxes, transfers and public debt). In these Parts, we highlight some differences between the traditional Keynesian approach and the equilibrium business-cycle approach to macroeconomics.

INCOMPLETE INFORMATION AND STICKY PRICES

Part VI focuses on interactions between money and the real economy. Chapter 16 extends the equilibrium business-cycle model to allow for incomplete information about prices in a setting of rational expectations. Chapter 17 introduces the Keynesian idea of sticky prices and wages, with a focus on the new Keynesian model, another major development since the mid-1980s. This model recognizes that, rather than being perfect competitors, producers typically set prices that represent mark-ups on costs of production. Most importantly, these prices adjust only infrequently to changed circumstances. Together, Chapters 16 and 17 usefully supplement the equilibrium business-cycle model to allow for significant real effects from monetary policy.

THE OPEN ECONOMY

In Part VII, Chapters 18 and 19 extend the equilibrium model to an open economy. In Chapter 18, we deal, first, with a purely real setting in which the home and foreign countries share a common currency. One significant topic is the current-account deficit, a great concern for many countries in recent years. Chapter 19 introduces different moneys and allows for the determination of exchange rates. An important issue here – relevant today to debates about China's currency – concerns the relative merits of fixed versus flexible exchange rates.

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Throughout the writing and development of this book, many dedicated professors have generously contributed their time and comments to help improve its presentation. We are grateful for their consideration and assistance. Angus Chu and Guido Cozzi would like especially to thank Margaret Davenport and Michael Ellington for their excellent research assistance.

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ROBERT J. BARRO

I was born in New York City, then moved to Los Angeles, where I attended high school. After studying physics at Caltech, including classes from Richard Feynman, I switched to economics for graduate school at Harvard. The change to economics was a great move for me! After jobs at Brown, Chicago and Rochester, I returned to Harvard as a professor in 1987. I am presently a senior fellow of Stanford's Hoover Institution and a research associate of the National Bureau of Economic Research. I co-edit Harvard's *Quarterly Journal of Economics* and was president of the Western Economic Association and vice president of the American Economic Association. I have been visiting China a great deal recently and am now honorary dean of the China Economics & Management Academy of the Central University of Beijing. My research has focused on macroeconomics and economic growth but includes recent work with my wife, Rachel, on the economics of religion. I am also studying the economic effects of rare disasters, such as depressions, world wars, epidemics and natural disasters. Aside from academic research, I enjoy more popular writing, including work as a viewpoint columnist for *Business Week* from 1998 to 2006 and as a contributing editor of *The Wall Street Journal* from 1991 to 1998. My recent books include *Economic Growth* (2nd edn, with Xavier Sala-i-Martin, who astoundingly served for a time as acting president of the famous soccer team F.C. Barcelona), *Nothing Is Sacred: Economic Ideas for the New Millennium, Determinants of Economic Growth* and *Getting It Right: Markets and Choices in a Free Society*, all from MIT Press.

ANGUS C. CHU

I was born in Hong Kong and moved to Vancouver, Canada, to attend high school, and to complete undergraduate studies at Simon Fraser University and graduate studies at the University of British Columbia. I then went to study at the University of Michigan in the United States and obtained my doctoral degree in Economics there in 2008. Recently, I have joined Fudan University in China as Professor of Economics. Before that, I served as Chair in Economics at the University of Liverpool, UK, where I still hold an honorary appointment. My research focuses on macroeconomics, monetary economics, economic growth, innovation and intellectual property rights. I have published my research in journals such as the *European Economic Review*, *International Economic Review*, *Journal of Development Economics*, *Journal of Economic Dynamics and Control*, *Journal of Economic Growth*, *Journal of International Economics*, *Journal of Money, Credit and Banking*, *Journal of Urban Economics*, *Macroeconomic Dynamics* and the *Review of Economic Dynamics*. Currently, I serve as an associate editor for the *Bulletin of Economic Research*, *Economic Modelling* and the *Singapore Economic Review*.

GUIDO COZZI

I was born in Rome and graduated in Economics at the University of Rome 'La Sapienza'. I continued my postgraduate studies at New York University, gaining my PhD in Economics in 2000. I have spent the past few years in Switzerland as Professor of Macroeconomics at the University of St Gallen. Before that, I served as Chair in Economics at the University of Durham, UK. My research focuses on macroeconomics, economic growth, innovation and intellectual property rights. I have published my research articles in journals such as the *Journal of Political Economy, American Economic Review, Review of Economics and Statistics, Journal of Economic Theory, Journal of* the *European Economic Association, European Economic Review*, *International Economic Review*, *Journal of Economic Growth*, *Journal of International Economics*, *Review of Economic Dynamic, Journal of Development Economics* and the *Journal of Economic Dynamics and Control*. I have collaborated with several private and public institutions, including the European Commission.

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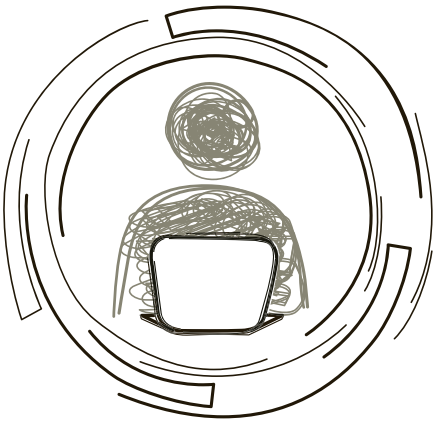

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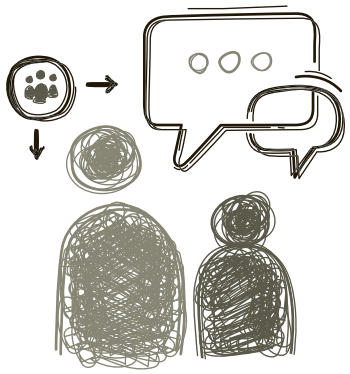


Introduction

1 Thinking about macroeconomics

2 National-income accounting: Gross domestic product and the price level

PART I

1 Thinking about macroeconomics

Macroeconomics deals with the overall, or aggregate, performance of an economy. We study the determination of the economy's total production of goods and services, as measured by the real **gross domestic product (GDP)**. We analyze the breakdown of GDP into its major components: consumption, gross investment (purchases of new capital goods – equipment and structures – by the private sector), government purchases of goods and services, and net exports of goods and services. We also examine the aggregates of **employment** (persons with jobs) and **unemployment** (persons without jobs who are seeking work).

These terms refer to quantities of goods or labour. We are also interested in the prices that correspond to these quantities. For example, we consider the prices of the goods and services produced in an economy. When we look at the price of the typical or average item, we refer to the **general price level**. We also study the **wage rate**, which is the price of labour; the **rental price**, which is the price paid to use capital goods; and the **interest rate**, which determines the cost of borrowing and the return to lending. When we consider more than one economy, we can study the **exchange rate**, which is the rate at which one form of money (e.g., the euro) is exchanged for another form of money (e.g., the British pound).

We will set up an economic model, which will allow us to study how the various quantities and prices are determined. We can use the model to see how the quantities and prices respond to technological advances, government policies and other variables. For example, we will consider monetary policy, which involves the determination of the quantity of money and the setting of interest rates. We will also study fiscal policy, which describes the government's expenditures, taxes and fiscal deficits.

The performance of the overall economy matters for everyone because it influences incomes, job prospects and prices. Thus, it is important for us – and even more important for government policymakers – to understand how the macroeconomy operates. Unfortunately, as is obvious from reading the newspapers, macroeconomics is not a settled scientific field. Although there is consensus on many issues – such as some of the determinants of long-run economic growth – there is also controversy about many topics, such as the sources of economic fluctuations and the short-run effects of monetary policy. The main objective of this book is to convey the macroeconomic knowledge that has been attained, as well as to point out areas in which a full understanding has yet to be achieved.

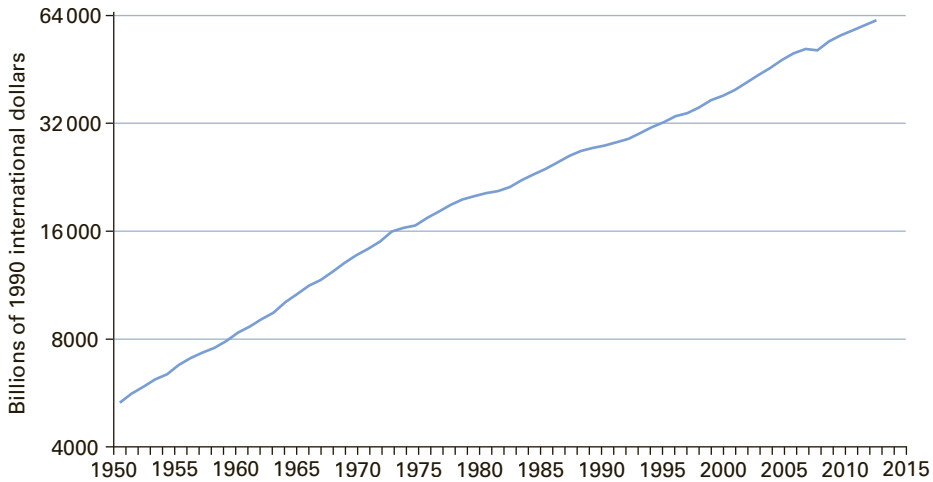
Output, unemployment and prices

To get an overview of the subject, we can look at the historical record of some of the major macroeconomic variables. Figure 1.1 shows the total output or production of goods and services in the world from 1950 to 2014. (The starting date is determined by the available data.)[1] Our measure of aggregate output is known as the **real gross world product**, which is computed as the combined **real gross domestic product** (GDP) of all countries in the world. Therefore, **gross world product** (GWP) is also known as the world GDP. Real GDP expresses quantities in

[1]DeLong (1998) provides estimates of the gross world product for some years between one million years BCE and the present time.

Figure 1.1 Real GWP, 1950–2014

The graph shows the real gross world product (GWP) on a proportionate (logarithmic) scale, and the numbers are in billions of 1990 international dollars.[2]



Sources: Data until 2010 on real GWP per capita are from the Maddison Project Database. Data on world population are from the United Nations Population Database. Data from 2011 on real GWP are from the World Bank, International Comparison Program database.

terms of a base year – in our case, 1990. Chapter 2 considers **national-income accounting** and thereby provides the conceptual details for measuring **real gross domestic product**.

The general upward trend of real GWP in Figure 1.1 reflects the long-term growth of the world economy. Figure 1.2 plots the growth rate of real GWP for each year from 1951 to 2014. A simple way to compute the growth rate for year t is to take the difference between the levels of real GWP in years t and $t-1$, $Y_t - Y_{t-1}$, and then divide by year $t-1$'s level of real GWP, Y_{t-1}:

$$\textit{growth rate of real GWP for year } t = \left(Y_t - Y_{t-1}\right)/Y_{t-1}$$

If we then multiply by 100, we get the growth rate of real GWP in percent per year.

The mean growth rate of real GWP from 1951 to 2014 was 3.9% per year. This growth rate meant that the level of real GWP, shown in Figure 1.1, expanded more than ten-fold from 1950 to 2014. If we divide through by population to determine real per capita GWP, it turns out that the mean per capita growth rate was 2.2% per year. This rate equals the 3.9% per-year growth rate of real GWP less the 1.7% per-year growth rate of population. The growth rate of real per capita GWP of 2.2% per year meant that real GWP per capita increased four-fold from 1950 to 2014.

Figure 1.2 shows that the year-to-year growth rates of real GWP varied substantially around their mean of 3.9%. These variations are called **economic fluctuations** or, sometimes, the **business cycle**.[3] When real GWP expands towards a high point or peak, the world economy is in a **boom**, or an economic expansion. When real GWP falls towards a low point or trough, the world economy is potentially in a **recession**, or an economic contraction. One condition that the International Monetary Fund uses to define a global recession is a decline in annual per capita real GWP. There are many other ways to classify periods of recession. In Chapter 9, we use a more sophisticated method to classify recessions at the national level.

Note in Figure 1.3 the global **Great Recession** in 2008, during which per capita real GWP declined by 2%. The other sharp reductions in the growth rates of real GWP in Figure 1.3 capture the effects of the oil crisis in 1973, the energy crisis in 1979, the oil price shock in 1990, the Asian financial crisis in 1997 and the burst of the dot-com bubble in 2000. Each of these shocks caused major recessions in different parts of the world.

[2]The graph uses a proportionate scale, so that each unit on the vertical axis corresponds to the same percentage change in real GDP. The international dollar, also known as the Geary-Khamis dollar, is constructed in such a way that this hypothetical unit of currency has the same purchasing power as the US dollar in the United States at a given point in time.

[3]The term 'business cycle' can be misleading because it suggests a more regular pattern of ups and downs in economic activity than actually appears in the data.

Figure 1.2 Growth rate of real GWP, 1951–2014

The graph shows the annual growth rate of real GWP. The growth rates are calculated from the values of real GWP shown in Figure 1.1.

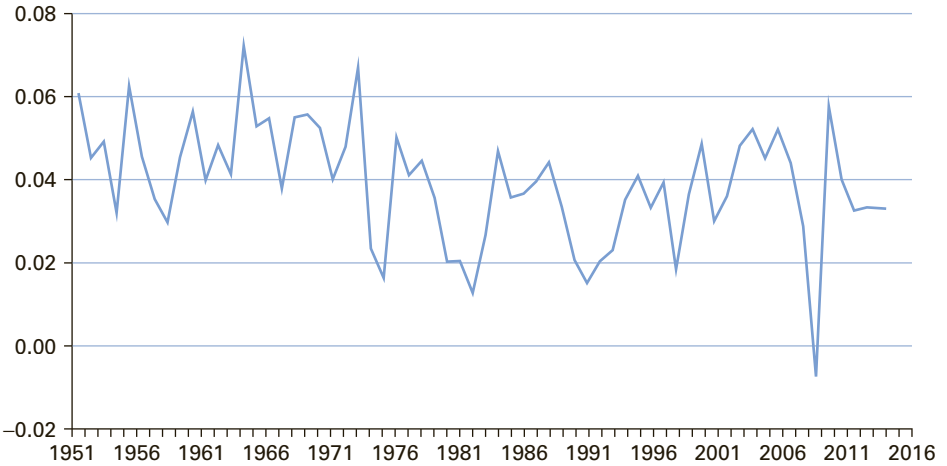
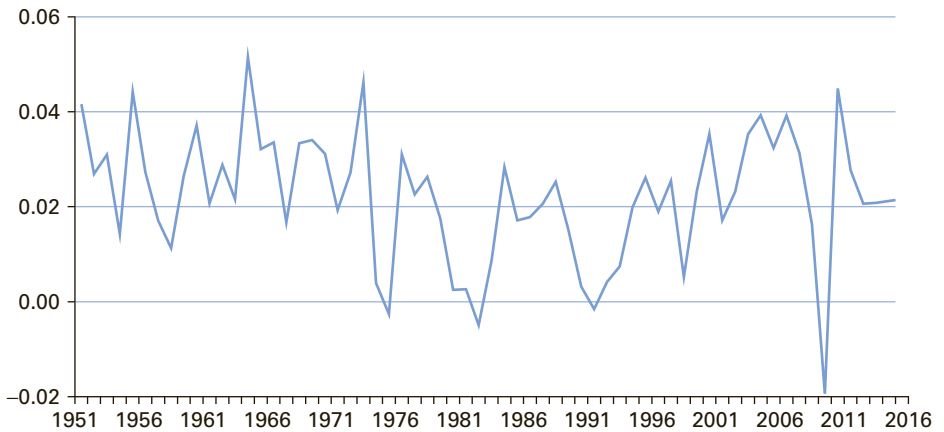


Figure 1.3 Growth rate of per capita real GWP, 1951–2014

The graph shows the annual growth rate of per capita real GWP.



Economics in Practice
The Great Recession

The global Great Recession was partly triggered by the subprime mortgage crisis in the United States. In 2006–07, the US housing bubble burst led to many homeowners defaulting on their mortgage payments. These mortgage defaulters were often subprime borrowers, defined as people who have higher-than-normal credit risks and a below-average credit history. These US mortgages were marketed as mortgage-backed securities around the world and held by major financial institutions due to their higher yields than US government bonds. When homeowners started to default on these mortgages, the value of the mortgage-backed securities collapsed causing substantial losses to major financial institutions. The most notable example was Lehman Brothers, which declared bankruptcy in 2008. The resulting panic on the inter-bank loan market led to severe financial losses by many large and well-established banks in the United States and Europe. This financial crisis also led to sharp reductions in household spending and business investment, partly triggering the global recession.

Another way to gauge recessions and booms is to consider the **unemployment rate** – the fraction of persons seeking work who have no job. Figure 1.4 shows the unemployment rates of the world and a number of countries for each year from 1991 to 2013. The mean unemployment rate of the world was 6.1% and fluctuated moderately from 5.4% to 6.5%. However, mean unemployment rates are quite different across countries and also more volatile within each country. For example, the mean unemployment rate of France was 10.0% whereas it was only 4.4% in China. The mean unemployment rates of other countries were somewhere in between: Saudi Arabia (5.6%), United Kingdom (7.0%) and United States (6.2%). From 1991 to 2013, the unemployment rates were more volatile in France, the United Kingdom and the United States than in China and Saudi Arabia. During recessions, the unemployment rate typically rises sharply. An example is the Great Recession in 2008, during which the unemployment rates rose from 7.4% to 9.1% in France, from 5.4% to 7.8% in the United Kingdom and from 5.9% to 9.4% in the United States within a year.

Figure 1.5 shows the evolution of the price levels of the world and a number of countries from 1991 to 2013. This graph measures the price level as the deflator for the GDP (we discuss the details of this price index in Chapter 2). For present purposes, the important point is that the GDP deflator is a broad index, corresponding to the prices of all the items that enter into the gross domestic product. One striking observation is the persistent rise in price levels across most countries. The only notable exception is Saudi Arabia, where there were clear up and down movements in the price level. For example, during the Asian financial crisis in 1997 and the Great Recession in 2008, the price level fell significantly in Saudi Arabia.

Figure 1.6 shows the annual **inflation rates** of the world and a number of countries from 1991 to 2013. Each year's inflation rate is calculated as the growth rate in percent per year of the price level of a country shown in Figure 1.5. A simple way to compute the inflation rate for year t is to take the difference between the price levels in years t and $t-1$, $P_t - P_{t-1}$, and then divide by year $t-1$'s price level, P_{t-1}:

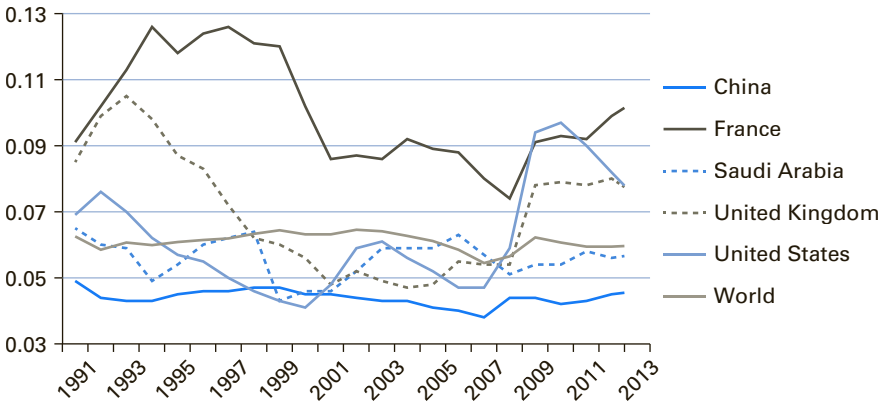
$$\text{inflation rate for year } t = \left(P_t - P_{t-1}\right)/P_{t-1}$$

If we then multiply by 100, we get the inflation rate in percent per year.

Notice from Figure 1.6 that the inflation rates in France, the United Kingdom and the United States were all greater than zero with mean inflation rates of 1.5% in France, 2.5% in the United Kingdom and 2.1% in the United States. In contrast, mean inflation rates were much higher in China (5.5%) and Saudi Arabia (4.5%), and inflation fell below zero in two major crises: the Asian financial crisis and the Great Recession. In subsequent chapters, we will relate the behaviour of inflation to the character of monetary institutions and monetary policy. Notably, central banks in developed countries, such as France, the United Kingdom and the United States, have successfully pursued a policy of low and stable inflation.

Figure 1.4 World unemployment rates, 1991–2013

The graph shows the unemployment rates of the world and a number of countries.



Source: Data on unemployment rates estimated by the International Labour Organization (ILO) are from the World Development Indicators. The ILO establishes international standards for labour statistics so that the ILO's data on unemployment rates can be compared between countries.

Figure 1.5 World price levels, 1991–2013

The graph shows the GDP price deflators of the world and a number of countries. The numbers are on a proportionate (logarithmic) scale, with the value for the year 1991 set at 100. Data are from the World Development Indicators.

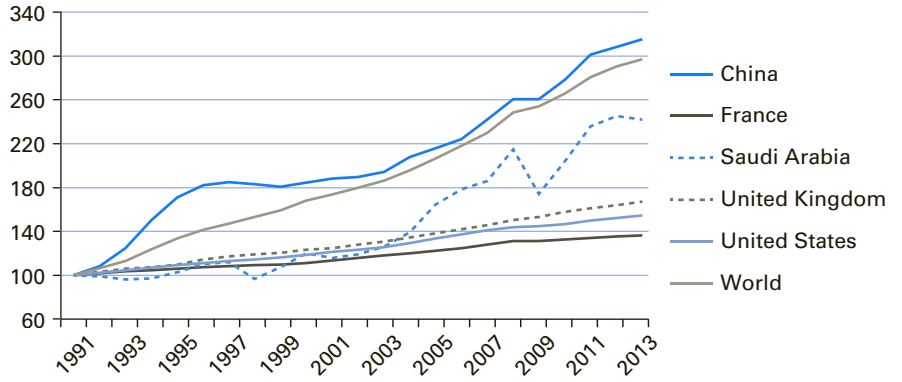
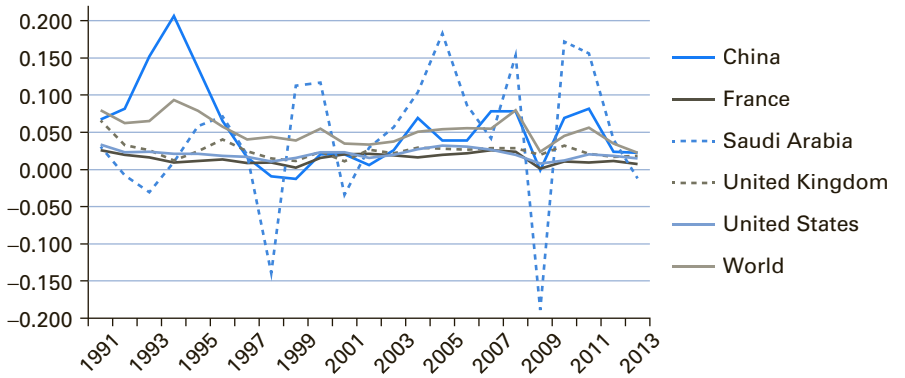


Figure 1.6 World inflation rates, 1991–2013

The graph shows the annual inflation rate based on the GDP deflator. The inflation rate is the annual growth rate of the price level shown in Figure 1.5.



Economic models

As mentioned, we want to understand the determinants of major macroeconomic variables, such as real GDP and the general price level. To carry out this mission, we will construct a macroeconomic model. A model can be a group of equations or graphs, or a set of conceptual ideas. We will use all of these tools in this book – some equations but, more often, graphs and ideas.

An economic model deals with two kinds of variables: endogenous variables and exogenous variables. The **endogenous variables** are the ones that we want the model to explain. For example, the endogenous variables in our macroeconomic model include real GDP, investment, employment, the general price level, the wage rate and the interest rate.

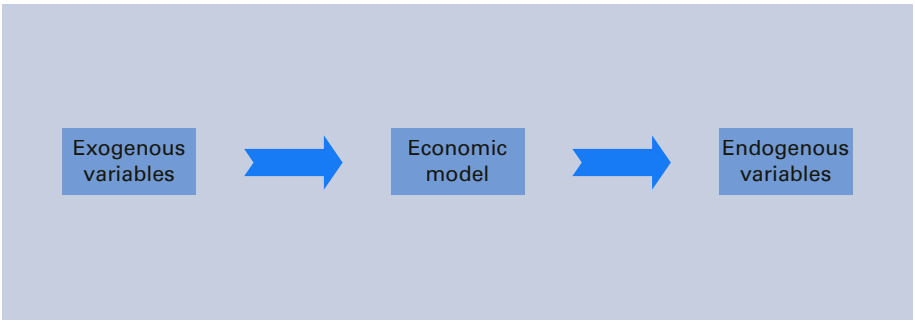
The **exogenous variables** are the ones that a model takes as given and does not attempt to explain. A simple example of an exogenous variable is the weather (at least in models that do not allow the climate to affect the economy). In many cases, the available technologies will be exogenous. For a single country's economy, the exogenous variables include the world prices of commodities such as oil and wheat, as well as levels of income in the rest of the world. In many cases, we will treat government policies as exogenous – for example, choices about monetary policy, and government spending and taxes. We also treat as exogenous war and peace, which have important macroeconomic consequences.

The central idea of a model is that it tells us how to go from the exogenous variables to the endogenous variables; Figure 1.7 illustrates this process. We take as given the group of exogenous variables shown in the left-hand box

in the diagram. The model tells us how to go from these exogenous variables to the group of endogenous variables shown in the right-hand box of the diagram. Therefore, we can use the model to predict how changes in the exogenous variables affect the endogenous variables.

Figure 1.7 The workings of an economic model

A model is a theory that tells us how to go from a group of exogenous variables to a group of endogenous variables. The model may be a list of equations or graphs or a set of conceptual ideas. The exogenous variables come from outside the model and are therefore not explained by the model. The endogenous variables are the ones that the model seeks to explain. With the help of the model, we can predict how changes in the exogenous variables affect the endogenous variables.



In macroeconomics, we are interested in the determination of macroeconomic – that is, economy-wide aggregate – variables, such as real GDP. However, to construct a useful macroeconomic model, we will find it helpful to build on a microeconomic approach to the actions of individual households and businesses. This microeconomic approach investigates individual decisions about how much to consume and save, how much to work, and so on. Then we can add up, or aggregate, the choices of individuals to construct a macroeconomic model. This underlying microeconomic analysis is called **microeconomic foundations**.

A SIMPLE EXAMPLE: THE COFFEE MARKET

To illustrate general ideas about models and markets, we can examine the market for a single product, such as coffee. Our analysis will focus on three key tools used by economists: demand curves, supply curves, and market-clearing conditions (quantity demanded equals quantity supplied).

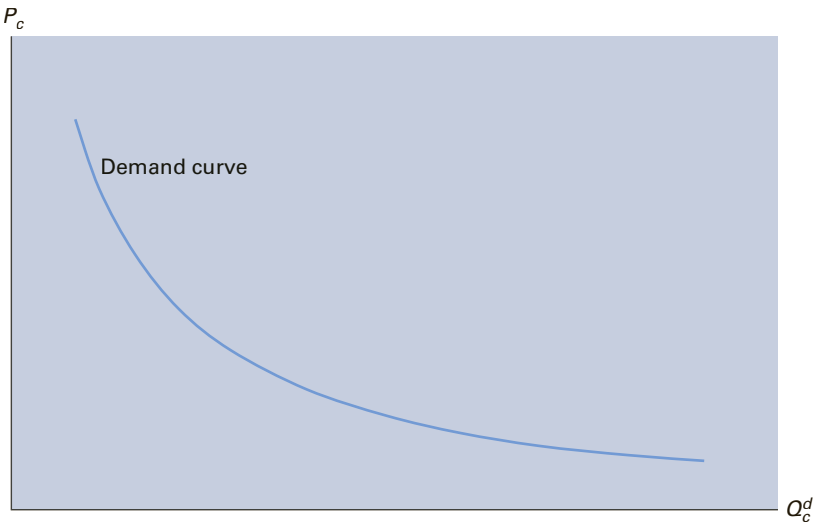
Individuals decide how much coffee to buy; that is, the quantity of coffee to demand. Influences on this demand include the individual's income, the price of coffee, P_c, and the price of a substitute good, say, P_T, the price of tea. Since each individual is a negligible part of the coffee and tea markets, it makes sense that each individual would neglect the effect of his or her coffee and tea consumption on P_c and P_T. That is, each individual is a **price taker**; he or she simply decides how much coffee and tea to buy at given prices, P_c and P_T. Economists use the term **perfect competition** to describe a market in which there are so many buyers and sellers that no individual can noticeably affect the price.

Reasonable behaviour for an individual household dictates that each household's quantity of coffee demanded would rise with income, fall with the coffee price, P_c, and rise with the price of the substitute good, P_T. These results for individual households are examples of microeconomic analysis. When we add up across all households, we determine the aggregate quantity of coffee demanded as a function of aggregate income, denoted by Y, and the prices P_c and P_T. We can isolate the effect of the coffee price, P_c, on the total quantity of coffee demanded by drawing a market **demand curve**. This curve shows the total quantity of coffee demanded, Q_c^d, as a function of P_c.

Figure 1.8 shows the market demand curve for coffee. As already noted, a decrease in P_c increases Q_c^d. Recall, however, that the demand curve applies for given values of aggregate income, Y, and the price of tea, P_T. If Y rises, the quantity of coffee demanded, Q_c^d, increases for a given price, P_c. Therefore, the demand curve shown in Figure 1.8 shifts to the right. If P_T falls, the quantity of coffee demanded, Q_c^d, decreases for a given price, P_c. Therefore, the demand curve shifts to the left.

Figure 1.8 Demand curve for coffee

The market demand curve shows the total quantity of coffee demanded, Q_c^d, as a function of the price of coffee, P_c. A decrease in P_c raises Q_c^d. The demand curve applies for given aggregate income, Y, and the price of tea, P_T. If Y rises, the quantity of coffee demanded, Q_c^d, increases for a given P_c. Therefore, the demand curve in the diagram shifts to the right. If P_T falls, the quantity of coffee demanded, Q_c^d, decreases for a given P_c. Therefore, the demand curve shifts to the left.



We also have to consider how individual producers of coffee decide how much to offer for sale on the market; that is, how much coffee to supply. Influences on this supply include the price of coffee, P_c, and the cost of producing additional coffee. We assume, as in our analysis of demand, that the suppliers of coffee are price takers with respect to P_c. This assumption could be questioned because some producers of coffee are large and might consider the effects of their actions on P_c. However, an extension to allow for this effect would not change our basic analysis of the market for coffee.

Reasonable behaviour by an individual producer dictates that the quantity of coffee supplied would rise with the price of coffee, P_c, and fall with an increase in the cost of producing additional coffee. For example, bad weather that destroys part of the coffee crop in Brazil would raise the cost of producing coffee and, thereby, reduce the coffee supplied by Brazilians. These results for individual producers are examples of microeconomic analysis.

When we add up across all producers, we determine the aggregate quantity of coffee supplied. One result is that a rise in P_c increases the aggregate quantity of coffee supplied, Q_c^s. The total quantity supplied also depends on weather conditions in coffee-producing areas, such as Brazil and Colombia.

Extending the Model

Demand and supply curves are functions

The market demand for coffee can be written as a function:

$$Q_c^d = D(P_c, Y, P_T)$$

The function $D(\cdot)$ determines the quantity of coffee demanded, Q_c^d, for any specified values of the three demand determinants, P_c, Y, and P_T. We assume that the function $D(\cdot)$ has the properties that Q_c^d decreases with the price of coffee, P_c, rises with income, Y, and rises with the price of tea, P_T. Figure 1.8 graphs Q_c^d against P_c for given values of the other demand determinants, Y and P_T. It is important to distinguish the demand curve, $D(\cdot)$, shown

in Figure 1.8, from the quantity demanded, Q_c^d, at a given price, P_c (and for given Y and P_T). The demand curve refers to the whole functional relationship between quantity demanded and price, $D(\cdot)$, whereas the quantity demanded, Q_c^d, refers to one of the points along the curve.

The market supply of coffee is also a function, which can be written as:

$$Q_c^s = S(P_c, weather)$$

We assume that the function $S(\cdot)$ has the properties that the quantity supplied, Q_c^s, rises with P_c and with better weather in coffee-producing areas. Figure 1.9 graphs the quantity supplied, Q_c^s, against P_c, for given weather conditions. It is important to remember that the supply curve, $S(\cdot)$, refers to the whole functional relationship between quantity supplied and price, whereas the quantity supplied, Q_c^s, refers to one of the points along the curve.

As in our analysis of demand, we can isolate the effect of the coffee price, P_c, on the total quantity of coffee supplied by drawing a market **supply curve**. This curve, shown in Figure 1.9, gives the total quantity of coffee supplied, Q_c^s, as a function of P_c. As already noted, an increase in P_c raises Q_c^s. This supply curve applies for given cost conditions for producing coffee and, in particular, for given weather in coffee-producing areas. If bad weather destroys part of Brazil's coffee crop, the market quantity of coffee supplied, Q_c^s, decreases for a given price, P_c. Therefore, the supply curve shown in Figure 1.9 shifts to the left.

Figure 1.10 shows the clearing of the market for coffee. The price of coffee, Q_c^s, is assumed to adjust to equate the quantity supplied, P_c, to the quantity demanded, Q_c^d. This market-clearing price is the value $(P_c)^*$ shown in the figure. The corresponding market-clearing quantity of coffee is $(Q_c)^*$.

Why do we assume that the coffee price, P_c, adjusts to the market-clearing value, $(P_c)^*$? For any other price, the quantities supplied and demanded would be unequal. For example, at point 1 in Figure 1.10, where P_c is less than $(P_c)^*$, the quantity demanded, Q_c^d, would be greater than the quantity supplied, Q_c^s. In that case, some coffee drinkers must be unsatisfied; they would not be able to buy the quantity of coffee that they want at the price P_c. That is, suppliers would be unwilling to provide enough coffee to satisfy all of the desired purchases at this low price. In this circumstance, we would think that competition among the eager demanders of coffee would raise the market price, P_c, towards $(P_c)^*$.

Figure 1.9 Supply curve for coffee

The market supply curve shows the total quantity of coffee supplied, Q_c^s, as a function of the price of coffee, P_c. An increase in P_c raises Q_c^s. The supply curve applies for given conditions that affect the cost of producing coffee. For example, a harvest failure in Brazil would decrease the total quantity of coffee supplied, Q_c^s, for a given price, P_c. Therefore, the supply curve shifts to the left.