CHAPTER 1

Introduction: equilibrium business cycle theory

[History] is a continuous process of interaction between the historian and his facts, an unending dialogue between the present and the past.

E. H. Carr, *What Is History?*

In the history of economics, no subject has been more puzzling than the business cycle. Although numerous theories have been suggested since the cycle was first recognized late in the eighteenth century, none of them has succeeded in providing a full explanation of this phenomenon. The causes of the cycle suggested by these theories seem to cover every kind of economic and noneconomic factor one could imagine. Some examples may be illustrative.

Jevons (1884) firmly believed in his "scientific" explanation, according to which the fundamental cause of the business cycle lay in the periodic movement of sun spots. H. L. Moore (1914) postulated a similar "law" of economic cycles, suggesting that the rhythm of economic time series was generated by the rainfall cycle. According to Moore, the rainfall cycle was caused by the movement of Venus, which came into the path of solar radiation to the earth at intervals of eight years. Its magnetic field affected the stream of electrons from the sun and thus disturbed the magnetism of the earth and its rainfall. Hexter (1925) even claimed that the business cycle was linked to the human emotions of optimism and pessimism, which were themselves causally connected to the death of friends or close relatives and the prospect of having children; he concluded that the control of population could change the course of business cycles.

There was also a healthy skepticism about the very existence of cycles. Fisher (1925) suspected that the business cycle was an illusion, something like the cycle of luck at Monte Carlo, and called it a myth. Slutsky (1937) showed the possibility of generating business cycles by relatively simple summations and subtractions of continuous random shocks. At its most extreme, Slutsky's demonstration admitted of the interpretation that the business cycle was nothing but a statistical artifact with no substantial meaning at all.

Speculations about the business cycle, as these examples show, were wide ranging and sometimes overimaginative. Some were even too fanciful to be included in the realm of pure economic thinking. As such, the business cycle was a continuing challenge to economic thinkers of the past.

Given such great efforts to solve the problem of the cycle, it is disappointing that attempts to explain it decreased rather suddenly after the Second World War.[1] Recently, however, a group of economists have challenged the old problem. Calling their theory the equilibrium business cycle theory, they are bringing business cycles back to the heart of macroeconomic thinking.[2]

The purpose of this book is to investigate the equilibrium business cycle theory from a historical perspective.[3] This chapter, as an introduction to the main work, discusses its theoretical arguments as background information for later chapters. In addition, it offers some reasons for the choice of problems to be pursued in this volume and delineates the manner in which these problems are approached. The final section provides an outline of the remaining chapters.

Equilibrium business cycle theory

Lucas's explanation of the cycle

The view that business cycles are equilibrium phenomena was not widely accepted among interwar business cycle theorists and Keynesians. With a few exceptions, such as Hayek (1933), who emphasized the incorporation of cyclical behavior into classical equilibrium theory, interwar theorists believed that cyclical fluctuations in a capitalist economy were very complex phenomena whose movements did not have a single cause or could not be easily captured by a simple theoretical framework, and certainly not by equilibrium price theory. Instead, they thought either that observed cyclical movements were a combination of several cycles (see, e.g.,

1 This is not to suggest that discussion about the cycle completely stopped after the war. In fact, there arose a class of deterministic growth cycle theories, to which Hicks, Baumol, Harrod, and Goodwin, to name a few, contributed. These growth cycle theories, however, were mostly by-products of the development of economic growth theory at that time and thus were not a major current in macroeconomic thinking. For an account of growth cycle theory, see Blatt (1983).

2 This class of theory, called here the equilibrium business cycle theory, is given different names by different writers. For instance, it has been called "new classical macroeconomics," "rational expectations economics," or "equilibrium approach to business cycles." Though each of them emphasizes different aspects, these names denote the same body of theory. In this book, the term "equilibrium business cycle theory" (EBCT) is maintained only for consistency of terminology.

3 For a general introduction to and bibliography of the EBCT literature, see Lucas (1981), Lucas and Sargent (1981), Begg (1982), and Sheffrin (1983).

Schumpeter, 1939) or that these complex phenomena could not be explained without constructing a complex theory of cycles (see Mitchell, 1913). In contrast, the Keynesian perception of business cycles was based on the idea that the actual economy we observe is mainly a result of market failure, so that the cycle was modeled as a successive dynamic process toward an equilibrium, which is hardly justifiable theoretically and extremely difficult to achieve. For this reason, Keynesians tended to ignore the business cycle, or at best their business cycle theory necessarily produced a large and complex model, leaving an important question unanswered: Why do markets fail to sustain an equilibrium, or why does the economy successively converge to an equilibrium?

Given this pattern of development of business cycle theory, it is quite remarkable that the equilibrium business cycle theory (EBCT), pioneered by Lucas, attempts to revive the equilibrium doctrine that was not accepted as a principle of modeling cycles by either Keynesians or most interwar theorists.

"Equilibrium" simply means that every agent in a decentralized market economy chooses his behavior so as to optimize his objectives given his constraints. The rational expectations hypothesis is an application of the optimization principle to a situation in which agents face uncertainty about future events and form expectations using the information available to them; it is a hypothesis about how expectations are formed in the most efficient way, that is, a hypothesis that the subjective expectations of an agent are equivalent to the mathematical expectations conditional on a given information set. In the case of linear models, rational expectations turn out to be equal to the least squares estimator. Therefore, it can be said that the rational expectations hypothesis is an extension of static Walrasian equilibrium theory, wherein an agent's optimization problem is essentially timeless, to the dynamic equilibrium, wherein the agent's planning horizon in his optimization problem is in principle infinite in time. In a macroeconomic context, this equilibrium doctrine implies that aggregate fluctuations should be consistent with the optimizing behavior of individual agents, provided that there is no serious aggregation problem. In other words, there should not be a contradiction between microeconomic behavior and macroeconomic phenomena, which had been a puzzle for Keynesians.

Under this relatively simple principle, the EBCT has theoretically elucidated important features of cycles, such as comovement among different time series, and has eliminated the Keynesian's ad hoc[4] assump-

[4] Lakatos (1970) distinguishes three different concepts of ad hocness. In contrast to the traditional Popperian notions of ad hocness, what he calls ad hoc$_3$ characterizes a theory that is obtained through a modification of auxiliary hypotheses that

tions, which have no foundation in optimization but are employed only to fit the observed data. Relying on a smaller set of principles than earlier theories, the EBCT represents an attempt to explain the facts that have puzzled Keynesians and thus to achieve scientific progress.

In his seminal papers, Lucas suggests the EBCT as a new approach to the business cycle (see Lucas, 1973, 1975, 1977). He views the business cycle as a reflection of the optimizing behavior of agents in a situation of incomplete information. In his model economy (the "island economy" fable),[5] an agent is isolated in his own market; he can precisely observe this market in which he participates, but he does not know what is currently happening in other markets. Except for this current information about other markets, an agent's information set includes the history of the entire economy and local elements such as changes in tastes and technologies, that is, his utility function and production function. In equilibrium, the state of this economy can be described by a set of relative prices. These prices carry to agents all relevant information, such as quantities and changes in tastes and technology, so that an agent's information set can be reduced to the history of prices in all markets and the current local price in his own market.

An agent, who does not have access to current relative prices (real wages), has to form expectations about the current economy-wide price level in order to make the work-leisure decision that depends on relative prices (real wages) using his information set and his knowledge of the economic structure.[6] If he guesses that the current price level is favorable to him, that is, if he perceives from the rise in local price that the structure of relative prices has changed in a way that is favorable to him, he will work

do not accord with the heuristic of the scientific research program. In the context of economics, Hands (1985) observes that recent theorists, in particular new classical economists, tend to use the term for theories not derived from individuals' optimizing behavior. That is Lakatosian ad hoc_3ness. In most cases in this book, the term implies this ad hoc_3ness, unless otherwise indicated.

5 The "island economy" fable was originally that of Phelps (1970).

6 Instead of contemporaneous substitution, the intertemporal substitution setup is another way of deriving the "Lucas supply function." Barro (1981) stresses the legitimacy of the intertemporal substitution approach for modeling the business cycle. In that case, agents will compare current local prices with expected future price levels. A change in intertemporal relative prices will induce agents to reallocate their labor supplies intertemporally. But this setup has some unclear aspects, such as its somewhat unrealistic intertemporal substitution of leisure and the assumption that the income effect does not dominate the substitution effect. In short, the question is whether the intertemporal substitution effect could solely account for historically observed volatile fluctuations in employment time series.

more, enjoy less leisure, and produce more. This is the story described by the "Lucas supply function,"[7] which establishes the comovements among price, employment, and output during the cycle.

Models similar to Lucas's, in which only unexpected price changes have an effect on output, were suggested by Friedman (1968) and Phelps (1970). Friedman, for example, postulates asymmetric information between producers and workers, and demonstrates short-run Phillips trade-offs but a vertical long-run Phillips curve. Friedman's model is virtually identical with Lucas's, except that Friedman uses the adaptive expectations formation. Like Lucas, he understands the short-run Phillips trade-off basically as a matter of information. During price fluctuations, workers cannot observe the economy-wide price level that is necessary for calculating their real wage, whereas producers do not need information on the price level because, for them, the prices of their products are the only information necessary for calculating real wages in their labor demand schedule. The workers' misperception of the price level leads to an incorrect work-leisure decision and thus to output fluctuations. Thus, Friedman's idea differs little from Lucas's EBCT, in the sense that in both cases the observed short-run Phillips trade-offs are viewed as trade-offs between unexpected inflation and output, caused mainly by an information deficiency.[8]

Lucas then introduces money as a source of price movements. The view that the monetary phenomenon is the main source of business cycles in a capitalist economy has been maintained by Hawtrey, Hayek, Fisher, and monetarists. Lucas follows this tradition. In his island economy, however, agents who know the working of this economy (including both the way money is generated and the neutrality of money), but who do not know the current level of money stock, utilize the movement of money to form expectations of the current price level. The result is the well-known proposition that the systematic part of money put in the economy has no effect on output and is fully reflected in the movement of the price level,

[7] By explicitly introducing the capital market in this economy, i.e., by postulating that what agents care about is the relative real rate of returns instead of relative prices, the Lucas supply function could be modified to include interest rates. Barro's (1981) approach would be an example of such a modified version. But even in this case, the results of this model would not be changed if one assumed that real interest rates are constant or independent of price movements. See Lucas and Rapping (1969).

[8] Gordon (1981) points out that the term "Lucas supply function" is misleading. He prefers "Friedman supply function." Indeed, Friedman's (1968) presidential address to the American Economic Association was published while Lucas and Rapping were working on the paper (1969) in which they introduced the Lucas supply function in an explicit form. See Lucas (1981, esp. the Introduction).

because it does not change the structure of relative prices, which is the only variable agents care about. Only the unsystematic part of money, which agents cannot successfully predict, affects output by creating a price surprise that forces agents to reevaluate their work-leisure decision. In short, cycle phenomena are generated by agents' misperception of relative prices, and the main cause of the cycle is money. In this way, Lucas explains one of the fundamental features of the business cycle – the procyclical movements of money, price, and output.

Central components of the EBCT

The EBCT has three fundamental components: (a) an optimization foundation in a general equilibrium context, (b) the natural rate hypothesis, or the neutrality of money, and (c) the incomplete information assumption.

The most distinguishing feature of the EBCT is that its modeling strategy is based on optimization[9] in a framework of general equilibrium.[10] To see this, consider an economy in which every agent optimizes his objective, taking into account the environment, such as the behavior of the other agents (e.g., the government) and the structure of the economy (e.g., tastes and technology). One way of describing such an economy is to define "equilibrium" as functions of environments. Then equilibrium prices will be a function of tastes, technologies, policy rules, and so on. Choice

[9] The notion of *market clearing* should be distinguished from the *optimization foundation*. Market clearing does imply an optimization foundation, but not the other way around. As Mishkin (1983b) emphasizes, non-market-clearing models can also incorporate the optimization foundation. Institutional factors, such as transaction costs, cost of collecting information, and moral hazard problems, can be barriers to market clearing in spite of the optimization behavior of agents who do not leave out unexploited gains from trade. Probably for this reason, Lucas and Sargent (1978) also distinguish these two notions.

[10] Hoover (1984), contrasting the New Classical economics of Lucas with the monetarism of Friedman, emphasizes the general equilibrium aspects of New Classical economics, which are significantly different from Friedman's partial equilibrium approach. Accordingly, he labels Friedman a Marshallian and Lucas a Walrasian. Also see Weintraub (1985), who classifies the EBCT as theory in the protective belt of the neo-Walrasian research program. According to Weintraub the EBCT's hard-core proposition is, in a Lakatosian sense, the optimization principle, which is also the hard-core proposition of the neo-Walrasian research program. The rational expectations hypothesis is nothing but a direct derivation from the optimization principle extended to the problem of expectations of future events.

functions, which are observable, are also functions of such environments. If the environment changes, equilibrium prices and choice functions will also change.

This is the idea of the Lucas critique of macroeconometric models (Lucas, 1976). If some part of the environment changes, he argues, a model constructed on the basis of observable choice variables is no longer valid. Coefficients of this model are not invariant under environmental changes, because agents react to these changes and behave differently than they did in the past. In this sense, the EBCT follows the general equilibrium approach. The partial equilibrium approach, in contrast to the general equilibrium approach, assumes that changes in the environment have no effect on the particular choice function under consideration. Even conventional simultaneous-equation econometric models, which pretend to adopt the general equilibrium approach, follow this partial equilibrium approach implicitly when assuming that the coefficients of the individual behavioral functions in the system are stable. Conventional macroeconometric models thus cannot be used safely for the purpose of forecasting effects of policy. A change in a policy rule results in corresponding changes in the coefficients in the system.

A natural way of avoiding the Lucas critique is to find "deep" parameters of tastes, technology, and so on, that are believed to be invariant to changes in the environment. That is to say, the strategy of econometric modeling of the EBCT is to formulate explicitly the agents' optimization problem and the policy variables and derive from this setup their behavioral equations, which are observable and are the function of tastes, technology, and policies. Thus, by connecting these deep parameters to observable variables theoretically, econometricians can construct the "cross-equation restrictions" that account for changes in the environment (see Sargent, 1981). If the policy regime changes, the cross-equation restrictions, which link the observable behavioral equations to policy variables, would require the coefficients to change in the behavioral equations. Econometricians then could test the cross-equation restrictions in their empirical work. But empirical testing presents certain difficulties: It is hard to find the policy regime changes,[11] and the results of empirical testing are very sensitive to the way in which the optimization problem is set up.[12]

[11] Lucas (1973) uses cross-country data to get around this difficulty.

[12] Geweke (1984) shows several examples of the sensitivity of the Lucas critique to the selection of representative agents and aggregation across prices. He seems to argue that the fundamental difficulty with the EBCT's econometric modeling strategy lies in the very fact that this strategy emphasizes the representative agents at a very micro level, but uses aggregate macro data. Criticisms of the EBCT's econometric strategy are discussed in depth in Chapter 5.

It is worth noting that the EBCT adheres to the natural rate hypothesis. According to the EBCT, changes in tastes and technology cause the real economy to fluctuate. (This can be interpreted as the natural rate.) Money is then superimposed onto the fluctuations. This monetary impulse generates further fluctuations of the economy. The critical point here is that the natural rate hypothesis is distinct from the optimization principle or the rational expectations hypothesis. The famous "policy ineffectiveness proposition" (Sargent and Wallace, 1975) is a theoretical demonstration that is possible only when these two hypotheses are jointly applied. Without the natural rate hypothesis, the policy ineffectiveness proposition does not necessarily hold. In this regard, the Fisherine tradition, reevaluated by Friedman (1968), is well accommodated by the natural rate hypothesis. If real interest rates are determined independently of monetary movements or if they are determined by tastes such as "time impatience," then the natural rate hypothesis will hold. Thus, empirical evidence for the Fisherine theory would be crucial for establishing the validity of the natural rate hypothesis and the policy ineffectiveness proposition (cf, Grossman, 1983).

Finally, an essential assumption of the EBCT, contrary to that of the classical tradition, is that information is not perfect. This assumption per se is consistent with traditional economic theory in the sense that information has to be treated as a scarce commodity; the profound impact of this assumption, however, stems from the fact that incomplete information can provide the theoretical justification for error terms, such as the measurement error or the specification error, that used to be employed for statistical reasons. If the world perceived by agents is uncertain, then the model should express this characteristic of the world in some way. One obvious way might be the introduction of errors in the agents' perception of the world. And the introduction of incomplete information necessarily makes the theory stochastic and dynamic.[13]

When this internally coherent theory, like the general equilibrium theory in its heyday, was introduced to the profession, some regarded the EBCT as a revolutionary advance in economic theory. However, it has also received diverse criticisms. Among them, Tobin (1980) cites the market-clearing assumption, the problematic formulation of rational expectations, the lack of a learning process, the aggregation problem, and the serial correlation problem. His criticisms are leveled mainly at the EBCT's assumptions, except that of serial correlation. If one follows Friedman's (1953) famous

[13] It is dynamic by virtue of the fact that it introduces expectations formation. If information were perfect, agents would have no need to form expectations about the future or anything else. Thus, under conditions of perfect information, the agent's optimization problem is static, and so is the theory.

instrumentalistic methodology, what matters is not assumptions but predictions. Thus, assuming that equilibrium business cycle theorists accept the Friedman methodology,[14] it would not be a direct criticism of the EBCT that its assumptions are unrealistic. For equilibrium business cycle theorists, the most serious criticism would be that their theory could not provide an explanation of the serial correlation of economic time series, while at the same time eliminating ad hoc assumptions and respecting the principle of optimization.

Real business cycle theory

A widely accepted definition of business cycles is that of Burns and Mitchell (1946):

> Business cycles are a type of fluctuation found in the aggregate activity of nations that organize their work mainly in business enterprises; a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; this sequence of changes is recurrent but not periodic. (p. 3)

In short, business cycles could be defined as phenomena of comovements and recurrences among aggregate time series. An important point is that, mathematically, this recurrence property of cycles can be generated by low-order random or stochastic difference equations (see Sargent, esp. ch. 11). That is, the low-order serial correlation of errors is the mathematical expression of recurrences of cycles.[15] This suggests that the failure to justify the serial correlation of forecasting error or the persistence effect of individual series directly implies that the EBCT could not successfully account for the recurrence property of cycles.[16]

[14] The only methodological statement by equilibrium business cycle theorists is that of Lucas (1980). Lucas emphasizes that the realistic artificial model is not necessarily superior to the unrealistic one; on the contrary, in most cases the unrealistic model has potential usefulness for thinking about reality. This sort of view, which is analogous to that of Simon (1969), has some flavor of the Friedman methodology.

[15] An equation with a serially correlated error term can be easily transformed into a stochastic difference equation. An equation with a first-order serially correlated error term, for example, is equivalent to a first-order stochastic difference equation with white noise that has a lagged dependent variable term in its right-hand side.

[16] Sargent (1979) gives an example of generating a form of business cycle by a second-order stochastic difference equation. Citing Granger (1966), who reports that the estimated power spectra of typical seasonally adjusted economic time series have a monotonically declining shape from the left to right, Sargent discusses the possibility of generating processes that resemble business cycles by

Acting on this criticism, equilibrium business cycle theorists have tried to incorporate serial correlation into their model. According to the EBCT, if the agent's information set includes the history of the variable being forecasted (i.e., prices), then the forecast errors should be serially uncorrelated. In other words, the agent's forecast error in this period should not be systematically connected with the forecast error in previous periods. If an agent commits a systematic error, he apparently violates the rational expectations hypothesis. Because he does not fully exploit the information available to him and leaves some part of it untouched, his expectations cannot be carried out in the most efficient way. Therefore, the only situation in which rational agents permit systematic errors is one in which their information sets do not include the complete history of previous prices. This situation could exist if "the price indexes appropriate to agents' decisions are never collected, so that the published price indexes are error-ridden" (Sargent, 1979, p. 331). But it is not at all realistic to attribute the serial correlation or the cyclical fluctuation of aggregate time series solely to the deficiency of published data.

Another way of looking at this problem is to distinguish sources of impulses from propagation mechanisms (Lucas and Sargent, 1978). This distinction has been known to econometricians since Slutsky (1937) and Frisch (1933) first pointed it out.[17] The idea is that it enables one to construct propagation mechanisms that convert impulses into serially correlated movements, while still keeping impulses serially uncorrelated. This simple idea is the starting point of the real business cycle theory. This is an effort to construct such propagation mechanisms that enable one to explain the serial correlation of the cycle, while maintaining the optimization principle of the EBCT. This theory is also a successor of old business cycle theories that postulated real sectors of the economy as the cause of cyclical fluctuations.

The modeling strategy of the real business cycle literature follows the one developed by the EBCT. It starts with an individual agent who optimizes his behavior under uncertainty. For instance, consumers maximize their expected utility function, which specifies their current and future preferences for commodities and leisure. A firm's production technology is characterized by a standard production function, which assumes positive

constructing low-order stochastic difference equations even though their power spectrum does not reveal a peak in the business cycle range. A downward-decreasing spectrum is a characteristic of highly, positively, low-order serially correlated time series. Thus, it is, at least mathematically, possible that even the first-order stochastic difference equation can capture the main feature of cycles.

[17] The historical development of the idea of the impulse and the propagation mechanism is dealt with in more depth in Chapters 3 and 4.