

provided by the expansion of the bleaching industry in Elberfeld and Barmen, two adjacent towns in the Duchy of Berg on the lower Rhine. Originally a guild monopoly, the process moved into the surrounding countryside, making best use of the River Wupper, and expanded from 15 enterprises in 1690 to 100 in 1774 and 150 in 1792. Following the inevitable tussle with the guilds, the government lifted all restrictions on production in 1762.

This summary of the development of rural manufacturing has deliberately avoided use of the contentious concept 'proto-industrialization'. First coined in 1972, it was advanced by its supporters as an explanation for the breakthrough from traditional forms of manufacturing to the industrial revolution, being held responsible for population growth, the commercialization of agriculture, capital accumulation, the generation of surplus labour, proletarianization and the creation of large markets. Subsequent criticism has left little of all this intact. It has been argued in return that the region from which the phenomenon was first derived – Flanders – was exceptional, matched only by England and one or two other small enclaves on the continent. Sheilaigh Ogilvie, the most effective critic of proto-industrialization, concludes:

In the rest of eighteenth-century Europe, proto-industry (like agriculture) was regulated by traditional institutions: guilds, merchant organisations, privileged towns, village communities, feudal landlords. The spate of research on proto-industrialisation has shown that industrial development was affected much more strongly by institutional variations than by the presence (or absence) of proto-industry.

From the point of view of the entrepreneur, the least attractive feature of putting-out was the lack of control over the workforce. The labourer worked unsupervised, at his own pace and when he felt like it. When the household's income reached a certain point, there was a tendency to prefer leisure to labour, even if the market – and the merchant – were crying out for more goods. One answer was to concentrate production in a single centre and to move from paying piece-rates to paying wages. That required higher fixed capital in the form of buildings, and consequently greater vulnerability to market fluctuations, but it did allow the workers to be supervised and kept up to their work. These 'manufactories' proved to be an effective way of responding to market opportunities in the eighteenth century. It has been estimated that there were about

1,000 of them in German-speaking Europe in 1800, of which 280 were in the Habsburg Monarchy (140 in Lower Austria and 90 in Bohemia), 220 in Prussia, 170 in Saxony and 150 in the Wittelsbach territories (Jülich-Berg, the Palatinate and Bavaria). Some of the individual units employed large numbers of workers on a central site: to select a few examples from the 1780s, the state-run woollen manufactory at Linz employed 102 dyers and finishers, a calico printing firm at Augsburg employed 350, the royal textile manufactory in Berlin employed c.400. Even luxury goods could record large numbers of factory workers, with around 400 at both Meissen and Berlin in 1750. Significantly, the further east one went, the more of these large enterprises were owned and run by great aristocratic magnates, exploiting both the raw materials and the cheap serf labour to be found on their estates. The greatest single entrepreneur in the Habsburg Monarchy was Count Heinrich Franz von Rottenhan, who established two large cotton factories and an ironworks on his Bohemian estates. Although the state was directly responsible for some of the largest concerns – the *Lagerhaus* in Berlin, for example, which made uniforms for the Prussian army – its numerical share was only about 6 per cent. On the other hand, there were numerous private individuals who amassed great fortunes from manufacturing – Schüle the 'calico king' of Augsburg, the Bolongaro brothers of Frankfurt am Main (tobacco), and the von der Leyen dynasty of Krefeld (silk), for example. Nor was the centralized manufactory a phenomenon confined to north-western Europe: in 1779 in Barcelona there were nine woollen factories employing 3,000, and there were many units in Russia with workforces numbered in thousands.

AN 'INDUSTRIAL REVOLUTION'?

Page upon page of evidence relating to the growing size of manufacturing units in Europe at the beginning of the nineteenth century could be paraded, but without adding much, apart from tedium. A more interesting question is whether the quantitative change was accompanied by a corresponding qualitative shift. To put the same question another way: was it just the old system producing more or had a structural change occurred? Until relatively recently, the answer would have been an unequivocal yes to the latter proposition. 'The industrial revolution',

beginning in England in the second half of the eighteenth century, was for most of the nineteenth and twentieth centuries as fixed a point of reference as was the French Revolution of 1789. Indeed, they have been often coupled together to mark the start of the modern world, as they were by Eric Hobsbawm in his still-popular *The Age of Revolution*. Hobsbawm also provided a good traditional definition of the economic wing of his 'dual revolution':

What does the phrase 'the Industrial Revolution broke out' mean? It means that some time in the 1780s, and for the first time in human history, the shackles were taken off the productive power of human societies, which henceforth became capable of constant, rapid, and – up to the present – limitless multiplication of men, goods and services . . . The economy became, as it were, airborne.

However, whereas the term 'French Revolution' was in use by contemporaries from the start, 'Industrial Revolution' took much longer to get established. It was first used in the French form '*révolution industrielle*' in the 1820s and it was also a French pun-dit – the economist Jérôme Adolphe Blanqui – who first pronounced on the world-historical nature of the phenomenon when he wrote in 1831, 'industrial conditions were more profoundly transformed than at any time since the beginnings of social life'. It was yet another Frenchman, the historian Paul Mantoux, who provided the classic historiographical statement of its centrality to the modern world:

The modern factory system originated in England in the last third of the eighteenth century. From the beginning, its effects were so quickly felt and gave rise to such important results, that it has been aptly compared to a revolution, though it may be confidently asserted that few political revolutions ever had such far-reaching consequences.

These cross-Channel observers were perhaps more perspicacious than those directly affected, for in England the phrase did not catch on until much later. In the catalogue of the British Library, there are hundreds of titles published in the twentieth century containing the phrase 'industrial revolution', but only a handful from the nineteenth and none at all from the eighteenth. Although Friedrich Engels made frequent use of the term in *The Condition of the Working Class in England*, first published in 1845, the work was not translated from German into English until 1886. Two years previously, Arnold Toynbee's posthumous *Lectures on the*

Industrial Revolution in England had begun the term's long and busy career as a central organizing concept in British historiography.

Once established, the idea of an industrial revolution which reshaped first England, then continental Europe, and then much of the rest of the world, took a strong hold. Oceans of ink have been spilt debating whether it was a bad thing that reduced the working classes to a 'state of downright bestiality' (Richard Altick) or a good thing that trickled increased wealth down to the meanest mill-operative, but its actual existence was generally accepted. Indeed, the idea of a revolution occurring in the economic history of the world, which then affected every other aspect of human activity (a combination of Prometheus and Proteus, as it were), was given a new lease of life in the middle of the twentieth century. In *The Stages of Economic Growth*, first given as a series of lectures in Cambridge in 1959 and then published as a best-selling book, W. W. Rostow adopted an aeronautical metaphor to summarize what happened when the Industrial Revolution occurred: 'take-off'.

The take-off is the interval when the old blocks and resistances to steady growth are finally overcome. The forces making for economic progress, which yielded limited bursts and enclaves of modern activity, expand and come to dominate the society. Growth becomes its normal condition. Compound interest becomes built, as it were, into its habits and institutional structure.

Few, if any, terms originating in economics have achieved such general currency. Its acceptance was facilitated by the almost simultaneous publication (in 1962) of another hugely influential model of industrialization, namely Alexander Gerschenkron's *Economic Backwardness in Historical Perspective*, although he preferred a more fluid metaphor – 'great spurt'. The belief that such watersheds had occurred in the past and could happen again in the future was very much in the air in the boom years of the 1950s and 1960s, encouraging politicians to coin slogans such as 'the white heat of the technological revolution' (Harold Wilson) or 'the great leap forward' (Chairman Mao). Nor did the checks of the 1970s and 1980s, following the Yom Kippur War of 1973, kill the concept. On the contrary, the rapid developments in information technology in the late 1980s gave birth to the notion of a 'third Industrial Revolution', the first having been based on coal and iron and the second on chemicals and electricals. As such, it remains as vital as ever.

Yet there have always been dissenting voices. Just as political scientists

such as de Tocqueville stressed the continuity between the old regime and post-Revolutionary France, so have there always been historians undertaking the same sort of exercise for economic development. While Rostow claimed that the British economy took off between 1783 and 1802, although conceding that it had taken a long time to taxi out from departure-gate to runway, others have suggested that it never got airborne, indeed that it was not an aeroplane at all. They see industrialization not as a revolution but as an evolutionary process, unsuited to mechanical metaphors. Rather it should be likened to an organism growing at moderate speed – something between an oak and a *leylandii* cypress. In particular they have drawn attention to the protean nature of the concept 'Industrial Revolution', lending itself to exploitation by both Marxists and apologists for western-style capitalism (Rostow subtitled his *Stages of Economic Growth* 'a non-communist manifesto'). Michael Fores, for example, has complained that it 'is a sort of turn-coat Vicar of Bray figure of scholarship, infinitely accommodating to the special interests of individual writers'. No one has stated this point of view more trenchantly than the late Rondo Cameron, who in an article provocatively entitled 'The industrial revolution – a misnomer', asserted: 'probably no term from the economic historians' lexicon has been more widely accepted by the public at large than "industrial revolution"'. That is unfortunate, because the term itself has no scientific standing and conveys a grossly misleading impression of the nature of economic change.⁷

This controversy has generated a huge amount of scholarly literature. As it involves such fundamental questions as the nature of historical change, indeed the nature of historical explanation per se, it can never be resolved, and certainly not here. However, it is necessary to examine, however briefly, some of the key economic areas involved in the period before 1815. A particularly strong argument in favour of the 'gradualists' can be found in the all-important field of communications. As we have seen in Chapter 1, many improvements were made during our period, none of them revolutionary but together having a cumulative effect sufficient to persuade contemporaries that a really major change had occurred. Looking back in 1784, the sixty-one-year-old German writer Friedrich Carl von Moser identified speed as the great development of his life. He recalled with nostalgia the good old days when the leisurely pace of travel accorded perfectly with the national character of the Germans, slow of thought and slow of motion. It was their neighbours,

the French, who thought, acted, marched, shot, hunted, ate, walked and travelled quickly. But all that had changed, he noted, and now the Germans too were rushing hither and thither, as demonstrated by a recent journey he had undertaken on a new highway (*Chaussee*), which had been so fast 'that I ceased to be able to hear or see properly'.

One must wonder how Moser, who died in 1798, would have responded to a railway journey. He might well have joined those who speculated that the human body could not tolerate speeds in excess of 30 miles (48 km) per hour. Although the railway age is usually dated to the opening of the first regular passenger service in 1825, when a train pulled by a steam locomotive began to ply between Stockton and Darlington, even here it did not arrive like a clap of thunder in a blue sky. A clear distinction needs to be drawn between railways and steam locomotives. The great advantage of a railway, defined as parallel tracks along which wheeled vehicles can be drawn, is that it greatly reduces friction, and hence increases proportionally the load that can be pulled by a given motive force. The latter can be human, animal or mechanical. Wooden railways had been in use in German mines since around 1500 and can be found in England about a hundred years later. Their load-bearing capability was greatly increased when iron began to replace wood. Between 1768 and 1771 Richard Reynolds introduced cast-iron rails at the great Coalbrookdale ironworks near Telford in Shropshire, adding an inner flange to the rail to improve stability. Later rails were constructed from malleable iron and the flange was transferred to the wheel. Eventually there were more than 20 miles (32 km) of rails within the Coalbrookdale works.

These early railways were usually purely private enterprises, built, financed and run by mining companies, but there were a few horse-drawn public railways in existence before the end of the eighteenth century, such as the line from Croydon to Wandsworth for freight and from Swansea to Mumbles for passengers. Steam-power was first applied on an experimental basis by Richard Trevithick in the late 1790s. By 1804 he was able to demonstrate a locomotive on the line at the Pen-y-Darran ironworks in Glamorganshire, which pulled ten tons of ore and seventy passengers at 5 miles (8 km) per hour. As is often the way with technology, once the trail had been blazed, others quickly followed, notably John Blenkinsop, whose five-ton locomotive *Salamanca* pulled ninety tons of coal on a level surface at 4 miles (6.5 km) per hour in

1812; William Hedley, another locomotive builder but better known for patenting a smooth wheel and rail system in 1813; and of course George Stephenson, whose locomotive *Blücher* of 1814 was the first successful flanged-wheel adhesion locomotive and could pull thirty tons of coal up a hill at 4 miles (6.5 km) per hour. In short, the 'railway age' was well and truly underway before 1815 and had taken so long to come to fruition that 'revolution' does indeed seem something of a misnomer.

That applies to both aspects of what became known collectively as the 'railway', namely iron rails and steam-power. Indeed, the manufacture of iron had come into common use in Britain as early as the eighth century B.C. It was discovered that heating iron-bearing ore to a high temperature with the use of charcoal, fanned by a draught of air, creates a solid lump of metal (a 'bloom'). When re-heated, the metal can be hammered into a shape. This is 'wrought iron'. If additional carbon is added to the ore, the melting temperature is reduced, which allows liquid iron ore to be poured into a mould. This is 'cast iron'. In the course of the fifteenth century, a furnace was developed which used blasts of heated and compressed air to drive up the temperature. This is a 'blast furnace'. The molten iron is run off into moulds consisting of a main channel connected to a number of shorter channels at right angles. As this resembles a sow suckling her pigs, the cast iron which results is known as 'pig iron'. A further innovation known as 'fining' allowed the impurities to be drawn off by oxidation, leaving semi-solid, malleable wrought iron in its place.

Two major innovations were made during our period. By the early eighteenth century, iron production in England was on the decline, not through want of demand but due to a shortage of the timber from which charcoal is made. In 1709, after much experimentation, the Quaker Abraham Darby succeeded in making iron using coke rather than charcoal. Coke is the residue left after mineral coal has been heated to a high temperature out of contact with air. As it is rich in carbon, it can substitute for charcoal both as a heating agent and as a necessary additive to the iron ore. On the other hand, because it is a much firmer, more robust substance, it can bear a much larger weight of iron ore in the furnace, thus allowing much larger furnaces to be built, with corresponding economies of scale. Darby's blast furnaces at Coalbrookdale were each soon producing up to ten tons of pig iron a week. As there were virtually limitless resources of coal, much of it close to the surface, the inhibition placed on iron production by timber shortage was removed.

The second major innovation was a response to the imbalance between improved pig-iron production and slow and inadequate 'fining'. In 1784 Henry Cort patented his 'puddling' process, which used a reverberatory furnace to turn pig iron into malleable iron. A reverberatory furnace uses hot air and gases to heat the metal, without allowing the latter to be polluted by coming into direct contact with the fuel used for heating. Puddling consists of stirring the molten pig iron on the bed of the furnace, thus allowing the circulating air to remove carbon and other impurities from the iron. Together with his development of a more efficient way of creating bar iron, patented the previous year, Cort's invention helped to encourage a rapid increase in iron production, which quadrupled during the next twenty years. Pig-iron output in Great Britain went from 17,350 long tons (a long ton is 2,240 pounds or 1,016 kg) in 1740 to 68,300 in 1788 to 125,079 in 1796 to 258,206 in 1806. Lord Sheffield, a prolific author on economic matters, predicted in 1786: 'it is not asserting too much to say that the result [of Cort's inventions] will be more advantageous to Great Britain than the possession of the thirteen colonies of America, for it will give the complete command of the iron trade to this country, with its vast advantages to navigation'. In 1750 Britain imported twice as much as iron as was manufactured at home, but by 1815 that relationship had been reversed to the extent that exports now outnumbered imports by a factor of five. It should be noted, however, that although iron production increased very rapidly, steel remained very much a minority metal. A technique for making steel in a crucible was discovered in the 1740s but it remained very expensive and confined to cutlery manufacture. Cheap steel did not become available until the middle of the following century.

A similarly gradual story unfolded in the second component of the railways — steam-power. Once again, innovation was driven by need. In this case, it was the need to pump water out of coalmines that had to go deeper as the surface seams were exhausted. In 1702 one mine in Warwickshire was using more than 500 horses to work the pumps. The first mechanical pump was invented by Thomas Savery in 1698. This ingenious device consisted essentially of a large metal container filled with steam. Cool water was then poured on to the metal casing, causing the steam inside to condense, thus creating a vacuum, which in turn drew up water from the mine. This was patented as the 'Miner's Friend', but it was barely practical, since the alternate cooling and heating was

hugely wasteful and the tin-soldered joints proved to be positively lethal in their failure to handle the steam pressure consistently. Much more efficient was Thomas Newcomen's 'atmospheric engine' of 1705, which used the partial vacuum created by condensing steam to move a piston inside a cylinder. This machine also had distinct limitations: it was slow and voracious in its appetite for coal. Indeed, its thermal efficiency was only about 1 per cent, or in other words of every hundred units of coal consumed, only one was actually used to pump water. However, the cost of coal was of little concern at the pit-head and Newcomen engines were introduced into almost all the large mines in Great Britain within a few years. By the middle of the eighteenth century there were more than fifty in use in the Newcastle coalfields alone.

The real breakthrough came when James Watt, a Glasgow instrument-maker, found a way of dispensing with the hot-cold routine that had made previous steam-engines so inefficient. While repairing the University of Glasgow's model Newcomen engine, he saw a way of employing all the steam generated: 'the idea came into my mind that, as steam was an elastic body, it would rush into a vacuum, and, if a communication were made between the cylinder and an exhausted vessel, it would rush into it, and might be there condensed without cooling the cylinder'. In 1769 he patented his 'new method for lessening the consumption of steam and fuel in fire engines', formed a partnership with the great Birmingham manufacturer Matthew Boulton and began producing steam-engines for use, not just in coalmines but in all forms of industry. Further developments by Watt, notably the double-action engine invented in the early 1780s, improved efficiency still further. It has been suggested, not without reason, that this was a truly epochal moment, because for the first time in its history, humankind had at its disposal a source of power wholly independent of location. Karl Marx made the point well in *Das Kapital*:

Not till the invention of Watt's second and so-called double-acting steam-engine, was a prime mover found, that begot its own force by the consumption of coal and water, whose power was entirely under man's control, that was mobile and a means of locomotion, that was urban and not, like the waterwheel, rural, that permitted production to be concentrated in towns instead of, like the waterwheels, being scattered up and down the country, that was of universal technical application, and, relatively speaking, little affected in its choice of residence by

local circumstances. The greatness of Watt's genius showed itself in the specification of the patent that he took out in April, 1784. In that specification his steam-engine is described, not as an invention for a specific purpose, but as an agent universally applicable in Mechanical Industry.

Marx was writing in the middle of the following century, by which time the full implications of Watt's inventions were there for all to see. At the time, there was less excitement. By 1800 there were only about a thousand steam-engines of various kinds in operation across the length and breadth of the United Kingdom. In terms of horse-power generated, they were still heavily outpointed by traditional energy sources, especially water-power, still very important in the woollen industry. Peter Mathias has estimated that even wind-power may have made a larger contribution than steam-power in 1800 and, moreover, that about 50 per cent of the latter was still being produced by Newcomen-type engines.

If neither metallurgy nor steam-power can sustain the concept of an industrial revolution, the sole remaining candidate is textiles, more specifically cotton. If less ancient than iron, cotton had nevertheless been around for a long time, first reaching Europe from Egypt around AD 900. In the eighteenth century it was mainly imported from Brazil, the Caribbean islands, the Middle East and India. Small amounts were grown around the Mediterranean and on the Portuguese and Spanish islands of the eastern Atlantic. The first cotton from the USA did not arrive until 1784. In understanding the significance of the innovations of the late eighteenth century, it is important to understand why cotton was an attractive but problematic fibre. Its great advantages are that it is flat, hollow, with a natural twist and a long 'staple' (the natural length of the fibre). Consequently, it combines comfort with strength and durability. Its great disadvantage is that it is very labour-intensive. The cotton 'bolls' which grow on the plant have to be harvested, ginned (separating the seed from the fibres), cleaned, roved (drawing out, lengthening and twisting) and carded (combing out, straightening and making the fibres naturally parallel) before it can be spun into yarn and then woven into cloth. The process has been described very well by Henry Hobhouse in his classic study *Seeds of Change*:

It was comparatively easy to grow a good crop of cotton, but picking a hundred pounds of bolls would take two man-days; ginning would take fifty man-days at

best; and baling by hand, cleaning and carding another twenty man-days. All this effort resulted in only about eight pounds of spinnable cotton, which would then require twenty-five to forty man-days to spin. An ethnic cotton thread, therefore, cost twelve to fourteen man-days of labour per pound. Even if some of this was cheaper child labour, or adolescent labour, the cost of this boring work was still high and inescapable. Compared to one pound of cotton, one pound of wool at the same date took at most one to two man-days from raw material to thread, linen two to five and silk about six.

As Hobhouse adds laconically, 'No wonder cotton was the luxury cloth in 1784.' Only mechanization could turn it into a cloth for mass consumption. The process came in fits and starts, with a number of inventions designed primarily for other fabrics. John Kay's 'flying shuttle' of 1733, for example, which doubled a weaver's productivity, was intended for woollens. However, it called for a corresponding increase in the spinning of yarn, which encouraged the invention of mechanical spinning devices. Lewis Paul and John Wyatt's roller spinning machine, patented in 1738, James Hargreaves' spinning-jenny, invented in 1764 and patented in 1769, Richard Arkwright's water frame of 1769 and Samuel Crompton's 'mule' of 1779 (so-called because it combined the functions of both the jenny and the frame) combined to bring a massive increase in productivity, economies of scale, improvements in quality and a precipitous fall in the cost of yarn. Such was the degree of change that it caught the eye of poets – of John Dyer, for example, who in 'The Happy Workhouse and the Good Effects of Industry' of 1757 recorded:

We next are shown

A circular machine of new design,

In conic shape: it draws and spins a thread

Without the tedious toil of needless hands.

A wheel, invisible beneath the floor,

To ev'ry member of th' harmonious frame

Gives necessary motion. One, intent,

O'erlooks the work: the carded wool, he says,

Is smoothly lapped around those cylinders,

Which, gently turning, yield it to yon cirque

Of upright spindles which, with rapid whirl,

Spin out in long extent an even twine.

By 1800 the cost of very fine yarn was one quarter of what it had been twenty years earlier. Cotton benefited most from these and other inventions, because its tough composition suited the crude technology of the early machines, because of a long-term shift in fashion towards lighter fabrics, because export markets in warmer climates were opened up and because the wearing of underwear became habitual for all classes. Sidney Pollard has estimated that a labourer spinning by hand needed more than 50,000 hours to work 100 pounds (45 kg) of cotton; Crompton's mule of 1780 needed 2,000 hours; and the power-assisted mule introduced in the mid 1790s needed just 300. In other words, the productivity of labour rose over 150 times in the course of the eighteenth century. The amount of cotton imported into Britain increased from 2,500,000 pounds (1,135,000 kg) in 1750 to 22,000,000 (nearly 10,000,000 kg) in 1787, by which time most of it was being cleaned, carded and spun by machines. As measured by the consumption of raw cotton, production increased ten times between 1760 and 1785 and then more than ten times between 1785 and 1827.

There was a clear appreciation among contemporaries that something momentous had happened. John Aikin wrote in 1795 that 'the rapid and prodigious increase of cotton manufacture is, perhaps, absolutely unparalleled in the annals of trading nations'. Yet numerous qualifications have to be made to what might be looking like a revolutionary scenario. After the promising spurt of productivity represented by the flying shuttle, weaving failed to keep pace with spinning. Edmund Cartwright patented a 'power loom' in 1785 but, despite subsequent improvements, the problem of combining speed with continuity was defeated by repeated breakages of the yarn. By 1815 there were only about 2,400 power looms in operation in the United Kingdom. Mechanical weaving was to be a nineteenth-century phenomenon. It has also been pointed out, by Samuel Lilley for example, that the jennies, frames and mules did not represent a technological breakthrough comparable with, say, the discovery of synthetic dyes or wireless telegraphy. He adds that 'the early stages of the Industrial Revolution – roughly up to 1800 – were based very largely on using medieval techniques and on extending these to their limits'. What Hargreaves, Arkwright and the rest did was to take different parts of the traditional spinning-wheel and put them together in new combinations. It has also been pointed out that in purely

quantitative terms, the contribution made by cotton to the national economy was modest. Peter Mathias's figures suggest that in the 1760s it amounted to less than half a per cent and was still less than 1 per cent in the 1780s. In 1770 cotton added £600,000 to the Gross Domestic Product, but wool added £7,000,000 and leather £5,000,000.

Of all the products associated with the British industrial revolution, cotton was also the one that spread furthest, fastest and earliest to the continent. However tedious, the following information gleaned from a number of regional studies gives some idea of the ubiquity of cotton manufacturing by 1815: at Rouen the number of manufactories increased by 1,800 per cent between 1763 and 1785 and by 800 per cent at Bolbec; at Mulhouse in Alsace, the number of printed cotton pieces increased from 30,000 to 120,000 between the 1750s and the 1790s; in 1786 the French imported 11,000,000 pounds (5,000,000 kg) of raw cotton (the British were importing about 18,000,000 pounds (over 8,000,000 kg) at the same time); during the last quarter of the eighteenth century, cotton began to be worked to the north-west of Milan in Gallarate, Busto Arizio and Vercelli; a cotton mill using the mule jenny was established at Monza in 1795; cotton manufacturing in Russia began with the firm of Chamberlain and Cousins in 1755 and spread quickly; between 1782 and 1786 ten cotton factories were set up in Prague; the Catalonian cotton industry was employing 80,000 by 1792; in the Austrian Netherlands, cotton factories were established at Antwerp, Brussels, Mechlin and Tournai; in Alsace in 1806 there were 25,026 people working in various branches of the cotton industry, or nearly half of all industrial workers in the province; in the *département* of the Roër (the northernmost of the four new *départements* created when the west bank of the Rhine was annexed to France) there were 65,000 people – c.10 per cent of the total population – working in 2,500 factories in 1811; in Europe as a whole in 1815 there were 1,500,000 spindles in the cotton industry, of which 1,000,000 were in France, 250,000 in Saxony and 150,000 in Switzerland. This kind of information could be replicated at will, but that will do.

Many of these enterprises were organized on a putting-out basis and many of them were manufactories rather than mechanized factories. Nevertheless, there is plenty of evidence that British technology found its way to the continent. Some entrepreneurs moved there to seek their fortunes, as did none other than John Kay when he failed to maintain

his patent rights to his flying shuttle. The French authorities gave him a grant of 3,000 *livres* and paid him an annual salary of 2,500 *livres* to tour Normandy to teach workers how to use his invention, while three of Kay's sons made shuttles in a Paris workshop. It spread through industrial espionage, with machinery being copied and operatives being bribed to divulge secrets. In 1785, for example, a German spy called Baden, arrested in Lancashire, was fined the very substantial sum of £500 for trying to recruit machine operatives. By 1815 local versions of jennies, frames and mules were in operation right across Europe, from Belgium to Russia.

Why were the British first in the field? No one explanation will work, for it is next to impossible to find a single characteristic peculiar to the British economy. Was it perhaps the excellent communications, both natural and man-made? The Dutch Republic was equal if not superior in this regard. Was it the accumulation of commercial and financial expertise, the integrated money market, the advanced commercial agriculture, the flexible social structure, the religious toleration, the relative immunity from war-damage? Here too the Dutch were at least equal and several other European countries boasted at least some of these factors. Was it the availability of raw materials, especially coal and iron ore (which the Dutch lacked)? Yet Belgium and several parts of western and central Germany were equally favoured. And so on. Perhaps a combination of all these advantages was needed to achieve the critical mass.

It is also possible that to look exclusively at the supply side of the economy is to invite certain disappointment. It was on the demand side that the British were so special. As Neil McKendrick has stated firmly in a seminal study, 'There was a consumer revolution in eighteenth-century England. More men and women than ever before in human history enjoyed the experience of acquiring material possessions . . . The consumer revolution was the necessary analogue to the industrial revolution, the necessary convulsion on the demand side of the equation to match the convulsion on the supply side.' What in the past had been seen as luxuries now became 'decencies' and what had been decencies now became necessities. The work of McKendrick, Sir John Plumb, Roy Porter and John Brewer has shown how eighteenth-century Britain, and especially eighteenth-century England, was increasingly gripped by a rage for spending which transformed the economy.

As Plumb observed, 'to spend has been the rising chord of Western capitalism' and 'aggressive consumption lies at the heart of successful bourgeois society'. The concept of the classless customer who was always right took hold, as Adam Smith recognized in *The Wealth of Nations* in 1776: 'consumption is the sole end and purpose of all production; and the interests of the producer ought to be attended to, only in so far as it may be necessary for promoting that of the consumer. This maxim is . . . perfectly self-evident.' Ultimately, what encouraged the Darbys and the Arkwrights to come up with ways of satisfying the market's appetite was the knowledge that these eager consumers were out there looking for products to purchase. As David Landes has observed, 'what distinguished the British economy . . . was an exceptional sensitivity and responsiveness to pecuniary opportunity. This was a people fascinated by wealth and commerce, collectively and individually.' Of course, there were consumers on the continent, notably in the Low Countries and in urban centres, but nowhere were they so numerous and so confident.

The British viewed continental developments with a complacency born of the knowledge that imitation is the sincerest form of flattery. They could afford to be patronizing in 1815, because they knew that the twenty-two years of warfare which had just ended had turned what was already a gap between the British and continental economies into a chasm. The reasons for this development must await consideration in a later chapter; here we can conclude with the question of whether the political revolution in France was accompanied, or perhaps even preceded, by an industrial revolution in Great Britain. A Marxist historian such as Eric Hobsbawm is in no doubt that it was:

If the sudden, qualitative and fundamental transformation, which happened in or about the 1780s, was not a revolution then the word has no commonsense meaning . . . The Revolution itself, the 'take-off period', can probably be dated with as much precision as is possible in such matters, to some time within the twenty years from 1780 to 1800: contemporary with, but slightly prior to, the French Revolution. By any reckoning this was probably the most important event in world history, at any rate since the invention of agriculture and cities. And it was initiated by Britain.

There is nothing ideological about such a view, although Hobsbawm likes to think that conservative (i.e. non-Marxist) historians are naturally

uneasy with anything to do with revolution. The American economic historian David Landes is equally convinced of the revolutionary nature of what happened in Britain in the late eighteenth century, and almost repeated Hobsbawm's words when he wrote, 'The technological changes that we denote as the "Industrial Revolution" implied a far more drastic break with the past than anything since the invention of the wheel.' On the other hand it is undeniable that scholars who see Great Britain as an 'old regime' see not revolutionary change but continuity. Jonathan Clark has written, with characteristic trenchancy, 'The "Industrial Revolution" is . . . not a thing, still less an event, but a term of historical art adopted long afterwards to celebrate an alleged watershed between premodernity and modernity: where the French Revolution brought to an end the *Ancien Régime* in France, the Industrial Revolution was supposed to have done the same in England.'

The economic historians have provided plenty of statistical evidence to support Clark's view. They have pushed the origins of industrialization further and further back in time, while simultaneously post-dating the effects. As David Cannadine has put it, the industrial revolution has been 'almost written out of modern British history'. In 1989, the bicentenary of the French Revolution, Donald Coleman summed up the current state of play:

If the evidence, largely in the form of contemporary statistics or ingenious modern reconstructions is approximately correct . . . then it would seem that before 1830 economic growth was slow, with neither output nor incomes per head showing much increase; and notable change, economic and technical, was severely limited. Only after the mid-century did the economy show much significant difference and even then it was more a matter of structural change, from agriculture towards industry, than the attainment of higher productivity. In short, continuity has been stressed and the discontinuity implied by the idea of a revolution downgraded or even dismissed.

How are we to resolve this dispute? Paradoxically, a clue to a possible solution is provided by Clark in a piece of evidence which he presents in support of his argument against the notion of an industrial revolution but may perhaps point in more than one direction. It is an extract from a treatise published in 1815 by the manufacturer and social reformer Robert Owen:

Those who were engaged in the trade, manufactures, and commerce of this country thirty or forty years ago, formed but a very insignificant portion of the knowledge, wealth, influence, or population of the Empire.

Prior to that period, Britain was essentially agricultural. But, from that time to the present, the home and foreign trade have increased in a manner so rapid and extraordinary as to have raised commerce to an importance, which it never previously attained in any country possessing so much political power and influence. This change has been owing chiefly to the mechanical inventions which introduced the cotton trade into this country.

The immediate effects of this manufacturing phenomenon were a rapid increase of wealth, industry, population and political influence of the British empire; and by the aid of which it has been enabled to contend for five-and-twenty years against the most formidable military and *immoral* power [France] that the world perhaps ever contained.

Clark believes that this shows Owen looking primarily to Britain's *commercial* prosperity as the key to its survival. It does indeed do that, but it also links the commercial transformation of the country 'chiefly to the mechanical inventions which introduced the cotton trade into this country'. Like most contemporaries, Owen did not make the economist's fine distinctions between various forms of wealth creation. What he saw was an expansion of the British economy proceeding so fast and so far as to justify revolutionary status, even if he did not use the phrase 'industrial revolution'. He looked around him and saw paupers going from rags to riches in just a few years. In Lancashire in 1780 it was recorded that within a single decade 'a poor man not worth £5, now keeps his carriage and servants, is become Lord of a Manor, and has purchased an estate of £20,000'. Significantly, Owen also linked this material prosperity to political stability and military success. The 'Second Hundred Years War', which had begun with the Glorious Revolution of 1688, had finally been resolved in Britain's favour on the field of Waterloo in the year that Owen published his pamphlet. As we shall discover in a later chapter, the latest phase of that conflict, between 1793 and 1815, greatly increased Britain's economic lead over her old enemy. To the triumphalist British, this seemed to be a victory not just of one country but of a whole culture, based on liberty, Protestantism and prosperity, the three foundations of their country's greatness. In other words, what contemporaries experienced as a fundamental change

in their economy was part of a wider complex of developments, which in just a century had turned an offshore island of marginal economic and political significance into the mistress of the world. Viewed in this way, the changes in commerce and manufacturing do deserve their revolutionary status. The world was transformed by industrialization, it did begin in Great Britain and it did begin in this period.