INTRODUCTION

My introduction to the first edition of this book was written in the very different economic climate of the early 1980s, and in the different intellectual climate which then prevailed, where industrial and social revolutions were still considered to be formative of our modern identity.

My book then was about industry and technology; it placed these at the centre of an account of the Industrial Revolution. For over a generation accounts had focused on the 'macroeconomics' of the Industrial Revolution—patterns of economic growth, capital formation, demand, income distribution and economic fluctuations made up the rather dull Anglo-American cuisine of the student diet. Indeed students in numbers studied economic history in Coventry, Birmingham, Leeds, Liverpool and Manchester, and found it increasingly easy to understand their subject without noticing the cities they lived in and without visiting the factories and workplaces which gave these places an industrial identity.

I hoped that my book would make a difference to this. It was meant to bring to light the long and varied experience of organizational and technological change in manufacture going back to the early eighteenth century. My book was about the content of that manufacture, not just its results in the indices of economic growth. The economy I analysed was not one of economic indicators and national accounts. It was made up of the people and processes of industry, their work, their inventions and their communities. It was furthermore a book which brought out of the shadow cast by quantitative history the processes of manufacture and parts of the labour force, especially women, children and the unskilled, which played a central role not reflected in official statistics. The book raised innumerable questions over criteria for 'transition', 'successes' and 'failures', and charted the different technological choices and routes of industrial development. It challenged former apocalyptic metaphors of change and the much-vaunted achievements of factory and large-scale power technologies. It called for new research into a whole range of industries which we still know little about, and enquiry into the social realities behind the changes in productivity at the time. My book was intended, if metaphor be allowed, to recreate a Babette's feast of trades, crafts, new products and industries, of girls, old women and mothers, as well as of proud artisans and casual labourers, of machines, tools and skills.

A new historical framework is now on the agenda, and I have written a new edition of the book to engage with this. First, a new economic climate has emerged from the restructuring of the 1970s and 1980s. The major feature of the 1780s to 1830s was the rise in the place of industry. Where industry's share in national product rose from 23 per cent in 1801 to 34 per cent in 1840, and on to 40 per cent in 1901, in the early 1990s that trend has been sharply reversed. In the course of two decades from 1973 to 1990 manufacturing's share of gross domestic product fell from 30 per cent to 20 per cent. Britain's manufacture of capital and intermediate goods and components all but dropped out of world trade during the 1980s. During the recession of the 1990s the industrial

towns of the Midlands and the North are in decline and demoralization. The factories and the workshops neglected by a past generation of students, by governments and by our cultural icons are now only skeletons.

David Lodge wrote about this in *Nice Work,* published in 1988 at the peak of a boom. He described the industrial suburbs of Birmingham, once the Black Country, as

> a district dominated by factories, large and small, old and new. Many are silent, some derelict, their windows starred with smashed glass. Receiverships and closures have ravaged the area in recent years, giving a desolate look to its streets… A factory is sustained by the energy of its own functioning, the throb and whine of machinery, the clash of metal, the unceasing motion of the assembly lines, the ebb and flow of workers changing shifts, the hiss of airbrakes and the growl of diesel engines from wagons delivering raw materials at one gate, taking away finished goods at the other. When you put a stop to all that, when the place is silent and empty, all that is left is a large, ramshackle shed—cold, filthy and depressing.[1]

The result of this economic decline and the savage reduction of the country's industrial heartland has been a period of prolonged introspection over the national identity. As Linda Colley has put it, the British 'came to define themselves as a single people not because of any political or cultural consensus at home, but rather in reaction to the Other beyond their shores'.[2] One part of this reaction was in defining themselves as the first industrial nation. That identity as 'first' has long disappeared, now so too has that of 'industrial' nation. The industry has, indeed, become part of the iconography of past glories—long-abandoned industrial sites have been made a part of the national heritage, a new picturesque landscape, a postmodern comment on the pastoral picturesque scenes of the eighteenth century. Those landscapes were not 'natural' as the poets and painters tried to present them, nor the remains of an ancient rural birthright. They were the deindustrialized and poverty-stricken regions of Scotland, Wales, the South-West and other 'marginalized' communities of Britain.[3] Our new industrial picturesque is likewise a celebration of a past at some remove from the industrial unemployment of the present.

A part of that introspection, however, has also been a calling to account of the industrial past. At one level this has been a questioning of the 'sacred cows' of the postwar boom—the heavy capital investment, large-scale industry and regional concentration. The failings of our own heavily capitalized, large-scale factories have been measured against the revival of alternative smaller-scale units elsewhere. And the inflexibilities and industrial conflict of hierarchically organized systems of management have entailed new attempts at network capitalism, just-in-time production systems, franchises, subcontracting and co-operative ventures. Smoke stack capitalism has had its day, its assembly lines and 'ramshackle sheds' abandoned for the airport and motorway flows of 'designer capitalism'.

At another level the historical facts of Britain's industrial identity have been challenged. These facts were not, however, investigated as I had hoped, through the processes of industrial change, the sources of innovation, the potentialities for or inhibitions upon technological creativity which existed within communities and industrial

structures. Instead, the application of different statistical techniques to quantitative indicators has brought to these a new precision, however spurious, and brought them to the forefront of analysis, to the exclusion of discussion of the processes and microeconomics of industrial change. Economic historians now emphasize slow continuous change rather than the dramatic break with the past which the term 'Industrial Revolution' once conveyed. The first edition of my book was published just before N.F.R.Crafts's *British Economic Growth,*[4] and, like the challenging articles by Crafts and Harley published before this,[5] I emphasized the broad coverage of industry and the role of proto-industrial development in the years long before 1780. But the focus of Crafts's analysis in his book and in later articles was to centre on the slow rate of productivity growth during the Industrial Revolution, especially during the period between 1780 and 1820. The brunt of the explanation for disappointing results as indicated in the newly estimated growth rates was borne not by a large agricultural sector, but by a large and sluggish industrial sector.

Britain was a much more industrial nation in the eighteenth century than once thought, but in Crafts's view much of this industry was traditional and overmanned. T.S.Ashton's spectacular 'wave of gadgets' was confined to a few small industries, notably cotton and iron which failed to overcome the deadweight of the older industries until after the 1830s. Crafts's new output and growth estimates were presented in the framework of macroeconomic analysis formerly followed by economic historians, but they turned its previous conclusions on their head. For his new estimates found no radical discontinuity in national income, industrial output, capital formation, gross domestic product per head and productivity.

Following soon on Crafts's new gradualism came Wrigley's continuity thesis.[6] Based on an ecological insight into the predominance of organic over inorganic resources in industry, it argued for limits to growth before the mid-nineteenth century. Resource factors were reinforced by a distribution of the labour force towards rural and traditional industrial occupations. 'Slow growth' and 'continuity' have thus become positions imposed on the period. These positions on the economy have fitted well with revisionist views in political and social history seeking constitutional continuities between *ancien régime* aristocratic oligarchies and 'gentlemanly capitalism'.

The new edition of my book is a challenge to the orthodoxy which now prevails on the dimensions of the eighteenth- and early-nineteenth-century economy. It is also a restatement and reformulation of my position in the first edition that the key to the Industrial Revolution was to be found in the dynamics of technological creativity and the structures of industrial communities. Orthodoxies have their fellow travellers for a time, but ultimately the statistical reworking of the same body of data must end in intellectual rigor mortis. The study of the Industrial Revolution will either be abandoned, or must seek out new frontiers of primary microeconomic research and new frameworks of analysis.

One such new framework must be women's industrial work, and female consumption of manufactured commodities. The hidden bias in all the existing estimates of productivity growth and distribution of the labour force is that they are based on male occupational categories. A male industrial revolution has been presented to us as the general experience. If women's workforce contributions, women's property-holding and capital investment were counted, what difference would this make to accounts of

productivity growth? If women's consumer decision-making, and family incomes rather than male wage rates were considered, what difference would this make to currently accepted views of the passive roles of home demand and international trade, and of stable, then steadily rising standards of living? In current accounts of the slow productivity growth of British industry during the eighteenth and early-nineteenth century, traditional, male labour surplus industries take the fore while new manufacturing industries deploying cheap female labour in conjunction with improved forms of economic organization and new machinery are excluded, or their place is understated. Narrative accounts along with partial quantitative indicators built up from specific regional and industrial studies provide insight into more rapid industrial transformation than ever conceived within the blinkered framework of current national accounting categories.

Another framework is the extent of Britain's difference, from the eighteenth century onwards, from her European and Asian neighbours. Perhaps the major contribution of Crafts's and Wrigley's books is their clarification of the distinctiveness of the British path of economic development. But this has been hidden behind more prominent messages of slow productivity change, limits to growth, organic resource bases and traditional labour forces. Crafts compared the rapid labour force deployment away from agriculture in Britain to the still largely agricultural economies of the rest of Europe. This reduction in the agricultural labour force was combined with organizational and technical change to produce a high productivity agriculture capable of feeding a rapidly growing population. Yet international specialization and comparative advantage went to a new, initially small but rapid growth industry—the cotton manufacture. It was not British industry which set the economy apart from the rest of the continent, but British agriculture plus the cotton manufacture.

Wrigley identified two other distinctive features of the British economy. One was its urban growth along with the extent of its rural manufacturing. Population growth over the course of the eighteenth century emerged from rural industrial expansion and an uninterrupted growth in the urban sector. The towns of Britain, especially those of small and medium size, were growing rapidly at a time when those in much of the rest of Europe were stagnating or declining. In 1800 Britain's urban population was surpassed only by the Netherlands, and the Dutch towns had been declining for a century.[7] Many of Britain's smaller towns were heavily industrial, closely integrated with concurrent proto-industrial development in rural hinterlands. Turnpikes, canals and rivers, and a constant traffic of human activity bound the countryside to the town.

Another distinctive feature was Britain's reliance on coal resources since the later eighteenth century. New potentials for growth set her apart from the stagnation facing the Dutch economy.[8] From this time on, Britain, unlike her neighbours, broke free of the limitations imposed by organic, land-based raw materials. Her industries shifted from woollen textiles, leather and construction to iron and steel goods, pottery, bricks, glass and inorganic chemicals.[9] The expansion of the northeastern coalfield was one of the miracles of the seventeenth century, and Newcastle was proverbial for its wealth and population even at the end of the eighteenth century.[10] By this time the other major coalfields of the Midlands and the North were in rapid development and dictated the location of new industry. Britain consumed more coal per capita than any other European country even in the nineteenth century. In 1850 her consumption of coal per capita

exceeded that reached by Germany in 1880, but the main industrial use for this coal was in the iron and the cotton industries.[11]

Coal, towns and labour deployment played their part, to be sure, and set a distinctive path for Britain apparent in all the available macroeconomic indicators. It was not these that set off the discontinuity, however, but a concentrated technological breakthrough combined with a more broadlybased technological innovation across a range of new manufacturing industries. What the Industrial Revolution involved, as Ralph Davis once wrote, was 'a movement on to quite different paths of industrial development from those that were being successfully followed'.[12] But the backdrop to this intensive capital-deepening kind of transformation, was the expansion of manufacturing usually associated with capital-widening. This too was accompanied in many newer industries by the application of the division of labour, as well as new tools and techniques if not mechanization.

The clustering of a key set of inventions was combined with new forms of work organization, centralized factories and workshops as well as decentralized subcontracting, and new labour forces, especially women, children and other uninitiated labour such as pauper apprentices. Framing this clustering was a rich diversity of technological and organizational change in a broad range of industries. As Mokyr has argued, 'per capita consumption and living standards increased little initially, but production technologies changed dramatically in many industries and sectors, preparing the way for sustained Schumpeterian growth in the second half of the nineteenth century'.[13] These fundamental changes in production systems were achieved by major inventors like Samuel Crompton who wrote that he spent 'fourand-a-half years at least wherein every moment of time and power of mind as well as expense which my other employment would permit were devoted to this one end'.[14] They were achieved by minor manufacturers such as James Bisset who could not brook the prospect of life as a journeyman japan painter, spending twelve-hour days painting snuff boxes with roses and anemones. He escaped by inventing a novel kind of painting on glass, called Imperial, and a whole range of other designer goods.[15] They were also achieved by such as Catherine Willcox, Wedgwood's designer and painter,[16] or the anonymous female spinner and engineer who escaped with Hargreaves when his spinning jenny was attacked by a mob.[17] And they were achieved by the groups of women who applied their own divisions of labour and female work patterns in the proliferating workshops and small factories of the new manufacturing industries.

Such technological and organizational change brought major dislocation to many communities. Manufacture was by no means new to the eighteenth century; cottage industries were widespread over the Scottish Highlands, West Wales, the Yorkshire Dales, the Derbyshire and Cornish countrysides, not to mention Ulster, Kilkenny, Mayo and Donegal. These regions experienced a new pastoralization and with it pauperization as a result of the onset of industrialization on an altogether different scale in a few key regions of mainland England and lowland Scotland. This 'euthanasia of cottage industries' may have been a 'great exercise in Schumpeterian creative destruction',[18] but for the families, and above all the women and children who played such a prominent part in these industries, the results were catastrophic, and entailed a long period of resistance to technology in many such communities.

Technological change and the expansion of manufacturing took shape within this diverse climate of enthusiasm and resistance, and were vigorous enough to produce the discontinuity which distinguished Britain from her continental neighbours. As O'Brien has put it, 'the productivity of the British workforce producing manufactures and urban services had to advance…rapidly enough to support the terms and levels of trade between industry and agriculture required for sustained structural transformation'.[19] At the back of all this, Britain had advantages over her neighbours. Over the period from the late seventeenth to the early nineteenth century Britain fought a long series of wars outside her shores. The results were a windfall of colonial markets, a huge navy and army which made international and domestic markets safer for British trade, and, even more significantly, the founding of the Bank of England, the creation of the City, and the shipping and insurance services which dominated world markets.

> Britain, by first obtaining a dominating position for herself in world markets, and then by servicing the commercial and industrial needs of other countries during their industrialization processes, built up an almost unassailable comparative advantage in these fields. In this case at least, then, the role of the external world in Britain's industrialization had a consequence of a permanent nature.[20]

Britain's economy was 'distinctive' in the eighteenth and early nineteenth centuries, not because of resource endowments and agricultural output, but, as contemporaries such as Tocqueville saw, because of the extraordinary industry and inventiveness of her manufacturing people. But distinctive does not mean isolated, for around this lay the allure, the adventure, and indeed the conquest of the world economy. Britain was not the first to understand the crucial role of this world economy: 'the splendid high noon of Dutch wealth and power' was achieved in the seventeenth century from this vantage point. The British learned their lessons from the Dutch, but took that major step into the beyond by connecting their dominant trading position to broadly-based expansion of their manufacturing sector along with concentrated growth in their new leading manufactures, cotton and iron.

This book is an industrial history, and it reasserts the primacy of the industrial experience to Britain's Industrial Revolution. That experience was tremendously varied and fraught with the struggles and controversies of both machinery and the intensive exploitation of labour. This is also a book about the process of restructuring and transformation of production, a process which was spread over a longer period and a broader range of manufacture than once thought. It is, nevertheless, a book about transformations and not about the gradualism and continuity of economic indicators. While these indicators have their place, the estimates on which they are based are fragile and incomplete. They are so far all we have in terms of quantitative estimates, but the story which is told on the basis of such estimates alone is not only not enough, it is also at odds with other narratives of the times. David Landes warned thirty years ago against masking the significance of discontinuities by concentrating on the absence of shifts in quantitative indicators: to him these were the historian's 'butterfly under glass or frog in formaldehyde—without the virtue of wholeness to compensate for their lifelessness'.[21] It is time that this warning was renewed.

Finally, this book forms part of a debate on the Industrial Revolution which I hope will continue to invigorate the subject. Crafts has given us new quantitative estimates of economic growth, and new ways of thinking about the sectoral developments of the economy. Wrigley has given us new ways of thinking about the agricultural and resource base of the economy as well as new estimates of the growth and distribution of the labour force. My book is not simply an account of the industrial facts which they have left out; it is an alternative analysis which questions the interpretations and significance placed upon the economic indicators.

These arguments are developed through twelve chapters. Chapters 1, 3, 8 and 9 are mainly theoretical, dealing with debates and issues. Chapter 1 summarizes the now orthodox quantitative treatment of the Industrial Revolution, the problems with this, and the new issues now opening for research. Chapters 3, 8 and 9 discuss a series of debates over industry, including classical writers such as Smith and Marx, as well as recent discussion of proto-industrialization, flexible specialization, the 'bosses' and labour process debates, and economic and social theories of technological and organizational change. The other chapters marshal both argument and evidence to present a different view of the place of manufacture in the British Industrial Revolution. This includes discussion of agriculture and resources as well as trade and consumption. Chapter 2 on Industries provides a broadly based and up-to-date survey of technological, organizational and productivity change in Britain's major industries. Chapters 10 to 12 provide an in-depth discussion of changes in techniques and work, and their social impact in Britain's two major and contrasting industries, textiles and metals.

This book still challenges the attachment of older generations of economic historians to the years after 1780, to the factory and to the cotton industry. But in this new edition it also challenges the current and now orthodox preference for gradual and continuous change over the discontinuity associated with the Industrial Revolution. That discontinuity was less short and sharp than once thought, but it was nevertheless a transformation, and one in which changes in manufacturing played a prominent part. This second edition, like the first, asks that we reconsider the kinds of changes taking place in the earlier eighteenth century and the context in these years for the rise of household and workshop industries. It asks for a closer analysis of the economic dynamic, the techniques and the labour forces of these cottage and workshop industries, and of the factories which grew up in the midst of some but not all of them. It asks finally that we look on the Industrial Revolution as a more complex, many-sided and long-term phenomenon than economic historians have recently assumed.

This book considers a range of debates over and analyses of industrial change. On specific industries, however, it is selective, and deals in depth with only some of the textile industries and some of the metal industries. Since the first edition, I have been able to draw on new research on the woollen industry by Pat Hudson and Adrian Randall, on the silk industry by Judy Lown and on the lace industry by Pamela Sharpe. But a range of other industries, examined from the viewpoint of their labour forces, work and technologies, remains neglected, including the whole range of food processing, papermaking, glass and pottery, shoemaking, and colonial finishing trades. As a general survey, this second edition, like the first, still raises more questions than it answers. I hope, however, that these will still provide the incentive for new research and new interpretations of the Industrial Revolution.

Part I
MANUFACTURE AND THE ECONOMY

1
CURRENT PERSPECTIVES AND NEW DEPARTURES

The Industrial Revolution has long been a terrain of debate and controversy among economic and social historians. Debates over how much change, how fast, and what impact this had on communities and peoples have been part of the process of making the concept itself. These debates, among what have become rather specialist historians, have in turn affected our wider historical sense of identity. The Industrial Revolution has been conceived of as a period of transition, however long the period and varied its characteristics. It is a part of the 'life story' of the nation, conceived generally as its formative childhood and adolescence. The Industrial Revolution has been the starting point of accounts of political and social change and of the making of the modern economy. The developmental indicators and their trends, centred on the growth of national output, capital formation, demographic growth, and changes in economic and industrial structures, are known just as surely as are the weights, heights, motor skills, speech and understanding of the developing child.

Recently these indicators have been called to account. Quantitative economic historians have re-estimated their trends, and have found the gap between the performance of the expected and the real adolescence of the British economy to be too great to claim a transition even over the long period from the early eighteenth to the mid-nineteenth century. 'Continuity' has replaced 'revolution', bringing a loss of confidence in the stages of the life story. From the Right, Norman Stone dismissed the 'industrial revolution' as the conceptual relic of a few outdated early twentieth-century economists.[1] From the Left, Gareth Stedman Jones described the 'changing face of nineteenth-century Britain' as the discovery of a continuity between eighteenth- and nineteenth-century class formations.[2]

QUANTITATIVE ESTIMATES: A NEW ORTHODOXY

Let us turn now to those analyses which have formed the foundation of our new times of historical doubt. During the 1980s a number of quantitative economic historians applied more sophisticated statistical techniques and incorporated research over the previous two decades to modify the quantitative indicators of output growth, wages and occupational structure. The national accounts and industrial and agricultural output estimates of Deane and Cole had, since the 1960s, provided the basic framework for patterns of economic growth over the course of the eighteenth and nineteenth centuries. Now these estimates were displaced and with them the historical turning points which had framed all previous

historiography. Deane and Cole's estimates had confirmed the received picture passed on by T.S.Ashton that 'after 1782 almost every statistical series of production shows a sharp upward turn'.[3] Deane and Cole found industry and commerce growing at 0.49 per cent for 1760–80, but 3.43 per cent for 1780–1801.[4]

The displacement of both estimates and turning points was summarized by N.F.R.Crafts. Gathering together and commenting on earlier work by C.K.Harley, P.H.Lindert and J.G.Williamson, Crafts produced new composite output series for the economic sectors, agriculture, industry and commerce, and government and services. He also produced estimates of the growth of national product and of total factor productivity growth. These estimates are summarized in Tables 1.1, 1.2 and 1.3.

Table 1.1 Output growth, 1700–1831 (% per year)

	New estimates			*Old estimates*		
	GDP	*Industry*	*Agriculture*	*GDP*	*Industry*	*Agriculture*
1700–60	0.7	0.7	0.6	0.7	1.0	0.2
1760–80	0.6	1.3	0.1	0.6	0.5	0.5
1780–1801	1.4	2.0	0.8	2.1	3.4	0.6
1801–31	1.9	2.8	1.2	3.1	4.4	1.6

Source: Crafts, The Eighteenth Century', table 3.
New estimates based on Crafts and Harley, 'Output Growth', and Crafts, *British Economic Growth. Old estimates based o*n Deane and Cole, British Economic Growth.

Table 1.2 Estimates of total factor productivity growth (% per year)

Estimates	*1760–1801*	*1801–1831*
ΔY/Y	1.0	1.9
ΔK/K	1.0	1.7
ΔL/L	0.8	1.4
TFP	0.1	0.35

Source: Crafts and Harley, 'Output Growth', table 5.

Table 1.3 Revisions to estimates of industrial output growth (% per year)

	Original	*Revised*
a) Crafts		
1760–1780	1.51	1.29
1780–1800	2.11	1.96

1801–1831	3.00	2.78
b) Harley		
1770–1815	1.60	1.50
1815–1841	3.10	3.00

Source: Crafts and Harley, 'Output Growth', table 2.
Original estimates from Crafts, *British Economic Growth,* table 2.6; Harley, 'British Industrialisation', table 5. New estimates based on data from Feinstein, 'National Statistics', table X.

New estimates provided evidence for several challenging conclusions on the patterns and structures of British industrialization. First, rates of growth of national ouput, total factor productivity, and industrial output were slow before 1830, and did not demonstrate that sharp upturn previously claimed by historians. The economy did not reach 3 per cent per year growth in real output before 1830. Real income growth was much lower than previously thought, leaving less scope for consumption to rise and less acceleration in productivity growth. Changes in investment proportions were also very gradual over the period, leaving total factor productivity growth at only 0.2 per cent per annum 1700–60, rising to only 0.35 per cent per annum in 1801–31. What increase in growth there was in the later eighteenth century was accounted for by faster growth of inputs rather than extra productivity growth. This demonstrated, contrary to all previous accounts, little effect of technical progress on productivity until well into the nineteenth century.

These new estimates discounted radical economic change, but they did not discount change altogether. For though growth in output and productivity were gradual they did sustain a much-increased population, and a population much more urbanized and more industrialized than either previously or in any other contemporary economy. It was in supporting a substantial proportion of this population *off* the land that Britain measured its achievement in comparison with other European countries.

Crafts, indeed, has described Britain as an 'idiosyncratic industrializer'.[5] Her idiosyncracy is defined by an early start on the road to industrialization, high productivity growth in agriculture which released labour to industry, but comparative advantage in exportable manufactures, especially cotton textiles. This was also a comparative advantage in goods made with relatively more unskilled labour than skilled, and it was this combined with a relatively large industrial sector and a smaller agricultural sector which set the route to later patterns of slow growth.[6]

It was thus the early productivity growth of and 'release of labour' from agriculture which, paradoxically, dictated the speed of subsequent economic growth. The problem of development faced by the British economy in the eighteenth century was not a large subsistence agricultural sector. On the contrary agricultural productivity increased steadily over the century. Crafts estimated that agricultural growth was in fact higher before 1760 than after. The first result of this was a new capacity to sustain higher populations than previously. Rates of population growth rose from −0.3 per cent in 1661 to 0.9 per cent in 1776 and up to 1.5 per cent per year in 1816.[7] Customary restraints on marriage and fertility helped to create conditions for higher income levels by the eighteenth century, and ensuing population growth did not result in the 'Malthusian Trap', that is the reversal of initial gains in living standards. High populations were

sustained by agricultural growth initially, and later by more general economic growth, without a large decline in living standards and a reversion to slower population growth.

Not only did agricultural output grow, but so did agricultural productivity based on labour-shedding innovation and investment. In order to feed a higher population and to industrialize, that is to feed those living in towns and engaged in non-agricultural activities, it is necessary to find ways of generating rising output per agricultural worker to allow a 'release of labour' to other sectors. Crafts pointed out that this requirement was met by British agriculture in the first half of the eighteenth century. Productivity growth in agriculture was faster than in any other sector of the British economy, and labour productivity in the sector was the highest in Europe. Not only this, but Britain reduced the share of its male labour force in agriculture, releasing this in the main to industry, and it urbanized, doing both at much greater speed than its European neighbours.

There is so far nothing fundamentally new in this presentation of the British pattern of development, apart from the earlier dating of the rise in agricultural productivity. What Crafts did point out, however, was the coincidence of high rates of agricultural growth along with 'release of labour', yet comparatively low rates of increase of industrial output. This led him to investigate the distribution of the labour force and productivity growth in the manufacturing and commercial sector.

It was clear from the new social tables devised by Lindert and Williamson that Britain in the late seventeenth and early eighteenth centuries had much higher percentages of its population in commerce and industry than previously thought, but the characteristics of employment of this population were only made clear by data from the 1831 census summarized by Wrigley. This revealed that much higher percentages of this industrial and commercial labour force were to be found in retail trade and handicraft than in manufacturing for distant markets. Crafts's breakdown of industrial output also

Table 1.4 Patterns of employment, income, expenditure and residence (%)

	1700	*1760*	*1800*	*1840*
Male employment in agriculture	61.2	52.8	40.8	28.6
Male employment in industry	18.5	23.8	29.5	47.3
Income from agriculture	37.4	37.5	36.1	24.9
Income from industry	20.0	20.0	19.8	31.5
Consumption/income	92.8	73.6	76.3	80.1
Investment/income	4.0	6.8	8.5	10.8
Exports/income	8.4	14.6	15.7	14.3
Urban population	17.0	21.0	33.9	48.3

Source: Crafts, 'The Eighteenth Century', table 1.

showed a large divergence in both the growth of real output across individual industries, and in the percentages of value added contributed by these industries. Industrial output

until the nineteenth century was, on Crafts's estimates, dominated by industries which showed little consistent dynamic performance. In his words,

> much of British 'industry' in the first half of the nineteenth century was traditional and small-scale, and catered to local domestic markets. This sector, responsible for perhaps 60 per cent of industrial employment, experienced low levels of labour productivity and slow productivity growth—it is possible that there was virtually no advance during 1780–1860.[8]

Some of those industries which initially contributed relatively small proportions of value added were also the glamorous innovative industries which captured contemporary imaginations—cotton and iron. The remarkable growth in real output of the cotton industry, in particular, from 4.59 per cent per year in 1760–70 to 12.76 per cent per year in 1780–90 should be combined with its contribution to industrial output of only 2.6 per cent per annum in 1770, rising to 17 per cent in 1801 and 22.4 per cent in 1831. Cotton's performance was remarkable, but it was not sufficient to overcome the deadweight of most other British industry, traditionally organized and serving only home markets. It was primarily to this traditional industry that most of the labour 'released' by an innovative agricultural sector migrated, and Britain became 'overcommitted' to these labour-intensive manufacturing activities.[9]

Britain's rapid productivity growth in those manufactures which were

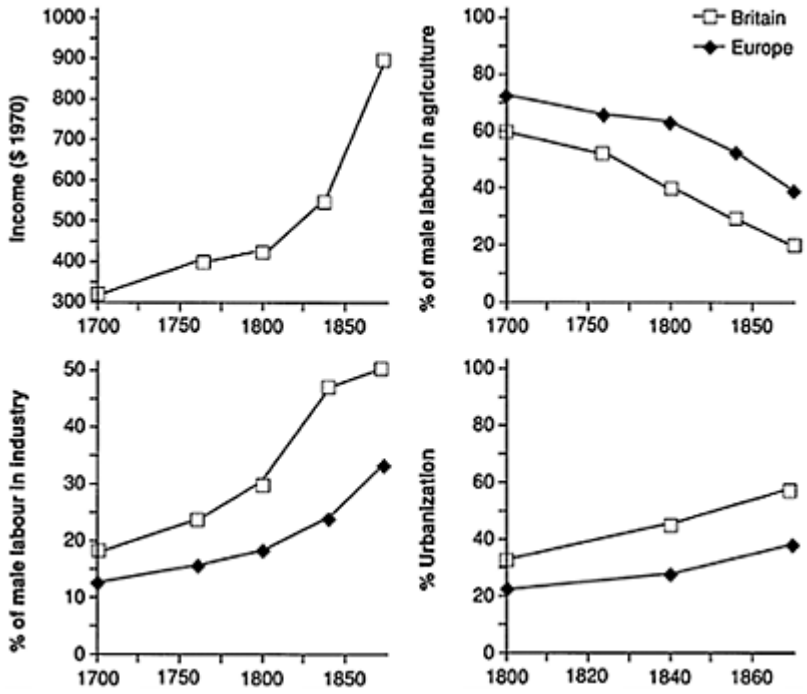

Figure 1.1 Britain's development transition in European perspective

Source: Crafts, 'British Industrialisation', table 2.

traded internationally did give her a large comparative advantage in those activities, and she scooped international markets in cotton. And indeed this was a major achievement, for throughout the nineteenth century cotton textiles constituted the largest part of world trade. This achievement, narrowly based on one industry, accounted for Britain's international position throughout the nineteenth century. As Crafts has pointed out, by the midnineteenth century Britain was exporting 60 per cent of its cotton output, in comparison with France's 10 per cent. Cottons accounted for half of British exports during the twenty-five years before then, and Britain controlled 82 per cent of the world-market for cotton cloth even as late as the 1880s. Overall, Britain's exports were virtually all manufactured commodities (90 per cent), and she exported a comparatively high proportion of her total industrial output (25 per cent compared to France's 10 per cent).

Yet the end result of this spectacular achievement from what was initially such a new and minor industry in Britain was ultimately disappointing. The British story was one of the 'pain of structural change, but without the reward of rapid income growth'. The success of cotton masked the backwardness of other sectors, and this unique model of success was built on short-term strategies of providing 'low-wage factory fodder' rather than high technology industries and a skilled workforce.[10]

The association of high growth rates in agriculture, urbanization and the deployment of labour to a low productivity industrial sector has provided the basis for a much more far-reaching version of the 'continuity' thesis of the Industrial Revolution. This is E.A.Wrigley's depiction of the period until the mid-nineteenth century as one dominated by 'organic' sources of raw materials and 'natural' technologies. It was an economy of definitely limited growth prospects, confirming the Malthusian and Ricardian barriers of population growth and resource scarcity. Nature, not technology, dominated the economy of the so-called Industrial Revolution. Williamson had pointed out that Crafts's estimates confirmed the classical economists' pessimism that between 1761 and 1831 the difference between the rate of growth of capital and that of output was trivial and failed to offset the impact of increasing land scarcity. Wrigley reinterpreted the analysis of Adam Smith and Thomas Robert Malthus to underwrite the new estimates. He argued that the classical economists were right to argue as they did—'their reluctance to envisage the possibility of large gains in individual productivity finds support in…Crafts's estimates'. Their systems were dominated by 'negative feedback loops'—most of the economic changes taking place until the 1830s and 1840s were thus best understood within the framework they posed of constraints of land or resource scarcity and population growth. The break beyond these barriers only came with the deployment of inanimate sources of energy and inorganic sources of raw materials.

> The natural technology of the day, though demonstrably capable of substantial development, especially under the spur of increased specialisation of function, was not compatible with the substantial and progressive increase in real incomes which constitutes and defines an

> Industrial Revolution…the raw materials which formed the input into the production processes were almost all organic in nature, and thus restricted in quantity by the productivity of the soil.[11]

Power sources and raw materials, based as they were in natural substances, under this regime, were subject like agriculture to declining marginal returns to land.

Wrigley placed eighteenth- and early nineteenth-century England in an advanced stage of the organic economy. His advanced organic economy had moved beyond the balance between energy gained and energy expended, and contained some anticipations of the future. But it was still strictly limited by fixed supplies of resources. Improvements in the efficiency of producing food and raw materials might release substantial amounts of the workforce from these activities, but all still depended on the flow of these resources whose size was ultimately limited. There was so far no access to capital stocks of energy which could sharply increase the quantity of energy per head.[12]

It was the use of coal which moved Britain into the advanced organic phase. For this reduced its dependence on organic raw materials. Coal output rose in Britain by 1700 to between 2.5 and 3 million tons, five times the output of the whole of the rest of the world.[13] This coal produced heat for domestic uses, replaced wood in processing manufactured commodities, and led to a change in building materials from wood to bricks. 'The transition to a partial dependence upon inorganic *stocks* of energy rather than upon organic energy *flows* played an important role in allowing the English economy to expand without debilitating pressure on the land in the early modern period.'[14]

The strictly limited possibilities to be expected from advanced organic growth were also revealed in the structure of the labour force. The growth of labour productivity in agriculture was, as we have seen, paramount over that of other sectors in the eighteenth century, and it was indeed the largest employer of the adult male labour force. But the proportions employed in agriculture were falling rapidly, as was the weight of the sector in the economy as a whole. Productivity increase overall thus depended not just on agriculture, but increasingly on other economic sectors. Most industrial employment was not, however, centred on high-productivity industries, that is, those deriving the greatest gains from coal-using resources and inanimate technologies. It was found in the retail trades and handicraft industry.

In spite of comparatively high urban populations, most of the labour force was working in occupations supplying goods for local markets. Those working in factories or proto-industrial workshops made up only 10 per cent of the adult male labour force. The bulk of industrial working men, by contrast, were employed in industries whose work practices were traditional, and whose opportunities of making gains from specialization were limited by the small size of their markets. These were reinforced by rapidly growing numbers in personal service, urban labouring, and clerical jobs whose productivity was probably static.[15] As late as 1831–41, at least two-thirds of the total increase in adult male non-agricultural employment were in occupations such as building labourers, butchers, alehouse keepers, shoemakers, tailors, blacksmiths and bakers.[16]

Britain became significantly more industrial over the course of the eighteenth century, but much of this industry was rural and traditional handicraft manufacture. The release of labour from agriculture supported this industrial expansion, and allowed a significant increase in population without pauperization. The population history of England, as

revised by Wrigley and Schofield, however, reveals that, despite considerable growth in numbers and the disappearance of major crises of mortality, there was no significant discontinuity in demographic *behaviour* in England from the sixteenth to the nineteenth centuries. The population regime was driven by marriage, and this changed as a lagged response to changes in the standard of living.[17]

The redeployment of labour from agriculture to industry was confirmed in a steady decline over two hundred years in the number of marriages in parishes under the influence of seasonal agricultural variations, and the steady increase in marriages in those not subject to such seasonality.[18] The picture again was of steady continuous industrial growth, rather than any discontinuity. It was achieved primarily through redeployment of labour away from agriculture, a process which had reached its limits by the nineteenth century. The consequent pressures on manufacturing profitability were only then solved with labour-saving technological change and a new resource base.

Industrialization in Britain, as conveyed in the historical orthodoxy which now prevails, was, rather than a series of distinct stages, a peculiarly 'fractured' process.[19] In Crafts's view, productivity growth in industry was skewed in the direction of one or two industries, and 'not only was the triumph of ingenuity slow to come to fruition but it does not seem appropriate to regard innovativeness as pervasive'.[20] For Wrigley, the eighteenth-century economy, in spite of considerable inventiveness, much of which was directed to greater specialization and division of labour, remained dependent upon organic resources and human and animal sources of energy. The Industrial Revolution occupied a transition time between the organic and the mineral-based economy determined by the random resort from this time to the use of coal-based energy.

The traditional stages of models of industrialization were broken by these new models of 'change' but 'continuity', yet the new models were but stage theories in another form. For the developmental indicators were still known, *post hoc*. Measures of economic and productivity growth, and analyses of social and economic structures were still considered in the light of other more recent industrial transitions.

QUESTIONS

The steadiness, 'continuity', and distinctly 'unrevolutionary' character of Britain's industrialization are now a very acceptable story, for it fits with all kinds of other historical orthodoxies. It fits well with the anti-Whig school of constitutional and social history which prefers a history of stable but civilized change. What was once the English Revolution has been transformed into an accidental event with few long-term consequences. Thus the *ancien régime* of the confessional state, based on deference, religion and a cohesive society, survived the eighteenth and early nineteenth centuries substantially unchanged. Social historians too have turned to addressing the continuity between eighteenth- and nineteenth-century social protest and radicalism. Chartism was no longer the herald of the class struggle. It was rather a chronological extension of radical democratic movements from the eighteenth century, concerned not with class but with political representation. Old analyses of the sources of social conflict in economic hardship prevail once again over histories of alternative radical social and economic critiques. What emerged from this 'continuous' history was a British economy and

society never fully committed to industrial growth. The landed aristocracy, metropolitan finance and 'gentlemanly capitalists' prevailed over an anti-competitive and paternal economy at the end of the nineteenth century in a manner not so very different from that of the seventeenth century.

The universalistic characteristics of economic, social and political life in the eighteenth and early nineteenth centuries had once been centred on revolutionary or at least modernizing tendencies. Now these were discarded in favour first of the complexities and particularities of these features, then in favour of the overwhelming hold of traditional social structures and an expanding but largely unreformed industrial sector.

It is time now to return to the place of the complexities and particularities of British industrialization. The novelty they introduced has, under the terms of the recent orthodoxy, been hidden by statistical aggregation. The nature of such aggregation is to smooth discontinuities, to mask the selective unbalanced growth of the economy. Changes in one or a few branches might take a considerable time to spread to the rest of the economy, or to have an important effect on the whole economy. The process of 'construction' was also in some senses one of 'destruction'—a better term might be 'restructuring'. Aggregate indicators only demonstrated the compensating effects of gains and losses of such changes, but were unable to reveal the process of change itself. Individual industries might, on aggregative output data, appear to have undergone no change over a period, but might in that same period have undergone dramatic changes in their labour forces, technologies and location. This was clearly the case for the silk, copper and woollen industries during the eighteenth century, and will be demonstrated in Chapter 2. The national accounts framework which now dominates the new orthodoxy of the Industrial Revolution gives only one side of the story, that provided by performance according to predetermined indicators. Those indicators, like child development trends, highlight the norm not the individual—they smooth disparities into continuities. Indeed, shifts in the aggregate measures of productivity growth are less likely to show up as significant during periods of rapid and fundamental economic transition than in periods of slower and more piecemeal adjustment. The story of these changes, their transitions in work and life styles, the specific effect on communities and individuals of their gains and losses, will be lost to us if we look only to the indicators of economic performance. Many of these will reveal significant increases in growth rates only some decades after the changes underlying these have occurred.

Once we believed that the child was precursor to the man, childhood a preparation for adulthood. But the impact of psychoanalysis has been to seek a return to the lost childhood, to seek an understanding of it and to reconstitute a 'life story' so as to arrive at a self-knowledge. In this psychoanalytic age it seems right to question the models, development paradigms, and growth norms by which we have so far judged the economic performance of nations and communities. It is time to question the norms, for what are these but constructs, fantasies, narratives of our own times? And it is time to return to the period of the Industrial Revolution as to a recovery of the child lost.

First we must turn to judgements on rates and discontinuities of growth. Even with the revised estimates, it is apparent that between 1831 and 1861 national income was growing four and a half times, and per capita income six and a half times, faster than rates estimated for the first six decades of the eighteenth century. The economic lead

Britain had achieved by the time of the Great Exhibition could not have been accomplished in the mere twenty years beforehand. A discontinuity did occur, and the productivity of the British industrial and commercial workforce had to rise fast enough to pay for food and resources for itself and its rapidly rising numbers of dependants. That productivity growth required, in turn, technological and organizational change in industry. Rates of increase in output and productivity levels have been judged in recent accounts against those of recent industrializers, not against rates prevailing earlier or among other contemporary neighbours. Part of the reason for this is the lack of reliable estimates, so comparison is made where and when the data do exist. But such judgement must also answer the question 'how big is big?' Initially low rates of increase are less important than the fact of a new trend of continuing and accelerating growth.[21]

Industrial transformation was vital to the Industrial Revolution, and it is this that the orthodoxy finds lacking. The work of Crafts, Wrigley and others can be combined with research on proto-industrialization to show industrial expansion extending back to the sixteenth century. This industrial expansion before and during the early years of the eighteenth century raises the base from which we measure growth in the later years of the century. Growth rates do then appear to be lower than those calculated by earlier historians. The implication of this, however, should not be to downplay growth rates in the period between 1780 and 1830 with hindsight from those of later in the nineteenth century, but to re-examine industrial growth in the eighteenth century from the backdrop of the early modern economy.

The national accounting framework deployed by Crafts and the occupational distributions relied on by Wrigley use the new social and occupational tables of Lindert and Williamson.[22] These tables give a higher profile to the industrial sector than did the earlier estimates of King, Massie and Colquhoun, and they fit well with work on the importance of proto-industrialization. But these tables are prone to error margins as high as 60 per cent, and estimates for shoemakers, carpenters and others are 'little more than guesses'. These occupational data, as well as those of the 1831 census, are based entirely on information for adult males. As will be clear from later parts of this book, women and children were a vital and growing pillar of the manufacturing workforce. There is no accounting for dual occupations or by-employments which were widespread at the time; indeed there was a common overlap between agrarian and industrial occupations. We cannot be as confident as the orthodoxy suggests of the occupations and social structure of early industrial Britain.

Nor can we be so confident of findings of the poor performance of the industrial sector. Estimates of sectoral outputs and inputs rely on multipliers from a handful of examples and a sample of industries. Industries left out of the picture because of lack of consistent long-run data include food processing, metal wares, distilling, furniture, shipbuilding, chemicals, engineering, pottery, glass and clothing. Subsectors of included industries are presumed to grow at the same rate as a single 'representative indicator'. Furthermore, the weights used to construct the overall index cover industries and activities which include not more than 57 per cent of total industrial output.[23]

National income accounting, by itself, is not adequate to the task of presenting national economic activity. Major problems of underestimation arise for activities embedded in unquantifiable and unrecorded non-market relationships.[24] In periods of fundamental economic change, the proportion of total industrial and commercial activity

showing up in the estimates is likely to change radically over time. Furthermore, entry thresholds in most industries, and especially new industries, were low. And industrial expansion often took place first and foremost among a myriad of small firms which also left few records. Innovation in product and techniques was often most rapid in the pygmies rather than the giants of an industry. For a number of industries, there is a strong case for arguing that there was a period during the eighteenth and early nineteenth centuries when more market power was held by smaller and medium-scale firms than before or after. On current indices their contribution is missed.

Assessing the performance of industry during the eighteenth and early nineteenth centuries runs into the unresolved problem of 'misplaced aggregation'. The growth paths of individual industries deviate widely from the average path for industry as a whole. Cotton was notable, iron somewhat less so. The contributions made by improvements in productivity to the promotion of long-term growth varied from industry to industry, and did not necessarily show up in rates of growth of output for each industry. The building industry is a good example, an industry which increased its contribution to industrial production from 11 per cent in 1770 to 25 per cent in 1841, but is presumed to have done so at constant or rising costs per unit of output.[25]

Slow industrial growth in the British economy of the time is explained in the current orthodoxy by the inordinate weight within the industrial sector of industries which underwent little technological change, combined with the concentration of labour in these same industries which in the main supplied local markets. Quantitative historians made an analytical division between 'modern' industries, that is the new proto-industrial and factory industries dealing in tradable commodities, and 'traditional', that is, locally based, handicraft industries. This division of the economy into traditional and modern sectors was based on economic theories of trade and development popular in the 1950s and 1960s. This new historical version distorts the characteristics of manufacturing in the eighteenth century, and hides major sources of productivity gain in manufacture. Rigid associations of productivity gain and technical progress with concepts of large-scale production, factories, powered machinery and capital-deepening pervade the new orthodoxy on the Industrial Revolution. In practice it was and is very difficult to make clear-cut divisions between the traditional and the modern, the tradable and the non-tradable, as there were rarely separate organizational forms, technologies, locations or even firms to be ascribed to either. Eighteenth- and nineteenth-century cotton manufacturers typically combined steam-powered spinning in centralized factories with large-scale employment of domestic hand-loom weavers using traditional techniques. The small metalworking shops of Birmingham, Sheffield and Lancashire fall into the Crafts and Wrigley classifications of traditional, handicraft employments, although they typically developed their high technology in the luxury goods trade of the home market and also broke into and extended foreign markets. Artisans in the sector frequently combined occupations or changed these over their life cycle in such a way that they too could be classified in both the traditional and the modern sector. Firms primarily concerned with metalworking, a 'traditional' sector, also diversified into metal-processing ventures, the 'modern' sector, as a way of generating steady supplies of raw material. The traditional and the modern industrial activities were often inseparable and mutually reinforcing.

Neither was technological and organizational change the sole preserve of the 'modern' sector. A study of individual industries in the next chapter will show the extent of technical and organizational change within the 'handicraft' occupations. The division and specialization of labour were an altogether more complex affair than the basic sectoral divisions of the economy. Wrigley found most industrial labour in occupations which he identifies as 'traditional'—the food and drink trades, shoemaking, tailoring, blacksmithing and trades for luxury consumption. But early industrial capital formation and enterprise typically combined activity in the food and drink or agricultural processing trades with more obviously industrial activities. Innkeepers and victuallers were common mortgagees and joint owners of metalworking enterprises. Peter Stubs, the Lancashire tool maker, became T.S.Ashton's pre-eminent industrialist. Yet he appeared in 1788 as a tenant of the White Bear Inn in Warrington. Here he combined the activity of innkeeper, maltster, and brewer with that of filemaker, using the carbon in the barrel dregs left from his brewing activities to strengthen his files.[26] There are many examples of this kind of overlap between services, agriculture and industry. Entrepreneurs and artisans diversified their portfolios and their activities to reduce the risks attendant on trade and harvest fluctuations, and also stood to gain from the external economies created by overlaps such as those found by Peter Stubs.

An account of the industrial sector must rely on far more than estimates of national industrial output, or even an aggregation of estimates of production and productivity change industry by industry. Statistical results themselves are not sufficient for such an assessment, unless supported from an external context of broader historical evidence. The well-documented studies of particular industries, regions and manufactures suggest more rapid rates of growth and greater productivity change than conveyed in the series devised by the orthodoxy. Growth rates of individual sectors, on their own, do not tell us about the processes underlying growth. Such processes involved industrial restructuring, including technological change, organizational or locational change and market readjustment. It is in understanding these processes, and not just in setting out new revisions of trend rates of output growth, that we find the key to the Industrial Revolution. It was in ways of working, of doing and making things that lives were changed.

It is thus that technology must remain crucial to the story of the Industrial Revolution. The new orthodoxy uses as a proxy measure for technological change total factor productivity growth. It measures this as a residual after accounting for inputs of labour and capital, and finds it wanting. On this basis, technology has been edged out of the story. But as we shall see in the following chapter, the processes and impact of technological change are very difficult to measure. This does not, however, provide grounds for discounting a wrenching and compelling force for change.

David Landes once wrote of the great achievements of the factory system and large-scale power technologies with the one caveat: 'The labouring poor, especially those by-passed or squeezed by machine industry, said little but were undoubtedly of another mind.'[27] He has since come to reconsider this presentation to powerful effect.

> What needs stressing…is the force with which technological change impinged on the livelihood of workers and often translated into protest, much of it violent. Changes may have been making their way in some

> regions more than others, in some industrial branches more than others, and slower than some enthusiastic scholars may have thought. But don't tell that to the people affected: the pauper apprentices taken from their parents and assigned to labour in mills, the women who were sent to work in the factories where their husbands or fathers would not go, the displaced craftsmen, the residents of once-green valleys now renamed the Black Country, the Irish immigrants who did the dirty work; or for that matter to the winners of the new, industrializing world: the managers, merchants, and shopkeepers, the new-skilled and the 'labour aristocracy', the multiplying professionals in growing towns and cities.[28]

NEW DEPARTURES

Challenges to the current historical orthodoxy of slow continuous growth during the Industrial Revolution have arisen recently on several fronts. These focus on the regional dimension of economic change, on technology and work organization, on the labour force, particularly its gender distribution, and on trade and consumption. Research in these areas has challenged both the continuity thesis of the Industrial Revolution and assessments of the industrial sector. These topics will be dealt with in depth in later chapters of the book; recent findings and their implications for current orthodoxies will be summarized here.

Regions

Pat Hudson has pointed out the extent to which aggregate analysis conceals significant spatial differences in development, averaging out the effects of the dynamism of some regions with the stagnation or decline of others. The uneven and unbalanced nature of industrial growth was above all a discontinuous transformation of different parts of the country.[29] There were obviously always regional differences in growth rates and industrial change across the country, and these remain to this day. Studies of local industries or other such case studies cannot however substitute for the attempt to place industrialization in a national and an international framework.

Nevertheless, there was an important 'regionalization' to the Industrial Revolution which is bypassed by aggregate data. This 'regionalization' furthermore became a part of the discontinuity and the transformation of the Industrial Revolution. A unique form of regional specialization took place between the eighteenth and the first half of the nineteenth century. Before the eighteenth century, pre-industrial regions were relatively cut off from one another, their communications networks oriented to the metropolis or international ports. From the mid-eighteenth century these were displaced by internally integrated regions concentrating on an interrelated set of industries. Cotton textile production, once distributed albeit in a small way across the country, became the industry of South Lancashire and southern Scotland. Yorkshire took over the woollen and worsted industry, increasing its share of national woollen output from 20 to 60 per cent during the century. The metal and hardware trades found their home in the Midlands, South Yorkshire, South Lancashire and the Glasgow region. The coalfields might dictate

industrial locations, perhaps only in the first instance. But this was enough to create the base of business enterprise, capital and labour forces reinforced by new regional externalities.[30] Sometimes the fact of the location itself, the novelty of enterprise, and the mix of activities were a strong enough brew.[31]

The new canal networks reinforced these internally unified, but separate, regions. They were succeeded by railways which structured freight rates to favour short-haul traffic, and with this regional economic activities.[32] Regional factor markets, with wage differentials and specific credit institutions prevailed.[33]

Regionalization during the eighteenth and early nineteenth centuries did not mean industrial production for local needs or home markets. For it was international trade which provided the incentive for the specialization of both proto-industrial expansion and concentrated industry. London, however, was not the centre of this spatial dynamic. The new export trades were conducted, not through London as in the seventeenth and early eighteenth centuries, but direct from the ports of the new industrial regions. First Newcastle and Bristol, then Liverpool, Glasgow and Hull became the hubs of new resources, industrial products and world trade.

Hudson has elsewhere described this regional dynamic for each of the specific areas of England, and I will not repeat this here.[34] The regional framework must always be present in any underlying analysis of industrial change and restructuring. It is dealt with in later chapters of this book as integral to industries, industrial decline and industrial organization.

Technology

It is technology above any other feature which is associated in the popular imagination with the Industrial Revolution. Contemporaries defined the transformation of their times in terms of a 'revolution in machinery'.[35] Writers on the Industrial Revolution from Toynbee to Landes placed changes in technology at the heart of their story. Ashton encapsulated the Industrial Revolution in a 'wave of gadgets'.

But the new orthodoxy discounts all this. Crafts concluded that for most of industry 'not only was the triumph of ingenuity slow to come to fruition but it does not seem appropriate to regard innovativeness as pervasive'.[36] Wrigley saw strict limitations in the gains to be made from the 'natural technology of the day'.[37] Crafts does concede that technological change did finally provoke a switch in the direction of economic growth, but the inventions in cotton textiles were 'random exogenous shocks'.[38]

Technological change and its effects are notoriously difficult to measure. The concept of total factor productivity growth, often used as a proxy for technological change, leaves much to be desired in the very nature of its restrictive assumptions. It is a measure which takes no account of innovation in the nature of outputs or of changes in the quality of inputs, including labour, materials and intermediate goods. It is a measure which fails to account for product innovation and qualitative improvements in the means of production. National income accounting unduly restricts the concept of technological change. Our knowledge of the timing and impact of innovation must depend on a broader background of research on science, economic organization, market developments, new products and processes, skills and workpractices.[39]

Not only is the definition and measurement of technological change upheld in current perspectives deeply suspect, but so too are failures to account for the 'discontinuity' of a clustering of key innovations. Mokyr has divided the innovations of the Industrial Revolution into 'macro' and 'micro' inventions, pointing out that the 'clustering' of inventions between 1765 and 1800 was unprecedented. A small number of macroinventions or major breakthroughs raised rates of return on improvements, and led to a whole series of microinventions and 'learning by doing'.[40] These inventions in textile machinery, power, and metal processing occurred together, creating a 'critical mass'. Their success, and the many microinventions, those improvements and adaptations that came to account for most productivity gains, depended not on chance, but on Britain's large skilled labour force. Its base of skills, not just in local crafts and luxury trades, but in adaptive mechanical techniques in metalworking, precision instrument making, and chemical processes, created the means by which the Industrial Revolution became 'not the age of cotton, or iron, or of steam; it was the age of improvement'.[41]

The glamour sectors were not the monopolists of innovation. Indeed early textile innovations—carding and scribbling machinery, the Dutch loom, the knitting frame, the flying shuttle and the jenny, silk-throwing machinery and finishing techniques in bleaching and calico printing—were all developed within rural manufacture and artisan industry, and few were initially developed for the high-profile cotton industry. The metalworking trades were proverbial for skill-intensive hand processes and hand tools. The stamp, press, drawbench and lathe were developed to innumerable specifications and uses, and new malleable alloys, gilting processes, plating and japanning were at least as important. Other industries experienced some form of transformation in materials or division of labour, if not in the artefacts of technological change. There are no productivity estimates for the range of hand tools and early machine tools in the metal industries, but their significance to overall productivity growth is a recurrent theme of economic history.[42]

Other forms of innovation also affected 'traditional' industry and handicraft production. The wool textile sector moved to new products—for example, from heavy serges to mixed stuffs—to reduce finishing times. New industrial uses for coal affected brewing, brickmaking, malting, sugar and soap-boiling as well as metallurgy and metalworking. Changes in materials had similar effects on saltmaking, hatmaking and luxury metalwares. Innovations in putting-out systems, wholesaling, retailing, credit and debt, and artisan co-operation were devised as ways of retaining the essentials of older structures in the face of new more competitive environments. Customary practices and ways of working were not static, but these too evolved to match the needs of more market-orientated production.[43]

Innovation was 'discontinuous' and clustered, but it was also embedded in a context of adaptive technical skill and rippled outwards to widespread 'improvement'. This innovation was also in the things that mattered. As Landes argues,

> the British innovations had wider economic consequences because the demand for these products was potentially larger and supply more elastic (compare cotton and silk for supply and cheapness); and because they had wider ramifications within the larger economy (thus multiple uses of iron and the general applicability of advances in power technology). They were the stuff of an industrial revolution.[44]

Labour forces

The one distinctive feature of the eighteenth and early nineteenth centuries pinpointed by Crafts and Wrigley is one of structural change—the shift of economic activity and labour forces away from agriculture to industries and services. Current estimates of the distribution of the labour force between agriculture and other employments have been based on Wrigley's calculation of the numbers which the expanding agricultural sector could support off the land. Census data on adult male labour for 1831 showed that only 10 per cent of this workforce were employed in industries serving distant markets. Lindert's estimates for industrial occupations in the eighteenth century relied on adult male burial records.

Yet it was not the men who mattered in many of the new industries. The labour force was not homogeneous, and the classic period of the Industrial Revolution was marked by the unprecedented incorporation of female and child labour into manufacturing industries. It is hard to quantify the amount of female and child labour, as such labour was usually excluded from official statistics until the mid-nineteenth century. But equally, male labour inputs have been assumed from occupational categories, notwithstanding high levels of unemployment and underemployment in many male occupations.

There are many good reasons why women mattered to manufacturing to a greater degree than they had done in the past, and indeed were to do so later in the nineteenth century. Female labour supply was high at the time, encouraged by population growth, the age structure of the population, feminine-skewed sex ratios and agricultural innovation which shed higher proportions of female than male labour. British industry used this labour force as a cheap and flexible input, and one which was furthermore experimented on with new work disciplines, new forms of work organization and new technologies.

The fact that only 10 per cent of adult male labour was to be found in the modernized progressive sectors, as Wrigley points out, does not tell us a great deal. For the preferred labour force for precisely these sectors was overwhelmingly young and female. Access to cheap supplies of labour, especially that of women and children, was integral to the spread of manufacture from the early modern period. But this labour was also endowed with special attributes of flexibility, dexterity and discipline which made it particularly suited to eighteenth-century technologies and work organization. Estimates for labour inputs and distribution of labour need to be disaggregated into gender and age differences, skill and labour intensity. There was a special place for women's and children's labour in the early industrial period which has only recently found a parallel in

the decentralized production processes in manufacturing in Third World and advanced industrial countries.[45]

Trade and consumption

Current perspectives on the Industrial Revolution focus almost exclusively on supply-side considerations. Foreign trade once ranked as of 'central importance' in the expansion of the economy,[46] or as the 'spark' which set the Industrial Revolution on its upward path.[47] But it has since been dethroned. Quantitative historians have argued that foreign trade was not essential to Britain's economic growth, and could indeed have been replaced by domestic demand or supply. Exports, furthermore, did not initiate growth, for the terms of trade were falling during key periods of expansion.[48] It has been argued that demand was not an independent variable in the process of economic growth, because it must itself arise from increasing incomes or from a reallocation of incomes.[49]

These general points have been elaborated for Britain's Industrial Revolution. It has been argued that export growth was internally generated—exports were driven by needs for imports, in turn giving trading partners purchasing power to buy British goods. Furthermore, the role played by external factors depended on appropriate economic responses in the internal economy.[50] Crafts's reassessment of Britain's economic growth during the period did not change the estimates of exports provided by Davis and Deane and Cole. But it removed international trade from the front line of analysis for the sources of the Industrial Revolution. Crafts restated the basic pattern of British trade during the period as the export of manufactured goods in exchange for food and raw materials. He found changes in these broad categories over the whole period of the mid-eighteenth to the mid-nineteenth century, however, to be relatively minor: 'the industrial revolution saw the consolidation of existing tendencies'.[51]

The result of these analyses was, for a time, to turn research away from international trade and other aspects of demand. But new research on the framework of international trade, on the rise of consumer demand, and on the impact of mercantile trade on sources of capital formation and institutions of credit and commerce is now reversing this trend. O'Brien has pointed out the role of British naval policy and military expenditure in making the international and domestic market safe for British trade. This also allowed British industry and commerce to capture the lion's share of international markets in manufactures and services.[52] The trade generated with Britain's American colonies was unmatched by European rivals,[53] and it was in commodities in which techniques of mass-production were most easily developed. The demonstration effect of internationally-traded commodities also rebounded on the home market; more household production was replaced by commercially produced goods.[54] This was a long-term process, not confined to the classic years of the Industrial Revolution, but nevertheless the extension of access to a range of cosmopolitan commodities also expanded the markets which in turn generated greater specialization and improvements in production processes.

Recent research has in these ways sought a reintegration of international trade and home markets. New analysis relies on a broader view of the gains from trade than that identified in contributions to gross national product (GNP). As O'Brien has summed it up: 'Attempts to apply counterfactual logic and the Ricardian theory of comparative advantage to denigrate the role of foreign trade in the first Industrial Revolution are no

longer convincing.' The significance of trade was not 'as expendable as cliometricians suggest'.[55]

Research on international trade may yet hold the key to much more. Whatever their views on reducing the relative importance accorded to trade, the quantitative historians did not accumulate new data on exports and imports. They used data compiled by Davis, Schumpeter and Deane and Cole in the 1960s. The accumulation of more data on textile prices and the quantities and values of colonial wares might change much more than our assessment of the role of international trade. For on these prices depend estimates of the value of output of individual industries, especially the textile industries. Higher growth rates in these industries would imply higher growth rates in the economy overall.[56] New quantitative data, combined with qualitative research, could point yet again to 'a major discontinuity'. No longer can we be so sure, as Crafts has argued, that 'the dimensions of economic change in Britain during the Industrial Revolution are now reliably measured'.[57]

Doubts on the now orthodox interpretation of the Industrial Revolution have generated a whole series of new departures in research areas. These areas and their findings will be explored throughout this book. What we must first turn to is an account of industrial growth over the eighteenth and early nineteenth centuries. For it is industry which must bear the brunt of debate over continuity and discontinuity, traditionalism and technological change.