

## Part I Introduction

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# 1 Introduction\*

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### Main objectives and epistemological considerations

When Jewkes, Sawers and Stillerman (1956) wrote their classic (though still controversial) study, *The Sources of Invention*, they commented on the neglect of technical change by most of the economics profession and suggested three reasons for this neglect. First, they suggested that economists were generally ignorant of science and technology and felt unprepared to venture into this unknown territory. Secondly, there were very few statistics to guide them. Finally, ever since the Great Depression of the 1930s they had been mainly preoccupied with problems of cyclical fluctuations in the economy and of the unemployment associated with these fluctuations. They were simply too busy with other things to pay much attention to technical change.

In this book we attempt to show that the first two problems can be at least partially overcome and indeed Jewkes and his colleagues already demonstrated this in their own work. What is of extraordinary interest here is the third explanation given by Jewkes *et al.* It is particularly revealing because, quite unconsciously, they show that even some of those economists who were prepared to make a considerable effort to do theoretical and empirical work in the area of technical change regarded this as something totally separate from the study of cyclical fluctuations in the economy.

We have only to turn to Schumpeter's (1939) *Business Cycles* to see the gulf which separates his work from this view. For Schumpeter, as for us, technical innovation is not a separate phenomenon, but is on the contrary a crucial factor in the explanation of business cycles and the dynamics of economic growth generally (Chapter 3).

This book is an exploration of a new approach to economic theory, capable of incorporating technical and institutional change into the mainstream of economic analysis and policy-making, rather than treating it as part of the rag-bag of 'residual' or 'exogenous' factors. This leads us not just to a critique of mainstream economic theory, but also to an attempt at an alternative formulation of some of the main issues. It is not more than a first attempt but the somewhat ambitious aim is to analyse in depth the role

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of technological change in relation to microeconomic behaviour, adjustment processes and macroeconomic patterns of transformation of the economic system.

We suggest some possible explanations and interpretive hypotheses, which we shall attempt to show fit the historical evidence rather better than mainstream neo-classical theory. We can summarise the main features of our approach as follows:

- (a) Technical change is a fundamental force in shaping the patterns of transformation of the economy.
- (b) There are some mechanisms of *dynamic adjustment* which are radically different in nature from those allocative mechanisms postulated by traditional theory.
- (c) These mechanisms have to do both with technical change and institutional change or the lack of it. As regards the former, we suggest it is both disequilibrating—and a source of *order* for the directions of change and the 'dynamic adjustment processes', as new technologies diffuse through the national and international economies. Paradoxically, despite its fluctuations and crises the world is actually more stable and better ordered than could be deduced from prevailing economic theory.
- (d) The socio-institutional framework always influences and may sometimes facilitate and sometimes retard processes of technical and structural change, coordination and dynamic adjustment. Such acceleration and retardation effects relate not simply to market 'imperfections', but to the nature of the markets themselves, and to the behaviour of agents (that is, institutions are an inseparable part of the way the markets work).

These propositions are hardly surprising for a non-economist or for those economists acquainted with Schumpeter. Neither would they be denied by most neo-classical economists. However, whilst nominally accepting the importance of technical and institutional change, mainstream theory and most modelling have in practice divorced economics from these crucially important processes of change, relegating them to the status of 'residual factors' or 'exogenous shocks' even though they were at one time subsumed within the general framework of classical 'political economy'. The various 'growth accounting' exercises, even after allowing for an entire Kamasutra of variables, generally remain with a big unexplained 'residual' (e.g. Denison, 1962) and fail to deal with the complementarities and interactions of these variables (Nelson, 1981). In general they are only a pale shadow of the growth theories of classical economics. For the classical economists it was quite natural to discuss technical and institutional change as an integral part of a general theory of economic growth and development.

In this introductory chapter we first of all raise some fundamental epistemological issues which are briefly discussed. We then consider

Schumpeter's heroic attempt to provide an alternative theory of economic development and why in our view it was not enough. Finally we outline the structure of the book and the way in which we propose to tackle our difficult and challenging objective.

### Some basic epistemological issues

All of those contributing to this book have been actively involved in empirical research on technical innovation and institutional change in many different countries. The results of this empirical research are presented in the book. They cannot be easily reconciled with some of the central assumptions of equilibrium theory and mainstream economics. All of us have come to feel that the main weakness of this theory has been inadequate attention to social learning processes, particularly technological accumulation and the institutions affecting these processes.

In its anxiety to be the 'theoretical physics of social sciences' and to achieve logical elegance and mathematical formalisation, neo-classical economics elaborated and refined quantitative equilibrium analysis and mathematical models, which, although useful as a modelling exercise on highly restrictive assumptions, neglected some of the crucial elements involved in the long-term behaviour of the system. They therefore appeared to non-economists and to other social scientists to be concerned with the endless elaboration and refinement of assumptions which lacked both realism in relation to certain fundamental features of the system's behaviour and rigorous falsifiability of the predictions derived from the models.

It is of course far from easy to remedy these weaknesses and one of the main reasons that the mainstream neo-classical paradigm continues to exert such enormous influence, despite its acknowledged flaws, is the apparent lack of any satisfactory alternative which could offer anything approaching the same power and rigour.

However, the difficulty of developing an alternative and more satisfactory theory should not deter efforts in this direction for anyone who is convinced that the mainstream theory is increasingly in conflict with much empirical evidence. We certainly do not claim to have developed a completely satisfactory alternative to the dominant theory, only to have taken a number of steps in the direction which all of us must ultimately take if we are to develop such a theory and appropriate models. We are encouraged in this effort not only by a great deal of work which has already been done both by 'heretics' such as Schumpeter and by those working within the neo-classical tradition, but also by parallel developments within other branches of the social and natural sciences.

It would of course be as dangerous for economic theory simply to adopt wholesale the concepts and methodology of biology as of physics. However, *all* the natural and social sciences face certain methodological

problems in modelling the evolution of complex systems once the terrain of Newtonian reductionism is left behind.

This attempt of course raises the most fundamental epistemological issues (these are discussed more fully in Sections II and III). Our approach has much in common with that of the classical political economists, as well as with the more recent tradition of the institutional and 'evolutionary' economists. In the words of Wilbur and Harrison (1978), it is 'holistic, systemic and evolutionary' (p. 71): *holistic* in the sense both that the whole shows behaviour which cannot be deduced merely by aggregating that of its constituent parts *and* that the parts themselves cannot be individually understood separately from the relationships they maintain with each other to make up the whole; *systemic* and *evolutionary* in the sense that the socio-economic system under investigation is conceived of as always in a state of flux and qualitative change, as its constituent elements alter their behaviour in relationship to each other and to the extra-systemic environment. In this work we have of course built on the pioneering contribution of Nelson and Winter (1982) in their evolutionary theory of economic change.

A satisfactory theory should certainly be one which conforms more closely to the available empirical evidence; it should also (like the other social sciences) take more account of the emergence of qualitatively new features of the system's behaviour and of the capacity of human agents to falsify predictions based on past experience. Greater humility is important as well as greater realism. The vitally important contribution of economists to policy debates and formation will not be diminished if it is more modest in its claims.

Many of the problems with the prevailing neo-classical orthodoxy have of course been raised by those working within the paradigm itself. Most of the criticisms raised in this book are familiar to its leading practitioners and indeed for many years some of them have felt the same uneasiness as we ourselves have felt with this framework. For example, Hahn (1987), in an interesting paper on 'Information Dynamics and Equilibrium', takes up the problem of imperfect information—'. . . agents cannot act on information which they do not have'—and more general problems of dynamic theory. He concludes:

Current economic theory by and large avoids dynamics at least non-equilibrium dynamics. This has the virtue that it allows orderly argument and conclusion. *But this order is bought at too high a price. Moreover even then it is not quite as satisfactory as was once thought* [my italics, CF]. Once it was recognised that we must study sequence economies it also became urgent to include expectations in the description of the agent. To avoid some of the difficulties we have been through rational expectations were simply postulated . . . Even so, it was soon found that this postulate is mostly insufficient to yield determinate equilibria . . .

This has led us to suggest that dynamics should be viewed as a learning process both about demand conditions and the strategies of near competitors. Once again, when an equilibrium is defined relatively to such processes it seems that they are

indeterminate unless history—that is information—is explicitly modelled and known. The path of history is the outcome of individual decisions and in turn helps to fix the latter. This is really the main message: the information available to agents at any time is determined by the particular path followed. The economy could have followed a different path and generated quite different information. There is something essentially historical in a proper definition of equilibrium and of course in the dynamics itself.

This conclusion, with its emphasis on the importance of history and of learning processes, closely resembles some of the conclusions of Sections III and IV of our own book.

But even though some of the main contributors to General Equilibrium Theory are well aware of difficulties with the neo-classical approach (Hahn, 1984; Solow, 1985), many economists nevertheless believe that it is epistemologically progressive and can be extended and strengthened. They have generally preferred to attempt to handle their problems within the framework of the paradigm rather than make a radical break with it. This type of situation is familiar to historians of scientific thought. It is reminiscent of the story told by Nelson (1981) of the drunkard who looked for his key under the street lamp because it was the only clear spot although he knew he had lost it somewhere else. Despite its logical elegance and the extreme sophistication of many contemporary developments, its failure to address some of the crucial problems of technical and institutional change and its lack of historical perspective weaken its claims to represent a satisfactory theory of economic growth.

### Why Schumpeter is not enough

Most economists, when they *do* consider technical change and the long-term dynamics of the system, turn to Schumpeter, and it is true that almost alone among major twentieth-century economists Joseph Schumpeter *did* attempt to place technical change at the heart of his system and did also address problems of social and institutional change. His work is certainly one of the major points of departure for this book.

Among the positive merits of Schumpeter's work were his consistent emphasis on innovation as the main source of dynamism in capitalist development, his sense of historical perspective, his recognition of the importance of the conceptual distinctions between invention, innovation and diffusion of innovations, and his recognition of the vital importance of the links between organisational, managerial, social and technical innovations. This led him, like other great economists (such as Smith, Mill and Marx), to a unified theory of the disparate social sciences and a general theory of global development.

However, he was only partially successful in his endeavour. He made rather poor use of economic statistics and, as he himself was at pains to emphasise, he only made the first attempt to open up some of the major



problems. He paid little attention to peripheral areas or what would now be called the 'Third World'. Although he certainly stressed the role of technological competition, he did not really extend his analysis to the case of international trade, or international diffusion of technology. He never formalised his models, which may well have helped the richness of his theory but did not help the exploration of the coherence and consequences of his propositions.

Some economists, such as Almarin Phillips (1971), have distinguished 'two Schumpeters'—the young pre-war economist before the First World War emphasising the role of the entrepreneur and the small innovative enterprise, and the 'mature' Schumpeter stressing the advantages of the big monopolistic firm and the bureaucratised process of technical change. These differences may of course be partly explained by the way the world was changing during Schumpeter's lifetime and illustrate the great importance of studying qualitative change within the system. But by the same token, more than thirty years after Schumpeter's death, we must take account of the enormous changes in the world economy and in our knowledge about the process of technical change and economic development. Although he pioneered the study of the relationship between technological revolutions and long cycles of economic development, he did not really develop any satisfactory theory of depressions. Moreover, he had very little to say about government policies for industry, technology and science, or the relationship between universities, government institutions and industrial research and development.

Finally, on more theoretical grounds, it is hard to reconcile Schumpeter's view of innovation, economic dynamism, and partial monopolistic appropriation of technological advances with his other view that equilibrium could still be defined in Walrasian terms. In this respect, the task of analysing the relationship between the dynamic forces of the economic system (i.e. what makes it change) and its equilibrating mechanisms (what keeps it together) is still largely unfulfilled.

For all these reasons and others, although a constructive critique of Schumpeter is the starting point for much of our work, we have tried to go well beyond Schumpeter in many respects, and especially in our treatment of international development issues, international trade (Part VI), the dynamics of the science and technology system, the taxonomy of technical change, government policies for science and technology (Parts IV and V), and generally the role of institutions in regulating the macroeconomic system (Part II).

### Structure of the book

This book has been written by a large group of authors from a dozen different countries. It has been a difficult undertaking and the editorial group has had major problems of coordination and integration. We felt

that the gains from the pluralistic involvement of this wide group outweighed the possible loss of that degree of coherence which can be achieved in a single-author book. Nevertheless, it is a complex book to read. For that reason we have provided brief editorial introductions to each of the six sections which follow. Here we outline the main themes of the book as a whole.

The chapters in Part II are intended to illustrate our basic ideas about technical and institutional change in relation to the long-term dynamic behaviour of the economic system, which have been briefly touched upon in this introduction.

This is followed in Part III with four chapters which return to some of the main problems of economic theory in attempting to formalise and model the behaviour of the system. Parts IV and V are concerned with the sources of invention and innovation in contemporary, industrialised, capitalist societies and the effectiveness of strategies and policies designed to promote technical innovation. Part IV deals with these problems at the level of the firm; Part V at the national level. The chapters in these sections are intended to provide a reasonably up-to-date account of the way in which the process of technical change actually takes place in advanced industrialised economies today. They are followed in Part VI by five chapters which take up the international dimensions and discuss international trade, differences in growth rates, the problems of underdevelopment and 'catching up' in world technology and the role of multinational enterprises in the international diffusion of technology. Finally, in Part VII we take up some of the problems of formal modelling of this complex process of innovation, diffusion of innovations and economic growth.

It is evident from this brief summary that our book is by no means comprehensive and leaves many big gaps in our analysis. For example, we do not address such fundamental problems as the change in patterns of consumer behaviour associated with waves of new technology (Pasinetti, 1981) or the theory of consumption more generally. Nor do we address the role of armaments and military policies in shaping technology and the behaviour of the economic system; nor even the issues of monetary and fiscal policy and the theory of money and banking. This is not because we think these issues are unimportant; on the contrary, all of us recognise that they are fundamental for any satisfactory general theory of economics. It is because we preferred to make a more limited contribution based upon our own special areas of competence. We do not claim to have developed a new General Theory, only to have shown the direction in which we must go to develop such a theory and to have taken a few steps down that road.

We hope also that those who work in the current mainstream of economic theory and policy-making will still find something of value to their own work and will make some response to our challenge, whether within the existing paradigm or by striking out in new directions. But above all we hope that our book will serve to stimulate a new generation of researchers

and students to tackle the many problems which remain for economics to regain its credibility as a discipline and to make a more valuable contribution to policy formation. For this reason we conclude the book with a brief 'policy-orientated research agenda' (Part VIII).

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