Chapter 1

Introduction

> The art of successful theorizing is to make the inevitable simplifying assumptions in such a way that the final results are not very sensitive.
>
> –Robert M. Solow (1956), p. 65.

1.1 Macroeconomics

1.1.1 The field

Macroeconomics has two defining characteristics. First, it is a study of the economic interactions in society as a whole. This could also be said of microeconomic general equilibrium theory, however. So the second defining characteristic of macroeconomics is that it aims at understanding the empirical regularities in the behavior of aggregate economic variables such as aggregate production, investment, unemployment, the general price level for goods and services, the inflation rate, the interest rate, the level of real wages, the stock market level, the foreign exchange rate, productivity growth etc. Thus macroeconomics focuses on the major lines of the economics of a society. The purpose is three-fold:

1. to explain the level of the aggregate variables as well as their movement over time in the short run and the long run;

2. to make well-founded forecasts possible;

3. to provide foundations for rational economic policy applicable to macroeconomic problems, be they short-run distress or problems of a more long-term, structural character.

To make our complex economic environment accessible for theoretical analysis we use economic models. What *is* an economic model? It is a way of organizing one's thoughts about the economic functioning of a society. A more specific answer is to define an economic model as a conceptual structure based on a set of mathematically formulated assumptions which have an economic interpretation and from which empirically testable predictions can be derived. In particular, a macroeconomic model is an economic model concerned with macroeconomic phenomena, i.e., the short-run fluctuations of aggregate variables as well as their long-run trend.

Any economic analysis is based upon a conceptual framework. Formulating this framework as a precisely stated economic model helps to break down the issue into assumptions about the concerns and constraints of households and firms and the character of the environment within which these agents interact. The advantage of this approach is that it makes rigorous reasoning possible, lays bare where the possible underlying disagreements behind different interpretations of economic phenomena are, and makes sensitivity analysis of the conclusions amenable. Moreover, by being explicit about agents' concerns and the social structures (market forms, social conventions, and juridical institutions) conditioning their interactions, this approach allows analysis of policy interventions, using the well-established tools of welfare economics. And expressing our assumptions mathematically opens up for use of the powerful mathematical toolbox. Without these math tools it would in many cases be impossible to reach any conclusion whatsoever.

Undergraduate students of economics are often perplexed or even frustrated by macroeconomics being so preoccupied with composite theoretical models. Why not study the issues each at a time? The reason is that the issues, say housing prices and changes in unemployment, are not separate, but parts of a complex system of mutually dependent elements. This also suggests that macroeconomics must take advantage of theoretical and empirical knowledge from other branches of economics, including microeconomics, industrial organization, game theory, political economy, behavioral economics etc.

At the same time our models necessarily give a *simplified* picture of the economic reality. Ignoring secondary aspects and complications is indispensable to be able to focus on the essential features of a given problem. In particular macroeconomics deliberately simplifies the description of the single actors so as to make the analysis of the interaction between different types of actors manageable.

The assessment of − and choice between − *competing* simplifying frameworks is based on how well they perform in relation to the three-fold aim listed above, given the problem at hand. A key condition for good performance is the empirical tenability of the model's implications. A guiding principle in the development of useful models therefore lies in the confrontation with data. This can be based on a variety of methods ranging from sophisticated econometric techniques to more qualitative case studies.

The union of connected and non-contradictory economic models and the theorems derived from these constitute an *economic theory*. Being about the interaction of *human* beings in *societies*, the subject matter of economic theory is complex and at the same time history dependent. This explains why economic theory is far from the natural sciences with respect to precision and undisputable empirical foundation. In particular in macroeconomics one should be aware of the existence of differing conceptions and even conflicting theoretical schools. Fortunately, however, recent years have witnessed considerable convergence (see the end of this chapter).

1.1.2 The different "runs"

This text subdivides macroeconomics into "short-run", "medium-run", and "long-run" macroeconomics. The first concentrates on the behavior of the macroeconomic variables within a time horizon of a few years, whereas "long-run" macroeconomics deals with a considerably longer time horizon − indeed, long enough for changes in the capital stock, population, and technology to have a dominating influence on changes in the level of production. The "medium run" is then something in between.

To be more specific, *long-run macromodels* study the evolution of an economy's productive capacity over time. Typically a time span of at least 10 years is considered. The analytical framework is by and large *supply-dominated*. That is, variations in the employment rate for labor and capital due to demand fluctuations are abstracted away. This is of course a simplification, but can be justified by the fact that these variations, at least in advanced economies, tend to remain within a fairly narrow band, anyway. Therefore, generally, the economic outcome after a 10-40 year interval reflects primarily the growth of supply side factors such as the labor force, the capital stock, and the technology. The fluctuations in demand and monetary factors are of limited quantitative importance within such a time horizon.

In contrast, when we speak of *short-run macromodels*, we think of models concentrating on mechanisms that determine how fully an economy uses its productive capacity. The focus is on the output and employment variations within a time horizon less than, say, four years. These models are typically *demand-dominated*. In this time perspective the demand side, monetary factors, and price rigidities matter significantly. Shifts in aggregate demand (induced by, e.g., changes in fiscal or monetary policy, exports, interest rates, the general state of confidence, etc.) tend to be accommodated by changes in the produced quantities rather than in the prices of the goods. In contrast, variations in the supply of production factors and technology are of limited importance within this time span. With Keynes' words the aim of short-run analysis is to explain "what determines the actual employment of the available resources" (Keynes 1936, p. 4).

The short and the long run make up the traditional subdivision of macroeconomics. But it is convenient and fruitful to include also a *medium run*, referring to a time interval of, say, four-to-ten years.[1] We shall call models attempting to bridge the gap between the short run and the long run *medium-run macromodels*. These models deal with the regularities exhibited by *sequences* of short periods. However, in contrast to long-run models which focus on the trend of the economy, medium-run models attempt to understand the pattern characterizing the fluctuations around the trend. In this context, variations at both the demand and supply side are important. Indeed, at the centre of attention is the dynamic interaction between these demand and supply factors, the correction of expectations, and the adjustment of wages and prices. Such models are also called *business cycle models.* They have received at lot of attention in recent years, both as attempts to explain the economic fluctuations we see and as frameworks suitable for reconciling and integrating short-run and long-run macroeconomics.

There is a further sense in which we deviate from the conventional textbook terminology relating to branches of macroeconomics. This relates to what the "long run" embraces. In this book we do not attempt to cover the modern theory of economic growth. Since the path-breaking contributions by Paul Romer and Robert Lucas in the late 1980s, there has been a surge of "new growth theory" or "endogenous growth theory", focusing on *endogenous* technical change. This has developed growth theory into a more specialized discipline studying the factors and mechanisms that *determine* the evolution of technology and productivity. In order not to have too many balls in the air at the same time, this text only occasionally touches upon this expanding line of work within macroeconomics.[2] When we refer to "long-run macromodels", we do not think of growth models in this modern sense. Instead, we use the term simply to denote macromodels with a time horizon long enough such that changes in the capital stock, population, and technology matter. Apart from a few illustrative examples, we leave the

[1] These number-of-years figures should not be understood as more than a rough indication. Their appropriateness will certainly depend on the specific problem and circumstances at hand.

[2] The reader is referred to dedicated textbooks, some of which are listed in *Bibliographic notes,* see the end of this chapter.

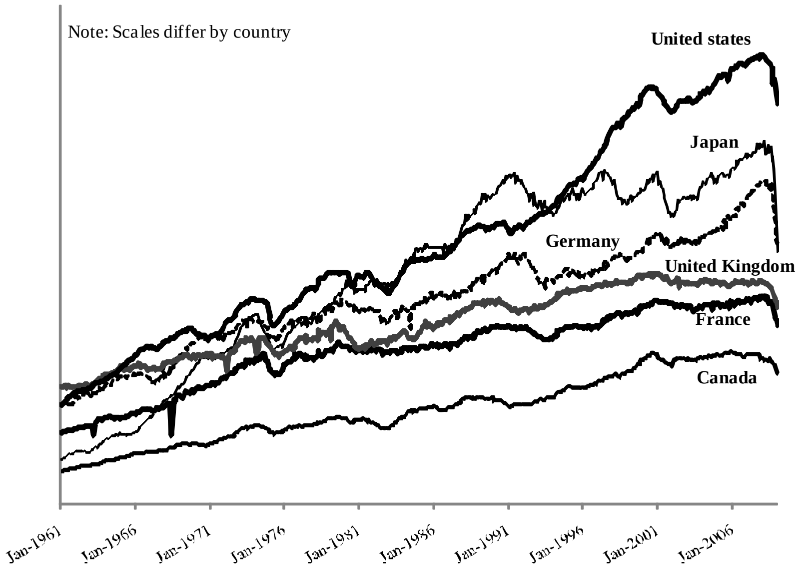

Figure 1.1: Industrial production indexes in six major countries Jan. 1961-Jan. 2009. Source: OECD, Main Economic Indicators.

sources of changes in technology out of consideration, which is tantamount to regarding these changes as exogenous.

It might be argued that this separation of different "runs" and themes involves a danger of overlooking possibilities that endogenous technical change plays a role in – and interacts with – business cycles. This is in fact a key hypothesis of "New Schumpeterian" theory. Ideas like this are not (yet) part of core mainstream macroeconomic modeling, but we shall briefly refer to such viewpoints and models when occasion arises.

In addition to the time scale dimension the national-international dimension is important for macroeconomics. Most industrialized economies participate in international trade of goods and financial assets. This results in considerable mutual dependency and co-movement of these economies. Downturns as well as upturns occur at about the same time, as indicated by Fig. 1.1. In particular the recessions triggered by the oilprice shocks in 1973 and 1980 and by the outbreak of the recent financial crisis in 2007 are visible across the countries. Many of the models and mechanisms treated in this text will therefore be considered not only in a closed economy setup, but also from the point of view of open economies.

1.2 Components of macroeconomic models

1.2.1 Basics

(Incomplete)

Basic categories
Goods, labor, and assets markets
Stocks vs. flows (cf. a bathtub).

Types of model relations
Although model relations can take different forms, in macroeconomics they often have the form of equations. A taxonomy for such equations is the following:

1. *Technology equations,* describe relations between inputs and output (production functions and similar).

2. *Preference equations,* expresses preferences, e.g. $U = \sum_{t=0}^{T} \frac{u(c_t)}{(1+\rho)^t}$, $\rho > 0, u' > 0, u'' < 0$.

3. *Institutional equations,* refer to relationships required by law (e.g., how the tax levied depends on income) and similar.

4. *Behavioral equations,* describe the behavioral response to the determinants of behavior.

5. *Identity equations,* are true by definition of the variables involved.

6. *Equilibrium equations,* define the condition for equilibrium of some kind (Walrasian demand equal to Walrasian supply, say).

Sometimes a model equation is a combination of two or more of these types of equations.

Analysis
Statics vs. dynamics. Modern macroeconomics studies processes in real time. Hence, the emphasis in this book is on *dynamic* models. Occasionally, a static model is considered, but only as a prelude to a more elaborate dynamic model concerned with the same issue as it comes into being in real time.

1.2.2 The time dimension of inputs and outputs

In macroeconomic theory the production of a firm, a sector, or the economy as a whole is often represented by a two-factor production function given by

$$Y = F(K, L), \tag{1.1}$$

where Y is output (value added), K is capital input, and L is labor input ($K \geq 0$, $L \geq 0$). The idea is that for many issues it is useful in a first approach to think of output as a homogeneous good which is produced by two inputs, one of which is a *producible* means of production, the other being a *non-producible* human input. Simple as it looks, an equation like (2.1) is not always interpreted in the right way.

First, how are the variables entering (2.1) *denominated,* that is, in what units are the variables measured? It is most satisfactory, both from a theoretical and empirical point of view, to think of both outputs and inputs as *flows:* quantities per unit of time. This is generally recognized as far as Y is concerned. Unfortunately, it is less recognized concerning K and L (which is probably related to a tradition in macroeconomic notation, as explained below).

Let the time unit be one year. Then the K appearing in the production function should be seen as the number of machine hours per year. Similarly, L should be seen as the number of labor hours per year. Unless otherwise specified, it should be understood that the rate of utilization of the production factors is constant over time; for convenience, one can then *normalize the rate of utilization of each factor to equal one.* That is, $K = 1 \times$ stock of capital and $L = 1 \times$ number of laborers. Thus, with one year as our time unit, we imagine that normally a machine is in operation in h hours during a year. Then, it is natural to define one *machine-year* as the service of a machine in operation h hours a year. If K machines are in operation and on average deliver one machine year per year, then the total capital input is K machine-years per year:

$$K \text{ (machine-yrs/yr)} = K \text{ (machines)} \times 1 \text{ ((machine-yrs/yr)/machine)}, \tag{1.2}$$

where the denomination of the variables is indicated in brackets. Similarly, if the stock of laborers is L men and on average they deliver one *man-year* (say h hours) per year, then the total labor input is L man-years per year:

$$L\text{(man-yrs/yr)} = L\text{(men)} \times 1\text{((man-yrs/yr)/man)}. \tag{1.3}$$

One of the reasons that confusion of stocks and flows may arise is the tradition in macroeconomics to use the same symbol, K, for the capital input in (2.1) as for the *stock* of capital in an accumulation equation like

$$K_{t+1} = K_t + I_t - \delta K_t. \tag{1.4}$$

Here the interpretation of K_t is as a capital *stock* (number of machines) at the beginning of period t, I_t is gross investment, and δ is a capital depreciation rate ($0 \leq \delta \leq 1$). In (1.4) there is no indication of the rate of *utilization* of the capital stock, which is, however, of key importance in (2.1). Similarly, there is a tradition in macroeconomics to denote the size of the labor force by L and write, for example, $L_t = L_0(1+n)^t$, where n is a constant growth rate of the labor force. Here the interpretation of L_t is as a stock (number of persons). There is no indication of the average rate of utilization in actual employment of this stock over the year.

This text will not attempt a break with this tradition of using the same symbol for two seemingly different concepts. But we insist on interpretations such that the notation is *consistent.* This requires normalization of the utilization rates for capital and labor in the production function to equal one, as indicated in (1.2) and (1.3) above. In this way we are allowed to use the same symbol for a stock and the corresponding flow.

A *second* conceptual issue concerning the production function in (2.1) relates to the question: what about raw material? Indeed, it may seem strange to regard output as produced by only capital and labor. Certainly, raw materials are generally necessary inputs at the micro level. In macroeconomics, however, we normally abstract from the engineering input-output relations, involving raw materials and intermediate products, in the different branches of the economy. We imagine that at a lower stage of production materials are continuously produced by capital and labor, but are then immediately used up at a higher stage of production, again using capital and labor. These materials are not part of value added in the sector or in the economy as a whole. Since value added is what macroeconomics focuses on and what the Y in (2.1) represents, materials therefore are usually not explicit in the model.[3]

To clarify this point as well as more general aspects of how macroeconomic models are related to national income and product accounts, the next section gives a review of national income accounting.

[3] On the other hand, if of interest for the problems studied, the analysis *should,* of course, take into account that at the aggregate level in real world situations, there will be generally a minor difference between produced and used-up materials which then constitutes net investment in inventories of materials.

1.3 Macroeconomic models and national income accounting

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Stylized national income and product accounts

We give here a stylized picture of national income and product accounts with emphasis on the conceptual structure. The basic thing to be aware of is that national income accounting looks at output from *three sides*:

- the production side,
- the use side,
- the income side.

Consider a closed economy with three production sectors. Sector 1 produces raw materials (or energy) in the amount Q_1 per time unit, Sector 2 produces durable capital goods in the amount Q_2 per time unit, and the third sector produces consumption goods in the amount Q_3 per time unit. The production factors are "land" (or non-producible natural resources more generally), labor, raw materials, and fixed capital.

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1.4 Some terminological points

On the vocabulary used in this book:

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Physical capital refers to reproducible means of production (equipment and structures). Non-reproducible means of production, such as land and other natural resources, are in this book not included under the heading "capital" but just called "natural resources".

We follow the convention in macroeconomics and, unless otherwise specified, use "capital" for physical capital and "investment" for physical capital investment, that is, procurement of physical capital. In other branches of economics and in everyday language capital may mean the funds that finance the accumulation of physical capital.

By a household's *wealth,* W, we mean the value of the total stock of resources possessed by the household at a given point in time. This wealth generally has two main components, the *human wealth*, which is the present value of the stream of future labor income, and the *financial wealth.* The latter is the sum of the value of the household's *physical assets* and *net financial assets* (the difference between the value of financial assets and the value of financial liabilities). Recall, *financial assets* include cash as well as paper claims that entitles the owner to future transfers from the issuer of the claim, perhaps conditional on certain events. Bonds and shares are examples. And a household's *financial liability* is an obligation of the household to in the future transfer resources to others. A mortgage loan is an example.

In spite of this distinction between what is called physical assets and what is called financial assets, in macroeconomics the household's "financial wealth" generally refers to all its non-human wealth, that is, including purely physical assets like land, buildings, and equipment.

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A *predetermined* variable is a variable whose value is determined historically at any point in time. For example, the stock (quantity) of water as of time t in a bath tub is historically determined as the accumulated quantity of water stemming from the previous flow. But if y_t is a variable which is not tied down by its own past but, on the contrary, can immediately adjust if new conditions or new information emerge, then y_t is a non-predetermined variable or a *jump variable* and y_0 can then in principle take on any value within some range. Returning to our bath tub example: in the moment we pull out the waste plug, the outflow of water per time unit will jump from zero to a positive value − it is a jump variable.

1.5 Brief history of macroeconomics

Text not yet available.

1.6 Bibliographic notes

The modern theory of economic growth ("new growth theory", "endogenous growth theory") is extensively covered in dedicated textbooks like Aghion and Howitt (1998), Jones (2002), Barro and Sala-i Martin (2004), Acemoglu (2009), and Aghion and Howitt (2009).

Snowdon and Vane (1997), Blanchard (2000), and Woodford (2000) present nice overviews of the history of macroeconomics. For surveys on recent developments on the research agenda within theory as well as practical policy analysis, see Mankiw (2006), Blanchard (2008), and Woodford (2009). Somewhat different perspectives are offered by Chari et al. (2009) and D. Colander and Mehrling (2008).