Monetary Macrodynamics

Toichiro Asada, Carl Chiarella,
Peter Flaschel and
Reiner Franke

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Monetary Macrodynamics

This book investigates the interaction of effective goods demand with the wage–price spiral, and the impact of monetary policy on financial and the real markets from a Keynesian perspective. Endogenous business fluctuations are studied in the context of long-run distributive cycles in an advanced, rigorously formulated and quantitative set-up. The material is developed by way of self-contained chapters on three levels of generality: an advanced textbook level, a research-oriented applied level and a third level that shows how the interaction of real with financial markets has to be modelled from a truly integrative Keynesian perspective.

Monetary Macrodynamics shows that the balanced growth path of a capitalist economy is unlikely to be attracting and that the cumulative forces that surround it are controlled in the large by changes in the behavioural factors that drive the wage–price spiral and the financial markets. Such behavioural changes can in fact be observed in actual economies in the interaction of demand-driven business fluctuations with supply-driven wage and price dynamics as they originate from the conflict over income distribution between capital and labour.

The book is a detailed critique of US mainstream macroeconomics and uses rigorous dynamic macro-models of a descriptive and applicable nature. It will be of particular relevance to postgraduate students and researchers interested in disequilibrium processes, real wage feedback channels, financial markets and portfolio choice, financial accelerator mechanisms and monetary policy.

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Contents

General introduction

This chapter provides a brief introduction to the general aims, specific topics and methods that we wish to address and use in this book. The basic objective is to provide the reader with an alternative to the current mainstream approaches to monetary macrodynamics, on both a textbook level as well as on a more advanced research-oriented level. This alternative sometimes comes close in formal structure to the more orthodox approaches, but it nevertheless differs significantly in its conclusions compared to what is achieved by mainstream economic theory.

The AS–AD approach of the traditional Neoclassical Synthesis

This book grew out of a set of lectures of one of the authors (Peter Flaschel) over the last two to three decades in the area of monetary macrodynamics. Its initial point of departure was the A(ggregate)S(upply)–A(ggregate)D(emand) framework of the old Neoclassical Synthesis in the compact (but nevertheless very detailed) dynamic form in which it was presented in Sargent (1979, 1987), where the topics of inflation and growth were also treated in an integrated way.

As a rigorous introduction to the Keynesian AS–AD analysis of that time, Sargent's presentation was indeed a very valuable one; however, the current book will depart significantly from it, not only in the topics that are treated, but also in the substance of the analysis. Our approach is driven by the view that the dynamic analysis in Chapter 5 of Sargent (1987) does not portray a coherent and appropriate approach from a Keynesian perspective, if the latter's evolution after Keynes' General Theory is properly taken into account.

However, in view of Keynes' (1936) explicit acceptance of the marginal productivity or marginal costs relationship (where he only altered the direction of causation), Sargent's Chapter 5 is completely to the point in revealing that Keynes' revolution of the Classical Theory was still incompletely formulated, since the neoclassical assumption that prices are (under perfect competition) equal to marginal wage costs in fact destroys the Keynesian AD framework if a conventional type of money–wage Phillips curve is added to the AD model and if, in addition, perfect myopic foresight is assumed.

This is so since the money–wage Phillips curve implies, in this ideal case (which gives only a hint of a deeper inconsistency within this combination of Keynesian and Neoclassical building blocks), a real wage Phillips curve and therefore dichotomizes the conventional Keynesian AS–AD model into a model of Solovian underemployment growth (since there are real wage rigidities added to it) and an appended purely nominal AD theory of the rate of interest and the rate of price inflation.

Keynes' (1936) model of the GT therefore represented only a partial revolution of the Classical Theory that he was attempting to overcome:

> I have called this book *The General Theory of Employment, Interest and Money*, placing the emphasis on the prefix 'general'. The object of such a title is to contrast the character of my arguments and conclusions with those of the classical theory of the subject, upon which I was brought up and which dominates the economic thought, both practical and theoretical, of the governing and academic classes of this generation, as it has for a hundred years past. I shall argue that the postulates of the classical theory are applicable to a special case only and not to the general case, the situation which it assumes being a limiting point of the possible positions of equilibrium. Moreover, the characteristics of the special case assumed by the classical theory happen not to be those of the economic society in which we actually live, with the result that its teaching is misleading and disastrous if we attempt to apply it to the facts of experience.
>
> (Keynes, 1936, p.3)

The solution to the stated internal inconsistency of the original AS–AD growth model is, however, a simple and very plausible one. As Barro (1994), for example, observes, IS-LM is (or should be) based on imperfectly flexible wages *and* prices and thus on the consideration of wage as well as price Phillips curves (a feature that was typical of the Neokeynesian fix-price approaches of the 1970s and 1980s). This is precisely what we shall do in this book, following Malinvaud (1980) for example, but – as we have already argued in Chiarella, Flaschel, Groh and Semmler (2000) – not with the consequence that the Keynesian regime is only one of the three possible outcomes of the baseline fix-price rationing methodology (the other ones being capital shortage and repressed inflation).

We, thus, will assume gradual wage and price adjustment (in place of infinitely fast adjustment processes), and will extend this approach in later portions of the book also to quantity adjustment processes (including inventory adjustment), since here too it is not very plausible to have continuous goods market clearing at all points in time.

By and large, the book will therefore formulate and extend a Keynesian theory of aggregate demand (and money and interest) where there are gradual adjustment processes for the aggregate price and wage level, as well as the economy-wide output level and where, therefore, disequilibrium adjustment processes are driving the real markets of the economy. In such a setup, the resulting D(isequilibrium)

AS–D(isequilibrium)AD framework will no longer give rise to neoclassical anomalies of the type indicated earlier, since the marginal productivity relationship then only determines the (profit-maximizing) capacity output of firms that only in the steady state will be strictly positively correlated to the demand-driven actual output level of firms.

This is the basic scenario that underlies the modeling philosophy of the book and which will be extended into a variety of directions in the various chapters that follow. However, in Chapter 1, we first discuss the state of actual textbook presentations of the macroeconomics literature that is characterized by a collection of short-term, medium-term and long-term modeling approaches that lack internal consistency.

Beyond the Neoclassical Synthesis of perfect competition and effective demand

Consequently, in more technical terms, the main objective of this book is to demonstrate that there exists a matured type of the conventional Keynesian AD–AS theory of monetary macroeconomics that builds on traditional Keynesian models, but also goes beyond them in essential ways, which is primarily dynamic in nature, and which conceives temporary economic behavior as always adjusting to observed disequilibria by a variety of adaptive learning mechanisms. The reason for adopting such an approach is that time has to be treated on the macrolevel essentially by continuous methods, though there may exist pronounced delays in a certain range of activities.

However, the data-generating process of actual economies on the macro-level is definitely of a very high frequency in general, also on real markets, since, for example, the aggregate price level is subject to numerous changes even on a daily level. In a continuous time framework, however, it is not sensible to assume that markets clear every 'second' so that it is very natural then to assume the prevalence of disequilibrium adjustment processes – which at one extreme may be simple rules of thumb and, at the other extreme, sophisticated learning algorithms – coupled with certain desired levels or ratios that may be the objective of the rational choice of economic agents.

Behavior in the context of non-clearing markets is, therefore, the essential modeling strategy used in this book. Through it, we seek to understand the basic causal structure or market hierarchy that, according to Keynes (1936), characterizes the macroeconomy and, on this basis, the feedback channels (or repercussions as Keynes (1936) called them) which in addition are operating within the downward hierarchy of markets on the macrolevel. In our view, the market hierarchy of modern capitalist economies leads from financial markets and their relative autonomous behavior to the goods markets, since investment in particular is dependent on the outcomes on financial markets, and from there to labor markets, which have to adjust to the circuit of income that the interaction between output, income and sales creates on the market for goods.

This is the causal nexus that Keynes (1936) formulated for the working of the macroeconomy, which of course does not work in isolation, but is surrounded by a range of feedback channels of not-so-dominant, but nevertheless important, type working in the opposite direction compared to the asserted causal nexus of Keynesian macrodynamics. Such feedback channels, by and large, work through the impact they have on the expected excess rate of profit and thus can impact on various channels such as the dynamics of real wages, or on the real rate of interest.

The book approaches such topics at first, in Part I, on the textbook level. After taking stock of the progress that has been achieved there and in the literature in general, it then continues its analysis, in Part II, on a level that is comparable to the advanced New Keynesian baseline model with both staggered wages and prices as it is, for example, presented on an advanced textbook level in Galí (2008). As in the New Keynesian approach, a necessary next step thereafter is to confront the theoretical model with what is occurring in actual economies and to estimate its behavioral equations by more or less advanced econometric methods.

Such parameter estimates represent the important contribution of the later chapters of Part II. The concluding Part III provides a theoretical outlook on what needs to be done next, once the too simplistic representation of financial markets by just an interest rate policy rule, of the New Keynesian approach and also our matured DAD–DAS macrodynamics, is replaced by the consideration of a model with portfolio choice amongst financial assets as the representation of financial markets on the macrolevel.

These introductory characterizations of what we intend to do in this book may appear to be overly complex, but they are not really so once it is realized that they are just natural extensions of what even intermediate textbooks, such as Blanchard (2009), actually provide as building blocks for the understanding of modern capitalist economies. We have simply taken seriously and acted upon Blanchard's suggestion that these building blocks must sooner or later be treated in an integrated way.

Keynesian macrodynamics in the mainstream textbook literature

> As will quickly become clear, Keynesian models differ from real-business-cycle models not just in substance, but also in style. … Keynesian models, in contrast, often begin by directly specifying relationships among aggregate variables. … The idea behind this shortcut aggregate approach to model building is threefold. First, it is simple. … Second, many features of the economy are likely to be robust to the details of the microeconomic environment. … And third, by insisting on microeconomic foundations, we could in fact miss important elements. … To give a more significant example, traditional Keynesian models give current income a particularly important role in consumption demand. … Of course, there are also disadvantages… .
>
> (Romer, 1996, 5.1)

In principle, we cannot but agree with these selective quotations from the second subsection of the first edition of Romer's introduction to his chapter on Keynesian macroeconomics.[1] However, the problem with the representation of the Keynesian model that follows these observations is that it is by and large only a static and very traditional representation of the Keynesian approach to macroeconomics, certainly much less advanced than, for example, what Sargent (1979) had already presented in his Macroeconomic Theory that we have briefly discussed earlier. Moreover, even when one restricts Keynesian analysis to the simple IS-LM-P(hillips)C(urve) framework – as it underlies for example Blanchard's (2009) intermediate textbook discussion – there follow conclusions, as we shall show in detail in Chapter 2, that have little in common with Romer's (2006) discussion of the Keynesian IS-LM analysis as a theory of business fluctuations and the nominal rigidities that may be their cause.

Traditional Keynesian IS-LM-PC analysis determines output and interest at each point in time as statically endogenous variables that then move in time through money–wage changes, transmitted in the simplest case through markup pricing into price level changes. These price level changes and the resulting rate of inflation are observed by the economic agents and lead to a revision of their expectation of future rates of price inflation. Again, in the simplest case of an adaptive learning rule, we can obtain, even then, four possible *dynamic* outcomes for the laws of motion that drive inflation and inflationary expectations, two of which are stable (monotonically or accompanied by business fluctuations). The other two possibilities are characterized by monotonic or cyclical divergence away from the steady state of the economy (where inflation is equal to the growth rate of money supply in the case that such a policy is pursued by the central bank).

These possibilities had already been discussed in Tobin (1975) and were later classified as Mundell(-Tobin) effects. These effects work through the real interest rate channel of the Keynesian IS-LM block via an assumed influence of the real rate of interest on investment (and durable consumption goods). Depending on the strength of the adjustment speed of inflationary expectations, we can then get instability in the IS-LM-PC framework when this parameter passes from below through a certain threshold level (which in fact need not be very large in magnitude).

This generation of at least local instability is, however, not discussed in the textbook literature as a *systemic* outcome of the traditional IS-LM-PC model, and thus as a possibility that is also of relevance during the normal (non-pathological) working of the economy. The exceptions are a few authors – see, for example, Scarth (1996), who have integrated Tobin's critical condition for instability of the real rate of interest channel into their macroeconomic thinking. However, the majority of macroeconomists do not like to see instability in their core reflections of the working of the macroeconomy, and thus put such observations, if they mention them at all, into considerations that are of marginal importance in their text.

1 These statements are no longer so definite in Romer (2006, 5.1).

Yet, Keynes himself had already stressed that situations may occur in which the economy becomes unstable and could even break down if one were to follow the orthodox advice of making money–wages as flexible as possible, and that workers are instinctively more reasonable than economists, to the extent that they are capable of making money–wages rigid at least in the downward direction. If instability is among the normal outcomes of the IS-LM-PC macro-model, the introduction of a downward rigidity of money–wages can indeed rescue the economy from economic breakdown. The resulting business fluctuations may not represent the best of all worlds, but such rigidities are at least able to generate persistent business fluctuations in place of processes of accelerating wage deflation or inflation, and thus definitely help to avoid the worst-case scenario.

Such are the results that one can already achieve from the most basic dynamic IS-LM analysis (discussed in detail in Chapter 2). It prepares the reader for a study of those situations where the macroeconomy does not work more or less perfectly, but is rather plagued by centrifugal forces for which certain behavioral changes are needed when these forces displace the economy too far away from its steady-state position. The real rate of interest channel (where the nominal rate component implies stability, but where the expected inflation component can generate an inflationary or deflationary spiral) is only one example from a set of the many feedback channels that may shape the movements of the macroeconomy over time. The discussion of such feedback channels is generally completely absent in the textbook literature, which instead uses IS-LM analysis only to discuss short-term restrictions on economic activity, while simpler monetarist constructions are generally used to discuss the theory of inflation, and where the entirely real model of Solow is then finally used to represent what will happen in the long run.

We will discuss such disintegrated views of the working of the macroeconomy in detail in the first chapter. After IS-LM-PC analysis proper (Chapter 2), we will then attempt in the third chapter to integrate the partial models of Chapter 1 into a coherent whole, also by including what has been achieved in Chapter 2 for the IS-LM-PC model, and will arrive then at our most basic AS–AD growth model, as it can be derived from a synthesis of the Keynesian theory of output and interest, the monetarist theory of money and inflation, and of the neoclassical theory of economic growth.

Yet, as already discussed above, if Solow's marginal productivity principle is used in this model type in its strict form (holding at each moment in time), we run into the difficulties of the AS–AD growth dynamics that we have described earlier and must therefore then at the least allow for gradual wage *and* price level adjustments in order to avoid (from a Keynesian perspective bizarre) the dichotomization into a core Solow underemployment model and an appended, purely nominal IS-LM theory of price inflation.

Part I of the book closes with a contribution (Chapter 4) of Amitava Dutt and Peter Skott, who reconsider Keynesian AD–AS analysis from a Post-Keynesian perspective and take stock of what has been achieved in this area so far.

This chapter also lays foundations, from a different perspective, for the contents of Part II of the book, which we discuss next.

Keynesian macrodynamics: new or matured?

For our purposes, the baseline New Keynesian model with both staggered wages and prices represents a combination of Keynesian as well as Walrasian structural equations (just as does the old Neoclassical Synthesis), with elements from the theory of monopolistic competition also interwoven. The Walrasian component is primarily given by the theory of consumer households, while the Keynesian element is harder to detect and may be related to the view that there are nominal rigidities present in this model type, since the model exhibits an IS curve that may be more Wicksellian than Keynesian in nature – see also Woodford (2003) in this regard. Nevertheless, we then have at our disposal a structural macromodel with only gradually adjusting prices and wages, an IS curve and, instead of an LM theory of the money market, a Taylor interest rate policy rule, which makes money supply endogenous at each moment of time.

The New Keynesian approach thus provides a baseline structure for macroeconomic reasoning that is on the one hand very compact, but on the other hand already fairly advanced (concerning analytical tractability in particular). It is rigorously microfounded and basically of market clearing type (avoiding rationing procedures). It is, in this baseline formulation, purely forward looking, and makes use of the rational expectations methodology in its constructions of the actual trajectories of the dynamics that are generally convergent (by assumption). Instabilities, therefore, can only exist if rational bubbles are admitted as a possibility.

The rational expectations methodology has various appealing features, but it also exhibits a number of conundrums, if not even bizarre outcomes. These conundrums are considered in detail from a deterministic perspective in Chiarella, Flaschel, Franke and Semmler (2009) (in models with predetermined as well as non-predetermined variables) in detail, and so will not be reconsidered in the present book. In the baseline New Keynesian model under consideration here, there is one predetermined variable (given through the definition of real wages) and three non-predetermined ones. We refer the reader to Galí (2008) for a detailed presentation of the features of this model type.

We will consider this New Keynesian macrodynamic model briefly in the starting chapter of Part II. We show there that it provides reasonable determinacy properties from the New Keynesian rational expectations perspective. We then go on and confront this model type with a wage–price spiral representation of the interaction of wages and prices, and a conventional type of IS curve (exhibiting the Mundell-Tobin effect through its assumptions on investment behavior) and also an interest rate policy rule. This model is in its formal structure quite similar to the New Keynesian alternative, but radically different in its implications, in particular due to the fact that it makes use of predetermined variables throughout. Its implications in fact generalize the IS-LM-PC analysis of Chapter 2 and thus also the central implications of this model type, namely that its stability depends on a critical threshold condition separating convergence from divergence by way of a cyclical loss of stability.

The central message of this chapter is therefore that there is a matured alternative to the New Keynesian break with almost any Keynesian tradition that preserves insights of the old Neoclassical Synthesis, but avoids the inconsistencies stemming from the integration of Walrasian pricing procedures into an otherwise Keynesian framework. Part II therefore starts with the formulation of a model proposed as alternative to the New Neoclassical Synthesis of models of the RBC (Real Business Cycle) and NK (New Keynesian) type, an alternative that is designed in a way that makes it formally seem of the same type as the New Keynesian one.

This matured type of Keynesian AD–AS analysis is extended in the chapters of Part II in various directions, in particular towards a disequilibrium AD–AS (DAD–DAS) approach that is then also estimated and calibrated in various ways. One essential element in the wage–price spiral that the DAD–DAS dynamics exhibit is the inertia that is put into this spiral by way of the concept of an inflation climate. We use as a simplifying device, as in Sargent (1987, Ch.5), myopic perfect foresight as far as the evolution of nominal variables is concerned. However, this now secondary abstraction from short-term inflationary errors is embedded into a situation where agents are aware of the fact that a medium-term inflationary climate surrounds these contemporaneous changes in the rate of wage and price inflation.

Such a setup is comparable to a situation where people have perfect information on the next day's weather, but consider in addition the season into which this information is embedded and the averages that have characterized the current season so far (or some more complex concept of such averages; see Chapter 9 for details).

Thus, the contribution of Part II is basically a DAD–DAS theory of demand-driven business fluctuations where persistence is often implied by the joint occurrence of local instabilities and globally bounding mechanisms such as the kinked money–wage Phillips curve (that is horizontal for employment rates that are sufficiently low).

Part III relates this DAD–DAS theory to the more general K(eynes)M(etzler) G(oodwin) approach to goods–market dynamics; see Chiarella and Flaschel (2000) and Chiarella, Flaschel and Franke (2005) for the origins and quantitative applications of this model-building strategy. It provides, as a central extension of the KMG approach, an outlook on future work by adding a financial sector (with Tobinian portfolio choice) to the disequilibrium dynamics of the real sector and thus now shows how monetary policy has to work its way through the assumed asset market structure of the model before it can reach the real sector and influence its activity and the rate of inflation that the resulting business fluctuations generate. The model built by this stage can be considered as a fairly advanced disequilibrium approach to real markets, with gradual wage, price and quantity adjustment processes, with stress on Keynesian feedback structures and with focus on a balanced representation of both real and financial markets.

Methods, aims and readership

The focus of our modeling strategy is, as already stated, the disequilibrium adjustment processes that are assumed to characterize the real market – at least in a continuous time framework. With respect to the earlier quotation from Romer (1996), we do not insist on microeconomic foundations, since we would indeed then fail to capture some important elements that shape the evolution on the macroeconomic level. Our overall modeling approach is guided by our firm belief that the imposition of the 'straightjacket' of microfounded market-clearing procedures, coupled in addition with rational expectations in the extreme information-processing way they are formulated nowadays, removes too many aspects of real economic life from consideration.

Disequilibrium, non-market-clearing approaches or out-of-equilibrium perspectives are merely an admission, in more or less provocative terms, that the actual economy is a complex adaptive system that must be formulated in descriptive macro-terms in the first instance (in order to know what needs to be microfounded), before microfoundations should be attempted. As the discussion of rationing procedures as part of the non-Walrasian macro-theory in the 1970s has shown, the introduction of rationing schemes can be very arbitrary, so that not too much hope can be attached to the micro-foundations of the adjustment rules that economic agents actually use in response to the disequilibria that they are facing.

Moreover, the formulation of disequilibrium adjustment processes can reveal in very direct ways the presence of multiple interacting feedback channels of monetary macrodynamics, which can be studied in isolation to a certain degree in order to reveal how the economy, for example, reacts to wage deflation. However, the interaction of these feedback channels must eventually be studied. The resulting higher-dimensional dynamical systems then require a local stability analysis, and, if instability is obtained, call for behavioral assumptions that can guarantee the global boundedness of the business fluctuations that these types of models can generate. This modeling strategy of endogenously generated persistent fluctuations in output, employment and inflation can be called the Keynes paradigm (see Chapter 22, in the General Theory), as opposed to the Frisch paradigm (where the business cycle is primarily explained by stochastic shocks).

To study such endogenously driven business fluctuations, in an advanced, coherent, quantitative, and rigorous way, is the aim of the book. We do so by way of relatively self-contained chapters on three levels of generality: an advanced textbook level, a more advanced research-oriented level and, in the closing chapter, in a way that we believe the interaction of real with financial markets should eventually be modeled.

Since Part I of the book can be used for teaching purposes, we finally add a few words on this aspect. This part leads the reader in a systematic way towards an integrated Keynesian macromodel in the form of three lectures that build on each other, and are aimed at discussing and overcoming the weaknesses of the static and dynamic macro-models of traditional Keynesian AD–AS growth dynamics.

The fourth lecture provides on overview on mainstream and post-Keynesian approaches.

- Lecture 1 (Chapter 1) provides an introduction to the state of the art in disintegrated AD–AS growth theory, as it is usually presented on all levels of teaching about macrodynamics.
- Lecture 2 (Chapter 2) provides an introduction to the dynamics of aggregate demand. We here make use of a conventional money–wage Phillips curve (coupled with markup pricing), expectations- and NAIRU-augmented, and adaptive expectations formation, in order to investigate the dynamic implications of two fundamental macroeconomic feedback chains, the interaction of Keynes and Mundell effects that is unavoidable in IS-LM analysis, based on the real rate of interest channel in investment (and consumption) behavior. In place of the implications of the monetarist baseline model of Chapter 1, we here derive an IS-LM-PC analysis with a variety of stability and instability features, which can be used as an explanation of stable depressions or persistent business fluctuations if downward nominal wage rigidity is added. Here, we also study the potential for monetary policies to influence such dynamic outcomes, in particular the role of interest rate policy rules, for stabilizing a situation of unstable real rate of interest dynamics.
- Lecture 3 (Chapter 3) provides an introduction to the dynamics of aggregate supply. Starting from neoclassical Solovian unemployment growth dynamics, we show its relationship to Goodwin's (1967) classical growth cycle dynamics and even to conventional AS–AD growth dynamics when inflationary expectations are of the myopic perfect foresight variety. In such a case, a real wage Phillips curve finds application, with interesting implications on the real evolution of the economy, though there is not yet provided a convincing theory of nominal inflation dynamics, both on the level of the simple Goodwin-Solow synthesis as well as in the integrated AS–AD growth dynamics when subjected to myopic perfect foresight.
- Lecture 4 (Chapter 4) provides the stocktaking by Peter Skott and Amitava Dutt of what has been achieved in mainstream and Post-Keynesian AD–AS macroeconomics.

Altogether, the material of Part I can be used for advanced courses on monetary macrodynamics – courses that stress that today's macroeconomics must be dynamic in nature and thus is dependent on the demonstration of its result on the mathematical theory of dynamical systems (which in the macro-framework of continuous time are in fact much less demanding than are the equivalent tools for the treatment of the generally discrete time systems of mainstream macrodynamics).

Therefore, the lecture part of the book can be viewed as providing an alternative treatment of monetary macroeconomics, in comparison to the books by Blanchard and Fisher (1989), Carlin and Soskice (2006), Handa (2000) and Romer (2006). Carlin and Soskice also focus their textbook on the treatment of market imperfections and a graphical treatment of the adjustment dynamics that these imperfections imply. If Chapters 5 and 6, which extend our AD–AS approach towards a AD–D(isequilibrium)AS model, are also taken into account, the covered material can also be usefully compared with more advanced approaches like Galí's (2008) book, and also with Turnovsky (1995) and Walsh (2003). However, in spirit, the book is much more closely related with Taylor (2004) in the attempt to reconstruct macroeconomics from a non-mainstream perspective – see also Godley and Lavoie (2006) and Cencini (2001) in this respect.

It is hoped that the economists who have read through the advanced textbook treatment of Part I will be motivated to go on with this type of study of an advanced version of Keynesian monetary macrodynamics that is competing with the advanced New Keynesian alternative in rigor, results and applicability. The outcome of this competition must, of course, be left to the judgment of the reader.

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Part I

Conventional AD–AS modeling

1 Models of growth, inflation and the real-financial market interaction

1.1 Disintegrated macro model building

The dominant tradition on the intermediate textbook level is to make use of the conventional IS-LM model of the real-financial market interaction to describe the short-run behavior of a closed economy on the macrolevel, while the medium run and inflation dynamics are modeled by a monetarist variant of this model type. For the long run, one, however, makes use of the real Solovian growth dynamics, the nonmonetary neoclassical growth model, in order to describe the basic forces of economic growth. The IS-LM equilibrium for output and interest is an attracting equilibrium if 'ultra-short-run' adjustment rules for output and the nominal rate of interest are added to this modeling framework; the steady state of the monetarist inflation dynamics of the medium run is attracting, since the interaction between the real rate of interest channel and the dynamics of inflationary expectations are modified in various ways in order to suppress the destabilizing Mundell effect; and the long-run balanced growth path of the Solow model is attracting, since one reduces everything here to the adjustment of the full-employment capital intensity state variable (by totally ignoring the unemployment models of the short- and the medium-run).

Thus, from the dominant traditional point of view, this foregoing sequence of models suggests that the dynamical processes shaping the macroeconomy are always convergent, that is, the deterministic core dynamics of employment, inflation and growth is of a shock absorber type. The basic message of this book, however, will be that such a conclusion is the result of a very particular sequence of models, and that this understanding of the working of the macroeconomy will not be confirmed if the three runs of this intermediate textbook literature are integrated into a consistent whole, relying strictly on the assumptions that are made in this literature. The first observation to be made here is that the neoclassical Solow growth model is not at all a model of IS-LM growth, since it neglects money and liquidity preference and since it does not consider the coordination of independent savings and investment decisions. The gap between this model type and Keynesian growth dynamics is therefore of a significant nature. Nevertheless, it is widely believed that the Solow model provides the essential explanation of the long-run growth dynamics of market economies, with short- and medium-run rigidities being of no importance for the understanding of this long-run process; this is, for example, the message of Mankiw's (1994) book. But the long run (not necessarily the steady state of an economy) is the result of its short- and medium-run evolution and thus cannot be separated from such an evolution by just reducing everything to the growth path of full-employment capital intensity driven by savings decisions and natural population growth.

Concerning the medium run, that is to say the theory of inflation, there have been various approaches that basically avoid discussion of the so-called Mundell(-Tobin) effects, which can destabilize the economy via accelerating inflation or deflationary spirals. Dornbusch and Fischer (1994) separate the real rate of interest effect in investment behavior into a stabilizing nominal effect (or Keynes-effect) which interacts with the real dynamics in the usual way as a shock-absorber, and a subsequent real interest rate dynamics which is also convergent. Blanchard (2006), by contrast, just assumes static inflationary expectations in order to avoid discussion of unstable expected real rate of interest adjustments in the normal working of his medium-run model (he does discuss, however, pathological processes of hyperinflation and of deflation in later chapters of his book). Nevertheless, in general, in the textbook literature on unemployment and inflation, there holds sway the view that this process is usually convergent to a steady state if not disturbed by monetary policy (or fiscal policy).

In this introductory chapter, we critically investigate these standard procedures of the textbook literature that divide the analysis into models of attracting balanced growth for the long-run, stable unemployment inflation dynamics for the medium-run, and finally output, employment and interest rate determination for the short-run. The modeling approaches chosen in each case are – as discussed earlier – too distinct from each other, with for example Say's Law applying in the first two cases, but not in the short run of the third. Due to this observation, they cannot therefore easily be integrated into a coherent whole, as is claimed in Blanchard (2006), to achieve dual objectives: first, the medium-run being obtained just as a continuation and extension (via wage–price dynamics) of the short run and growth dynamics being again just as an extension of the medium run, by adding the laws of motion for labor and capital; second, a confirmation of the conclusions drawn from the isolated dynamics of Keynesian IS-LM, the monetarist view on inflation and the neoclassical growth approach from such an integration perspective. We shall in fact see in the course of this book that the results of the disintegrated textbook treatments of steady growth, medium run inflation dynamics and short-run real-financial (output-interest rate) interaction are not at all supported by an integrated Keynesian treatment of IS-LM-P(hillips)C(urve) growth where wage–price dynamics and investment-driven growth interact with a real-financial view of goods and money market interdependence.

The extension of conventional Keynesian short-run real-financial interaction or simply IS-LM theory to topics concerning the medium- and the long-run evolution of the economy in a coherent way is the subject of Part I of the book, where we approach such questions, in Chapter 2, from a partial consideration of the dynamics of aggregate demand (representing dynamic AD or IS-LM-PC dynamics proper) and, in Chapter 3, from a partial consideration of the dynamics of aggregate supply (AS), later on, in combination with Keynesian AD. It is in Part II that we shall come to an integration of these two sides of traditional macrodynamic model building, in the form of a coherently formulated AD–AS growth dynamics. In Chapter 4, we shall in addition consider in detail alternative formulations of more or less Keynesian analysis of the short run and thus show there that the conventional IS-LM framework with given wages and prices (and thus a horizontal aggregate supply curve) need not be the only possibility as a starting point in the pursuit of fully integrated macrodynamics over the three runs considered. These alternative points of departure will, however, not be used in the present book to provide alternative formulations of fully integrated macrodynamics, but will be taken up again in future work where, in particular, Postkeynesian approaches to integrated macrodynamics will be presented and investigated.

We instead extend, in Part II, our AD–AS framework of Part I (which already overcomes a variety of weaknesses of conventional AS–AD growth dynamics) towards a fuller treatment of the dynamics of aggregate demand by also including in the framework adopted sluggish quantity adjustment processes, and thus full goods market disequilibrium (besides the already given sluggish wage and price adjustments based on disequilibrium in the use of the stock of capital and of labor, respectively). We thereby arrive at a model type that we consider to be the proper reformulation and extension of traditional Keynesian IS-LM short-, medium- and long-run analysis with full real market disequilibria on the one hand and full financial market equilibria on the other hand. This approach and some of its many extensions, here in the direction of endogenous average saving rates, endogenous natural growth, extended portfolio equilibria and more, will be the subject of Part III, the character of which is therefore more (but not exclusively) that of an advanced textbook or even research monograph, compared to the first two parts of the book.

In this current chapter, we discuss in compact form the conventional component models of textbook macrodynamics, the long-run (Solovian factor supply driven more or less steady growth), the short-run (IS-LM under- or overemployment equilibria with respect to both labor and capital) and the medium-run (AD–AS or wage–price dynamics of various types), on an elementary but to some extent also on an advanced level. We shall show that these components, often presented in splendid isolation from each other, are not easily linked together. We go on to show that, if such links between these three components of macrodynamic analysis are provided, the resulting dynamics do not at all confirm the conclusions obtained from the unlinked systems. Advanced textbooks that consider AD–AS growth dynamics through a complete set of behavioral and budget equations represent the exception, as for example Chapter 5 in Sargent's (1987) book, and in fact cannot really fulfill this task, as we shall demonstrate in Chapter 3.

The latter, still conventional, type of integration of Keynesian aggregate demand with supply-side dynamics of monetarist and Solovian type indeed creates more problems than it helps to solve, as we shall show in Part I. Our analysis, therefore, in fact, reveals that an integration along these lines may not be the final solution for the formulation of supply-side growth dynamics within Keynesian aggregate demand restrictions. Our strategy in Chapters 5 and 6 consequently will be to add further Keynesian elements to the traditional integrated AD–AS growth dynamics of the textbook literature such that these problems can be avoided completely. Our approach will be built on the analysis of growth, the interaction of output and interest on goods and financial markets, and wage–price dynamics augmented by inflationary expectations adjustments to be considered in the next three sections. These additions, basically of further delayed adjustment processes caused by disequilibria on the real side of the economy, will provide us finally, in Chapter 5, with a model type that indeed overcomes the problems that we have pointed out in the conventional type of AD–AS growth dynamics.

In the next section, we will present the Solovian real growth dynamics in basically the same terms as in the original approach of Solow (1956) and its numerous textbook representations. We will provide here two equivalent representations, in terms of labor intensity as well as capital intensity, augmented by the neoclassical theory of income distribution between labor and capital. There exist now many significant extensions and modifications of the Solow supply-side growth dynamics; see Romer (1996) and Barro and Sala-i-Martin (1995). Adding the insights of this new growth theory into the intended integrated framework of Keynesian growth dynamics is, however, not an easy task and will be left for future research, since the focus of this book is on the extension of this framework to a full disequilibrium treatment of the real markets (and a full equilibrium treatment of the financial markets), but not yet the inclusion into it of new growth theory.

With respect to the short run, in this chapter represented by traditional IS-LM analysis, we will provide in this introductory chapter only a brief characterization of Keynesian IS-LM model building, since this topic is taken up again in later parts of the book. We believe that the medium- and long-run behavior of the economy should be derived by a systematic extension of such short-run features, the topic of both Part I and Part II, and thus by the evolution of such alternative frameworks in place of their simple replacement through the neoclassical theory of economic growth and income distribution for discussion of long-run issues, and a quantity-theory-based analysis of inflation dynamics for the medium run. In Keynesian analysis, it will generally not be true that the economy is always on the transition to a steady state of Solovian type since its determination of steady-state positions can be different from the neoclassical one. More importantly, it will also be true that the forces that shape the dynamics of integrated Keynesian growth dynamics will often be such that persistent fluctuations are endogenously generated and thus characterize the long-run behavior of the economy, which moreover need not cycle around its steady-state position, and can thus significantly depart on average from the steady-state position, if the number of laws of motion of the dynamics becomes sufficiently high.

Employing the idea of a transition from the short run to the long run, in particular when based on Friedman-Phelps-type inflation theory as discussed here in Section 3, thus illegitimately restricts the possibility of the outcomes of the nonlinear dynamical world in which we live and may also exclude important aspects of a Keynesian analysis of wage–price dynamics as we will show in Chapter 5 on the Keynesian analysis of goods and labor market dynamics in a growing economy.

In the present chapter, we will, however, provide globally asymptotically stable dynamics for the medium-run representation of fluctuating inflation and unemployment rates that are linked to conventional IS-LM analysis only in the extreme case of a vertical LM-schedule (where interest-rate-oriented policy has no meaning) and that is also fairly unrelated to the monotonic full-employment path towards the steady state of the Solow growth model. The baseline model of the monetarist theory of inflation considered in this chapter therefore does not provide a bridge that relates the short run of IS-LM type (Section 4) with long-run growth (Section 2), and therefore does not properly describe the transition process between these two extremes of macroeconomic theorizing.

This closes our brief critical summary of the currently popular modeling approach of the textbook view of supply-driven growth in the longer run, demand-determined output, interest and unemployment rates in the short run, and Phillips curve inflation theory coupled with adjustments in inflationary expectations describing the transition from the short to the long run. These topics are usually taught by means of three different, nonintegrated types of macromodels even in quite recent textbooks, as the one of Blanchard (2006), despite its claim (see the preface to that book) to provide an integrated view of macroeconomics. On the contrary, these disintegrated model types – Keynesian IS-LM analysis, monetarist inflation theory and neoclassical growth theory – represent three partial modeling approaches with deficiencies in each component model and with a variety of problems that prevent their proper integration. By and large, the integrated view on macrodynamics is therefore missing in the traditional macroeconomic literature, which thus continues to ignore the need to provide baseline integrated models for the analysis of market economies on the macrolevel.

1.2 Neoclassical growth theory and the long run

The following brief discussion of the Solow (1956) growth model builds on Flaschel (1993, Ch.3) and Chiarella *et al*. (2000b, Ch.2). The Solow growth model is, of course, presented in numerous textbooks, old and new. A classic source for a detailed presentation of this model type is Jones (1975), and contemporary presentations and extensions are found in Romer (1996) and Barro and Sala-i-Martin (1995). The present book will not develop the Solovian growth theory into the now-fashionable direction of endogenous growth theory, but will aim at embedding it into a coherently formulated theory of AD–AS disequilibrium-cum-growth, leaving, however, the surely important issue of endogenous growth (along Schumpeterian lines) for future research on the potential of this type of analysis to also cope with waves of technological innovations, their diffusion and their decline.

1.2.1 The Solow model

Solow's (1956) one-good model of economic growth is based on full-employment throughout, and is made determinate with respect to its steady-state solution by the assumption (or if modeled, then by the implication) that growth adjusts to exogenously given labor force growth (plus productivity growth, if Harrod neutral technical change is added to it, see the following section). It provides a monotonic one-dimensional transition towards its steady-state solution for all initial values of capital-intensity or labor-intensity. It can be varied in many ways, including for instance differentiated saving habits and endogenous saving rates and endogenous technological change.

One variation of the Solow growth model is, however, rarely considered, namely its extension by an independent and in particular Keynesian investment function of firms, which is not closely related to the saving decisions of the households sector. This is the type of extension that we will pursue at the end of this book (in Ch.10) after demand side issues and portfolio approaches have been integrated with supply side issues in Part II. Without this integration, Solovian growth dynamics is not subject to any of the feedback mechanisms that we will discuss in this book, and thus in particular not plagued at all by unstable adjustment processes and the like.

The typical starting point of Solovian growth theory is the following set of assumptions (where in particular capital stock depreciation and technical change are still ignored for the time being):

$$Y = F(K, L^d) \quad \text{the neoclassical production function,} \tag{1.1}$$

$$S = sY, \; s = const. \quad \text{Harrod type savings function,} \tag{1.2}$$

$$\dot{K} = S \quad \text{capital stock growth driven by household savings decisions,} \tag{1.3}$$

$$\dot{L} = nL, \; n = const. \quad \text{labor force growth,} \tag{1.4}$$

$$L^d = L \quad \text{the full-employment assumption,} \tag{1.5}$$

$$\omega = F_L(K, L) \quad \text{the marginal productivity theory of employment.} \tag{1.6}$$

The notation in these equations is fairly standard (see the list of notations at the beginning of the book). We here use L^d to denote labor demand and $\omega = w/p$ to denote the real wage. Technology is described by means of a so-called neoclassical production function[1]

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

1 See Jones (1975, Ch.2) for a detailed presentation of the mathematical conditions characterizing such a production function and also a detailed analysis of its properties. We here only recall that marginal products F_L, F_K are homogeneous of degree zero in both arguments, since the production function is assumed to be homogeneous of degree 1 and that $Y = F_L L + F_K K = \omega L + rK$ holds in such a situation with respect to the income distribution between labor and capital.

which exhibits constant returns to scale and marginal products of capital $F_K(\equiv r)$ and of labor F_L, which are positive and decreasing, so that $F_{KK} < 0, F_{LL} < 0$.[2]

There is only direct investment of savings into real capital formation in this model type – that is, Say's Law is assumed to hold true in its most simple form, namely

$$I \equiv S = sY$$

with savings being strictly proportional to output and income Y. Labor is growing at a given natural rate n and is fully employed, so that this model simply bases economic growth on actual factor growth without any demand-side restriction on the market for goods. Full-employment is assumed to follow from the equality of real wages ω with the marginal product of labor at the full-employment level, which means that the real wage always adjusts such that price-taking firms are maximizing their profits at the full-employment position and thus will clear the labor market. A perfectly flexible real wage ω thus is assumed to guarantee the full employment of the labor force at each moment of time.[3] The growing labor supply ($\dot{L} = nL$) is consequently always fully employed, and the profit-maximizing output can always be sold as there is no Keynesian problem of effective demand – all output that is not consumed is voluntarily invested into new capital formation.

It is obvious that Solow's growth model – despite many opposite statements in the literature – has not much in common with Harrod's or Domar's approach to economic dynamics, which this model intended to criticize. There are neither accelerating sales expectations nor capacity utilization problems based on an independent investment behavior. The problem of coordinating independent savings and investment behavior is thus absent from the model. No multiplier interacts with the accelerator principle to generate possibly unstable economic dynamics. Instead, its dynamics result solely from increases in factor supplies on the basis of the assumption of their full-employment.

Let us now consider some of the basic implications of Solow's growth model in its foregoing formulation. For the supply of new capital, we know from the foregoing that

$$\dot{K} = sF(K, L), \text{ where } L = L^d,$$

due to the full-employment assumption. Let us denote labor intensity L/K by l. Due to the assumption of constant returns to scale, we can reduce the dynamic analysis of this growth model to the movements of this ratio l, given by

$$\hat{l} = \dot{l}/l = n - \hat{K} = n - sF(K, L)/K = n - sF(1, l) = n - sf(l), \tag{1.7}$$

2 One generally also assumes $F_{KL}(= F_{LK}) > 0$, i.e. the marginal product of one factor increases if more of the other factor becomes available.

3 See Jones (1975, Ch.2) – and the following discussion – for the details of this neoclassical theory of income distribution, which determines the shares of labor and capital by their marginal products *and* the assumption of their full-employment.

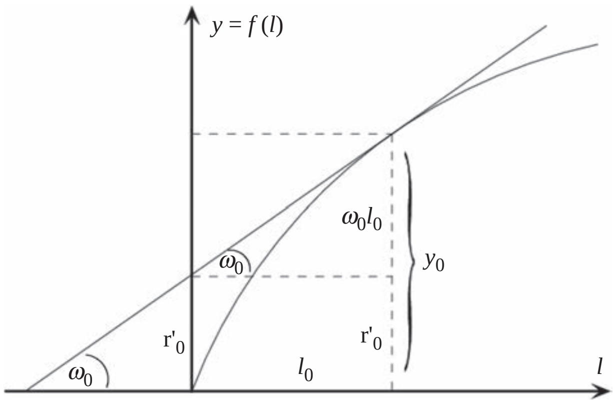

Figure 1.1 The Solow model; income distribution in the case of perfect competition, full-employment and neoclassical smooth factor substitution.[5]

where $f(\cdot) = F(1,\cdot)$ denotes the foregoing production function in its so-called intensive form (here expressed by means of labor intensity in the place of capital intensity $k = K/L$). The economic and mathematical conditions that are placed on the original production function $F(K,L)$ imply the following standard form (see Figure 1.1) for the function $y = f(l)$, where $y = Y/K$ the output–capital ratio.[4]

Because of the relationship $\omega = F_L(K,L) = F_L(1,K/L) = f'(l)$, this intensive form of the production function allows for a simple graphical presentation of the functional distribution of income between labor and capital and its variation if the relative factor supply term l is changing as shown in Figure 1.1 (see Jones(1975, Ch.2) for further details). The comparative statics associated with the Figure 1.1, characterizing the theory of income distribution behind Solovian growth, is thus very straightforward. It basically states that the factor of production which becomes the more abundant one (here measured by changes of the labor intensity l) will get a decreasing remuneration, here shown by the corresponding changes in ω and r.

Equation (1.7) is the so-called fundamental equation of Solow's growth model. In words, it simply states that the growth rate of labor intensity is positive if labor supply grows faster then the capital stock (and vice versa) – that is, labor intensity must rise or fall according to the difference that exists between labor force growth and the growth rate of the capital stock $sf(l)$.

This fundamental Equation (1.7) can easily be transformed into its more common form (which uses as dynamic variable the capital intensity expression

4 Jones uses capital intensity $k = 1/l$ for his presentation of the Solow growth model.

5 Note that $r = f(l) - f'(l)l = y - \omega l = F_K$ the rate of profit (a residual), see Jones (1975, Ch.1) and Sargent (1987, Chs.1, 5) for the details of such economic and also accounting relationships.

$k = K/L$ in the place of labor intensity $l = 1/k$) by making use of the relationships

$$\tilde{f}(k) = F(k, 1) = f(l)/l \text{ or } f(l) = \tilde{f}(k)/k,$$

which give (because of $\hat{k} = -\hat{l}$)

$$\hat{k} = sf(l) - n = s\tilde{f}(k)/k - n,$$

or simply

$$\dot{k} = s\tilde{f}(k) - nk.$$

The last law of motion gives rise to the following alternative characterization of Solow's fundamental equation and its components:

- nk is the amount of capital currently used per laborer that is needed to employ the current additions to the labor force nL without a change in the capital intensity k (the needed capital-widening to employ the growing labor force)
- $s\tilde{f}(k)$ is the amount of capital per laborer that is actually invested
- On this basis, the change in capital intensity k is then determined by the difference of these two terms (showing the resulting capital-deepening implied by the fundamental equation).

The comparative statics associated with Figure 1.1, characterizing the quantity side of the Solovian growth theory, is again a very simple one. Increases in natural growth increase the rate of growth of the economy as well as labor intensity and capital productivity, while increases in the savings rate of households do just the opposite.

Returning to the form (1.7) of the fundamental dynamic equation of Solow's growth model, the analysis of the stability of the steady-state position of this model is a simple matter, since the dynamics are only of dimension 1. A graphical presentation, as in Figure 1.2, is sufficient here to convince the reader of the validity of the important assertions of the Solow model. These assertions are:

- There is a unique steady-state value l_0 if it is, for example, assumed that the Inada conditions hold true; that is, $f(0) = 0, f'(0) = \infty, f(\infty) = \infty$, $f'(\infty) = 0$.
- The steady-state value is globally asymptotically stable – that is, the economy approaches n, the natural rate of growth, over time by an appropriate change in the labor intensity that is used in production.
- The steady-state values of labor intensity l_0, as well as of consumption per laborer $c = (1 - s)\tilde{f}(k)$,[6] depend on the rate of savings s , but the steady rate of growth of the economy is independent of it.

6 The consumption per a laborer c will be maximized when the savings rate s is chosen such that $n = \tilde{f}'(k)$ holds true (i.e. $S = sY = rK = Y - \omega L$), which gives the so-called golden rule of accumulation

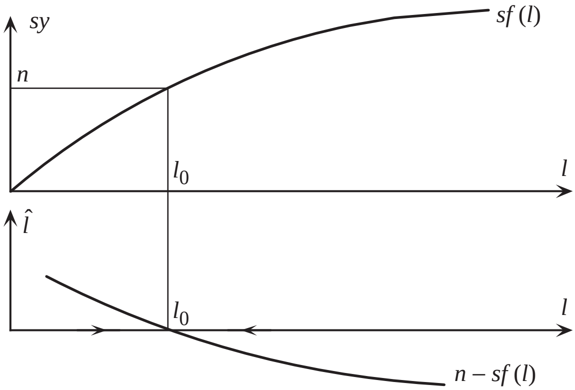

Figure 1.2 The one-dimensional quantity dynamics of the neoclassical growth model.

- In the steady-state we have

  $$n = sf(l_0) = sy_0 = s/\sigma_0,$$

  which is the equality of Harrod's warranted rate of growth s/σ with the natural rate of growth n. There is thus no conflict between these two rates here.

The stability of the natural rate of growth path is achieved through variations in capital productivity y (or the capital–output ratio $v = 1/y$) by means of an appropriate change in labor or capital intensity, in the course of capital accumulation. From the perspective of supply, based on Say's Law ($I \equiv S$) and the full-employment of the supplied factors, there is thus no problem involved in the process of capital accumulation, since the factor that is more scarce in relation to the other (with regard to the steady-state ratio l_0) will always grow faster, so that a non-steady value of the labor intensity l will always be modified in the direction of its steady-state value l_0.

Yet, the foregoing analysis depends not only on the assumption that real wages ω are manipulated at each moment in time such that full-employment results. In addition to this counterfactual statement, it also depends on the classical view that goods supply will (always) create its appropriate goods demand, so that all income that is not consumed will be invested.

Adding capital stock depreciation at the rate δ to the model is not a big issue. For the ratio l, this addition gives rise to the extended fundamental equation

$$\hat{l} = n + \delta - sf(l), \text{ since } \dot{K} = sF(K, L) - \delta K,$$

(in which case investment is exactly equal to profits. In a model of differential swing, this result would correspond to the situation $s_w = 0, s_c = 1$ for the saving rate of workers (s_w) and capitalists (s_c), in the place of the uniform savings rate of the Solow model).

with $Y = F(K, L)$ being the gross national product of the economy. The addition of capital stock depreciation therefore only adds one further parameter to the model.

The same holds true if disembodied Harrod neutral technical change of the constant rate n_x is added to the Solow growth model ($x = Y/L$, the System of National Accounts measure of labor productivity). We denote the given natural rate of growth of the labor force by n_l and use n to denote the sum of these two given rates of growth, so that $n = n_l + n_x$. Harrod neutral technical change in the case of neoclassical smooth factor substitution is defined as

$$Y = F(K, \exp(n_x t)L)$$

and states that technical change in this economy would occur in a uniform way if the work effort of all laborers were to increase at a constant growth rate n_x, a situation that has been called labor-augmenting technical change in the literature; see Jones (1975) for a very detailed discussions of this issue. We note that Hicks neutral and Solow neutral technical change can be defined in similar ways (by making use of the expression $\exp(n_x t)$ in other places in the production function), but that Harrod neutral technical change is the only one among these three types that allows for a steady state solution, as it is derived in the following Section.

We shall continue to neglect depreciation and now approach neoclassical growth theory by using capital intensity in the place of labor intensity, which gives rise to

$$\hat{k} = s\tilde{f}(k) - nk, \; k = K/(\exp(n_x t)L), \;\; \text{since } \dot{K} = sF(K, \exp(n_x t)L).$$

Note that capital intensity has had to be redefined here in order to allow for a ratio that can be stationary in the steady state. This new measure, $k = K/(\exp(n_x t)L)$, is called capital intensity, measured in efficiency units in the literature, and is to be distinguished carefully from the System of National Accounts measure of capital intensity K/L. The above form of the Solovian fundamental equation follows immediately from the growth rate formula $\hat{k} = \hat{K} - (n_l + n_x)$ when the equation for $\dot{K}$ is taken into account. The Solow growth model is therefore again not changed very much by the addition of technical change (of Harrodian type), if account is taken of the facts that now we have to make use of

$$y = \frac{Y}{K}, \; x = \frac{Y}{\exp(n_x t)L}, \; l = \frac{\exp(n_x t)L}{K}, \; k = \frac{K}{\exp(n_x t)L}$$

when interpreting the model and the two Figures 1.1 and 1.2. Note in this regard also that the real wage ω must now be replaced by the wage share $v = wL/pY$ in Figure 1.1, while the definition of the rate of profit in this figure remains the same, namely $r = (Y - vY)/K$, but is now of course based on the wage share in the place the real wage in order to clearly see its stationarity in the steady state.

As the model is now formulated, it implies the following trend growth rates in the steady state by way of its stationary steady state solution:

- $\hat{Y} = n$ Output growth, explained by the sum of natural and productivity growth,
- $\hat{K} = n$ Capital stock growth, explained by the sum of natural and productivity growth,
- $\hat{\omega} = n_x$ Real wage growth, equal to productivity growth,
- $\hat{r} = 0$ No trend in the rate of profit (and the wage share),
- $\hat{I} = n$ A given share of investment in output growth.

This in turn implies that the System of National Accounts measure of capital productivity (the output–capital ratio) has no trend in the steady state (just as the rate of profit r and the wage share v), while that of actual labor productivity Y/L must then grow at the rate n_x, just as the real wage ω. Actual capital intensity K/L must grow at the rate n_x while the share of investment in national product is again a constant. These steady-state properties conform nicely to the stylized facts of the growth of capitalist economies as they were formulated by Kaldor; see Jones (1975). The Solow model augmented by Harrod neutral technical change thus, in particular, explains (in very basic terms, however) the observed systematic growth of capital employed per worker and also the growth rate of the real wages observed from a secular point of view. However, it is not only steady growth theory that allows for these and other stylized facts of long-run growth.

A further stylized fact of the evolution of capitalist economies is that, in the very long run, there is no trend in the rate of unemployment; however, the level of unemployment settles at a value significantly above zero (representing absolute full-employment) and the inflation rate at a value that remains positive in the very long run. NAIRU theories (on Non-Accelerating-Inflation Rates of Unemployment) which attempt to explain this fact will be considered, beginning with the next section, in various places in this book. If this rate can be considered to be determined outside the scope of the Solow model, the conclusions of this model type will, of course, remain intact with a positive NAIRU rate of unemployment (so-called full-employment) in the place of absolute full-employment.

Yet, it is highly questionable whether the NAIRU level can indeed be considered a given magnitude for the explanation of economic growth (see Chapter 6) and it may also be questioned whether steady-state analysis should be used to explain secular tendencies in capitalist economies or whether the long run is rather to be considered as referring to a historically unique long period in the evolution of such economies, like industrialization, the evolution of the welfare state and the like, referring to time spans that are generally considerably shorter than even one century see also Marglin (1984) in this regard. If such a perspective on the modeling of long-run growth is accepted, we may in addition postulate that such a period is characterized by a certain investment climate and thus be given by an investment demand schedule which is quite independent in its behavioral form from the schedule that characterizes aggregate savings per unit of capital. The latter

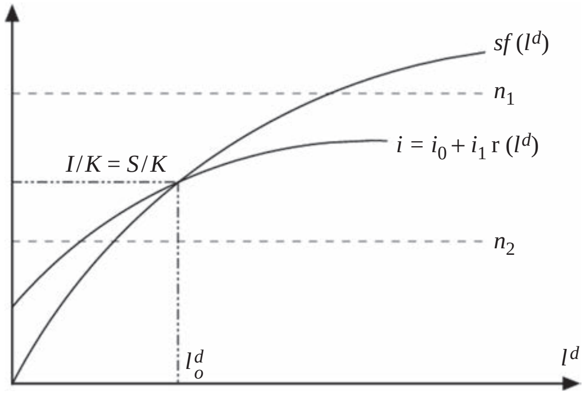

Figure 1.3 Investment-driven economic growth: leaden and golden ages.

is, of course, to be derived from households' decision making, while the former is in fact a consequence of firms' behavior which, up to certain episodes or sectors of the economy, is quite independent from the forces that shape the savings behavior of the households (though, of course, interacting with it).

1.2.2 Investment-driven growth

In order to show in as simple a way as possible that the logic of the Solow growth model need not at all apply to the explanation of growth in factual economies, we now assume as the investment schedule in this framework, besides the savings function we have already considered, the simple expression[7]

$$I/K = i_o + i_1 r, \quad r = (1-v)y, \quad y = Y/K, \quad v = \omega L^d/Y, \; i_o, i_1 = const. > 0.$$

Here, investment per unit of capital thus depends solely on the rate of profit r of the economy (in a positive fashion) and investment itself exhibits an autonomous trend term i_o that may be related to an animal spirit explanations of investment behavior (of a particular historical episode of a capitalist economy). The addition of such an investment function to the Solow growth model is easily shown to give rise to the following graphical situation, where – for reasons of simplicity and also exposition – we have assumed that the parameter i_1 is chosen so small that the investment schedule is flatter than the one for savings, as shown in Figure 1.3.[8]

In Figure 1.3, we see, in contrast with Figure 1.2, that growth is no longer determined by the natural rate of labor force growth, but by the intersection of the

7 Here, we abstract again from depreciation and technical change ($n_2 = n_l = n$).

8 In terms of the following determination of the slope of $i(.)$, this amounts to assuming that $sf'(l^d) > -i(\cdot)f''(l^d)l^d$ holds true.

investment schedule with the savings schedule (both per unit of capital). In order to see this clearly, we must, however, first relate the rate of profit to the actual state of the labor intensity $l^d = L^d/K$ in order to be able to draw both the investment and the savings functions on the same diagram. This is easily done as follows. We have (due to the assumption of a price level that is always given by marginal wage costs)

$$r = f(l^d) - f'(l^d)l^d \quad \text{and thus} \quad r'(l^d) = -f''(l^d)l^d > 0,$$

that is, the rate of profit depends positively on the level of l^d, since the latter is strictly negatively correlated with the level of real wages (as we already know). The investment schedule can thus be written as

$$i(\cdot) = I/K = i_o + i_1 r(l^d) = g(l^d), \quad g'(l^d) > 0,$$

which is the function drawn in Figure 1.3. It has been drawn as strictly concave, but this needs not be the case, it would depend on the properties of the production function f. The intercept of the graph of the function with the vertical axis is given by the autonomous amount in the investment behavior (somehow determined by animal spirits outside the model), while its slope is always less than the corresponding one in the savings function.[9] We briefly note that the considered situation will lead to stable adjustments of labor intensity if there is movement out of the steady-state position.

Since $S/K = sf(l^d)$ is strictly increasing and takes on all values between zero and infinity, and since the investment function (based on l^d as well) is flatter than the savings function (and starts at zero with a positive value), there must be a unique and positive steady-state solution for the actual labor intensity $l_o^d \neq l_o$ where capital stock growth is the same considered from the perspective of savers and of investors and where profits assume the level $r_o = f(l_o^d) - f'(l_o^d)l_o^d$. Furthermore, at the steady state, we have that i_o, as one given trend in investment growth, is augmented by endogenously generated further investment growth $i_1 r_o$ and in sum gives $i_o + i_1 r_o$ as the resulting growth rate of the economy. This growth rate may be smaller (or larger) than n, the growth rate of the labor force, in which case workers are assumed to be repelled into (attracted from) segments of the economy (not modeled here), where they basically do not exercise pressure on the labor market and the rate of change of money wages.

Note here that we indeed do not go into a discussion of the formation of money wages – which is the subject of the following section – but simply assume that the price level of the economy is always determined, as in Keynes (1936), by perfect competition and thus through marginal wage costs, giving rise to the equality between real wages and the marginal product of labor even without

9 In the case of a Cobb-Douglas production function $Y = K^\alpha (L^d)^{1-\alpha}$, this amounts to assuming that $s > i_1\alpha$ holds true.