1

Introduction and brief overview

Economic growth is arguably the issue of primary concern to economic policy makers in both developed and developing economies. Economic growth statistics are among the most widely publicized measures of economic performance and are always analyzed and discussed with interest. As a consequence, growth theory has long occupied a central role in economics.

The study of economic growth illustrates the power of compound interest. A seemingly small growth differential can accumulate over time to substantial differentials in levels. To take one very simple example, suppose two countries begin with the same level of income. A sustained 1% growth differential in output between the two economies implies that in seventy years – just one lifetime – the output *level* of the faster-growing economy will be *double* that of the slower-growing economy. Indeed, the dramatic changes in relative incomes among the OECD countries that one can observe between the end of World War II and the present are in some cases the accumulated results of these seemingly small differences in growth rates.

1.1 Some background

Long-run growth was first introduced by Solow (1956) and Swan (1956) into the traditional neoclassical macroeconomic model by specifying a growing population coupled with a more efficient labor force. The direct consequence of this approach was that the long-run equilibrium growth rate in these models was ultimately tied to demographic factors, such as the growth rate of population, the structure of the labor force, and its productivity growth (technological change), all of which were typically taken to be exogenously determined. Hence, the only policies that could contribute to long-run economic growth were those that would increase the growth of population, and

manpower training programs aimed at increasing the efficiency of the labor force. Conventional macroeconomic policy had no influence on the long-run growth performance. It could, however, influence the transitional growth path and thus the long-run capital stock and resulting output. Moreover, the slower the economy's rate of convergence, the longer it remained in transition, and the more significant the accumulated level effects.

Over the last half-century, economic growth theory has produced a voluminous literature, doing so in two distinct phases. The Solow–Swan model was the inspiration for a first generation of growth models during the 1960s, which, being associated with exogenous sources of long-run growth, are now sometimes referred to as *exogenous growth models*. Research interest in these models tapered off abruptly around 1970 as economists turned their attention to shorter-run issues, perceived as being of more immediate significance, such as inflation, unemployment, and oil shocks, and the design of macroeconomic policies to deal with them. Beginning with the seminal work of Romer (1986), there has been a resurgence of interest in economic growth theory, giving rise to a second generation of growth models, and continuing to this day. This revival of activity has been motivated by several issues, which include: (i) an attempt to explain aspects of the data not discussed by the neoclassical model; (ii) a more satisfactory explanation of international differences in economic growth rates; (iii) a more central role for the accumulation of knowledge; and (iv) a larger role for the instruments of macroeconomic policy in explaining the growth process; see Romer (1994). These new models seek to explain the long-run growth rate as an endogenous equilibrium outcome of the behavior of rational optimizing agents, reflecting the structural characteristics of the economy, such as technology and preferences, as well as macroeconomic policy. For this reason they have become known as *endogenous growth models*.

One can identify interesting differences between the first and second generations of growth models, both in terms of the range of issues they address and the methodology they employ. The earlier models focused almost entirely on the role of physical capital accumulation as the source of economic growth, coupled with the exogenous growth in population and technology. The approach tended to be what one might call "sequentially structured," meaning that one begins with the simplest model and then augments it in various directions to incorporate additional aspects. This is well illustrated by Burmeister and Dobell (1970), which at the time of its publication was a state-of-the-art review of the literature. Beginning with the one-sector model, they first extend it by introducing technological change, then go on to two sectors, add a second asset, and subsequently

advance to a range of multi-sector models, before culminating with a discussion of optimal growth.

In contrast, contemporary growth theory is more wide-ranging. While physical capital accumulation remains a central source of economic growth, many other aspects are discussed in parallel. These include the accumulation of human capital, knowledge and education, the role of public capital, the quality of health, demographic factors, and recently, the role of institutions, the political environment, and even religion. The transmission of technological change and innovation is also assigned a central role. Recognizing that the spoils of growth are not shared equally among society, the relationship between economic growth, the level of development, and income distribution is a central issue that also has a long history. One consequence of studying growth from this broader perspective is that the study tends to be more motivated by empirical observation rather than by trying to develop a unity of structure as was more characteristic of the earlier literature.

One other contrast between the two generations of growth model is that whereas the old theory focused almost exclusively on closed economies, the new theory tends to have more of an international orientation; see e.g. Grossman and Helpman (1991). This may reflect the increased importance of the international aspects in macroeconomics in general and the international linkages that exist throughout the economy. But it may also reflect the greater emphasis placed by the current literature on empirical issues and the reconciliation of the theory with the empirical evidence. In this respect, differential national growth rates and evolving differential national income levels are central topics and have given rise to the widely debated issue of the so-called convergence hypothesis. The question here is whether or not countries have a tendency to converge to a common per capita level of income, and if so, how long it takes.

As one assesses the new growth theory, one can identify two main strands of the theoretical literature, emphasizing different sources of economic growth. One class of models, closest to the neoclassical growth model, stresses the accumulation of (private) physical capital as the fundamental source of economic growth. This differs in a fundamental way from the neoclassical growth model in that it does not require exogenous elements, such as a growing population, to generate an equilibrium of ongoing growth. Rather, the equilibrium growth is internally generated, though in order to achieve that, certain restrictions relating to homogeneity must be imposed on the economic framework. Some of these restrictions are of a knife-edge character and have been the source of criticism; see e.g. Solow (1994).

In the simplest such model, in which the only factor of production is capital, the constant-returns-to-scale condition implies that the production

function must be linear in physical capital, being of the functional form $Y = AK$. For obvious reasons, this technology has become known as the "AK model." As a matter of historical record, explanation of growth as an endogenous process in a one-sector model is not new. In fact it dates back to Harrod (1939) and Domar (1946). The equilibrium growth rate characterizing the AK model is essentially of the Harrod–Domar type, the only difference being that consumption (or savings) behavior is derived as part of an intertemporal optimization, rather than being posited directly. These one-sector models assume (often only implicitly) a broad interpretation for capital, taking it to include both human, as well as nonhuman, capital; see Rebelo (1991). This is necessary if the model is to be calibrated plausibly using "real-world" data. A direct extension of this basic model is a two-sector investment-based growth model, originally due to Lucas (1988), that disaggregates private capital into human and nonhuman capital. This has also generated an extensive literature; see e.g. Mulligan and Sala-i-Martin (1993) and Bond, Wang, and Yip (1996).

A second class of models emphasizes the endogenous development of knowledge, or research and development, as the engine of growth. The seminal contribution here is that of Romer (1990), which develops a two-sector model of a closed economy, where new knowledge produced in one sector is used as an input in the production of final output. The knowledge/education sector has been extended in various directions by a number of authors; see e.g. Aghion and Howitt (1992), Zhang (1996), Glomm and Ravikumar (1998), Bils and Klenow (2000), and Blankenau (2005). A related class of models deals with innovation and the diffusion of knowledge across countries, and a comprehensive discussion is provided by Barro and Sala-i-Martin (2000, ch. 8).

One is beginning to see a confluence of some aspects of the old and new growth theories. The new growth models are often characterized as having scale effects, meaning that variations in the size or scale of the economy, as measured by population, say, affect the size of the long-run growth rate. For example, the Romer (1990) model of research and development implies that a doubling of the population devoted to research will double the growth rate. Whether the AK model is associated with scale effects depends upon whether there are production externalities that are linked to the size of the economy; see Barro and Sala-i-Martin (2000). By contrast, the neoclassical Solow–Swan model has the property that the equilibrium growth rate is independent of the scale (size) of the economy; it is therefore not subject to such scale effects.

Empirical evidence does not support the existence of scale effects. For example, Jones (1995a) finds that variations in the level of research

employment have exerted no influence on the long-run growth rates of the OECD economies. Backus, Kehoe, and Kehoe (1992) find no conclusive empirical evidence of any relationship between US GDP growth and measures of scale. These empirical observations are beginning to stimulate interest in the development of non-scale models. Such models are hybrids in the sense that they share some of the characteristics of the neoclassical model, yet their equilibrium is derived from intertemporal optimization as in the new growth models.[1] Jones (1995b) proposes a specific model, in which the steady-state growth rate is determined by the growth rate of population, in conjunction with certain production elasticities, in his case pertaining to the knowledge-producing sector.

1.2 Scope of this book

It is clearly beyond the scope of this book to present an exhaustive discussion of growth theory. For that the reader should refer to specialized textbooks, such as Grossman and Helpman (1991), Aghion and Howitt (1998), Barro and Sala-i-Martin (2000), and Acemoglu (2008), which provide comprehensive treatments of the subject from different perspectives. Nor is it a comprehensive treatment of international macroeconomic dynamics. This too is a broad area and discussed from various viewpoints by Frenkel, Razin, and Yuen (1996), Obstfeld and Rogoff (1996), and Turnovsky (1997a). Rather, the purpose of this book is to exposit investment-based growth models, but from an international perspective, and more specifically from a viewpoint that is more applicable to a small open economy. This means that numerous topics central to international macroeconomics are not addressed.

The book has three parts. We begin our discussion in Chapter 2 by expositing a canonical model of a small open economy that is sufficiently general to encompass alternative models that appear in the literature and that we shall discuss. The remainder of Chapter 2 and Chapter 3, which together make up Part I, develop models that have the property that the economy is always on its balanced growth path. It is important to stress that this characteristic is not assumed, but is derived as the only equilibrium that is intertemporally viable.

These initial models can be viewed as being alternative versions of the AK growth model. Such models have been extensively used to analyze the effects of fiscal policy on growth performance; see e.g. Barro (1990), Jones and

[1] Jones (1995a) refers to such models as "semi-endogenous" growth models.

Manuelli (1990), King and Rebelo (1990), Rebelo (1991), Jones, Manuelli, and Rossi (1993), Ireland (1994) and Turnovsky (1996a).[2] Most of these endogenous growth models have been developed for a closed economy, although several applications to an open economy now exist; see Rebelo (1992), Razin and Yuen (1994, 1996), Mino (1996), Turnovsky (1996b, 1996d, 1997c), van der Ploeg (1996), Baldwin and Forslid (1999, 2000), and Chatterjee (2007).

Section 3 of Chapter 2 begins with the simplest Romer (1986) model with fixed labor supply, characterizing in detail the equilibrium that is attained. Section 4 then discusses an open economy version of the Barro (1990) model, where government expenditure is productive, and analyzes optimal fiscal policy in that setting. Chapter 3 extends this basic model to the case where labor is supplied elastically. It emphasizes how going from one assumption to the other fundamentally changes the determination of the equilibrium growth rate and the impact of fiscal policy. Adjustments that are borne by the accumulation of capital when the labor supply is fixed, are accommodated by an adjustment in the capital–labor ratio, when labor is supplied elastically.

These initial models all abstract from transitional dynamics, so that in each case the economy is always on its balanced growth path. This implies that the economy fully responds instantaneously to any structural or policy change. While this may be pedagogically convenient, it is obviously implausible. It is also inconsistent with the empirical evidence pertaining to convergence speeds, which suggests that economies spend most of their time adjusting to structural changes. Part II therefore presents in some detail several natural ways that transitional dynamics may be introduced.

Chapter 4 discusses two ways of accomplishing this in a one-sector economy. Like much of international macroeconomics, the benchmark assumption being adopted is that the small country can borrow or lend as much as it wishes, at a fixed given interest rate. One way to introduce dynamics is to replace this assumption, which in any event is a polar one, with an assumption that the small economy has restricted access to world financial markets, in the form of borrowing costs that increase with its debt position. This is particularly likely to be relevant for a small developing economy, but it is also plausible as a general proposition. The second modification, which again is a move toward reality, is the introduction of

[2] There has been less research analyzing the effect of monetary policy on endogenous growth. Two studies that consider monetary aspects include van der Ploeg and Alogoskoufis (1994) and Palivos and Yip (1995).

government capital, so that in contrast to the Barro model, government expenditure influences production as a stock of public capital, rather than as a current expenditure flow.

Transitional dynamics can also be introduced in other ways, and these are discussed in the following two chapters. Chapter 5 treats the case where the production technology is augmented to two sectors, a traded and a nontraded sector, showing the nature of the dynamics that this introduces. The two-sector model, where the two sectors consist of physical (nonhuman) and human capital, respectively, was one of the original models of endogenous growth pioneered by Lucas (1988). Other authors who analyze the two-sector model include Mulligan and Sala-i-Martin (1993), Devereux and Love (1994), and Bond, Wang, and Yip (1996). This aspect is particularly relevant for international economies, where it is natural to identify the two sectors with nontraded and traded capital, as in the traditional dependent economy model.

As we have already noted, the endogenous growth model has been subject to criticism along two lines. First, it is often associated with "scale effects" meaning that long-run growth rates are linked to the size of the economy, a characteristic that is not supported by the empirical evidence. Second, it holds only if strict "knife-edge" conditions on the technology hold. In response to this, we have seen the development of non-scale growth models, which have the property that long-run growth rates are independent of the scale of the economy. This model is also associated with transitional dynamics and is discussed in Chapter 6. In particular, we show that if we combine this more general technology with the increasing cost of debt, introduced in Chapter 4 we are able to replicate quite complex behavior of debt, which in some cases was associated with the episodes of the Asian debt crisis in the 1990s.

Part III of this book combines some of the elements presented in Parts I and II and applies them to the issue of foreign aid. Specifically, we construct an endogenous growth model of a small developing economy that faces restricted access to the world financial market. The country is relatively poorly endowed with public capital, which it then receives in the form of foreign aid from abroad. The issue that the model addresses concerns the form that the aid should take. Should it be tied in the sense of being committed solely to public investment, or should it be untied, in the sense of being used for any purpose that the recipient country wishes, including debt reduction, consumption, or perhaps private capital formation? By combining the accumulation of public with private capital, together with costly debt accumulation, the macroeconomic equilibrium is represented by a higher-order dynamic system, the effective analysis of which can be conducted only

numerically. Chapters 7 and 8 perform this in some detail, thus illustrating the use of straightforward numerical simulations to assist in our understanding of this process. We should emphasize that the answer to the basic question being posed here – the relative merits of tied versus untied foreign aid – is highly sensitive to many aspects of the economic structure, and for this reason we need to conduct substantial sensitivity analysis.

Throughout this book, our main objective is to exposit the structures of the various models in their basic form rather than to analyze any one in detail. The models provide powerful analytical tools that can be adapted to various needs and circumstances. One key issue that distinguishes the endogenous growth model from the non-scale model is the impact of policy on the long-run equilibrium growth rate. Before embarking further, we should acknowledge that the empirical evidence pertaining to this issue is mixed. If one takes the evidence on non-scale growth models seriously, and accepts that the long-run growth rate is determined as suggested by Jones (1995b), the scope for fiscal policy is limited, although less so than in the Solow model. Indeed, empirical evidence by Easterly and Rebelo (1993) and Stokey and Rebelo (1995) suggests that the effects of tax rates on long-run growth rates are insignificant, or weak at best. Stokey and Rebelo argue that their findings provide evidence against those models, such as AK models, that predict large growth effects from taxation. In order for the predictions of these models to be consistent with their evidence, these growth effects would have to be largely offset by changes in other determinants of the long-run growth rate. But other studies, such as Grier and Tullock (1989), Barro (1991), and Barro and Lee (1994), obtain negative relationships between growth and government consumption expenditure, while Barro and Lee also find that government expenditure on education has a positive effect on growth. Taken together, we do not view the empirical evidence as necessarily contradicting the ability of fiscal policy to influence the growth rate. It may well be the case that a higher income tax has a significant negative effect on the growth rate, but that this is roughly offset by a significant positive growth effect of the productive government expenditure it may be financing, thus yielding a small overall net effect.[3] Indeed, the welfare-maximizing rate of taxation in the simple Barro (1990) model of productive government expenditure coincides with the growth-maximizing tax rate, so that if the tax rate is in fact close to optimal there

[3] Kneller, Bleaney, and Gemmell (1999) argue that the results finding weak evidence for the effects of tax rates on growth are biased because of the incomplete specification of the government budget constraint.

should be little effect on the growth rate, precisely as the empirical evidence seems to suggest. But to understand this relationship, it is important to develop a model in which the various components of fiscal policy are introduced explicitly, and their separate and possibly conflicting effects on the growth rate analyzed. It is in this vein that we view the AK model as providing an instructive framework for analyzing the effect of fiscal policy on growth.

PART ONE

Models of balanced growth