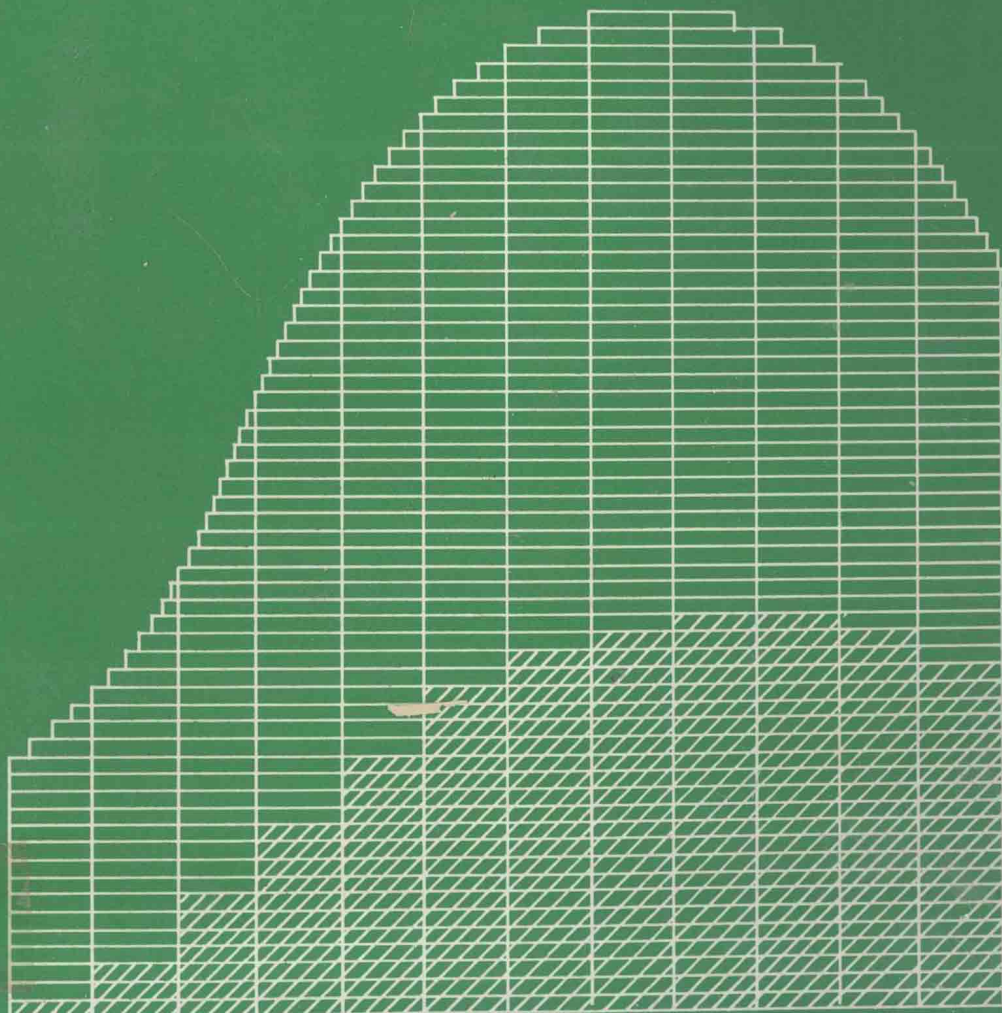


# UNEMPLOYMENT AND TECHNICAL INNOVATION

Study of Long Waves and Economic Development

Christopher Freeman  
John Clark  
Luc Soete



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## INTRODUCTION

The debate on the effects of the micro-processor (the 'chip') has shown an extremely wide range of views about technical change, employment and unemployment. Some commentators tend to look upon this and other technical innovations as a major source of unemployment, whilst others stress their beneficial effects in generating millions of new jobs. Probably all would acknowledge that technical change both destroys old jobs and creates new ones, but the emphasis on one or the other side of the process varies widely. One school of thought tends to assume that there is an inherent equilibrating tendency, which keeps the two tendencies in balance. Whilst not denying the existence of such equilibrating tendencies, our analysis in this book also points to sources of disequilibrium and to the links between technical innovation and fluctuations in the economic system.

The high levels of unemployment recently experienced have led to renewed interest in these problems of long-term structural change and technical innovation — problems largely neglected by both Keynesian and monetary economics. In commenting upon this neglect, Jewkes and his colleagues (1958) observed: 'Future historians of economic thought will doubtless find it remarkable that so little systematic attention was given in the first half of this century to the causes and consequences of industrial innovation' (p. 19). They explained the neglect in terms of the inherent difficulties in measuring and understanding technical innovation, the specialisation of science and technology, and the preoccupation of most economists with other issues which appeared to them more urgent and more susceptible to analysis — such as unemployment and the overall management of the economy.

We would certainly not underestimate the first of these difficulties, and we are only too well aware of the inadequacy of our own attempts to analyse and measure the flow of innovations and their economic consequences. However, the fact that a problem is difficult to understand and to analyse should not deter us from making the attempt if it is important enough. And it is our contention that the problem is of great importance. Moreover, as will become evident, we do not regard the problems of unemployment and overall management of the economy as separate from the

problems of technical innovation, so that we do not see them as alternative pre-occupations, but rather as part of the same pre-occupation. Economic analysis and policy making that lacks a technological dimension is simply not good enough to cope with our present problems.

This is not to say that the economics profession has been underestimating the importance of technical change. Such a criticism would be unfounded and totally unjustifiable. One of the things on which economists of all persuasions are in agreement is the great importance of technical change for the long-term growth of productivity and for raising standards of living. However, because of the great complexity and diversity of technical change and because of its unfamiliarity, there has been an understandable tendency to treat it as a 'black box' and make simplifying assumptions about it. After a while these simplifying assumptions tend to be taken for granted; for example as part of the traditional *ceteris paribus* clause in much economic analysis. It is, of course, essential to make some simplifying assumptions, as otherwise no progress could be made through the impenetrable jungle of detailed observations. However, it is also necessary to remember that any model or abstract representation of the behaviour of a system can only be as good as the assumptions that are fed into it, and that if these are seriously in error, misleading results may emerge.

For some short-term analysis it may not matter very much that some doubtful simplifying assumptions have been made, as their effects may be relatively insignificant over a short period. However, if the analysis is extended to the long-term then serious misjudgements may result. It has now become obvious that some assumptions about economic behaviour which appeared to be valid in the 1950s and 1960s, and gave apparently good results in forecasting models at that time, were no longer valid in the changed circumstances of the 1970s and still less the 1980s.

It is the contention of this book that the simplifying assumptions about technical change in much economic analysis can obscure the real processes of change rather than clarify them, if we are considering long periods such as half a century. For example, it is often convenient to assume a constant rate of technical change or that technical change is 'neutral' in some sense, i.e., as having neither a 'labour-saving' nor 'capital-saving' bias. A common assumption made in many neo-classical growth models (see, for example, Solow 1969) was that although capital stock per person would tend to increase steadily as a result of technical change, it would do so in such a way as to preserve a constant ratio of capital to

output thus maintaining conditions for a steady long-term full employment equilibrium growth path. In the long period of high growth and relatively full employment after the war such an assumption appeared plausible, but (as we attempt to show in detail in Chapter 8) it does not provide a satisfactory description of what has been happening since. Such questions are far from being hair-splitting academic controversies; they have an important bearing on the prospects for employment in the 1980s and the scale and type of public and private investment needed to improve these prospects.

Just as a realistic technological dimension is fundamental to a proper understanding of the behaviour of the economy, we also believe that an historical and institutional dimension is vital. The development of industrialized economies cannot be reduced to statistics of the growth of GNP, of industrial production, of capital stock, investment, employment etc., valuable though these statistics undoubtedly are. Underlying these statistical aggregates are the growth of entirely new industries and technologies and the decline of old ones and many social and institutional changes in the structure of industry and government. An account of the growth of nineteenth century economies that ignored the railways, the joint stock company or the steam engine would be seriously inadequate and the same would be true of an account of the twentieth century that ignored the electronic computer, the oil industry and the multinational corporation. This means that statistical analysis must be complemented by economic, social and technological history, if it is to illuminate the real processes of change which we are trying to interpret. This is why we have rejected a purely econometric approach to the problem. On the other hand a purely descriptive anecdotal historical analysis is inadequate without some attempt to measure the overall trends in the economy and the principal components.

Our method, therefore, is one of 'reasoned history'; we attempt to interpret the statistical evidence of changes in the international economy over a long period in the light of a discussion of the incidence of major technical and organisational innovations and their assimilation in the economies of the industrialized countries. After a brief introductory chapter in which we present the basic statistical facts about long-term trends in unemployment and discuss some problems of measurement, definition and theory of unemployment, we take up the issue of the occurrence of radical innovations and their impact on the economy. This approach to economic development is associated, above all, with the name of Joseph Schumpeter

and it will be evident from Chapter 2 that we owe a great deal to him. In this chapter we discuss the relationship between innovations, long-term structural change and fluctuations in investment and employment. Schumpeter insisted that opportunities for profitable technical innovation were very unevenly spread over time, being subject to explosive bursts as entrepreneurs realised the possibility of exceptional profits and growth arising from new combinations of technical and organisational change.

Following Schumpeter we stress some of these discontinuities in the process of technical change. We argue that major inventions and innovations have been unevenly distributed in their incidence, both over time and in terms of their effects on the various sectors of industry and services. They lead to the rapid rise of entirely new industries and technologies and to the decline and disappearance of old ones. Such processes have an international dimension, as well as a regional dimension within countries, and they may be far from smooth and painless in their impact, since they are essentially disequilibrating. There is no warrant for complacent assumptions about self-correcting adjustment mechanisms, which would lead rapidly and automatically to 'compensating' new employment for all the jobs lost through technical change. On the contrary, even in terms of non-Schumpeterian economic paradigms, there is little to justify such complacency, and more reason to expect some of the adjustments to be long-term and far from automatic.

We then discuss in Chapter 3 the 'bunching' or 'clustering' of innovations and the possible relationship between such clusters and long cycles of growth and stagnation. A pioneer in this field has been Gerhard Mensch, who in his book on the 'technological stalemate' (1975) propounded the view that depressions accelerated the introduction of radical innovations, which consequently tended to cluster in deep depression decades — such as the 1880s and the 1930s — and provided the impetus for subsequent phases of strong growth and prosperity. Although we criticize some aspects of this theory rather strongly in Chapter 3, we would like to acknowledge our debt to Mensch and his colleague, Alfred Kleinknecht, for their pioneering and thought-provoking work in this field of innovation studies. Our differences with them relate not to the importance of radical innovations and clusters of innovations, but to the social and economic factors which influence the timing of such clusters and their reciprocal influence on the behaviour of the economy.

In Chapter 4 we further develop our own approach to the clustering of innovations and their relationship to the growth of new industries and the economy more generally. We stress the importance



of the 'diffusion' process and the way in which a series of further innovations are generated as a swarm of imitators move in to invest in a new technology, attracted by the exceptionally high profits achieved or anticipated by one or more of the pioneers. Unlike Mensch we stress also the role of advances in basic science, whether in physics, chemistry or biology, and of social, managerial and organisational changes in triggering and facilitating clusters of basic inventions and innovations. The bunching of technically related 'families' of innovations may not only give rise to several new industries but may simultaneously or subsequently affect many other (existing) industries — as for example in the familiar contemporary case of micro-electronics. We therefore discuss the rise of 'new technology systems', rather than just new 'industries', in order to capture the full scope and complexity of these developments.

In Chapters 5 and 6, in line with the basic approach that has been outlined, we attempt to illustrate the argument with two examples of new technology systems that have been particularly important in the post-war growth cycle — synthetic materials and electronics. These examples show that one or several major new technologies are capable of imparting a sustained impetus to the economic system lasting several decades. However, as economies of scale are exploited and the technology is to some extent 'standardized', a more capital-intensive phase of growth sets in. Following the entry of a swarm of imitators, profits are gradually 'competed away' and then the opposite process of concentration sets in, accompanied by a 'shake-out' with the elimination of some competitors. During the early period of rapid growth and imitation there is a tendency for new firms, including small ones, to move in and for employment to expand rather rapidly; but as a technology matures, competitive cost pressures, standardization and labour-saving technical change associated with economies of scale tend to predominate. The pattern of investment changes from capacity expansion to rationalization and gives rise to a lower rate of employment growth, or even to a reduction of employment.

We are, of course, only too well aware that the two examples which we discuss certainly do not encompass the totality of economic and technical change which has taken place since World War II. But, for the purposes of this book, we have confined ourselves to these two illustrative chapters. However, in Chapters 7 and 8 we extend the analysis to discuss how far the more generally available statistics of industrial production, productivity, investment and employment, particularly for the UK and USA, support the type of analysis which we have advanced.

Chapter 7 discusses the variations in growth of output, productivity, prices and employment between the principal branches of manufacturing, contrasting the fast and slow-growing sectors. It attempts to relate those variations both to the direct effects of technical change and to the changing pattern of consumer demand. Chapter 8 discusses trends in capital investment and the growth of capital stock in the principal industrial countries. The tendency for smaller increments of employment to be associated with each new 'vintage' of machinery and plant may mean that massive new investment would be required to achieve a return to full employment, or in other words that unemployment could persist as a serious problem because of 'capital shortage'. The implications of this analysis are that the problem of unemployment must be approached not only in the context of short-term manipulation of demand or the money supply, but also in the long-term context of technical and structural change and the associated international trade competition. The pattern of new investment that is feasible is highly constrained by this intense international technological competition.

In Chapter 9 we take up the question of the changing *locus* of international technological leadership with all the associated consequences for patterns of trade, investment and employment. It is obvious enough that countries such as the UK, which were the leaders in the early phases of technical innovation and industrial growth, are no longer in that position today and are suffering from some of the pangs of adjustment. The leadership that passed to the USA and Germany in the third and fourth Kondratiev cycles (i.e., the waves of expansion associated with the internal combustion engine, electric power, the heavy chemical industry, and other clusters of radical innovations) is now challenged by Japan. Such changes depend not only on scientific or technical leadership but also on the capacity to initiate those social and organizational changes that facilitate the widespread adoption of the new families of innovations. This leads on to the brief concluding discussion in Chapter 10 of the policy implications of our analysis.

From this outline of the contents of the book it is evident that it has two major themes: unemployment and the process of long-term technical change. The first issue — unemployment — is discussed relatively briefly and mainly at the beginning and the end of the book in Chapter 1 and Chapter 10, whilst Chapters 2 to 9 are largely concerned with the dynamics of long-term economic growth. This balance, however, does not reflect the balance of our concern, but simply the fact that it is necessary to understand some

## INTRODUCTION

aspects of long-term structural and technical change in organizations with unemployment. We believe the problem of unemployment to be the most serious confronting the industrialized countries in the 1980s and analogies with the 1930s are by no means far-fetched.

It must always be remembered that Hitler's accession to power in 1933 was directly associated with the effects of the Great Depression. Support for his party remained relatively small, even immediately after the run-away inflation of 1923, but his vote soared from 1930 to 1932, when mass unemployment provided a fertile breeding ground for his doctrines and thousands of recruits for the storm troops and other paramilitary formations. The riots in English cities in 1981 were a further salutary reminder of the potentially explosive psychological and political consequences of large-scale unemployment associated with inner-city decay.

In a project closely related to our own Jahoda (1982) has concluded that the destructive psychological consequences of unemployment for the individual are more severe than the alienating effects of the less pleasant forms of employment. She has also concluded that the harmful effects of unemployment in the 1980s are potentially as severe as those of the 1930s, in spite of the intervening changes in social welfare arrangements. She was one of the first to study the destructive social psychological consequences of prolonged unemployment in Marienthal, a village in Austria, in the 1930s and her views must command great respect.

If the analysis in this book has any validity it will not be easy to avert some of the adverse consequences of large-scale unemployment in the 1980s. However, it is our hope that by focussing attention on the long-term problems associated with technical change and economic development, we may contribute in a small way to the amelioration of these difficulties.

# CONTENTS

Introduction	vii
1 The dimensions of the unemployment problem and theories of unemployment	1
1.1 Levels and structure of unemployment	1
1.2 A return to 'full employment'?	8
1.3 Technical change and unemployment	13
2 Schumpeter's theory of business cycles and innovation	18
2.1 Schumpeter's theory of long cycles	19
2.2 The debate on Kondratiev and Schumpeter	22
2.3 Capital accumulation, investment and employment	26
2.4 Equilibrium and structural change	31
2.5 Schumpeter or Schmookler?	35
3 Mensch's theory of 'bunching' of basic innovations	44
3.1 The bunching of innovations in the twentieth century	45
3.2 Depression as an accelerator mechanism for innovation?	51
3.3 Long-term fluctuations in patents, inventions and R and D	57
4 'New technology systems': An alternative approach to the clustering of innovations and the growth of industries	64
4.1 Clusters of innovations and the diffusion of innovations	64
4.2 Diffusion theory	68
4.3 Diffusion, process innovation and social change	70
4.4 'Natural trajectories' of technologies	73
4.5 New technology, employment and long waves	75
4.6 Conclusions	80
5 Demand and technical innovation in the growth cycle of the synthetic materials industry	82

5.1	The trend of basic inventions and secondary inventions and the growth of the synthetic material industry	82
5.2	Basic science, invention and innovation	87
5.3	Schumpeter's mark II model and the rise of the plastics industry	91
5.4	The growth cycle of a new technological system	94
6	Electronics	101
6.1	The electronics industry	102
6.2	Radio and television	103
6.3	The computer	107
6.4	Solid state technology	110
6.5	Micro-electronics	119
6.6	Summary	124
7	The pattern of post-war structural change	127
7.1	A brief statistical exploration	127
7.2	Structural change and technical progress	131
7.3	Technical progress and changes in demand and industry structure	134
7.4	Technical change, recovery and the identification of new demand	141
8	Some statistical characteristics of the 'fourth long wave'	148
8.1	Introduction	148
8.2	Employment and output	152
8.3	Investment, capital intensity and employment	157
8.4	Capacity utilization and 'investment requirements'	162
9	The international perspective	166
9.1	The changing locus of economic growth and innovation	167
9.2	A brief statistical exploration	175
9.3	Some thoughts about catching up and long-wave economic development	182
10	Conclusions	189
10.1	The role of technology policy	191
10.2	The limitations of technology policy and of demand management	195

## CONTENTS

v

10.3	Technical change, employment and inflation	197
10.4	Lessons from Japan?	198
10.5	Concluding remarks	200

Appendix A	201
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References	203
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Index	213
-------	-----

# 1 THE DIMENSIONS OF THE UNEMPLOYMENT PROBLEM AND THEORIES OF UNEMPLOYMENT

The purpose of this introductory chapter is to provide some basic statistics on unemployment and to outline some theories of the relationship between technical change and employment. The chapter is divided into three parts: first, data are presented on the level and structure of unemployment; secondly, the notion of 'full employment' is discussed to provide a context for assessing the magnitude of the problem implied by the data; and thirdly a brief discussion of causes of unemployment, with particular reference to technical change, is presented. The overall intention is to provide a background for the more specific theoretical ideas and empirical evidence presented in later chapters.

## 1.1 Levels and structure of unemployment

There is little need here to dwell at length on the fact that measured unemployment has shown a persistently high and generally upward trend in most OECD countries over the last decade. Table 1.1 summarises the situation prevailing in a number of countries in selected years in the post-war period and in the Great Depression of the 1930s, in both relative terms as a percentage of civilian labour force (Table 1.1(a)) and absolute levels (Table 1.1(b)). Comparison with the unemployment levels of the 1930s shows that the situation is not yet as serious as it was fifty years ago in most countries, especially in the leading industrial countries — USA, Japan and Germany. However the deterioration in the overall position since the 1960s is clear as is the rapid deterioration in 1980–1. There are no grounds for complacency, particularly as many economists believe that serious difficulties will persist well into the 1980s.

Some commentators maintain that data such as these, taken at face value, do not accurately reflect the problem facing developed countries. Such arguments fall into two main groups. First, it is sometimes suggested that the data suffer from serious, even overwhelming problems of measurement. Large numbers of people are included who should not be — those who, for example, are incapable of work, or are 'voluntarily' unemployed. Secondly, from a more theoretical perspective, some schools of thought would regard

Table 1.1(a) Unemployment levels, as a percentage\*

	1929	1931	1933	1935		
Belgium	0.8	6.8	10.6	11.1		
Denmark	8.0	9.0	14.5	10.0		
France	1.2	2.2	n.a.	n.a.		
Germany‡	5.9	13.9	14.8	6.5		
Ireland	n.a.	n.a.	n.a.	n.a.		
Italy	1.7	4.3	5.9	n.a.		
Japan	n.a.	n.a.	n.a.	n.a.		
Netherlands	1.7	4.3	9.7	11.2		
UK	7.2	14.8	13.9	10.8		
USA	3.1	15.2	20.5	14.2		
	1959-1967 (average)	1973	1977	1979	1981 (1st quarter)	1981 (December)†
Belgium	2.4	2.9	7.8	8.7	10.6	12.9
Denmark	1.4	0.7	5.8	5.3	8.0	9.5
France	0.7	1.8	4.8	6.0	7.1	8.9
Germany‡	1.2	1.0	4.0	3.4	4.1	6.7
Ireland	4.6	5.6	9.2	7.5	10.0	11.5
Italy	6.2	4.9	6.4	7.5	8.3	9.6
Japan	1.4	1.2	2.0	2.0	2.1	2.2
Netherlands	0.9	2.3	4.1	4.1	6.3	10.2
UK	1.8	2.5	5.7	5.3	9.4	11.3
USA	5.3	4.9	7.0	5.8	7.2	8.9

Sources: 1929-1935: Maddison (1980). These estimates are rather lower in many cases than those from other sources. 1959-1981: European Economy Annual Economic Report 1980-1, Commission of the European Communities, November 1980; US Department of Commerce, 1980; *Statistical Abstract of the United States from Colonial Times to the Present*, Basic Books New York, 1976; OECD 'Main Economic Indicators'.

\*1929-1935 as a percentage of total labour force; 1959-1981 as a percentage of civilian labour force.

†Seasonally adjusted latest figures, mainly from *The Economist* 30 January 1982.

‡The Federal Republic for the period 1959-1981.

the figures as reflecting, in large measure, a 'socially necessary' or 'natural' state of affairs, or otherwise maintain that a proper interpretation implies that current unemployment is less unacceptable than a cursory examination of the data suggests. We shall briefly touch on such arguments below, but it is not our intention to devote a great deal of space to them. Our own position is that, despite inaccuracies in the data and despite the range of interpretations of them, unemployment now clearly represents a major social problem in most developed countries, and hence is a priority issue for analysis and policy.



Table 1.1(b) Absolute numbers of unemployed (1929-1935, 1973-1981) (in thousands)

	1929	1931	1933	1935	1973	1977	1979	1981
Belgium	6	41	62	66	87	308	352	488
Denmark	43	53	97	76	21	147	138	214
France	10	64	305	464	576	1072	1350	1817
Germany	1899	4520	4804	2151	273	1030	876	1343
Ireland	21	25	72	123	66	106	90	132
Italy	301	734	1019	964*	1305	1382	1653	1979
Japan	n.a.	n.a.	n.a.	n.a.	680	1110	1170	1333
Netherlands	28	138	323	385	117	207	210	404
UK	1216	2630	2521	2036	575	1484	1391	2871
USA	1550	8020	12830	10610	4304	6856	5963	7900
Total (excl. Japan)	5074	16225	22033	16875	7324	12592	12023	17148

Source: Mitchell (1975), EEC (1981) for European Countries; US Department of Commerce (1980) and OECD (1981) for USA and Japan. These figures are from different sources than in Table 1.1(a); in particular the 1929-35 estimates cannot be compared with the estimated ratios of Maddison given in Table 1.1(a).

\*1934