Introduction

Opening Pandora's jar

The story of Pandora exists in several versions which differ somewhat from each other. A summary of the most widely received version would run much as follows. Both Pandora herself and her jar were created at the command of Zeus who was hoping to punish Prometheus for having stolen fire from the sun to animate his man of clay. Pandora was made the personification of beauty and possessed many abilities. She was commanded to present her jar to the man whom she married. She was intended to captivate Prometheus but he was wary of accepting her and her jar. Instead she married Prometheus' brother, Epimetheus, who lacked his brother's caution. Despite receiving a warning about acting imprudently, Epimetheus, on being presented with the jar, opened it. In doing so he released into the world a host of evils but also hope which might, in some sense, offset them.

Any close analogy between this story and the industrial revolution might seem ludicrously far fetched. Yet in some respects there is a telling resemblance between the myth and the historical event. The industrial revolution was unexpected by contemporaries and many of the features of the period which have attracted so much attention with the benefit of hindsight went largely unnoticed at the time. Like Pandora and her husband when the jar was opened, nothing in their past experience had prepared people at the time for what was to follow. The possibility of a transformation which would radically enhance the productive powers of society was at the time generally dismissed as idle optimism. The nature of the new situation was acknowledged and understood only by a later generation and for a time any benefit from it was hotly disputed. Marx, for example, recognised the vastly enhanced power to produce which had come into existence but considered that the bulk of the population was condemned to receive little or no benefit from it, and was deeply angered by his assessment. Then

for more than a century an improvement in the material circumstances of whole populations appeared indisputable if uneven. More recently new uncertainties and misgivings have become increasingly prominent. The use of fossil fuels as the prime source of energy has vastly increased the power to produce of countries throughout the world but it is accompanied by environmental hazards which threaten disastrous consequences. If they are to be avoided speedy and radical action appears to be necessary. And the massive increase in the power to produce has been accompanied by an equally great rise in the power to destroy. There are able and well-informed observers who think that mankind as a species will be fortunate to survive to the end of the present century. The powers which were unleashed by the industrial revolution, in other words, have proved to possess the capacity to bestow blessings without earlier parallel but also to cause harm on a scale previously unknown. Once released from the jar they cannot be reconfined but it is reasonable still to remain in doubt whether the balance between their benefits and their dangers is favourable or malign.

It is said that Zhou Enlai, on being asked whether he considered the French revolution to have been a success, paused, and then replied that he thought it was a little early to tell. Most people if asked the same question in regard to the industrial revolution would probably reply positively, but the transformation of the capacity of societies to produce material goods brought about by the industrial revolution has brought with it matching dangers. The analogy with Pandora's jar may appear somewhat tenuous but the myth and the later reality are not without parallels. Many of the powers which were released by the industrial revolution have proved unambiguously beneficial but the attendant dangers are not trivial. The Cuban missile crisis was a stark reminder of how close to the edge of a precipice we stood and stand. The power to destroy and to pollute has risen in step with the power to produce. Any final verdict remains uncertain.

Overview of the nature and structure of the book

The England of 1850 was vastly different from the England of 1600. During the intervening quarter millennium it had been the setting for the beginning of one of the two greatest transformations of human society since hunter-gatherer days. And yet the pace of change throughout was more often measured than hectic. Many of the most widely used

indicators of economic and social change have recorded far more rapid change in the century-and-a-half after 1850 than in the preceding period. The economy has expanded more rapidly, real incomes have risen at a faster pace, and expectation of life at birth has improved more quickly in the post-1850 period than in the two centuries which preceded it.

Everyone can name the transformation which took place, the change which makes this quarter millennium in England so central to world history. It is conventionally termed the industrial revolution and this term has been in common currency for so long and has become so deeply embedded in the general consciousness that it is idle to suggest that it should be replaced, even though both the adjective and the noun are somewhat misleading. Although everyone can name the transformation, neither its definition, nor its origins, nor its chronology, nor its relationship to other changes of the period are matters on which there is a wide consensus. And there is the further oddity that despite its profound significance (or perhaps, some might say, because of its profound significance) it was for the most part curiously and instructively imperceptible to contemporaries. The man in the street in the 1790s would be in no doubt about the occurrence of a revolution across the Channel in France but would have been astonished to learn that he was living in the middle of what future generations would also term a revolution and would regard as having far greater long-term importance. Nor was it just the man in the street who was unaware of the transformation in train. The three greatest of the framers of classical economics, Adam Smith, Thomas Malthus, and David Ricardo, not only were equally unaware of it, but were unanimous in dismissing the possibility of what later generations came to term an industrial revolution.[1]

In this book, I shall attempt to throw light on the developments which set the new age apart from the agricultural societies which had come into being because of the only earlier transformation of comparable magnitude, the neolithic food revolution.

One feature of my approach should be stressed immediately. It is conventional to focus on the question of how a breakthrough to more rapid growth, a 'take-off', was achieved; how it was possible to change the rate at which the economy expanded so markedly that for the first time in human history there was a prospect of vanquishing mass

[1] See below pp. 10–17 for a description of their views.

poverty. This approach tends to carry with it the implicit assumption that once the decisive acceleration had occurred, it was natural to expect it to continue. But this is to allow what actually happened to obscure a matter of fundamental importance. In my view the most important single issue on which to focus in trying to gain a clearer understanding of the industrial revolution is not how the period of more rapid growth began, but why it did not come to an end. All past experience appeared to justify the expectation that the very process of growth would set in train changes which would arrest and might well reverse the growth which had occurred. The faster the rate of growth achieved, the sooner and more abruptly it would cease. I hope to make clear the nature of the arrester mechanism which had always operated so powerfully before the industrial revolution and also to direct attention to those features of the growth process in England between the reigns of Elizabeth and Victoria which made it possible for the country for the first time to escape a similar fate.

There can be no single, 'true' account of the industrial revolution. Since its nature can be defined in different ways, it follows that a description and explanation which are satisfactory in the context implied by one definition are unlikely to carry conviction when the industrial revolution is differently defined. Even where there is agreement about definitions, the problem remains, partly because of the complexity of the *explicandum*, and partly because the limitations of much of the empirical evidence make conclusive proof (or, still more important, conclusive disproof) of a particular hypothesis elusive. What follows represents an attempt to provide good reasons for accepting a particular approach to the problem of making sense of the transformation which occurred. In developing my argument I shall hope to make clear the assumptions, the preconceptions, some may say the prejudices, which underlie my approach.

The book has a particular form. It marshals the discussion of the industrial revolution round a single, central theme, the history of energy availability and use. There are only glancing references to some aspects of change during the early modern period which are central to other interpretations of the events taking place. For many historians, for example, the absence of any extended discussion of the changing institutional and legal framework of society means missing the key background factor to the possibility of an industrial revolution occurring. Amongst other things, an independent and powerful

judiciary implementing a legal code which affords protection to private assets was, it is argued, essential. The maxim *Quod principi placuit legis habet vigorem* does not provide a congenial setting for stable and consistent growth.[2] Or again, there is only passing reference to the striking scientific advances of the age which can reasonably be portrayed as having provided an insight into the nature of physical, chemical, and biological processes which cleared the way for a host of improvements across the whole range of productive activity. Perhaps even more important, it may be argued, was the way in which scientific progress produced a different mindset, seeking and finding explanations for every aspect of the functioning of the natural world without invoking the operation of divine providence.

These and other similar general explanations of the extraordinary transformation of traditional into modern economies have received much attention and it would be both presumptuous and mildly ridiculous to downplay their importance. A full and rounded account of the industrial revolution must incorporate them or find a compelling reason for failing to do so. But it is difficult to avoid a loss of clarity in seeking to be comprehensive. The problem in incorporating a full range of possible explanations of or contributory factors to the industrial revolution is that they are essentially incommensurable. The facility does not exist for weighing their relative importance. I have therefore, in a sense, chosen the easy way out. The topics treated in this book are not free from this problem but it is less prominent than in more inclusive treatments and I trust that there is a gain in clarity as a result. And, to repeat, the book has a more limited purpose than general treatments of the industrial revolution. It seeks above all to provide an explanation not for an acceleration in economic growth but for the absence of a subsequent deceleration. The choice of the topics selected should be judged in the light of this fact.

This book is divided into four parts. Part I consists of two chapters which describe the general thesis of the work, providing a background which should help to make clear the relevance of the topics discussed in the subsequent text. There are four chapters in Part II. Each considers the nature of the relationship between elements within the economy which promoted or accommodated change and growth,

[2] The maxim can be rendered as 'What is pleasing to the prince has the force of law.'

the type of relationship which is often referred to as one of positive feedback. These chapters should also clarify the nature of the changes taking place between the reigns of Elizabeth and Victoria which made it possible for growth to continue and even accelerate when past experience had always suggested that growth must give way to stagnation. In Part III there are two chapters. The first describes the timing and nature of the changes taking place during the industrial revolution. The second discusses the relevance of the concept of 'modernisation' to the changes which took place in England during this period; some of the issues involved are explored by a comparison of England and the Netherlands in the early modern period. Part IV is very short: it consists of a single chapter reviewing and restating some of the central theses of the earlier chapters.

It will be clear, therefore, that the book is neither a general history of the industrial revolution, nor a monograph presenting the findings arising from recent research, but rather an attempt to specify a particular interpretation of the key characteristics of the industrial revolution, supported by a series of essays dealing with the relevant aspects of changes taking place. Half a century ago in his inaugural lecture, F. J. Fisher, ever a plain speaker, said that the traditional monograph 'consisted of a thin rivulet of text meandering through wide and lush meadows of footnotes'. Whatever the drawbacks of this convention, however, they were clearly less objectionable, in his view, than what he termed the 'archetype of our modern fashion' in economic history 'in which a stream, often a less than limpid stream, of text tumbles from table to table and swirls round graph after graph'. He noted that his predecessor had asked for greater use to be made of statistics: 'The Almighty has answered his prayer, not with a shower, but with a deluge.'[3] I belong to that branch of historical enquiry which Fisher had in mind when amusing himself and his listeners and might be said to have been, at times, severely afflicted by a tendency to resort to quantification. For many purposes I believe firmly in its validity and value. Nevertheless I have done my best not to allow this weakness to figure too prominently in this book, without, however, failing to make use of quantification where it is effective either in description or in clarifying an argument.

[3] Fisher, 'The dark ages of English economic history', p. 184.

PART I

A sketch of the argument

1 *The limits to growth in organic economies*

The neolithic agricultural revolution massively increased the quantity of food which could be produced from a given area of land and thereby made possible a matching growth in population. Whereas previously men and women had competed with other animals to secure a share of the natural products of the land, the development of agriculture, which was the defining feature of the change, meant that plant growth over vast areas was restricted to plants for human sustenance or to feed flocks of domesticated animals. This multiplied by orders of magnitude the capacity of each acre suitable for agriculture to support a human population.

All economies which developed in the wake of the neolithic food revolution may be termed organic. In organic economies not only was the land the source of food, it was also the source directly or indirectly of all the material products of use to man. All industrial production depended upon vegetable or animal raw materials. This is self-evidently true of industries such as woollen textile production or shoemaking but is also true of iron smelting or pottery manufacture, although their raw materials were mineral, since production was only possible by making use of a source of heat and this came from burning wood or charcoal. Thus the production horizon for all organic economies was set by the annual cycle of plant growth. This set physical and biological limits to the possible scale of production. Organic economies therefore differed fundamentally from economies transformed by the industrial revolution since many of the industries which grew most rapidly thereafter made little or no use of organic raw materials. Above all, access to a mineral rather than a vegetable energy source expanded the production horizon decisively. The significance of this distinction is the basic issue to be explored in this chapter.

The views of the classical economists

The writings of the classical economists provide an illuminating, in many respects a definitive, account of the reasons why it had seemed impossible to secure prolonged expansion of production at a rate which would allow the living standards of the mass of the population to rise progressively. There were, they argued, three factors involved in all material production: labour, capital, and land. The supply of the first two could, in favourable circumstances, expand as required. The supply of the third was fixed. This created a tension which must grow steadily greater in any period of expansion. More people meant more mouths to feed. An expansion in woollen textile production meant raising more sheep and therefore devoting more land to sheep pasture. A rise in iron output involved cutting down more wood to feed the furnaces and implied an increase in the area to be committed to forest. Each type of production was in competition with every other for access to the products of the land. Such pressures in turn must mean either taking land of inferior fertility into agricultural use, or working existing farmland more intensively, or, more probably, both simultaneously. The result must be a tendency for the return to both labour and capital to fall. Growth must slow and eventually come to a halt. Improvements in production techniques and institutional change might for a time offset the problems springing from the fixed supply of land. This might delay but could not indefinitely postpone the inevitable. In short, the very fact of growth, because of the nature of material production in an organic economy, must ensure that growth would grind to a halt. And this impasse was reached not because of human deficiencies, or of failure in political, social, or economic structures but for an ineluctable physical reason, the fixed supply of land.

Ricardo's chapter 'On profits' in the *Principles of political economy* contains a long discussion of the necessary tendency of the level of profit to fall over time replete with an arithmetic exposition of the process. He concludes with a summary in the following terms:

> Whilst the land yields abundantly, wages may temporarily rise, and the producers may consume more than their accustomed proportion; but the stimulus which will thus be given to population, will speedily reduce the labourers to their usual consumption. But when poor lands are taken into

cultivation, or when more capital and labour are expended on the old land, with a less return of produce, the effect must be permanent. A greater proportion of that part of the produce which remains to be divided, after paying rent, between the owners of stock and the labourers, will be apportioned to the latter. Each man may, and probably will, have a less absolute quantity; but as more labourers are employed in proportion to the whole produce retained by the farmer, the value of a greater proportion of the whole produce will be absorbed by wages, and consequently the value of a smaller proportion will be devoted to profits. This will necessarily be rendered permanent by the laws of nature, which have limited the productive powers of the land.[1]

Ricardo provided a particularly clear and pungent exposition of the dilemma facing all organic economies, but it did not differ greatly from the views of Adam Smith or Malthus.

Adam Smith identified the rate of return on capital as the proximate determinant of growth or stagnation. He had no doubt that the productivity of the land set the bounds to possible growth and that the return on capital declined steadily as the opportunities for profitable investment became rarer. For a time growth might be brisk and the demand for labour strong, leading to an increase in the prevailing level of wages and improving the living standards of the labouring poor, but such periods were bound to be transient:

In a country which had acquired that full complement of riches which the nature of its soil and climate, and its situation with respect to other countries, allowed it to acquire; which could, therefore, advance no further, and which was not going backwards, both the wages of labour and the profits of stock would probably be very low. In a country fully peopled in proportion to what either its territory could maintain or its stock employ, the competition for employment would necessarily be so great as to reduce the wages of labour to what was barely sufficient to keep up the number of labourers, and, the country being already fully peopled, the number could never be augmented. In a country fully stocked in proportion to all the business it had to transact, as great a quantity of stock would be employed in every particular branch as the nature and extent of the trade would admit. The competition, therefore, would everywhere be as great, and consequently the ordinary profit as low as possible.[2]

[1] Ricardo, *Principles of political economy*, pp. 125–6.
[2] Smith, *Wealth of nations*, I, p. 106.