When William Aitken, a one-time factory worker and agitator for political reform, sat down to write his memoirs in the late 1960s, he considered himself to be living in ‘the most industrial age the world has ever seen’. Aitken, like most Victorian commentators, did not speak in terms of ‘industrialisation’ – the word and the concept are both twentieth-century creations. Nonetheless, the absence of a vocabulary of industrialisation should not be interpreted as a failure to notice the profound changes that were restructuring the British economy, landscape and society during the nineteenth century. Some construed these changes in positive light – as for example, did Aitken himself, who despite his earlier career as a reformer, later considered that capitalism had made ‘the desert blossom as the rose’; though many others took a considerably bleaker view. All, however, perceived themselves to be in the midst of a period of dramatic economic change, and were fully confident of Britain’s position as a world leader in the middle of the nineteenth century. However we interpret these changes, it is clear that the Victorian economy grew considerably in strength and size and that this period was a pivotal moment in Britain’s transition from a pre-industrial to industrial economy. In this chapter we shall explore what ‘industrialisation’ actually was, and consider how the Victorian economy was affected by the process.

Perhaps the most important characteristic of the Victorian economy is the sheer extent of growth that was attained, and although precise measures are difficult to obtain a sense of this achievement can be demonstrated by looking at a wide range of economic indicators. The indices for industrial output, for example, reveal steady gains throughout the final three quarters of the nineteenth century. Between 1830 and 1860, Charles Feinstein has estimated that industrial output was expanding at a rate of 3.3 per cent per year – a rate of growth that was sufficient to produce a doubling of output in just thirty years. Matthews, Feinstein and Odling-Smee’s estimates for the second half of the century are a little more muted yet still reveal substantial growth. They have estimated that manufacturing output increased at a rate of 2.6 per cent per year between 1856 and 1873, dropping slightly to 2 per cent per year between 1873 and 1913.

Furthermore, these buoyant rates of industrial growth had a favourable effect on the wider economy. Economists commonly use gross domestic product or GDP, which

---

1 William, Aitken, ‘Remembrances and struggles of a working man for bread and liberty’, in Robert G Hall and Stephen Roberts, eds., William Aitken, the Writings of a Nineteenth Century Working Man (Tameside, 1996), p.27
2 Ibid.
is defined as the market value of all the goods and services produced within the country in a year, in order to measure a country’s economic performance. Between 1830 and 1860, Feinstein’s figures suggest GDP grew at 2.5 per cent per year. Matthews et al offer a slightly lower estimate of 2.4 per cent per year between 1856 and 1873, falling to 2 per cent per year between 1873 and 1913. Nonetheless, these were significant yearly increases, permitting the British economy to double in size between 1830 and 1860 and to double once more between 1860 and the end of Victoria’s reign. Furthermore, this rise in GDP was well in excess of anything that the British economy had previously achieved and thereby marked a departure from the existing pattern of growth.

The trends for industrial output and GDP are the most straightforward evidence for change, but they are not the only ways of measuring the performance of the Victorian economy. It is useful to contrast the progress of GDP with demographic trends and the real wage in order to establish whether economic growth was a simple consequence of population increase, as well as to assess how well the economy met the welfare needs of the population. As with the economy, the population exhibited strong positive growth throughout the nineteenth century, increasing at just over 1 per cent per year: these year-on-year increases were sufficient to cause the population to more than double over the period of Victoria’s reign. Furthermore, it is worth noting that the rate of population growth was slightly lower than the growth of GDP, which suggests that economic growth was not simply the consequence of a larger workforce. The discrepancy between the two series indicates that the productivity of each worker was improving, hinting at the possibility of an underlying restructuring of the economy.

One final way of measuring economic performance may be obtained by looking at the real wage. Charting the progress of the real wage requires information about the wages received by manual labourers and their cost of living and it is notoriously difficult to measure with any degree of accuracy. Nonetheless, a number of estimates are unanimous in detecting a pronounced upward trend throughout the final three quarters of the nineteenth century – the most recent estimates imply annual increases of somewhere between 1 and 1.5 per cent. As real wages were...

---

6 Matthews, Feinstein, and Odling-Smee, British Economic Growth, table 2.1, p.22.
rising more slowly than GDP, it implies that much of the extra wealth generated by industry during Victoria’s reign was not filtering into the hands of those who worked hardest to produce it. Nonetheless, taken over the span of Victoria’s reign, the rise in real wages produced sizeable gains in the living standards of the working classes. By the end of Victoria’s reign the economy was able to feed, house and clothe the population far more comfortably than it had at the beginning, and this achievement is yet more remarkable when it is recalled that the population was also much larger. Thus not only was the economy providing a better standard of living for the people, it was doing so for a considerably larger number as well.

Across a wide range of measures it is possible to demonstrate the Victorian economy attaining higher rates of growth than had been known in the eighteenth century and before. Yet it is not simply the rate of growth that was impressive during the nineteenth century: no less important than the overall pace of growth was the change in its nature. Economic growth was not, after all, a uniquely Victorian phenomenon. Historians of medieval Britain have sketched out a period of sustained expansion between the eleventh and the mid-thirteenth century; further gains were made over the sixteenth and seventeenth centuries as well.9 Yet no matter what advances were made during these earlier periods of prosperity, they were never sufficient to bring about significant improvements in living standards. The limited nature of economic progress prior to industrialisation can be grasped by considering Gregory Clark’s estimates of the craftsman’s real wage over the six centuries between 1200 and 1800.10 His figures indicate sizeable fluctuations in the real wage over the period yet no long term increase. At the end of the period, a builder’s wage bought him little more in the way of food, housing and clothing than had been enjoyed by his mediaeval ancestors, leaving large numbers eking out a precarious living on the margins of a decent existence. Why had economic growth not resulted in any substantial gains in living standards? The difficulty was that earlier periods of economic growth had always given rise to demographic growth; so although the economy was considerably larger in 1800 than it had been in 1200, so too was the population.11 The outcome was an economy capable of feeding larger numbers, but not able to feed them very much better.

At some point during the nineteenth century, the economy broke out of this older cycle of limited growth and sustained improvements in living standards were established: by the century’s end the value of the real wage was three times above its value in 1800 and wages were higher than at any previous point in history. Not only did the real wage steadily increase over the nineteenth century, but these increases were maintained and extended in the years that followed: by the end of the twentieth

---

10 Clark, ‘Condition of the working class’, table A2, pp.1324-5.
century real wages had risen a further fourfold. And in this respect, the nineteenth-century economy was behaving in a way that was fundamentally different to the way it had ever behaved previously. Although the population was continuing to expand, economic growth was now outstripping population growth by a comfortable margin, giving rise to a prolonged upward trend in living standards. The past two centuries have seen material gains for every man, woman and child that were simply unimaginable for earlier generations, and in this respect the achievements of the Victorian economy stand out as an event of great historical significance.

It is in this context that we should situate the economic slowdown of the 1870s and 1880s, sometimes labelled the Great Depression, and which has attracted considerable attention from both contemporaries and historians. By the end of the century it was apparent to most informed commentators that Britain had slipped from its glorious mid-century pre-eminence, giving rise to gloomy assessments of the decline of the Victorian economy. Most recent studies, however, have been considerably more positive about economic progress during the last quarter of the nineteenth century, concluding that Britain’s late Victorian decline was relative rather than absolute, the consequence of industrialisation spreading to the rest of Europe rather than of deficiencies within the British economy. Certainly taking the longer term view, it is not accurate to characterise the late nineteenth century as a period of economic decline. The rate of increase of GDP may have slowed slightly, and was exceeded in many neighbouring nations, but the overall trend continued upwards and formed part of a much longer period of largely unbroken growth in national wealth and living standards. Industrial economies are ever haunted by cycles of boom and bust: yet at the same time, and in contrast to pre-industrial economies, the long term trend of economic growth continues upwards and each generation enjoys a higher standard of living than it predecessor.

It is surely for this reason that the concept of industrialisation has proved so enduring throughout the twentieth century. Whilst critics have sometimes questioned whether the changes were sufficiently rapid to justify being labelled an ‘industrial revolution’, scholars have largely agreed that at some point between the eighteenth and the nineteenth centuries a step change in the economic order took place, a change so fundamental that a special vocabulary is appropriate. This was

---

12 Clark, ‘Condition of the working class’, table A2, pp.1324-5.
not simply growth, but the creation of a new economic system capable of sustained growth over the long term. And given the historical significance of this development at the heart of the economy, it is necessary to consider in greater detail how and why this restructuring occurred.

There are many different pathways to industrialisation: different nations will follow their own route according to their own unique historical development. In Britain, however, we must look primarily to coal in order to explain how the old pattern of limited growth was broken and the modern era of prolonged economic expansion established. In the early nineteenth century, burning coal was one of a number of ways of providing the energy needed for cooking, heating, and powering industry, and the profound significance of coal can be most easily grasped by thinking about the alternatives and their limitations. If energy is not derived from coal, it might instead be harnessed from the winds or from rivers by means of windmills and waterwheels. Alternatively, energy may be obtained from the soil, either directly through the burning of wood, or more indirectly, by the muscles of humans or animals – in this instance, their energy is provided by consuming food or fodder produced by the land. Yet the energy that can be obtained from wind, water and the soil cannot be increased indefinitely. Improvements to the efficiency of agriculture, for example, might lead to higher yields, but the amount of energy that can be obtained from a given landmass is ultimately fixed and cannot be extended continuously using traditional farming techniques. Likewise, innovations in the design of waterwheels might lead to some rise in the energy obtained from waterways, but no matter what ingenious refinements are made, the energy contained in Britain’s rivers is also fixed and cannot be substantially increased simply through modifications to the waterwheel. And these energy constraints effectively placed a cap on the extent of economic growth that could be achieved. As Tony Wrigley has explained, ‘as long as the land remained the principal source not only of food but also of almost all the raw materials used in manufacture, it was inevitable that the productivity of the land should set limits to possible growth’.16

When industry began to burn coal rather than wood, the age-old constraints which had placed a ceiling to the development of industry in previous centuries were at a stroke removed, and new and previously unimaginable rates of growth were now attainable. By digging under the soil, vast new expanses of economic possibility were opened; an apparently limitless source of fuel permitted a long term rise in output on a previously unimaginable scale. No longer were the needs of industry and human sustenance in competition for the same set of resources: the coal mines could provide fuel for industrial processes, cooking and heating, and the land could

---

be used to grow crops to feed the growing population that an expanding industrial sector required. Though coal is of course itself a finite resource, in the context of the period, and in comparison with the fuel sources that had preceded it, the opportunities it presented for economic growth were seemingly endless.

The switch to coal was not, however, accomplished in the short span of Victoria’s reign, and emphasising the centrality of coal forces us to consider the chronology of British industrialisation. Coal already made a substantial contribution to Britain’s energy needs in the early nineteenth century, and had indeed done so for several centuries. As early as 1700, coal provided about one half of all the energy consumed in England and Wales – animals, humans and firewood provided the bulk of the rest, with wind and waterpower making only a marginal contribution.\(^{17}\) Coal consumption rose steadily over the eighteenth century and provided three-quarters of England and Wales’ energy by 1800; it continued to rise in the following century and provided over 95 per cent of the nations’ energy needs by 1900. At the same time as the contribution that coal made to supplying Britain’s fuel needs rose, the overall quantity of energy consumed also underwent a sustained increase; yet once again, this was a process that had begun well before the Victorian period. Energy use doubled from approximately 33 GJ per capita in the 1720s to 67 GJ per capita in 1837, and then more than doubled again to approximately 150 GJ per capita over the course of Victoria’s reign.\(^{18}\) Clearly, then, both the switch to coal and the rise in energy use were long and drawn-out events that had been underway for at least a century prior to the 1830s. Given the long taproot of change, it is important to determine in what respects, if any, Victorian coal consumption departed from existing trends.

It is possible to shed light on this problem by looking at the uses to which coal was put. Industry was not, after all, the only consumer of coal. Coal was also used extensively within the home for cooking and heating, and so long as the population continued to expand, the demand for coal was sure to rise. At the start of the eighteenth century, just over half of Britain’s coal consumption was for domestic use: industry and mining consumed 45 per cent (waste comprised the rest).\(^{19}\) By 1830, these proportions had only shifted modestly: industry and mining now consumed 55 per cent of Britain’s coal output, whilst 40 per cent was used within the home.\(^{20}\) Of course, as coal consumption had also increased dramatically over this period the amount of coal that was consumed by industry had also risen considerably. Nonetheless, the structure of coal use had not undergone significant change, and this suggests that although the economy was growing, it was still continuing to function in the traditional way. In the following 70 years, however, the proportion of coal put to domestic use fell sharply away, dropping to 18 per cent, whilst that used in


\(^{18}\) Ibid., appendix 3, pp.131-8.


\(^{20}\) Ibid.
industry and mining rose to 73 per cent, and the historian of the nineteenth-century coal industry, Roy Church, has concluded, ‘It is difficult to exaggerate the importance of coal to the British economy between 1830 and 1913’. So whilst the use of coal was not in itself a new phenomenon, the application of coal to industry and manufacture nonetheless gained considerable momentum in the Victorian era.

Yet indicating the dramatic rise in industry’s coal consumption during the nineteenth century quickly raises another question. As the coal had always existed, and was indeed widely used in British homes and in some sectors of industry, what caused the sudden increase in industrial coal consumption during the nineteenth century? Or to put the question another way, why had so many manufacturers been so slow to take advantage of the nation’s relatively cheap and abundant coal reserves? The answer to this lies in understanding the technological challenges often inherent in replacing one source of fuel with another. Fuel sources are not necessarily interchangeable. To take a modern example, electricity and cars have both been around for a hundred years yet, despite decades of experimentation, substituting electricity for oil in road transport continues to pose considerable engineering difficulties. Similar obstacles faced nineteenth-century manufacturers who were accustomed to using animals, humans, windmills, waterwheels or charcoal to provide the energy needed to process raw goods into manufactured articles. Technologies are developed to use a particular type of fuel. The humble spinning wheel was designed to be powered by hand. No amount of coal was going to improve the speed or efficiency of its operation; an entirely new technology was required before coal could be used to spin yarn. And it was for this reason that manufacturers were often slow to exploit domestic coal reserves. One of the great achievements of the Victorian economy, therefore, was the development of a series of technological breakthroughs, many of which were in essence technologies designed to replace the power provided by muscle, wind and water with coal.

As might be expected, the switch from organic sources of energy to coal was well underway by the onset of Victoria’s rule; indeed in some industries the switch had been largely completed. The iron industry is one such example. Iron production depends on two processes: smelting the ore in the furnace and then refining the pig iron in the forge. Both elements require very high temperatures, and therefore large quantities of fuel, and wood in the form of charcoal had traditionally been used. Yet the industry’s reliance on a valuable and relatively scarce fuel not only ensured that the finished product was expensive, it also placed limits on the possibilities for further growth; and both encouraged producers to search for a way to produce iron from coal rather than charcoal.

---

The search for a form of coal-smelting had been underway since the early seventeenth century at least, but it was not until Abraham Darby’s experiments with ‘coking’ the coal – that is treating it to remove impurities – and using this rather than coal in his furnaces that a satisfactory solution was found. His success in replacing charcoal with coke rested upon a series of further adjustments to the size of the furnace and the blast from the bellows. Despite Darby’s discoveries, the industry was relatively slow to move over to the new smelting techniques: in 1750, 95 per cent of pig iron was still being produced using charcoal, and it was not until the 1760s that a more widespread switch to coal-smelting occurred. Likewise in the sphere of iron refining the substitution of coal for charcoal was far from straightforward. The ‘potting’ process designed by the Woods’ brothers in the 1760s worked by using coal to melt the pig iron and remove its silicon and then reheating the desiliconised iron in small pots with a flux such as lime to remove the remaining sulphur and carbon and produce wrought iron. Cort’s ‘puddling’ process removed the need for pots and lime by using a coal-fired reverberatory furnace instead. Both were effectively techniques that refined iron using coal rather than charcoal. Key stages in the process of iron production depended, therefore, not simply upon coal, but also on a series of technical innovations that enabled manufacturers to switch from their old fuel source to the new. It is what one historian has described as a ‘typical problem in substituting coal for wood: the coal introduced impurities, so new technology had to be invented to eliminate them’. More generally, the example of the iron industry reminds us that Victorian industrialisation drew heavily upon the achievements of earlier generations.

Nevertheless, despite the successful restructuring of the iron industry along inorganic lines during the eighteenth century, for most industries this process of restructuring did not occur until the nineteenth century. Some of the forces at work may be seen with particular clarity in the cotton industry. During most of the eighteenth century and earlier, the work of spinning yarn into thread had been performed by women, sitting at a small spinning wheel turned by hand. In the 1760s and 1770s, the process of spinning was revolutionised by a series of inventions: the spinning jenny, the water frame, and the mule, which together replaced the work performed by women’s hands with various mechanical devices. James Hargreaves’

---

spinning jenny replaced the spinner’s one spindle with several (initially eight or sixteen), enabling the machine operator to spin the yarn onto several spindles at the one time, thereby considerably increasing the quantity of yarn that could be spun in a given period of time. Richard Arkwright’s ‘frame’ (or ‘throstle’) produced a stronger thread by using three sets of paired rollers to produce yarn and a set of spindles to twist the fibres together; it was too large to be operated by hand, and after some experimentation was powered by a water wheel instead, thereafter becoming known as the ‘water frame’. Samuel Crompton’s mule combined elements of both the jenny and the water frame to spin strong and good quality cotton thread, which in turn facilitated the weaving of fine cotton cloth on a large scale. These inventions were sufficient to produce a spectacular increase in output: output rose at an astonishing rate of 2,200 percent between 1770 and 1815.\(^{29}\) It is important to note, however, that although eighteenth-century inventions in cotton manufacture displayed real conceptual novelty and were instrumental in causing a significant rise in productivity, power continued to be supplied to the industry by organic sources. The spinning jenny was operated by hand: as the machines grew larger greater sources of power were needed, but the industry moved over to waterpower not coal. Yet waterpower could not be extended indefinitely as the supply of sites close to fast-running rivers was limited, and these gains were likely to falter unless a new form of power could be brought on stream.

The solution for the cotton industry lay in the use of coal-fired steam engines. Engines had been around for the best part of a century, yet, in what should by now be a familiar pattern, the use of engines in the cotton industry was delayed until the industry had discovered a way of using the steam engine to power their machines. Thomas Newcomen’s steam engine had been invented in 1712, but as it only provided power on the down stroke, its uses were largely confined to pumping water out of mines and to keeping waterwheels turning when water levels ran low. It was not until Watt patented his ‘Double Acting Rotative Engine’ in 1784, which could transmit power on both the down and the upstroke and convert it into circular motion, that coal could be used to power engines in the textiles industry. Even with this innovation, however, the spread of steam engines in the textile industry was relatively slow, as each different machine needed to be individually connected to its engine. As one historian has pointed out, ‘one of the major problems that faced the early mill builder was the construction of the machinery of transmission from the source of power to the various machines’\(^{30}\). Hence the delay that occurred in industries such as cotton, wool and worsteds, and paper, between the mechanisation of key processes and the adoption of coal-fired steam engines. S. D. Chapman’s estimates suggest that the industry moved quite slowly over to steam power down to 1820 and then switched from waterpower to coal more rapidly thereafter: by 1835


coal was providing power for three-quarters of the cotton industry in England and Scotland.\textsuperscript{31}

The cotton industry was negligible in the middle of the eighteenth century, but on the back of a series of ground-breaking inventions it rapidly grew to become one of Britain’s largest sectors. With much of this growth accomplished without the use of coal, the industry provides a powerful reminder of the extent of growth that was possible within an organic economy. Yet the cotton industry also brings into sharp relief the distinguishing features of both the organic and the inorganic economy, and lends considerable support for arguments that stress the necessity of tapping new sources of fuel. A combination of revolutionary technical change and traditional power sources had permitted extremely rapid growth in the cotton industry during the eighteenth century, and no doubt some further growth along these lines might have been achieved in the nineteenth century. But so long as the cotton industry’s machines were powered by waterwheels, there was a limit to the extent to which it could expand. Steam engines provided a way out of this impasse, and their use thereby raised the ceiling for growth. It is perhaps significant in this respect that the application of coal and steam did not revolutionise the industry’s rate of growth: cotton inputs expanded approximately tenfold in the second half of the eighteenth century; they expanded by roughly the same again in the first half of the nineteenth.\textsuperscript{32} The significance of coal to the cotton industry, therefore, lies not in enabling a marked rise in the rate of growth but rather in enabling continuous growth.

Although few industries were transformed by steam engines by quite the same extent as the cotton industry, the spread of steam was not confined to cotton. From about the 1830s, steam engines began to proliferate throughout the rest of the textile industry (woollens, worsteds, silks, linen) and beyond. By 1870, the textile industries combined consumed only about one third of the power used in British industry in 1870. As over ninety percent of power was provided by steam engines in 1870, it follows that the remaining two-thirds of the manufacturing sector must also have depended very heavily upon coal. Few sections of the manufacturing economy were entirely untouched by steam power by this point: iron and brass production; metalworking; machine-building; leather-working; chemicals; food processing; paper-making; brick-making; and construction were just some of the nation’s major industries heavily reliant on coal. A few of these had switched to coal in the eighteenth century, but for most the switch was delayed until the coming of the steam engine in nineteenth. Thus whilst the use of coal in industry was not itself a new phenomenon, the nineteenth century nonetheless marks a departure from existing trends in terms both of the quantity of coal used and the pervasiveness of its use throughout the manufacturing economy.

The development of transport during the Victorian era embodies many of these themes and provides perhaps the clearest evidence of the power of new fuels and


\textsuperscript{32} Daunton, \textit{Progress and Poverty}, table 3.d.i, 3.d.ii, pp.585-7
new technology to revolutionise the traditional ways of doing things. At the beginning of the nineteenth century, goods and passengers were moved around the British Isles by winds, tides and horses in much the same way as they had been for hundreds of years. Admittedly, waterborne transport had been significantly improved in the eighteenth century with the building of canals, yet as freight was moved along the canal network by horses, the canals did not mark a decisive break with existing forms of transport. The nation’s entire transport network was transformed, however, with the advent of the railways and steam-shipping. Furthermore, in common with many of the breakthroughs of this period, these new forms of transport required not only large inputs of coal but also the development of new technologies in order to utilise coal in the movement of goods and people.

Consider the railways. Railways and engines had both developed long before the Railway Age, and Victorian achievements drew heavily upon these existing technologies. In the eighteenth century, the owners of coal mines commonly laid tracks to transport heavy loads around their mines; they also used engines to pump water from their mines. Yet no one had invented a way to use coal-fired engines to move freight along tracks, so men, horses and gravity were used to move wagons instead and engines were confined to pumping. Before coal could be used for locomotion, a series of exceptionally complex technological difficulties had to be overcome. First the existing steam engine needed to be adapted to provide locomotive power, a feat first accomplished by Richard Trevithick in 1804. Then it was necessary to engineer tracks capable of withstanding the weight of a steam engine: Trevithick's engine broke the cast-iron tracks over which it ran, and these needed to be substituted with wrought iron and redesigned before a system of steam-driven engines and iron rails became feasible. Finally, the early locomotive steam engines ran too slowly to have wide use, and it was not until George Stephenson’s work in the 1820s that a lighter locomotive capable of pulling at speed was developed. His ‘Rocket’, it is worth recalling, was something like the seventieth railway engine to be built, and was in turn soon superseded by new designs. Clearly, coal on its own was not going to revolutionise transport: yet the combination of coal and technological innovation unlocked new and previously unimaginable possibilities in the world of transportation.

Piecing together the themes that we have looked at in this chapter it becomes possible to construct a coherent account of Victorian industrialisation. Victorian industrialisation was effectively a combination of two separate forces – new fuels

and new technologies. Coal had always lain under British soil, but it could only be made economically useful by the application of new technologies. Furthermore, whilst this process was certainly underway during the eighteenth century, it gained considerable and unstoppable momentum during the nineteenth, owing largely to refinements to the steam engine which made possible the application of coal across industry and transport.

We have been thinking about the nature and causes of Victorian industrialisation. Before closing, however, it is important to consider the consequences of industrialisation. The combination of new fuels and new technologies led to significant changes in working patterns, life-styles, landscape and social geography. Furthermore, whilst some areas were undoubtedly touched to a far greater degree than others, the reach of industrialisation was wide and very few corners of Britain were left untouched by the process by the end of Victoria’s reign. So let us in conclusion look at these effects and explore some of the myriad ways in which industrialisation permanently altered the fabric of British society.

Part of the difficulty evaluating the outcome of the industrial revolution is the sheer variety of different forms that industrial development took. Even confining our attention to those regions most obviously transformed by the growth of manufacturing, it is clear that considerable diversities existed, as new industries tended to cluster together giving rise to discrete industrial regions each with their own unique characteristics. South Lancashire, for example, was dominated by the growth of the textile industry, cotton in particular. This in turn led to the rise of several large and medium-sized towns – Manchester, Preston, Blackburn, Burnley, Rochdale, Wigan, Oldham, Stockport, and Bolton. With the proliferation of steam in the second quarter of the century, production became concentrated in large factories, giving rise to a uniquely large, urban, factory workforce, unprecedented in both British, and world, history. In Birmingham and the Black Country, by contrast, the metal working-industries predominated. Metal-working largely remained a cottage industry throughout the century, with production based in small domestic workshops and relying upon hand-held, rather than mechanised, tools. This created, in effect, an industrial district almost entirely lacking the great factories that have tended to dominate our ideas about the industrial revolution. In South Wales and the north east, industrialisation took yet another form. As in Lancashire and the Black Country, there was a sizeable coal-mining industry: in addition, however, both regions also possessed iron deposits, which caused heavy industry to grow in tandem with the mining industry. These regions saw the emergence of number of very large concerns combining coal mines, iron mines, furnaces and refineries, employing thousands of workers across a wide range of production processes. The Central Belt of Scotland combined many of these characteristics, with the development of the cotton and wool industries, as well as heavy industry in the form of coal-mining, iron foundries, ship-building and steel. In each of these areas, the occupational structure of the population was highly distinctive with low numbers

working in agriculture and high numbers working in manufacturing, mining, and the service industries. At the same time, however, industrialisation was not a monolithic process; it could, and did, take many different forms.

No less significant than the evident diversities between Britain’s industrial regions, was the partial and incomplete nature of the industrialisation process. It is clear that different parts of Britain were affected by industrialisation to different degrees. Large parts of rural Britain did not experience its most obvious outward manifestations: they possessed no mines, few factories, and no great cities, and agriculture rather than industry remained the primary employer. At the same time, however, it is doubtful that such areas were left entirely untouched by industrialisation. Studies of occupations suggest that considerable change was occurring in rural areas throughout the nineteenth century, with a pronounced shift of workers out of agriculture and into the manufacturing and service sectors of the economy. And even those remaining in agriculture frequently encountered significant changes to their working patterns owing to the growth of large farms and the gradual introduction of harvesting, threshing and reaping machines. Furthermore, improvements to agriculture and transport all contributed to a lowering of the cost of food and helped to free labourers from the land to work in the new industries. By the Victorian era, the British economy was complex and interconnected, and the effects of rapid industrial growth in some districts inevitably rippled out to the rural regions as well.

At the same time as the emergence of new working patterns, there were significant shifts in population. Prior to the Victorian period, the south of England had been the most populous and prosperous part of the country. Defoe, writing in the early eighteenth century, had considered that the counties south of the Trent were ‘infinitely fuller of great towns, of people and of trade’. Throughout that century, most fairs took place south of a line drawn between the mouth of the Severn and the Wash, and one historian has concluded that ‘the greater weight of economic activity still lay to the south’.39 But the movement of large numbers in the eighteenth and nineteenth centuries out of agricultural counties and into industrial ones reversed the economic significance of north and south. Gerard Turnbull has observed that population was moving toward the coalfields: ‘migrants flocked to jobs of all kinds, in traditional as well as new industries, on the coalfields. Population gathered there in concentrations far in excess of previous levels’.40 Migration to cities in the north and the Midlands, as well as to the rural-industrial hinterland around many large towns, created a strip of relatively thickly populated areas running from south Lancashire, across to west and south Yorkshire, and down through Nottingham and Leicester to the west Midlands. In Scotland, population congregated in the Central Belt, running from Greenock and Glasgow in the west across to Edinburgh in the east. Victorian industrialisation, therefore, produced a fundamental shift of population away from southern agricultural areas to northern urban and industrial areas and significantly altered the human geography of Britain.

40 Ibid., p.556.
Alongside these demographic changes, developments in transport also had far-reaching consequences throughout the broader economy and society. Although recent attempts to measure the economic significance of the railways have suggested that their overall contribution to the growth of GDP was more modest than an earlier generation of historians sometimes assumed, it is nonetheless clear that the railways had a sizeable impact in many spheres of economic activity. The building of railways and locomotives, for example, called for large quantities of heavy materials, and thus provided a significant stimulus, or ‘backward linkage’, to the coal-mining, iron-production, engineering and construction industries.\(^{41}\) Railways, alongside other improvements to roads and waterways, helped to reduce transaction costs, which in turn lowered the costs of goods: the distribution and sale of perishable goods such as meat, milk, fish and vegetables were transformed by the emergence of the railways, giving rise not only to cheaper produce in the shops but also to far greater variety.\(^{42}\) Furthermore, the emergence of the railways encouraged the development of new ways of doing business. From the outset, railway companies were unusually large by contemporary standards. In 1850, all of the largest firms listed on the Stock Exchange were railway companies: they controlled a vast amount of capital in the form of tracks, bridges, tunnels, stations and locomotives and employed a large and dispersed workforce. As such, they posed formidable organisational challenges and triggered the creation of more sophisticated business practices. Finally, by improving personal mobility the railways were a significant force for social change. Rail transport had originally been conceived as a way of moving coal and industrial goods. One of the first stretches of public railway – the Stockton to Darlington Railway opened in 1825 – had been intended as a coal line serving a number of the region’s many collieries: passenger carriages were added to the service only as an afterthought. Yet of course, the railway operators quickly realised the potential for market for railway travel, leading to an extremely rapid expansion in passenger services. The number of railway passengers trebled in just eight years between 1842 and 1850: traffic volumes roughly doubled in the 1850s and then doubled again in the 1860s.\(^{43}\) As one historian has noted, ‘in terms of mobility and choice they added a new dimension to everyday life’.\(^{44}\) The railways brought not simply cheaper goods and services they also promoted greater personal mobility and freedom. In a number of ways, therefore, the railways, were integral the emergence of an ever more complex commercial and social world.

Defining the British industrial revolution as a shift from an organic to inorganic economy provides a model for industrialisation that may applied in other times and places. The precise path that each country takes to industrialisation will always be

---


\(^{42}\) Aldcroft, ‘Railway age’, p.75.


\(^{44}\) Aldcroft, p.75.
unique. Factories, small workshops, and cottage looms; revolutionary inventions and small scale technological improvements; cities, towns, and villages – all will have their place in pathways to industrialisation. Whatever the exact form that industrialisation takes, underpinning the process is the harnessing of new sources of energy. These might be new resources (coal and oil), or new technologies (dams or nuclear power), or some combination of the two. In the process the age old conflict between human needs and industrial production is finally broken, and the door is pushed open for society to move forward into a new era of sustained economic growth. Emphasising the pivotal role played by coal not only provides a remarkably coherent and compelling explanation for Britain’s industrial revolution, it also helps to explain the spread of industrialisation across the globe. Finally, when industrialisation is conceived in this way it also becomes clear that the industrial revolution, though it drew upon earlier achievements, was in fact a Victorian achievement. The eighteenth century was a period of sustained economic growth, but for most of this period manufacturers adhered to the old ways of doing things. It was only when a more widespread switch to coal occurred within industry that industrialisation can be said to have occurred, and this switch, as we have seen, was largely delayed until the Victorian era.