PART I

INDUSTRIAL GROWTH AND POPULATION CHANGE
I. THE ARGUMENT

It is a commonplace that coal was the basis of the industrial economies of Europe and North America during the later nineteenth century. It was the common nexus connecting the various aspects of industrial change at that time. Almost every industry which was transformed by the Industrial Revolution became a consumer of coal, both directly as a fuel, and indirectly because coal was used in the manufacture of its equipment and the transport of its raw materials and end products. In particular, coal was indispensable in the use of the two most important of all the technological inventions of the new age: the steam-engine and the coke-fired blast furnace. These were the two developments which more than any other made possible the unprecedented expansion of industrial production which took place during the second half of the nineteenth century; and both were enormous consumers of coal.

It is further a commonplace that as an industrial raw material coal was exceptional in two ways. It was exceptional in the quantity which was consumed—no other industrial raw material was used in comparable amounts; and in that it is the classic example of what Weber called a ‘gross’ material: a material which is consumed as it is used. Because of the weight of coal required by industry, and because of its ‘grossness’, any industry in which coal was a major item in factor cost of production was strongly pressed to seek a coalfield location. Every mile away from the source of coal meant added costs of production for such industries. There was, therefore, a very rapid growth of industry and of industrial population in the coalfield areas in the early decades of the new era.

The broad outlines of the changes which took place are not in doubt. They follow from an elementary knowledge of the nature of the changes, and from the first principles of economics: but the rigorously with which any abstract theory of the nature of the changes was obeyed in the hurly-burly of economic life; the nature of the influence of local conditions on the size, type, and speed of growth of industry; the importance of national differences in influencing rates of growth in similar areas in two neighbouring countries; and the effect of the growth of industry on the size of local industrial populations, have not often been carefully examined, perhaps for the very reason that the general shape of the relationships is widely accepted. The first part of this study is taken up with questions of this nature.
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The belt of coalfield industrial areas stretching in a shallow arc from Pas-de-Calais in the west to the Ruhr in the east provides a good subject for the study of these questions. Within it was to be found most of the Belgian heavy industry, more than half the German, and a substantial share of the French. At the end of the nineteenth century these coalfields (which throughout will collectively be termed the Austrasian coalfield since they lack a general title) provided the entire Belgian output of coal, and more than half the output of both France and Germany. This was by far the most important industrial region in continental Europe. In heavy industrial production only England and the north-eastern United States were of comparable importance.

The period covered is the half-century between c. 1850 and 1914. The general introduction of the coke-fired blast furnace and the steam-engine into industrial life suggests a beginning for the period. By the middle of the century both were known and used in all parts of the Austrasian field. Coal was rapidly changing in its industrial character from being a useful adjunct to some forms of industrial production to being the sine qua non of most modern industrial establishments.

The importance of the steam-engine lay in its provision of power on a scale far greater than any which had previously been available for industrial purposes. Before its introduction most of the power needed to work the machinery and tools of industry came still from the worker’s hands, wielding the hammer at the forge, cutting the metal sheet, thrusting the shuttle across the loom, hauling the rope. In a few industries water power was important (for example, in the new cotton spinning mills, and in some sectors of the iron industry). Occasionally either wind or animal power was used: but, in general, industrial power meant man power. There were strict limits to the possible expansion of industrial production when this was the case: with the steam-engine there was almost no limit to possible growth. One man might have the power of ten, a hundred, even a thousand at his touch; and his productivity moved into a different dimension from that of his forebears. Steam power greatly magnified the productive power of changes of technique already sketched in miniature. It brought to a new fruition the ideas embodied in inventions of several centuries past in the haut-fourneau, the forge-hammer, and pumping and haulage in mines; or of more recent times in the mule, the jenny and the mechanical loom. The steam-engine spread from industry to industry as machines were invented to simulate the movements of the human hand in a hundred trades and crafts. Wherever there were wheels to turn, holes to punch, regular or eccentric movements to be performed; wherever the

1 The name is suggested, of course, by the old division of the Carolingian Empire.
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application of a great pressure was required, the steam-engine could be harnessed to do the job more quickly, more accurately, and on a vastly greater scale than had previously been possible. Many operations which were not feasible before became possible when such power was available. Levasseur expressed the new situation in France forcefully and picturesquely. He wrote, ‘En effet, si, conformément à l’évaluation de l’administration des mines, on estime le travail d’un cheval-vapeur comme équivalent à celui de 21 manœuvres, on voit d’une part, qu’en 1840 l’industrie et le commerce disposaient de 1,185,000 manœuvres de cette espèce dont le travail ne coûtait que de la houille—qui étaient de véritables esclaves, les plus sobres, les plus dociles, les plus infatigables que l’imagination puisse rêver; d’autre part, qu’en 1885–7 leur nombre s’était élevé à près de 98 millions: deux esclaves et demi par habitant de la France.’ In almost all industries coal consumption grew rapidly. In the lighter industries this might not in itself be sufficiently important to enforce a coalfield site for the successful development of the industry; but a firm with an abundance of cheap coal at hand was clearly at an advantage, and might be encouraged to install modern machinery because of the cheapness of the fuel.

The introduction of coke firing into blast furnace practice was of equal significance, permitting for the first time the cheap production of iron on a very large scale. By 1850 this method was known in all parts of the Austrasian field, though in the less advanced areas in the east it had not by then supplanted the charcoal furnace as the chief source of iron supply. Iron was essential to modern industrial growth because of its physical properties: it could be very accurately worked, was rigid and durable. For most of the requirements of the new mechanical industries it was a much more suitable material than its predecessor, wood. It was as vital to the development of modern transport as to industry. ‘Sans fonte, ni fer, ni rails, ni locomotives, ni steamers: c’était l’isolement des marchés, l’impossibilité de développer les échanges.’ Iron had long been in demand for many industrial uses; but as long as furnaces were charged with charcoal it could never become plentiful or cheap. To produce iron with charcoal on a scale to meet the needs of the later nineteenth century would have denuded the forests of western Europe within a few decades.

Together with the steam-engine, the coke-fired blast furnace helped to liberate industrial production from the bounds set by the techniques of the past, and raise it into a new realm of high production. Iron was the skeleton of modern industry, just as the steam-engine formed the muscles

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of the new giant. Both required coal in large quantities: each emphasized the advantages to be gained from a coalfield site.

Between the middle of the century and 1914 industrial growth was rapid throughout the Austrasiain field industrial area; population grew swiftly; it was the classical period of coalfield growth, unbroken by any prolonged war, and unmarked by any technological innovation which seriously threatened the industrial supremacy of the coalfield area. Towards the end of the period there were signs of changing circumstances. The generation of thermal electricity made power almost as cheap at a distance from the coalfields as within the older industrial areas. Hydro-electric power and oil, though not absolutely of much importance, showed that in future coal would have rivals as source of industrial power. Transport costs had fallen very substantially since the early days of coalfield industrial growth, and coal was used much more efficiently, a combination of trends which reduced the saving in production costs attending a coalfield location. For example, a point was reached about 1890 when it became cheaper to carry coke to the Lorraine iron ore fields than to carry the ore to the Ruhr, because blast furnaces had grown much more economical in their use of coke than in the early days of the coke-fired furnace, and the lean ores of Lorraine were unusually costly to transport. None of these new developments, except perhaps the last, had made serious inroads into the economic strength of the coalfield areas, or undermined their unique advantages before 1914: but they, and a host of changes arising out of the dislocation of economic life during the war, combined to produce a very different European economy in the inter-war period. The outbreak of the First World War, therefore, makes a convenient end to the period within which the characteristic features of the regional growth of coalfield industry and the relation between industrial growth and population changes can best be explored.

Although the close links between coalfields and industrial growth are well known, some aspects of the tie deserve a closer review as background to later discussion.

The concentration of new industrial development in the coalfield areas has frequently been remarked, and the reason for it is generally understood: that coal is perhaps the most transportempfindlich of all industrial raw materials. The fact that coal is bulky, heavy, and used in very large quantities necessarily means heavy expense if it is transported over any distance to the point of consumption; but this is less important than its nature as a raw material. If the full weight of the raw material is embodied in the product there is no saving in the total cost of transport when the
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source of the raw material is also the point of manufacture: but if a part or the whole of the weight disappears during manufacture, the saving in transport costs which follows from manufacture at the source of the raw material may be considerable. Two very simple examples in the primary processing of raw materials may serve to illustrate the point. The milling of grain into flour is an example of the first case: the product is almost as bulky and heavy as the raw material, less amenable to bulk handling, and more likely to deteriorate or be damaged in transit. Processing at the point of origin is, in consequence, not usually desirable when economic considerations govern policy. On the other hand, in the treatment of non-ferrous metal ores, such as copper, there is a great saving in transport costs if the concentrating is done near the mine, for the metal content may be only one or two per cent of the ore body. Coal is a still more extreme example than copper ore since its whole weight disappears when it is used as a fuel:¹ but it is far from being as simple a case as corn and flour, or copper ores and concentrates because it is the source, not of a substance to be further processed or sold, but of power and heat: and power and heat were needed by almost all industries in some degree.

All industries were not, of course, equally dependent on coal. Some were large absolute consumers and yet not closely tied to coalfield areas because coal was not an important element in factor cost of production. The textile industry of the period is an example of this. A small percentage saving in labour costs (which were a much more considerable element in factor cost) obtained by establishing a factory a hundred miles from a coalfield might reduce total production costs, even though hundreds of tons of coal were used each year and coal prices were doubled by its distance from the field. At the other end of the scale, in the iron industry, coal was usually more than a quarter of the factor cost of production. Other things being equal, to erect a blast furnace a hundred miles from the nearest source of coking coal would greatly increase the cost of production: things were seldom so unequal as to justify this. The great majority of the new blast furnaces were, therefore, erected in the coalfield industrial areas. In this connexion the absolute level of transport charges is very important. At one extreme, if there were no charges for the transport of coal, its nature as a ‘gross’ material would be irrelevant, and there would be no especial advantage in a coalfield site. At the other extreme, exceedingly high transport charges would make it very difficult for any coal-consuming industry to establish itself away from the coalfields. In the mid-nineteenth century the new railway networks, over which most of the coal moved, were only just taking shape on the Continent, and charges per

¹ Economically, if not chemically.
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...ton-kilometre were several times higher than at the end of the century. These were the formative years of the coalfield era, and the scale of transport charges was a strong reason for seeking a coalfield site.

Although the advantages of coalfield location were less pronounced in the case of the lighter industries, indirectly such industries might benefit greatly. As a large, experienced industrial population grew up on the Austranian field and a wide range of service industries developed, many types of industry shared in the dramatic upsurge of production in which the heavier industries led the way. A close transport net, good water supply, developed banking and commercial services, and a large local market proved a strong attraction. The rapid growth of all industries in the coalfield areas is an excellent example of the well-known 'snowball' effect of marked and sustained prosperity and expansion in one group of industries upon all other economic activities in the area.

The presence of coal was of cardinal importance to rapid industrial expansion. Where it was cheap and abundant the portents for swift growth were encouraging. If such a condition were fed into an economic model reflecting the salient economic characteristics of the period, the result would be vigorous expansion.

Not all coalfields, however, were equally stimulating to industrial growth. Within the Austranian field there were half a dozen major coal-producing areas; some well endowed, others with poor or inaccessible resources. Coal was everywhere a cheap raw material, costing usually between five and fifteen shillings a ton during the half-century 1850–1914: but it was much more expensive in the poorer areas than in the richer ones. Pithead coal prices in the Belgian part of the field, for example, were often more than half as much again as in the Ruhr: but coal did not move from the cheaper to the dearer areas, because the cost of transporting a ton of coal from the one to the other much more than wiped out the price differential. Each division of the Austranian field, therefore, in so far as coal influenced its economic life, followed a separate destiny. This is a point of the first importance. In areas where coal was plentiful, of good quality, and easily mined, production might be rapidly and cheaply expanded as demand grew; whereas the reverse was true of the more poorly endowed areas. The low-cost coal-producing areas could not gain a foothold directly in their rivals’ territories by winning markets for their coal within their rivals’ boundaries. Their advantage told indirectly through the more rapid growth of industry in areas which flourished on cheap coal. It was to be expected that the better-endowed parts of the Austranian field would grow more quickly. If it can be established that the pace of indus
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trial growth in the major divisions of the Austrasian field varied in direct accord with the abundance or poverty of their endowment of coal, then an analytic tool of some power lies to hand. New light is shed upon the reasons for rapid growth in some parts of the field and comparative stagnation in others. Furthermore, the part played by national or other influences upon their economies may be inferred from the extent to which the development of the several divisions of the field diverges from what might be expected on theoretical grounds.

The argument used in the last paragraph is essentially the same as that used by W. S. Jevons in his book *The Coal Question* published almost a century ago. Jevons’s fear for Britain’s industrial future arose from his belief that coal production tended to grow by geometrical progression parallel with general industrial growth. He considered British coal reserves too slight to sustain this type of growth much longer without an enormous increase in costs of production; and discussed the prospects of her chief rivals in terms of their coal resources. He thought it likely that those best endowed with coal would prove the most formidable rivals. His argument depended upon a high degree of mobility in the factors of production other than raw material resources. Only when capital and labour are willing and able to move to exploit superior resources in raw materials, and when markets are equally accessible after such a move, can the potential advantages of the superior raw materials be realized. Since the Austrasian field areas were close together geographically and had a long history of interchange of men and money, this is a less rash assumption in the present context than in the context of Jevons’s discussion; but it is still an assumption. An effort will be made to justify it in the later chapters of this section.

The connexion between conditions of coal mining, the rate at which coal production expanded, and general industrial growth forms one main theme of this section. The other is the link between industrial activity and population growth; for, just as the whole range of industrial activity on the Austrasian coalfield had a nexus in coal on the one hand, so on the other it was reflected in the size and rate of growth of industrial populations. These two are the most convenient tools available for the type of regional analysis which is the main concern of both parts of this book. Together they make possible both the comparison of different parts of the Austrasian field, and the comparison of each national section of the field with the national whole of which it is a part.

An example drawn from Blanchard’s study of the Nord department will serve to illustrate the intimate connexion between industrial activity
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and population growth. The population of the group of communes near Armentières, which was the heart of the French linen manufacture, rose slowly during the first forty-five years of the nineteenth century, increased sharply in the next thirty years, and then reverted to a more sedate rate of increase in the last decades of the century. The period of most rapid growth coincides with the period when the Belgian linen industry was in full decline after a crisis in the 1840s as a cottage industry. The decay of the cottage industry of Belgian Flanders was the opportunity of the factory production of the Armentières entrepreneurs. Their success is clearly reflected in the record of population growth of the area (as a complement to the spurt of population in and near Armentières, the populations of East and West Flanders grew slowly, or, in the worst years, declined in the crisis period). In contrast to the history of the Armentières group of communes, the rate of increase in the nearby wool manufacturing communes of Roubaix-Tourcoing showed no such time of unusually strong advance, but instead pursued a steady, even course throughout the century. In other words, the mid-century burst of the Armentières area was not simply a part of a similar acceleration of growth throughout the whole Lille textile area, but can be attributed to its successful rivalry with the Flanders linen manufacture.

The sensitivity of populations dependent upon industry to the changing industrial fortunes of an area, of which the above is a crude example, is of the first importance to the argument of the first part of this study. One of its main objects will be to attempt to relate the size and rate of increase of coal production to the total industrial production of an area and its rate of increase, as a basis for the discussion of regional differences. The most direct approach to this task would be to measure the total physical volume of production and/or its total value in each separate major division of the Austrasian field, and to set the results against the coal production material. Though desirable, this is not practicable. Production series for such small areas do not exist for all classes of production. Such series as do exist are seldom uniform throughout the period, for the constant tension between the desire to perfect the bases of each series and regret at introducing a break into it, which is the bane of the statistician, led to frequent changes during the half-century. In addition there is the difficulty of equating differing national statistical definitions.

The problem, therefore, has to be tackled indirectly through the measurement of industrial populations. If it can be shown that industrial populations grew in an intelligible relationship to increases in industrial

1 R. Blanchard, La Densité de population du département du Nord au XIXe siècle (Lille, 1906).
production, then they may be used as substitutes for it for certain purposes, and it becomes possible to examine the problems touched on above, in a framework of regional rather than national analysis. Population returns for each of the three countries during the half-century after 1850 were regular, and fairly accurate: and unlike most statistical series it is possible to compare returns from one country with those from another without so many problems of definition as bedevil the comparison of industrial statistics. The counting of heads is a simpler affair than, say, the definition of an employee in the textile industry. Coal and population series are the warp and weft of the tapestry upon which the picture of coalfield industrial growth will be woven in the next four chapters. They form the two great nexus of industrial growth on the Austrasiian field. Their use permits some interesting possibilities of regional analysis to be explored.

The Austrasiian field may be divided up in several ways for the purposes of a regional analysis. The simplest is to separate only those areas which are geographically discontinuous. In this case there would probably be five divisions—the Ruhr, Aachen, Liège, the Hainaut fields, and the French group serving the Lille textile area and the Valenciennes metal communes (the last might perhaps be sub-divided). This system of division has much to commend it, especially as it is easy to obtain the necessary statistical information about each of the five divisions. Yet for the purposes of this essay, a division into eight areas has been preferred because the wider range of examples provides a better test for the techniques used, and illustrates more fully the characteristics of coalfield industry during this half-century. One limiting factor upon the choice of units is that they must be areas for which information about coal production and population growth is available throughout the period, or at least for all but the earliest years. With this limitation in mind, the Ruhr has been divided into three; Regierungs-bezirke Arnsberg, Düsseldorf and Münster (in effect Kreis Recklinghausen); and the French area into two; Nord and Pas-de-Calais, making eight divisions in all. These eight divisions provide a fair sample of the several different ways in which coalfield industrial areas developed.