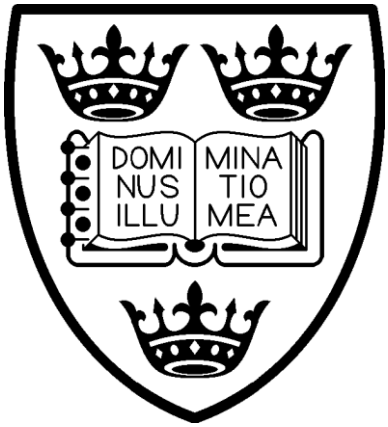

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BRITISH AND EUROPEAN INDUSTRIALIZATION

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Abstract

Modern economic growth – the simultaneous increase in population and average incomes – has been capitalism's greatest achievement. This growth first became apparent in Britain in the nineteenth century and then spread to continental Europe (and the United States). The process is usually associated with the Industrial Revolution in Britain and the spread of British-type industrialization to follower economies. This chapter reviews the emergence of modern economic growth and suggests that the usual view is misleading in that it focuses is too limited both in time and in the technological change it usually emphasizes. On one hand, the of famous industries – textiles, iron and engineering – contributed only modestly to growth because they constituted only a small proportion of the economy. Furthermore, the emergence of growth was much more gradual than traditionally understood. In new views, Britain was already a substantially industrialized economy with relatively high wages before the early eighteenth century. The origin of growth appear to lie in the ability of an economy in which both product and factor markets were well developed in both the rural and urban areas to partially overcome Malthusian constraints. The spread of growth to continental Europe is often seen as the spread of new technology of the British Industrial Revolution. This too seems somewhat misleading. The industries were small relative to the entire economies and their success depended on particular conditions. Furthermore, just as Britain's early success rested importantly on productive capitalist agriculture, the emergence of increased incomes on the continent depended on agricultural reforms that increases in its productivity.

Modern economic growth – the simultaneous doubling of income and population in fifty or seventy years –has been capitalism's greatest triumph. It first became apparent in Britain in the mid-nineteenth century and spread to America and continental Europe. Modern growth did not, however, spread elsewhere and a great divergence developed between income per capita in the few leaders and the rest (Figure 14.1).

It is common to attribute modern growth to the factory-based industrialization that emerged from British inventions in textile production and steam power in the later eighteenth century – the Industrial Revolution, represented dramatically by the patents of both Richard Arkwright's water frame for the mechanical spinning of cotton thread and James Watt's improved steam engine in 1769. These inventions created an explosion of urban factory-based industry particularly in textiles that made Britain the "workshop of the world" by the 1850s. By that time British factories provided some two-thirds of the world's output of "new technology industries" (Bairoch 1982, p.288). Growth seemed to be the product of novel urban factory-manufacturing and the social changes that it brought about. Marx and Engels starting with the *Communist Manifesto* in 1848 put forward a forceful theory of economic growth in which "the class of modern capitalists, owners of the means of social production and employers of wage labor," occupy center stage as the agents of disruptive but productive change (Marx & Engels 1848, chap.1). The spread of modern economic growth is usually seen as the spread of the British factory system to continental Europe and America. Marx remarked 'the country that is more developed industrially only shows, to the less developed, the image of its own future.' (Marx 1867, p.ix). Economic historians, however, now question the closeness of the connection between urban factory industrialization and the emergence of modern economic growth. Estimates of overall income show modest connection with the

famous industrial breakthroughs. Britain was already relatively rich when the Industrial Revolution occurred and the innovations that created urban factory industrialization were the product of the already advanced economy. Similarly, incomes in continental Europe in the nineteenth century are not well explained by adoption or non-adoption of the technology that Britain pioneered.

The emergence of Britain's modern economic growth depended more on a long history of capitalism than on the Industrial Revolution. British capitalism, involved in large measure in enterprises of modest scale and created institutions – particularly markets – that supported efficient allocation, and reallocation, of resources and provided incentives consistent with wealth accumulation and innovation. As Chapter 1 pointed out the displacement of custom and command with durable and long lasting markets was potentially of key importance. Goods and factors markets were well-established in the late medieval Britain and Holland and persisted through the following centuries. These societies developed an economic lead that was apparent by the sixteenth century and rested on agricultural productivity and efficient service industries as much as on industrialization. The emergence of growth in continental Europe in the nineteenth century depended less on the spread of British-style industrialization and more on the spread of British-type capitalism and the institutions that supported it. Rising productivity across the economy created growth; excessive concentration on the spread of factory manufacturing overlooks much of a broader process.

The British Industrial Revolution

Estimates of aggregate economic activity underlie understanding of the beginnings of modern economic growth. Early quantitative analysis of the growth of British national

income appeared to support the traditional view of late eighteenth century inventions creating an Industrial Revolution (Hoffmann 1955; Deane & Cole 1967). Deane and Cole's systematic use of the early censuses to estimate national income showed per capita income accelerated during the Industrial Revolution. Revision of the aggregate estimates since, however, has questioned sudden aggregate change arising from great factories of industrial capitalists. Some historians, most notably, Sir John Clapham who also drew on census data on occupations, had earlier questioned the representativeness of the new factory industries and the impact they had on the fundamental issue of raising standards of living. (Clapham 1926). Using Deane and Coles income estimates, D. N. McCloskey published a revealing calculation that suggested that technological advances in the "new technology industries" were insufficient to explain the acceleration of national income and concluded that technological change had become pervasive in early nineteenth century Britain, although it was still slow by twentieth century standards (McCloskey 1981, p.114). Views of a broader process of change and a revision of the timing of change were strongly supported when scholars revisited the pioneering estimates in the mid 1980s and concluded that Hoffmann's and Deane and Cole unconsciously exaggerated the discontinuity in the final decades on the eighteenth century. Harley pointed out that Hoffmann's estimate of industrial production index dealt with the incomplete coverage of manufacturing industries with an implicit assumption that other industries, in aggregate approximately the size of cotton textiles, shared cotton's exceptional growth following Arkwright's inventions (Harley 1982). Crafts re-examined Deane and Cole's extrapolation of nineteenth century census data into the eighteenth century and their conversion of estimates of income in current prices into real income and concluded that aggregate growth was substantially slower between 1770 and

1840 (Crafts 1976; Crafts 1985). The changes in the aggregate estimates are illustrated in Figure 14.2. Slower growth in the late eighteenth and early nineteenth century implied that eighteenth century Britain must have already been richer than we had previously thought and that nineteenth century income levels depended less on the famous technological breakthroughs.

Research (initially spearheaded by historians of the Asian economies (Pomeranz 2001; Parthasarathi 1998; Parthasarathi 2011) has also placed British and European economic growth in a broader framework. Multinational comparisons of economic performance are tricky even if data are extensive and much harder in data scarce historical circumstances. However, labor income makes up the majority of national income. It can also be reasonably argued that the well-being of ordinary people is the best indicator of societal well-being and their income is almost entirely labor income. It is also the case that labor income is the most readily available component of historical income because corporate, public and private bodies whose archives make up most of the historical record regularly hired wage labor. Scholars have collected this material for the earlier developers and increasingly for later developing societies. The records are, of course, not perfect indicators of societal well-being particularly as in many societies only a small part of labor income passed through organized labor markets. Nonetheless, wage data deflated by indicators of the cost of living provide us with significant insights into historical economic performance.

Prior to the nineteenth century, the balance between population and resources was the prime determinant of real wages. Figure 14.3 shows this clearly in the case of England. The fourteenth century Black Death which killed off over one third of the population resulted in a dramatic increase in real wages. Real wages declined to near pre-plague levels when

population eventual recovered, beginning at the end of the fourteenth century. Slower population growth after 1650 led to a rise of wages that ended in the mid-eighteenth century when population growth resumed. Only after the first quarter of the nineteenth century did increases in real wages accompany continued population growth – a transformation to modern economic growth which reinforces traditional narratives of transformation at the end of the eighteenth century.

Placing England's experience in the context of other European regions, however, reveals a different picture (Allen 2001). The Malthusian fall in real wages of the fifteenth century occurred throughout Europe but by the sixteenth century another dynamic appeared. In the North Sea economies – the Low Countries and England – real wages declined significantly less than elsewhere and in the early seventeenth century wages began to grow. This phenomenon, which Allen called the great divergence in European wages and Jan Luiten van Zanden the "little divergence," (to distinguish it from the great divergence between developed economies and the rest) directs attention to a period well before the classical Industrial Revolution.

Wage data are not as extensively available outside Europe and its off-shoots but research is beginning to fill the gaps (Allen 2001; Allen et al. 2011). Preliminary results show that in the eighteenth century real wages in major Asian cities were comparable to those in most of Europe with the important exception of the North Sea economies. European wages generally started to trend upwards in the nineteenth century but Asian wages declined until mid century and fell behind those in all but the poorest areas in Europe. The wage data challenge most economic historians' supposition that European incomes generally were superior to those in Asia in the early modern period and who have postulated general features

of European society as causes of modern economic growth. Perhaps we should not be surprised, however. Allen found that in most of Europe an unskilled laborer's real earnings fell in early modern times to below levels needed to support a modest family on the cheapest diet available (the unit (1) on the vertical axis of Figure 14.4 is the cost of supporting a family of a man, a wife and two small children on a bare subsistence diet primarily of oatmeal gruel or its equivalent).

Although long-run comparative data have made it clear that we need to take a longer and broader view of the process of industrialization, the Industrial Revolution between 1770 and 1840 remains important. The famous new technologies did not, in and of themselves, transform the economy, but they were early manifestations of the acceleration of the rate of technological change that characterizes modern growth. Most inventive activity undoubtedly arises from conscious search and successful technological improvement seldom emerges fully formed but rather requires expensive continuing research and development. Market conditions in late eighteenth century Britain greatly increased the likelihood that new technologies that substituted machinery, mechanical power sources and mineral fuels would occur there rather than elsewhere.

First, as we have seen, British workers earned higher wages than workers elsewhere (the Low Countries excepted). Second, only in Britain had coal been extensively mined and technologies for its use as residential and industrial fuel evolved ((Allen 2009b; Hatcher 1993; Nef 1932). Consequently, British manufacturers chose cost minimizing techniques that used capital and energy to save labor and British research and development had a machinery-using, fuel-intensive starting point. Elsewhere there was much less incentive to explore possibilities of this sort because firms were not currently employing coal-using and labor-

saving techniques. In addition, outside of Britain small improvements that used capital and fuel to save labor would not lower costs of production. It is hardly surprising, then, that the breakthroughs in machine-based cotton spinning, steam engines, and coke-iron production were British (Allen 2009b; Allen 2010).

Of course, the innovations in machine-based cotton spinning, steam engines, and coke iron production were not small improvements but massive breakthroughs. Arkwright's water frame – the most spectacular – reduced the price of coarse cotton yarn to about a third of its mid-eighteenth century by the early nineteenth century and finer yarn by much more (Harley 1998); Watt's steam engine revolutionized power supply; Cort's puddling-furnace and rolling-mill made coke production of wrought iron on a large scale profitable. Nonetheless, these changes modified existing practices adapted to high wages and cheap energy. While there seems to be no *a priori* reason to think that capital-intensive and energy-using techniques were more likely to generate technological breakthroughs than other techniques, it appears that for the past two centuries technological change has mostly clustered around improvements of techniques used in rich economies that employed capital, energy and raw materials intensively(Allen 2012). It is unclear whether this reflects the nature of possible technical improvement or identifies technologically advanced societies with advanced engineering skills and advanced capacity for innovation, and consequently high income levels.

The argument that machine technology emerged from a conscious search process undertaken by entrepreneurs experienced in using capital-intensive methods because they operated with expensive labor and cheap energy seems compelling. As an explanation as to how and why economies entered into the era of modern economic growth, however, it is

unsatisfactory. Crudely, Allen argues that Britain became richer in the nineteenth century because it was already rich in the eighteenth. This is likely true, but it begs the basic question: why was eighteenth century Britain rich? Just as national income estimates and comparative real wages drive us to consider earlier developments, so does the search for the sources of the technology of the British Industrial Revolution.

British prosperity: productive agriculture

Nineteenth century international comparisons provide insights into the sources of Britain's development leadership. The common perception is that economic advancement arose from superior productivity in modern manufacturing but when data allow comparison in the nineteenth century, Britain, although it pioneered the Industrial Revolution and developed a much larger manufacturing sector than its rivals, does not have much higher output per worker in manufacturing than France or Germany. Patrick O'Brien and C. Keydar (Keyder & O'Brien 1978) in their reinterpretation of French economic growth, estimated that labor productivity in French industry exceeded that in Britain during the first half of the nineteenth century by between ten and forty percent. These estimates may overstate the French achievement but Britain had little or no lead in industrial labor productivity (Crafts 1984a). Nonetheless, Maddison estimates of French per capita income for 1830 at barely over two-thirds the British level and Allen reports real wages in Paris as between half and three quarters of those in London. Similarly, comparison with Germany for later in the century yields similar results. Stephen Broadberry estimated that labor productivity in German manufacturing in 1871was 93 per cent of British manufacturing productivity even though GDP per worker was only 60 percent (Broadberry 1997).

A main determinant of Britain's higher per capita income was much higher productivity in agriculture. Low agricultural productivity characterized Europe outside the Low Countries. In Britain around 1840 (at a per capita income level of about $550, 1970 US dollars) the share of the labor force (25 percent) and the share of income (24.9 percent) in agriculture and extraction were very nearly equal. The average European experience at that income was an agricultural labor force share of 54 percent and an income share of 37 per cent. This implies that while output per worker in British agriculture was about the same as in the rest of the economy, the European norm of labor productivity in agriculture was only half of that elsewhere (Crafts 1984b; Crafts 1985). Broadberry finds that German agricultural productivity was 56 percent of British in 1870. The gap between agricultural productivity in Britain and the continent (outside the Low Countries) appeared between the early seventeenth century and the mid eighteenth century, well before the Industrial Revolution (Allen 2000).

The distinctive, highly capitalistic nature of British agriculture appears to have generated high productivity. In most of Western Europe the typical farm was a peasant operation with customary tenancy and family control of farm operations and labor input. In contrast the typical British farmer was an entrepreneur who rented land from a landowner, provided the farm's working capital and employed hired labor (Shaw-Taylor 2005; Shaw-Taylor 2012; Caird 1852). In older views improving landlords and enclosure of the open fields drove British agricultural change but research has firmly established that in the seventeenth and eighteenth centuries yeoman farmers on modest size farms initiated and adopted productivity enhancing changes in open-field villages as well as on enclosed farms (Allen 1992; Allen 1999; Allen 2009b, chap.3).Underlying driving forces cannot be firmly established but British agriculture's high level of market orientation both in selling its

produce and in organizing its inputs played a key role. This market orientation was longstanding, going back to medieval times and reinforced in the aftermath of the Black Death.

Robert Brenner' theory on the origin and nature of British agricultural precocity based in theories of capitalism provides a useful framework (Brenner 1976; Aston & Philpin 1987; Pamuk 2007). He saw capitalist farming evolve from late medieval class struggles. In Britain, the feudal elite became landlords with large land holdings and secure property rights. At the same time, all vestiges of medieval servile labor – where serfs were required to work on the lord's demesne – disappeared. Markets replaced customary and power relationships. Landlords had to compete for tenants to farm their land and tenants depended on the market for access to land. A regular agricultural wage labor market developed, particularly for young adults. Farmers who increased productivity were able to offer higher rents, hire labor and increase the size of their operations while less successful farmers gradually became wage laborers without the option of remaining family workers on customary tenancies.

In contrast, in most of Western Europe, particularly in France and the western Germany, late medieval change abolished un-free feudal labor, but failed to provide elites with clear property rights. Instead, direct agricultural producers gained control of the land on customary tenures from which they could be removed only with difficulty. The elites integrated into state structures and extracted resources through taxation. Incentives to increased productivity were much weaker than in England. Landowners had little opportunity to select successful tenants to increase rental incomes. Less successful farmers did not depend on a rental market for access to land. Consequently, it was much more difficult for successful farmers to acquire larger holdings and less productive peasants were much less

likely to be forced into wage labor. Customary relationships remained strong and family workers tended to remain on agricultural holding when marginal product fell below wages elsewhere in the economy because they had access to a share of the returns of the family agricultural holding.

The dating of the dominance of capitalist agriculture in Britain and its relationship to productivity advance is a matter of some dispute. The best documented evidence of the evolution of efficiency and agricultural structure comes from R.C. Allen's study of the South Midlands (Allen 1992; Allen 2009b, chap.3). He shows that the most impressive gains in agricultural productivity occurred between 1600 and 1750. Although he argues that these were the product of the family farm, his evidence shows the importance of capitalist agriculture. He defines three farm categories: peasant farms of less than 60 acres relying on family labor; capitalist farms over 100 acres, where hired labor dominated the workforce; a transitional category completed the taxonomy. In the South Midlands in the early seventeenth century, enclosures occupied about 17.5 per cent of all land and 90 percent of this was in farms over 100 acres (although most of this was in very large holding that may have been sublet). In open field villages land was approximately evenly divided among the three classes of farm size. Overall, farms over 100 acres occupied a little over forty percent of all land and the other classes under thirty percent each. By the early eighteenth century the proportion of enclosed land had nearly doubled to about a third of the total. The dominance of large farms on enclosed land had declined somewhat but they still occupied nearly three quarters of the land. Large farms gained ground in open field villages where they now occupied over half the land. Overall, large farms occupied nearly sixty percent of the land in the South Midlands around 1700. Medium sized farms that employed labor on a continuous basis occupied

another twenty percent of the land. Peasant families on the French model where the decision margin regarding the use of labor was the peasant patrimony and not the labor market farmed only the remaining twenty percent of the land (Allen 1992, pp.31, 73).

Recently, Leigh Shaw-Taylor has examined Allen's conclusion. He confirms that the data from the South Midlands appears representative of the English heartland although it cannot hold for all of England. He also finds capitalist farming reached to smaller farms than Allen supposed. The majority of farms between 20 and 30 acres in Buckinghamshire reported to the 1851 census that they employed at least one male worker on 31 March, a slack date in the agricultural calendar (Shaw-Taylor 2005). He finds that "in 1700 small-scale capitalism predominated in the south-east with three-quarters of the adult male agricultural workforce being proletarian" (Shaw-Taylor 2012, p.57).

It is perhaps strange that capitalist farming arose so strongly in England since in the early middle ages (11th and 12th centuries) feudal manorialism, where elites held non-market rights to labor of the agricultural population, was particularly strongly entrenched. In contrast, in the Low Countries, where capitalist agriculture and high productivity also emerged, manorialism was subverted by urban markets (Bavel 2010). Productive agriculture in both part of the North Sea economy emerged in conjunction with well-organized markets for factors of production (land, labor and capital). Product markets in peasant economies are common and developed in most parts of medieval Europe (see chapter by Persson in this volume). Markets for occasional labor are also common but very unusually a labor market emerged in the North Sea economies that played a primary role in labor allocation.

The underlying determinants of labor market development are hard to trace but it seem associated with another unusual feature of north-western Europe – the early emergence

of the European Marriage Pattern where newly married couples established a new household independent of the previous generation. The marriage union was consensual and brides were much older than typical in other societies. In late sixteenth century England brides were typically about 25 and grooms two or three years older. Elsewhere, marriages were usually arranged by parents, new couples integrated into families of the preceding generation and teenage brides typically married substantially older men. In late medieval England and the Low Countries young men and women left their parental home in their early teens to work for wages, usually in agriculture. They accumulated resources for about a decade and established independent households on marriage. Wage labor markets became well-established with young men and women forming the majority of participants. There is uncertainty as to the exact timing and extent of this market. Christopher Dyer has estimated that in fourteenth, fifteenth and sixteenth century England just under half the population was active in the labor market (and probably more in the most commercialized areas of the southeast) (Dyer 2005, pp.218–20). In the most advanced parts of the Low Countries estimates have up to sixty percent of the population dependent on wage labor (Van Zanden 2009; De Moor & Van Zanden 2010).

Markets for the sale and leasing of land also developed in late medieval Europe, first in Italy and then in the North Sea economies (although England's strong manorial tradition delayed its emergence somewhat). Modern short-term competitive leasing systems developed in parts of the Low Countries in the fourteenth and fifteenth centuries and perhaps a century later in England (Bavel 2008).

The precocious allocation of labor to manufacturing

A substantial portion of the English labor force was employed in manufacturing well before the Industrial Revolution. Deane and Cole's path breaking quantitative assessment relied heavily on social tables Gregory King constructed about 1690 as a starting point. They tentatively concluded that agriculture employed somewhere between 60 and 80 percent of the labor force (Deane & Cole 1967, p.137). Indispensable as he was as a starting point, King painted a misleading picture – "a nation consisting of just London and a vast, poor agricultural hinterland....England and Wales were almost surely more industrial and commercial than he has led us to believe" (Lindert 1980, p.707). Peter Lindert and Jeffrey Williamson modified this view (Lindert 1980; Lindert & Williamson 1982; Lindert & Williamson 1983) suggesting that King's time 56 percent of the labor force was in the primary sector (agriculture), 18 percent in the secondary (manufacturing) and 26 percent in the tertiary sector.(service). In this picture Britain was still a highly agricultural economy (Crafts 1985).

The Cambridge University Group for the History of Population and Social Structure (Shaw-Taylor & E. Wrigley 2008; Shaw-Taylor et al. 2010) are currently re-estimating eighteenth century occupational structure on the basis of information in a large number of baptismal records. Their preliminary results indicate that considerably fewer English men worked in agricultural and considerably more worked in manufacturing than even Lindert and Williamson's work suggested. The new estimates for about 1710 show agriculture and mining employed about 43 percent of the occupied male population and manufacturing employed 39 percent. Over the next century, the share of the labor force in agriculture declined only modestly to about 39 percent while the secondary sectors' share increased to

only 42 percent. These results strongly reinforce the conclusion that Britain was already well on the way to a modern economy at the beginning of the eighteenth century.

Although the great late eighteenth century innovations in textiles and in iron contributed to rising real incomes by lowering the costs of these products they do not seem to have greatly increased the proportion of the labor force in manufacturing. However, manufacturing concentrated geographically. In the early eighteenth century, Britain's secondary sector employment was widely distributed. The proportion of males in the sector in Northern counties (47 percent) was higher than in the agriculturally-advantaged Southern counties but the southern proportion was still 39 percent. By the early nineteenth century, industrial employment had concentrated on a crescent of counties running from the West Riding of Yorkshire through Lancashire then south and west to Glamorgan in South Wales. In southern counties, the proportion of manufacturing workers had declined by more than a quarter to 28 percent while in the North, principally in Lancashire and the West Riding, they had increased by close to 62 percent. The bulk of southern de-industrialization occurred in textiles. Male employment in clothing manufacture also declined significantly, presumably due to the rise of ready-made clothing manufacture in the East Midlands and a feminization of the trade (Shaw-Taylor et al. 2010). A second factor was replacement of charcoal-based iron production by coal-based technology that drew the industry to the coal fields.

Britain was already substantially an industrialized economy by the early eighteenth century. Manufacturing was widely dispersed and production units were still small. They, nonetheless, clearly produced for the market and were subject to competitive pressure. Textiles; clothing; leather processing; food and drink processing; and construction were by far the largest sectors, accounting for over three quarters of manufacturing in the mid-

eighteenth century (Harley 1982). Metal workers produced a wide variety of hardware and trinkets for consumer markets as well as tools for agriculture, construction and manufacturing. The high level of manufacturing production was a consequence of the relatively high income levels. Efficient agriculture released labor and there was consumer demand – even building laborers' incomes provided a margin above subsistence and artisans could afford modest luxuries including imported groceries, particularly sugar, tea and tobacco, and modest amounts of manufactured goods. The well-to-do, including a rising middle class, probably still constituted the major consumer market for manufactured goods.

Exports contributed importantly to Britain's industrialization. Crafts calculated that exports made up about 45 percent of manufactured output in 1801 (Crafts 1985, p.127). Exports of woolen cloth to European markets completely dominated British exports until the early eighteenth century. Manufactured goods continued to dominate exports during the eighteenth century but important diversification occurred. By the third quarter of the eighteenth century exports to the Americas nearly equaled exports to Europe and were widely diversified with woolen cloth only a little over a quarter while metal products made up nearly twenty percent and miscellaneous manufactured goods were nearly as important as woolens (Davis 1962; Davis 1979).

Competitive imperial expansion and mercantilism characterized the eighteenth century Atlantic Economy. Britain and France, and to a lesser extent the Netherlands, challenged Spain's imperial claims and established colonies in the Caribbean and the English developed colonies on the North American mainland (chapter by O'Brien in this volume). The colonial economies revolved around export staples (principally sugar but also tobacco in the English Chesapeake Bay) produced by African slaves. Mercantilist regulation reserved

the trade of each imperial power to its own subjects. In the mercantile contest the English did better than their rivals in developing markets for manufactured exports. Success did not arise from superior colonies in the Caribbean – the British islands were high cost sugar producers, unable to compete with the rapidly growing output of French Saint Dominique without protection and their prosperity depended on English consumers paying higher sugar prices to support them. Nor were the English colonies particularly large compared to their rivals. What differentiated the British Empire was the large population in the settler colonies of the mainland who had been drawn, at least outside the Chesapeake, not by an export staple but by the prospect of establishing an independent existence in a new land.

The settlers succeeded and population grew rapidly. By the third quarter of the seventeen century, some sixty percent of English manufactured exports to the Americas went to the mainland colonies (Davis 1979). These colonials financed their imports by selling temperate agricultural and forest products to the sugar islands and providing mercantile and shipping services. In this way the English paid for their sugar imports with manufactured goods exports. To what extent, then, did the growth of English manufactured exports depend on West Indian slavery? Certainly slave products ultimately financed exports to America. However, the answer to the more interesting question: would those exports have not existed if slavery had not existed? is less clear. The mainland colonies flourished largely independently of slavery. Englishmen probably would have settled and population grown rapidly even if the West Indian slave colonies had not existed. They would still have demanded European industrial goods. Without opportunities in the West Indies, they would have had to find other ways of financing imports that were inferior to those they used and imports would have been

smaller but it is likely that they would have remained substantial and helped to sustain Britain's precocious industrialization.

Conclusions on Britain's industrialization

Britain's industrialization had deep roots; produced in an already well-developed capitalist economy that had long been mediated by markets. Product markets developed well before the Black Death. They may have retreated some with population decline but remained substantial and expanded when population recovered in the sixteenth century. More importantly and more unusually, late medieval markets for factors of production were also well-established. In early modern England most land was held in market contracts. In addition, most English men and women experienced a labor market in the countryside or in towns. Agriculture was unusually productive, probably because of its capitalist organization. The land rental market allowed successful farmers to expand while their less successful rivals lost land. In the early seventeenth century family labor remained important on most English farms but most of the acreage farmed employed hired labor. Under these circumstances, labor decisions were made with reference to a labor market. Feudal relationships had long since disappeared. There was not significant class of peasant cultivators – at least in sense of small farms that had customary or ownership rights to their land, who were only tangentially involved in the product market, and organized their labor independently of labor markets.

The penetration of markets resulted in what economic historians have come to refer to as 'Smithian growth' following Adam Smith's observation that specialization and productivity advance was limited by the extent of the market. Smith recognized three growth inducing processes: specialization and exchange that exploits comparative advantage; capital accumulation; technological improvement. These can all be seen in Britain by the eighteenth

century. Agricultural improvement was stimulated by market opportunities, presented most conspicuously by the growth of London as a trading, administration, production and consumption centre. Modern industrialization is often seen as a process that substitutes mineral sources of power for pre-modern sources based on human and animal muscle and wood all of which are limited by agricultural resources. Britain developed coal as a source of power and fuel long before the late eighteenth century industrialization. Englishmen had been learning how to use coal from at least the seventeenth century (Allen 2009a; Allen 2009b; Hatcher 1993; Nef 1932). Builders experimented in the use of coal for domestic heating and by the eighteenth century Newcastle coal heated London houses. Coal also provided heat for many industrial processes from brewing beer to refining copper. Iron masters experimented in using coal but chemical problems remained unsolved until the end of the eighteenth century. Within textile production, the largest pre-modern manufacturing industry, large numbers of merchant manufacturers, many immigrants from warfare in the Low Countries and religious intolerance in France and others inspired by continental examples developed new techniques and fabrics (the so-called New Draperies).

In this view of British development, which rests on statistical analysis, long-run international comparisons of standards of living and a long view of institutions and innovation, it appears inappropriate to overemphasize the famous decades of the 1760s and 1770s and the achievements of Arkwright, Watt and Cort. There are two perspectives that are worth reviewing. First, how much did the inventions contribute to economic growth? Here statistical analysis shows that the impact was limited. More importantly, did these developments mark the start of an era of faster and more sustained technological change? By current standards technological change and growth of living standards before the nineteenth

century was so slow as to be barely noticeable. Growth, mainly driven by technological change, accelerated in the middle of the nineteenth century to eventually reach twentieth century levels of about one percent per year (Crafts 2004a; Crafts & Harley 1992; Crafts & T. C. Mills 2009). Although the technological change in textiles in the late eighteenth century and early nineteenth century was rapid and had the highly visible impact of enlarging an already large textile sector and concentrating it in urban factories, its impact on overall growth was modest. The innovations of the late eighteenth century can be seen as the result of a sustained research and development program that extended existing ideas in a high wage environment; the inventions fit within a longer continuum of Smithian growth.

Arkwright transformed and concentrated Britain's largest manufacturing sector in a manner that caught the attention of contemporaries and historians but did not greatly increase aggregate growth. Nonetheless, the successful application of mechanical manipulation ('clock-work') on a large scale and the development of the factory as a primary locus of production marked important steps in the evolution of technology. Cotton factories stimulated the development of specialist machine producers who became a locus of improved technology (Rosenberg, 1994). That said, however, it is hard to see fundamental changes emerging from the textile innovations. For example, we might ask: did the cotton innovations make the railway more likely? Probably not. In many ways the breakthrough in cotton was not all that different from, say, the expansion of large-scale pottery production in the West Midlands by Wedgewood and others. Watt's improvements in the steam engine and Cort's development of improved methods of using coal to produce wrought iron had similar characteristics. They were the result of conscious application of resources to already defined research and development programs. They both marked stages on the evolution of

technological change. Both involved, at least at a modest level, the introduction of science into industrial research and development.

During the nineteenth century the success of the industries of the Industrial Revolution within the international economy continued to influence Britain. The textile industries, highly concentrated in Lancashire and the West Riding of Yorkshire, and the large coal-based ironworks on the coal fields captured the most attention. Foreign trade contributed the growth of both. Even before the French Revolution, the Lancashire cotton industry enthusiastically supported freer trade and the Eden Treaty with France (1786). Competition drove down the price of yarn dramatically and low yarn prices in England attracted foreign buyers even in the face of severe wartime disruption. By the time peace was restored in 1815 the British cotton mills were selling to foreign customers as much as to their countrymen. Although the technology quickly became available overseas as a result of foreigners copying the English practice, hiring British mechanics and, after the 1843 repeal of the British prohibition of the export of machinery, buying machinery exported by English makers (Jeremy 1981), the British remained the low cost producer of all but the simplest fabrics and two-thirds of output was exported until the outbreak of the First World War. Woolen manufacturers did not capture world markets to the same extent but exported a large portion of their output. Consequently, the textile industries were much larger than they would have been if they had depended on domestic markets (Findlay & O'Rourke 2007).

Puddling and rolling for wrought iron production also grew in response to Britian's changed position in the international market. Before Cort's inventions nearly sixty percent of the wrought iron used in Britain was imported, principally from timber and ore abundant Sweden and Russia ((Hyde 1977; Harley 1982; Fremdling 2000). The industry initially grew

largely by displacing imports. By the early decades of the nineteenth century, however, Britain was exporting pig iron and wrought iron. The railways, first in Britain and then elsewhere, greatly increased the demand for iron and Britain was the principal international provider. Rainer Fremdling calculated that in the late 1840s railway iron consumed a little over a quarter of British iron production and about forty percent of that was exported for use in the United States and Western Europe. Although the importance of railway iron declined in the subsequent decade to a bit over a sixth of output as the pace of British railway construction eased and output increased by about seventy percent as other uses of iron expanded. Exports continued to increase primarily to meet the demands of the expanding railway networks in the United States and Europe (Fremdling 1977). Technological leadership also supported the growth of British engineering. In the 1840s the industry succeeded in having prohibitions on the exports of machinery repealed and exports expanded rapidly. British machine-makers dominated world textile markets and were strong in other industries. British engineers and machinery were central to early railway construction on the Continent. For example, between 1838 and 1841 the Prussian Railways purchased 48 of its first 51 locomotives from British manufacturers – the dominance of British manufacturers then declined and locomotives were almost entirely of German manufacture (Fremdling 1977).

British technological leadership was enhanced by the isolation engendered by the Revolutionary and Napoleonic Wars – for twenty years British firms gained experience in the new technologies while potential rivals on the continent had little access to British practice. Lower prices from technological leadership led to extensive exports. We should, however, be careful not to attribute too much gain to the British from these exports. British competitive

capitalism eliminated excess profits rapidly. Prices fell as firms entered industries to take advantage of lower costs. The benefits from technological improvement took the form of cheaper goods enjoyed by consumers and not higher profits for firms. Exports grew because prices fell; the foreign consumers of the goods shared the benefits of improved productivity with British consumers (Harley 2004).

In the long run, the steam engine was probably the most important technological development of the classical Industrial Revolution. Several points need to be made, however. First, Watt clearly drew on earlier developments, particularly Newcomen's pumping engine that had been in use since early in the eighteenth century. Second, the impact of the steam engine depended as much on its further development as on Watt's innovations. Third, the impact of steam engines, even in cotton manufacturing which dominated its earliest use outside of pumping applications, was minor until the 1830s (von Tunzelmann 1978). The great contribution of steam to increased efficiency came from its later application to transportation – railways and steamships. These innovations impressively lowered costs and induced investment that increased the amount of capital per worker (Crafts 2004b; Crafts 2004a). Crafts calculated that from 1830 to the First World War, steam power and the investments it induced in transportation networks generated about a third of a percent per year growth in labor productivity, but before 1830 its contribution was barely noticeable at one or two tenths of a percent per year. The contributions of the other famous industries were much less. The cotton industry's spectacular technological transformation may have increased the growth of the economy by a eighth of one percent a year between 1780 and 1860. Improvements in agriculture (a much larger sector with slower technical change) contributed a little more. The other modernized industries together contributed rather less

than cotton (Harley 1999). The sustained growth in per capita income after 1830 (a little over one percent per year, three quarters of which arose from total factor productivity growth) resulted from improvements broadly across the economy and cannot be explained mainly by changes in the famous industries. No historian has yet carried out an accounting exercise to quantify this process but we know changes were widespread. Agricultural productivity continued to rise. New, improved and cheaper chemicals and glass appeared. Food processing improved with such things as better flour mills, refrigeration and packaged food. The sewing machine increased productivity in clothing manufacture and shoe making. Improvements in machine making and steel contributed to productivity advance but generally it must be concluded that change were broadly spread through the economy. This was the dynamics of capitalism at work on a broad scale (Bruland & Mowery 2005).

During the Industrial Revolution (1770-1830) the average real wage of British male workers changed little (Feinstein 1998; Allen 2007; Clark 2005). Wage experiences varied – rural workers in the south of England suffered as population growth and deindustrialization hit their labor market; handloom weavers initially benefited from cheap yarn but then their swollen numbers were victims of mechanization. Wages increased in urban factories but workers faced an unhealthy environment, loss of freedom and an absence of amenities (Williamson 1985). During and after the French Revolution, the state responded to war and fear of unrest by suppressing working class rights and political expression. Child labor intensified and the economic conditions of working class women probably deteriorated with the enclosure of common lands and the decline of manufacturing in the countryside – certainly the widespread employment in spinning disappeared (Humphries 2011). Optimists, however, point out that factors other than industrialization keep wages down: population

grew at one and a half percent a year – a rate that historically would have been accompanied by falling wages; the Revolutionary and Napoleonic Wars were extremely expensive and protracted. From the 1830s the real wages of working men clearly trended upwards and were about fifty percent higher by 1880. Many working-class families in Britain at the end of the nineteenth century remained desperately poor but almost all were less poor than their great-grandparents had been at the end of the eighteenth century and few experienced the levels of poverty that were common in Italy or eastern Europe – the poorer parts of Europe.

Industrialization in Continental Europe

Narratives of the spread of industrialization in Europe have tended, following Marx's comment that "the country that is more developed industrially only shows, to the less developed, the image of its own future," to revolve around the spread of the leading industries of Britain's Industrial Revolution – factory-based textiles; iron; mechanical engineering – with tables of cotton consumption, pig iron output, coal production and railway mileage (Pollard 1981; Landes 1969). This provides insights into the particular industries and the process of technology transfer but is inadequate for three reasons. First, these industries are insufficient to explain Britain's success. Second, local conditions – particularly expensive labor and cheap energy from coal – strongly influenced these industries' success in Britain and affected continental development. Third, Britain's industries grew because falling prices and Britain's continuing first-mover advantage supported massive exports markets. Followers could hardly have replicated this experience.

Britain's technological achievement, particularly in textiles and iron, significantly affected continental industries but there were important national differences in responses. Imports from Britain challenged established producers who obtained tariffs protection.

British technology was copied, particularly in modern textile production, through industrial espionage and more importantly through the employment of skilled British workers and after the 1843 by the purchase of British machinery, (Bruland 2003). Textiles emulated British methods but experience differed from place to place. France adopted heavy tariff protection in the face of cheap British imports after the Napoleonic Wars. Consequently, machine spinning became established with the aid of British skilled workers but with higher costs than in England. (Landes 1969, pp.158–63; Milward & Saul 1973, pp. 270–7, 316–22). In Prussia, however, protection was moderate and consequently, imports of British yarn expanded as did handloom weaving. In the late 1830s about two thirds of the cotton yarn used in the German states was imported (Pollard 1981, p.181).

The spread of coal-based iron production was more complicated because success depended on coal and ore and because the older charcoal-based technology produced superior iron that commanded a higher price. Again tariff policy was important. France adopted complete protection while the German Zollverein enacted lower tariffs with a structure that encouraged the import of pig iron for domestic refining. Continental iron masters adopted new iron technologies at different rates and in different combinations depending on resources and markets. Charcoal-smelted pig iron persisted but coal was increasingly used for refining wrought iron. Even in the highly protected French market, coal-smelted pig iron initially had trouble competing. The coming of the railways in the 1840s created a mass demand for lower quality iron and coal-based pig iron production finally became established on coal fields in France and Belgium and Silesia, and, after deep mines were sunk in the 1840s, in the German Ruhr (Fremdling 1977; Fremdling 2000; Evans & Rydén 2005). Elsewhere the absence of coal precluded the industry's development.

The most important transfer of British technology was undoubtedly the railways. They stimulated investment and finance and transformed the fortunes of the iron industry. More fundamentally they integrated national markets allowing greater specialization in both industry and agriculture.

In narratives that revolve around textiles and iron, Belgium and Germany emerged as the principal successes while France disappointed. Belgium maintained its position as highly industrialized region with about 30 percent of its national income in the industrial sector in 1870 (only Britain with 34 percent had more) (Broadberry, Fremdling, et al. 2010, p.170). In the mid nineteenth century, factory textile firms took over from traditional textile producers (present from medieval times) but not without creating hardship for traditional hand-loom weavers. More importantly, engineering firms developed impressive capacity in machine-building (although they were slow to turn to new industries in the final years of the century). The Belgian iron industry continued to grow with the successful switch to steel production and the development of larger firms and plant. It, however, lost its initial continental leadership to German rivals (Milward & Saul 1977, pp.154–65).

After the 1848 revolutions, Germany was the great success in this narrative. Building railroads and political change began the transformation and the iron and steel industry took pride of place. In the final quarter of the century, German iron and steel firms increased the size, capital intensity and modernity of their plants and firms like Krupp became technological leaders. Germans produced a quantity of steel second only to the United States and exported steel, particularly to markets in continental Europe (Landes 1969, pp.249–69). Along with iron and steel, engineering flourished in the aftermath of the railway. German

capitalists supplied not only the domestic market but also much of the machinery, outside of textile-machines, demand in Europe.

The conventional narrative delineates the development of some important industries but one must question how much insight it provides into the process of modern economic growth. Although the title of this essay is "European industrialization" the process by which sustained growth of income per head developed is clearly the important issue. In our discussion of Britain we have already seen that the "British model" of textiles and iron can explain only a small proportion of Britain's growth. Similar conclusions are appropriate for continental Europe. Narratives that assume modern economic growth emerged by emulating the leading sectors of mid-nineteenth Britain exaggerates the role and contribution of a few new industries.

First, the industries that are most studied and taken to indicate the emergence of economic growth made up only a modest a share of manufacturing and a much smaller portion of national income. In Germany, the metal industries – including iron and steel and engineering – contributed about 15 percent of the value of manufacturing around 1870. Since manufacturing, including mining, construction and utilities, amounted to a little over a quarter of national income these industries amounted to less than four percent of national output (Broadberry, Fremdling, et al. 2010, pp.168–74). The Germany metal industry in 1913 was about 10 times as large as it had been in 1870. This is impressive growth but some simple calculations put it into perspective. First we can exaggerate the sector's effect by assuming for simplicity that the growth occurred without increasing the share of resources used in the industry (thus not reducing the output of other sectors of the economy). In fact, although productivity gains in metal production were impressive at 2.4 percent per year

(Milward & Saul 1977, p.26), this plus an increase in the labor force equal to population growth would have only increased metal output by a little less than four-fold. If all the ten-fold growth had been productivity gain it would have increased national income by about thirty-five percent. Thirty-five percent appears to be a large increase but is a growth rate of somewhat under 1 percent annually. German population was growing at 1.16 percent per year so productivity growth of the metal industries alone would have resulted in a decline in per capita income. More realistically, if we assume the rest of the economy grew at the same rate as population growth, the growth of metal production would have increased per capita income about twenty percent or under half a percent per year. Since Germany per capita income more than doubled between 1870 and 1913, the contribution of the metal and engineering industries was modest. Many will object to placing much weight on the preceding calculations. After all, the key story of the geneses of dynamic change is absent from the calculation. However, quantitative historians are fond of quoting Samuel Johnson on the effect of simple calculations: "That, Sir, is the good of counting. It brings everything to a certainty, which before floated in the mind indefinitely" (quoted in (McCloskey 1981, p.105)).

Cotton textiles, which led the introduction of the factory system in Britain, is the other industry on which traditional narratives concentrate. Again, unless the goal is to trace emulation of Britain, the focus is strange. Factory-based machine-spinning became established throughout Europe and the textile industries grew but if we were to carry out an exercise like that above we would find a similar result. On average the textile and clothing industries were a little over twice the size of the metal industries but grew more slowly. More troubling, however, is the fact that textile industries in continental Europe depended on

protection from the more efficient British industry. This had, of course, also been true of the metal industries until the last quarter of the century when Germany's industry became competitive. No such growing-up of mass-production textile industries occurred and consequently European consumers' real incomes were reduced by the growth of their domestic textile industry. There were, of course, some exceptions. Silk production grew in France and Italy thrived in export markets and was never threatened by British firms. French firms successfully held onto high fashion textiles and clothing. The protected cotton industries introduced urban factories to the continent, and may have stimulated mechanical engineering and generally enhanced the technological capability but most of the industry's machinery was imported from Britain. It is hard to sustain a claim that cotton textiles were the engine of growth.

Railways are the third great indicator of industrialization and here the story is somewhat different. Transportation services are, of course, location specific and not tradable. Railway technology was quickly adopted across Europe, with some modest delays relating to government policy and finance. Technology and finance were readily available internationally although modest commercial prospects in more backward regions led to government involvement in finance either directly with state debt or by guaranteeing interest on railway debt. In either case most of the capital came from foreign investors. The direct impact of railways on transportation varied depending on the pre-existing transportation network and the level of commercial development. In particular the impact was less in regions with well-developed water transportation. Various calculations of the transportation cost saving generated by the railways, while somewhat problematic, are in the neighborhood of five percent of national income (Broadberry, Federico, et al. 2010, p.81). Unlike iron and

steel or textiles, transportation improvements brought by the railway almost certainly had spill-over that affected growth widely. In particular, cheaper, faster and more reliable transportation and communications (aided by the telegraph that accompanied railways) integrated national economies allowing greater specialization in both industry and agriculture. Efficient producers expanded at the expense of small local and relatively inefficient firms and household production. For example, Berlin – situated in a backward agricultural area east of the Elbe distant from the main markets in western Germany – become a major producer of engineering and consumer products for all of Germany. Agriculture was profoundly affected. Agricultural historians note that market access was an important determinant of investment and technological improvement (Hoffman 1996; Grantham 1989; Allen 2003). Railways brought remote areas all across Europe into closer contact with urban markets and stimulated productivity advance. Nonetheless, the impact of railways was large only when they successfully interacted with wider forces of economic change.

Per capita income and inadequacy of 'British model'

Historians have constructed estimates of national income for the past. These figures should be viewed as work in progress and used with care. The data that modern statisticians use are not available before the mid-twentieth century and officials who collected earlier statistical material did not think in terms of a concept of national income. Nonetheless it is almost impossible to think about economic growth without an estimate of aggregate activity. Without them, we rely on impressions that overemphasize the novel, the spectacular and the new. Table 14.1 below provides estimates for European countries from the eighteenth century to the First World War. They show (as do the long-run real wage figures above) there was a

gradient of incomes in Europe prior to the nineteenth century industrialization. The highest incomes were in the Netherlands and Britain while lower incomes prevailed in the Southern and Eastern periphery. The national income figures also correspond with the narrative history's conclusion that Germany was a particular success but that success was primarily in overcoming initial backwardness. Even in 1913 Germany does not stand out as having achieved high income per capita. National income statistics also highlight the fragility of narratives of economic growth based on industrialization driven by textiles and iron. They show the success of Germany and Belgium but the companion story of failure of France and the Netherlands must be abandoned.

When we look at the structure of industry in France we are struck almost immediately by the small size of the metal and mining sectors which loom large in conventional narratives. French economy grew quite slowly in aggregate when compared to Britain and Germany (1.6 percent per year in contrast to 1.9 and 2.8 percent for Britain and Germany) but during the same period British population increased by two-thirds and German population nearly doubled while France's increased by only fourteen percent. Consequently, as we can see from Table 14.1, German growth per capita only slightly exceeds that of France and France grew considerably faster than Britain. France grew with a very different economic structure than Germany or Britain. Metal and mining were unimportant primarily because France had poor coal resources. Industrialization followed a different path and agriculture declined relatively more slowly without substantially hurting overall growth. In 1870, France and Germany both had half their working population in agriculture; by 1913, the share in Germany had fallen to thirty-five percent but in France it remained at forty-one percent. French slower population growth put less pressure on rural population.

Research on the French economy now effectively challenges the failure narrative. O'Brien and Keyder demonstrated that productivity in French industry was high during the eighteenth and nineteenth century. They summarize the difference between French and British industry as follows:

> Value added per worker remained high in France because industry specialised in higher-value products. For such products, differentiated in quality and style, the workshop unit of production, often organized on a family basis, could train skilled labor and cater effectively for local and other specific demands (Keyder & O'Brien 1978, pp.178–9).

Mechanization, large factories and the extensive use of mineral fuels were among the changes in industrializing Europe but they were not necessary to generate economic growth. In many sectors small-scale capitalist enterprises remained efficient and profitable. By the last years of the nineteenth new industries were developing and France performed well, achieving leadership in automobile, aviation and electrical engineering, for example. Recent detailed examination of comparative income statistics confirms the high levels of productivity in French industry in the early twentieth century (Woltjer et al. 2010).

The national income statistics reveal two other successful economies that did not follow the British-Germany model – the Netherlands and Denmark. The Netherlands is covered in detail in another chapter. Here it is only necessary to note that although a story of relative failure of growth in the Dutch economy in the eighteenth and nineteenth centuries has large elements of truth, per capita income remained high despite the failure to adopt the so-called key industries. Efficient services, specialized agriculture and associated food production and other light industries provided incomes that rivaled those in Britain through most of the nineteenth century. The Danish story is even more impressive. The economic

structure was even more heavily biased towards specialized food production and processing than the Dutch but the Danes attained growth rates of per capita income between 1820 and 1913 that were close to those achieved by Germany by specializing completely differently.

Gerschenkron, relative backwardness and convergence

Exploring the development of the industries that were at the forefront of Britain's Industrial Revolution provides information about the spread of technology but fails to provide an adequate basis for understanding the mechanisms involved in the emergence of modern economic growth. In what is probably the most influential essay in European economic history in the past two generations, Alexander Gerschenkron suggested a typology of the history of European industrialization that gave prominence to initial conditions of backwardness at the start of industrialization and focused on systematic substitutions for the "prerequisites" of growth that had been present in Britain's industrialization (Gerschenkron 1962).

Contemporaries and historians alike were aware that the most advanced economies lay in Britain and the Netherlands in the north-west. Moving east across the North European Plain gradation of backwardness seemed obvious. France's relative backwardness vis a vis the ‘North Sea economies’ was perhaps open to debate. The western states of Germany, however, were clearly more backward than France or the Low Countries. As one crossed the Elbe, the level of backwardness increased and Russia was clearly well behind. Moving from north to south a similar gradient appeared although generalization was more tenuous because legacies of earlier urban commercial success remained and significant differences in climate affected agriculture. The south of France was behind the north; Italy, despite its illustrious

past, lagged badly. The Balkans, influenced by their troubled history on the periphery of the Ottoman Empire, as well as their fragmented geography, lagged even further behind.

Gerschenkron accepted that backwardness was multi-dimensions but various indicators yielded the same ranking. The most obvious indicator was per capita income, or general standard of living but the profile of backwardness was also visible in a range of institutional features, three, all characteristics of developed capitalism, stand out: the organization of agriculture; the extent of commercialization and urbanization and the general penetration of commodity markets; the development of factor markets for both labor and capital. Capitalist agriculture with well-developed markets in labor and land predominated in Britain and, in a different form in the Low Countries; peasant farmers dominated French agriculture and western Germany; beyond the Elbe aristocratic landlords farmed under feudal relations using forced labor and draft animals of serfs. At the most extreme was Russian serfdom. The extent of markets diminished from west to east. Britain and the Netherlands had well-developed financial markets; France, although it lagged somewhat behind, also had well-developed, if somewhat different, institutions (Hoffman et al. 2001). There was some financial development in western Germany but little further east. In Britain and in the Netherlands, labor markets dominated the allocation of labor and most of the population had labor market experience. In French and western Germany some two-thirds of the labor force in the eighteenth century was in agriculture mainly organized on the basis of the custom of the peasant family rather than the labor market. The serfdom east of the Elbe was based on un-free labor under obligation of providing labor to landlords.

Gerschenkron put forward a number of hypotheses regarding the influence of relative backwardness, some of which have survived critical examination better than others. His

predictions include the hypothesis that industrialization in a more backward economy started with a more rapid spurt than had characterized more advanced economies. This rapid growth arose out of several related ideas. First, there was a gap between the technological possibilities demonstrated by the advanced economies and the current economy. If the institutional forces preventing development could be overcome, there was a potential for rapid catch-up growth. Second, in backward economies, the majority of the population in low productivity agriculture and organized on the basis of either family or servile labor (or some combination of both) demanded few goods on the market and so could not provide the basis for development of consumers' goods industries. For growth to occur it was necessary to achieve a 'development bloc' of producers' goods industries that could provide each other markets. Consequent, growth began with a 'big spurt.'

In conditions of backwardness, markets for finished goods and factors of production were poorly developed and consequently, entrepreneurs could not rely on wide-spread competition among buyers and sellers to insure that products could be readily sold at competitive prices or that inputs and intermediate goods could be readily purchased in required quantities. In Industrial Revolution Britain broad markets existed permitting firms to develop on a small scale and concentrate on a production niche confident that inputs could be readily purchased and output, even intermediate goods in a longer production chain, could be sold. In backward economies, firms found that it was necessary to adopt hierarchical organization within the firm to overcome market limitations. As a result, larger firms emerged that often integrated the entire process from raw material supply to final product sale under managerial control (Harley 1991).

Finance also was less market-oriented in more backward economies. In Britain, small firms had been able to finance development by a variety of means because financial transactions were well-developed. Firms generally grew from funds accumulated in pre-existing mercantile-manufacturing, personal contacts, the existing network of trade credit and the short-term financing that British commercial banks were willing to offer. Behind these arrangements, well-developed financial markets in bills of exchange, and a stock exchange supported the development of diversified portfolios for investors. For more capital intensive infrastructure like turnpikes and canals, trusts and companies were organized to tap more extensive sources of funds (Harris 2000, sec.2). When railways demanded exceptionally large amounts of capital in a short period of time, they were able to borrow directly on the stock exchange. In conditions of moderate backwardness, in Gerschenkron's narrative primarily Germany but also France and Italy, commercial sources and financial markets did not have the capacity to provide the same financing and substitutes developed in the form of the large universal banks beginning with the Crédit Mobilier in France and then dominating finance in Germany. These institutions accepted deposits and made commercial loans but were also willing to take longer-term positions in the financing of large firms and to act as intermediaries in the issuing and distribution of stock to investors. In conditions of extreme backwardness, exemplified by Russia, conditions were too backward even to support this sort of bank and the state played an important role in industrial finance with public debt proving an instrument that investors, particularly the richer west, were willing to hold.

Backwardness also influenced the choice of techniques by firms in newly established industries. Backwardness provided a tension for entrepreneurs between employing the latest technology that had been developed in more advanced economies to suit their high wage

conditions and the cheap labor of the backward economy. In fact, however, the dilemma was to a large extent false. To be sure raw brute labor was cheap but skilled labor and even disciplined labor suitable for factory production was scarcer than in advanced economies. Consequently, and apparently paradoxically, industries like steel the backward economy installed the most advanced labor-saving technology in key parts of production while using cheap unskilled, or brute, labor as much as possible in auxiliary operations.

Backward agriculture played a major role in Gerschenkron's thinking and was the subject of two of his major works (Gerschenkron 1943; Gerschenkron 1966). He concluded that the contribution of agriculture to the growth process declined with backwardness because the poverty of agriculture and the tenuous connection of agricultural workers to the market limited the sector’s contribution to demand. Because of its institutional nature the agricultural sector did not release labor and create a market-oriented work force as happened in Britain.

Gerschenkron's schema provides substantial insight into the variation within European industrialization, particularly when combined with an awareness of the importance of coal for the development on industry on the British model. It is particularly useful in illuminating differences in institutional structure that emerged in different countries. It is hardly surprising that the generalizations have proven too sweeping to be a totally reliable guide to the complex economic history of modern Europe. Gerschenkron – despite his avowed aim to replace Marx's great generalization that more backward countries follow the path of industrialization carved out by the first example – still thought in terms of emulating the British experience of large urban factories and a vibrant iron industry. The substitutions of prerequisites that he identified – large hierarchical firms, a key role for banks and the state in finance, the adoption of the most advanced technology to overcome the shortcomings of

labor in backward economies – were largely relevant for the ‘big industries’ and like other discussions with similar focus, it is less helpful in understanding less spectacular development of other sectors.

Gerschenkron's ‘big spurt’ at the start of industrialization has proven hard to find in aggregate statistics (Crafts et al. 1991). However, there is connection with the idea of convergence of income levels among economies is particular ‘growth clubs’ in which economies that have initially lower incomes tend to grow more rapidly and converge towards income levels of initially richest economies. Convergence certainly occurred in Western Europe by the late twentieth century although in the European periphery it was little in evidence until the mid–twentieth century. Convergence is, of course, by no means guaranteed. On a global scale the history of the nineteenth and twentieth century has been one of ‘divergence, big time’ with a small ‘club’ of successful economies in western Europe and its offshoots growing much faster than poorer economies elsewhere, increasing global inequality.

Agriculture

When we shift our focus from the ‘great’ industries to a more holistic view of economies and the levels of income that they generated, backwardness and its implications for growth across European return our attention to agriculture. High agriculture productivity was a leading determinant of Britain's relatively high incomes at an early date. Allen’s recent estimates of comparative output per worker in agriculture for some key European countries are presented in Table 14.3 along with estimates for the years just before the First World War.

The high productivity of the Netherlands (shared with Belgium) in the late eighteenth century is apparent but low productivity elsewhere is more striking. Contemporaries did not see these data but the relative backwardness of continental agriculture was apparent and associated with agricultural institutions. In England capitalist agriculture had proceeded to its limit. In France, and to a somewhat lesser extent in western Germany, peasant proprietors with secure title to land farmed with family labor. In France, peasant security of title was enhanced by the Revolution and as Patrick O'Brien notes, "[b]y abolishing seigniorial dues and suppressing tithes, the Revolutionaries also transferred agricultural income back to those who farmed the land. At a stroke, the tax and judicial reforms of the 1790s lightened burdens on the peasantry and enhanced their capacity to prosper on small plots of land" (O'Brien 1996, p.228).

In Germany east of the Elbe a more backward feudal system of estate agriculture – *Gutsherrschaft* – predominated. Aristocrats farmed their estates to the largest possible degree using enforced serf labor of which there were two classes. More substantial peasants with property rights were required to provide draft animals and stipulated labor services. Lesser peasants without legal property provide only labor. The extent of labor required from a peasant farmstead was considerable:

> As a rule of thumb, one can say that enforced serf labor did not exceed 2-3 days a week for peasants with property in their land. As for peasants without property, it depended entirely on the requirements of the estates. There were quite often 4, 5 or even 6 days of enforced labor per peasant-farmstead. As the great majority of the peasants … had no property rights in their land we can

> quite confidently say that enforced labor for more than 3 days a week was very widespread in these areas. (Harnisch 1986, p.45)

The system provided cheap labor, draft animal capital and serf-built structures that underpinned a profitable system for the landowning aristocracy. Harnish quotes a prominent Pomeranian official who wrote that "managing an estate with enforced labor might not lead to the highest possible yields and would certainly cause a lot of irritation and annoyance,...but it was 'convenient and cheap'" (Harnisch 1986, p.45). In Russia serfdom was even more strongly entrenched with heavier peasant obligations and even less freedom.

The institutions and productivity in agriculture across northern Europe invites further consideration of Robert Brenner's triptych of class structures differing in terms of conditions and priorities for those engaged in agriculture – the means of social reproduction – that emerged in the centuries following the Black Death. Brenner saw the institutions that emerged in the late medieval and early modern era determining the development possibilities into the eighteenth and nineteenth centuries. He emphasized the technological improvements that occurred with the British structure that allowed labor to leave agriculture and expanded the market for non-agricultural goods. From another perspective, landlessness and wage labor in the countryside removed the possibility for the agricultural labor force remaining in subsistence peasant agriculture.

In France, peasant communities gained substantial de jure and de facto property rights in land that were dramatically reinforced by the Revolution (Brenner 1976, pp.68–72; O'Brien 1996). Brenner describes the dynamics of the peasant farm as follows:

> On the one hand, the peasant had every positive incentive to hold onto his holding, for it formed the basis for his existence, and that of his family and heirs. On the other hand, purely economic forces seem to have worked to

> undermine the peasants' property only in the very long term. Thus the point is that the peasant proprietor was under relatively little pressure to operate his plot as profitably or efficiently as his potential competitors in order to survive, for there was no direct means for such competitors to "defeat" him. In other words, the peasant did not have to be competitive, because he did not really have to be able to "hold his place" in the world of the market, either the market for tenants or the market for goods. Unlike a tenant, the peasant proprietor did not have to provide a level of rent equal to what the landlord might get from any other tenant — or else be evicted at the expiration of his lease. Unlike the independent artisan, he did not have to be able to produce cheaply enough to sell his goods profitably at the market price — or else go out of business. All that was necessary for survival for the peasant proprietor (assuming of course that he was a food producer) was sufficient output to provide for his family's subsistence and to pay his taxes (Brenner 1976, pp.72–3).

In serf agriculture farther east the dynamics were different again. Here economic relationships were subsumed within power relationships in an aristocratic polity. Brenner's classic essay again provided a stark assessment:

> [The] structure of class relations in the East had as its outcome the "development of underdevelopment", the preclusion of increased productivity in general, and of industrialization in particular. First of all, the availability of forced laborers whose services could be incessantly intensified by the lord discouraged the introduction of agricultural improvements. Secondly, the lord's increasing surplus extraction from the peasantry continually limited the emergence of a home market for industrial goods. Thirdly, the fact of direct and powerful controls over peasant mobility meant the constriction of the industrial labor force, eventuating in the suffocation of industry and the

> decline of the towns. Finally, the landlords, as a ruling class which dominated their states, pursued a policy of what has been called "anti-mercantilism"; they attempted to usurp the merchants' function as middlemen and encouraged industrial imports from the West, in this way undermining much of what was left of urban and industrial organization (Brenner 1976, p.60).

Brenner's assessments are stark and exaggerate backwardness but are good starting points. The French peasants were certainly not so unresponsive to economic opportunities as the quotation above suggests. They reacted to market opportunities as adjustment to the railway and the expansion of quality viticulture demonstrated. Nonetheless, the peasant family's attachment to the farm and the small size of the typical farm characterized French agriculture into the twentieth century. The French farm was small and, by English standards, poorly capitalized. It had only sixty percent of the draft animals per worker of British agriculture; only 24 percent of the value of output consisted of meat and milk (the British figure was 67 per cent) and thus less natural fertilizer (Keyder & O'Brien 1978, pp.113–9).

The greatest adjustment that French peasants made to support their independence was to reduce fertility dramatically. By the end of the Napoleonic Wars, the French birth rate had fallen, achieved by drastically reducing births within marriage well before that occurred elsewhere, so that population grew at ten percent per generation compared to a rate of about forty percent elsewhere. Between 1820 and 1913 Western Europe population approximately doubled – German population increasing more than two and a half-fold – but French population increased by less than a third. Undoubtedly maintaining the peasant family holding and connection to the land was a key objective. Sons remained even if the farm's income per worker fell to below the wage in non-rural occupations. Peasant ownership and

slow population growth made this strategy possible. In contrast in British capitalist agriculture, farmers hired only until marginal product of labor equaled the wage rate so labor input was significantly lower with a higher average product than on a peasant farm (Crafts & Harley 2004; Cohen & Weitzman 1975). O'Brien and Keyder concluded in their sympathetic study of the French economy "that French farmers probably did as well as can be expected given the...constraints on investment exercised by smaller units of ownership and production." (Keyder & O'Brien 1978, p.139). The small units were a product of institutional history and acted as a drag on the economy as a whole. The French peasantry, however, quite clearly preferred the family farm and ownership of the land allowed it to exercise that preference even at the cost of dissipating potential agricultural rents. Nonetheless, French agriculture performed creditably during the nineteenth century. Output per worker closed some of the gap with Britain; between 1880 and 1910 agricultural productivity grew at one and a half percent per year, which is slightly faster than per capita national income (Broadberry, Federico, et al. 2010, p.66).

German agricultural change was more complex. The west was broadly similar to France. In the east change revolved around the abolition of servile agriculture. Eighteenth century east-Elbian German agriculture was by no means isolated from markets; noble estates supplied a vibrant grain market fueled by demand in the Netherlands and also increasing in Britain. More prosperous peasant farmers were also market orientated, often hiring workers to provide the labor services they owed to the aristocratic estates (Harnisch 1986, pp.50–9). The elimination of serfdom in Prussia and elsewhere in Central and Eastern Europe was a conscious modernizing policy. Peasant unrest was apparent before the French Revolution and military defeats in 1806 triggered the Stein-Hardenberg reforms in Prussia that started a half-

century process of replacing feudal with capitalist agriculture. Reforms emancipated the peasantry from feudal tenures and redefined property right in land. Aristocratic landowners, unlike in France, had the political power to ensure compensation for the loss feudal benefits and increased the land under their direct control. The aristocratic estates adopted capitalist agriculture using wage labor. Many large and mid-sized peasant farmers also benefited from secure land tenure and the elimination of feudal services. In the first half of the century for Prussia as a whole output per worker increased by between forty percent and two thirds and east of the Elbe, where reforms had most effect, labor productivity in 1860 was more than two and a half times its 1800 level. From 1850 to 1913 output continued to grow at 2.1 per cent per year and output per worker increasing at 1.8 percent to more than triple – a faster rate of growth than German per capita income (Pierenkemper & Tilly 2004, pp.23–9, 76–80).

Poor rural residents without legal land rights became impoverished wage laborers their numbers swollen by rapid population growth. Unlike France where the elimination of the remains of feudal tenure strengthened the property rights of the peasants, led to a near cessation of population growth and inhibited the growth of a mobile wage labor force, reform on the east Elbian estates contributed to the creation of a proletariat for the country's industrialization. Poor rural inhabitants found themselves transformed to wage laborers and at the same time population growth accelerating to over one percent per year (largely due to falling death rates while birth rates declined only in the twentieth century) (Pierenkemper and Tilly 2004, 87-94). East of the Elbe population growth and agricultural change led to dramatic out migration after 1860. At first many went abroad, mainly to the United States, but as urbanization and industrialization developed in the Rhineland, Westphalia and around Berlin migrants from the east became urban factory workers. In the twenty-five years to 1907

more than two million people migrated (equal to about two-thirds of the surplus of births over deaths) from the eastern provinces of Prussia. At the same time the Berlin region and the western industrial provinces received about the same number of migrants. Between 1880 and 1910 the German agricultural share of the labor force fell from just under half to thirty six percent (Pierenkemper & Tilly 2004, pp.87–104; Milward & Saul 1977, p. 45).

The contrast between institutional development in agriculture in French, on one hand, and Germany and England, on the other, highlights a complication in assessing European industrialization. In both England and Germany the conversion of agricultural workers into free wage labor (proletarianization) contributed to industrialization by easing labor recruitment and swelling the numbers of urban consumers (who purchased a disproportionate share of mass-produced consumer goods). In France, rural labor – the peasantry – was free to move but chose to remain on the land, often substantially self sufficient and at lower material reward than urban alternatives offered. They were able to make that choice because they owned the land. By staying on the land the peasant family chose a lifestyle that misallocated labor if we accept the criterion that marginal product should be the same in alternative uses – the retention of labor on family farms reduced the marginal product of labor in agriculture below that in the rest of the economy. In effect, peasant families chose to expend potential land rent on maintaining rural peasant status. It is hard not to accept that at least for the generations making the choice that this was an informed and rational decision. English and German rural workers would almost certainly have made the same choice had they been able to. This poses a dilemma for analysis of industrialization. Mobility of labor enhanced industrialization and allocated labor more efficiently. This increased measured national income in Germany and England relative to France. The measured increase overstates the

welfare gain, however, since the increased welfare from peasant existence – whose reality French peasants' choices demonstrated –is not included in national income accounts.

Conclusions: Capitalism and European Industrialization

European industrialization was a triumph of capitalism. However, large firms employing masses of proletariat workers – a usual conception of capitalism – played a modest role. Modern economic growth was achieved by societies in which markets became pervasive. In the initial leaders, the Netherlands and England, market capitalism was firmly established long before the Industrial Revolution. In many places elsewhere in Europe, capitalist roots were deep and growth spread quite rapidly during the nineteenth century. In general, per capita incomes tended to converge as more backwards economies benefited from advanced technology, institutional change and capital inflow from the leaders. The contours of European industrialization varied, influenced particularly by relative backwardness and by the availability of coal. Large capitalist firms, of course, played their role, particularly in highly visible large urban factories and in heavy industry. Nowhere, however, were they extensive enough to drive growth of the entire economy and in some economies that attained the highest levels of income per capita these industries hardly existed.

The capitalism that drove growth pervaded small and medium sized firms, usually family controlled, that produced most industrial and service output even in Britain and Germany. Also, importantly, capitalism came to prevail generally in agriculture. Agriculture has featured rather more prominently than might be expected in a narrative of European industrialization. However, Europe's transformation would not have happened without vigorous agricultural growth. In 1750 (outside of England and the Low Countries) the proportion of the labor force in agricultural was approximately sixty percent plus a rural non-

agricultural population of an additional twenty to thirty percent (Allen 2000, p.11). Substantial economic growth was practically impossible without productivity improvement in the countryside. In many cases, particularly in the east, agricultural change involved institutional change. In the event, productivity advances in agriculture rivaled advances elsewhere in the economies.

Sustained growth in per capita income rests on technological change. Unfortunately, the origin of technological change and the process by which it spreads is elusive. The relevant technological change was not limited to famous inventions. Britain was already rich by the standards of the time when the Industrial Revolution occurred. A high wage economy rested on earlier advances in agriculture and a wide range of manufacturing and services that had developed in a capitalist market economy. Even though most firms (and farms) were small, the economy was well-integrated and product and factor markets were broad. Firms' need to compete insured that costs were controlled and products improved. The possibility to profit from innovation motivated inventors like Richard Arkwright to undertake research and development.

Continental Europe, except the Netherlands, generally lagged behind Britain in income and industrial technology. The technological gap, although it certainly exhibited a gradient of backwardness as one move east, should not be overstated. France experienced impressive eighteenth century growth and its textile industries were not dissimilar to Britain's. The French certainly led in silk and other luxury products. The technological breakthroughs of the Industrial Revolution occurred in Britain, probably because high wages and cheap coal provided incentives to explore the relevant technology. When relevant to local costs, new techniques moved rapidly to continental Europe as local capitalists sought to

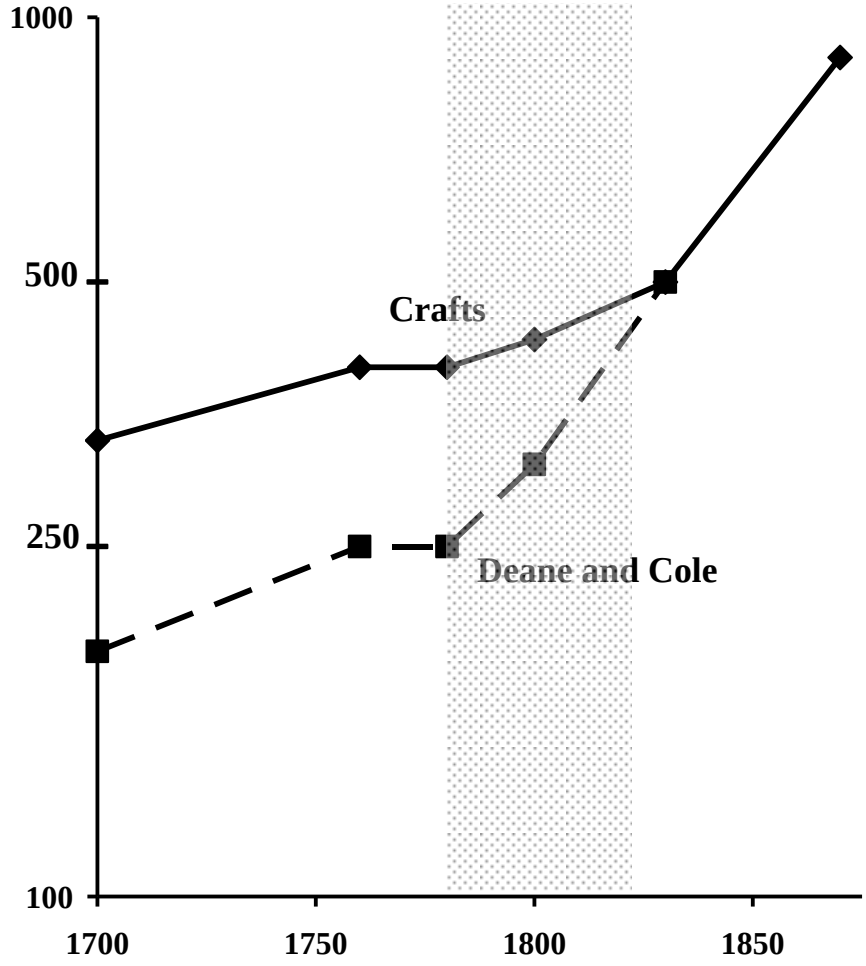
emulate British successes, often employing skilled British workmen or purchasing machinery British engineering firms. Certainly when we focus on factory textiles, iron, coal, and steam the story was one of British leadership and continental emulation. But these industries should not be overemphasized. Their traction in France was limited and they had little impact in the Netherlands or Denmark but income grew in these countries because technology advanced in other industries, sometimes possibly stimulated by the example of British textiles and engineering but also often along original lines. By the second half of the nineteenth century it was clear that technological capacity had developed in all the leading economies and new technology diffused rapidly from place to place. Nonetheless, resources, past experience, and labor force characteristics caused paths taken to differ and an attempt to force the economic history into too rigid a mould only leads to misunderstanding.

Finally, Europe needs to be briefly placed in a broader global perspective. The European story was one of widespread technological change, rapid diffusion and convergence to similar levels of technological competence and incomes, tempered by institutions of backwardness particularly in agriculture. To be sure convergence was far from compete when Europe tore itself apart with wars and depression in the first half of the twentieth century and was only completed in the second half of the century. Then all of Western Europe converged on the United States, now the technological leader. At this time in many continental economies the rapid reallocation of large work forces from low productivity agriculture and traditional services speeded growth. When, however, we look at global history, we realize that convergence, which apparently seems so natural, is, in fact, exceptional. Most of the world was unable fully to utilize the improved technologies that emerged during and after the Industrial Revolution and global income inequality increased

dramatically. Consequently, when growth economists think about the transfer of technology and income convergence, they emphasis convergence clubs and social capacity to use technology. The history of European industrialization clearly demonstrates that most of Europe belonged to a ‘convergence club’ since at least the beginning of the nineteenth century and it is intriguing to speculate on the nature of the ‘social capacity’ that made this the case.

It is far beyond even the immodest aims of this essay to answer this question. Certainly, long-developed traditions of markets dating from at least medieval times – capitalism if you like – are central to the answer. So too is the historic unity of Europe in its disunity of competing states which led to competition among polities. Long distance trade connected the continent. Shared religion and culture played a role – the Renaissance and the Enlightenment contributed. The development of unified and competent states and the emergence of constitutional government also played their role. The underlying determinants of economic success seems likely to rest in the realm of culture, society and politics rather than in the simply technological.

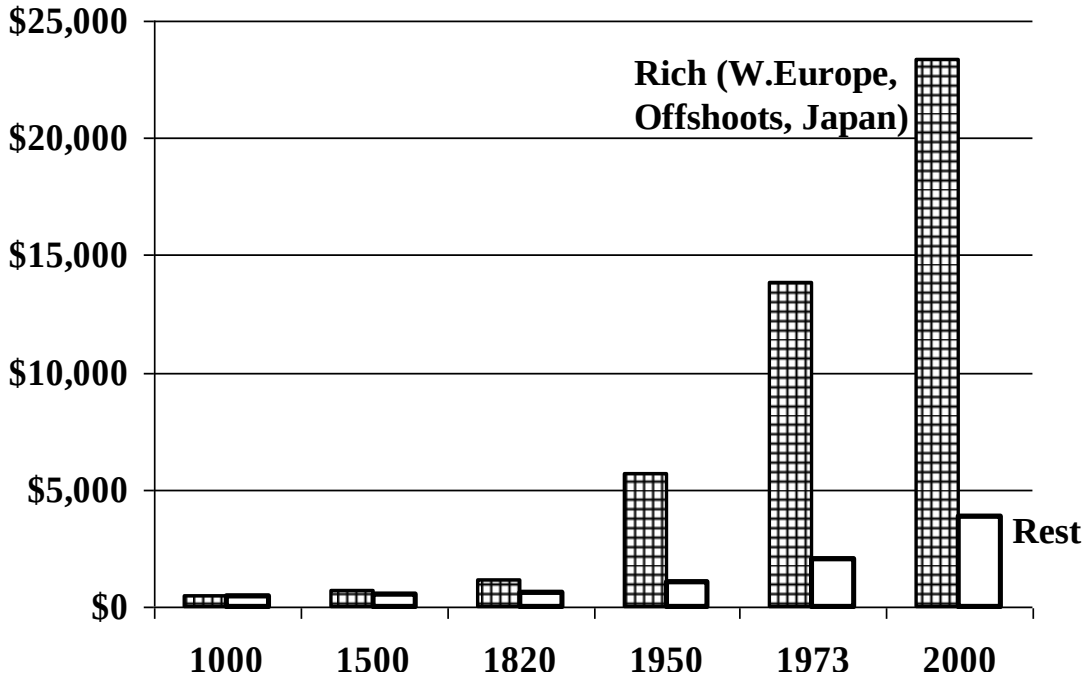
Figure 14.1: British National Income, 1700-1850,
Crafts and Deane and Cole



Data in Figure 14.

	Per Capital Income	
	Crafts	D&C
1700	330	190
1760	400	250
1780	400	250
1800	430	310
1830	500	500
1870	900	900

Figure 14.2 Great Divergence 1000-2000
(Per capita GDP,1990 International Dollars)

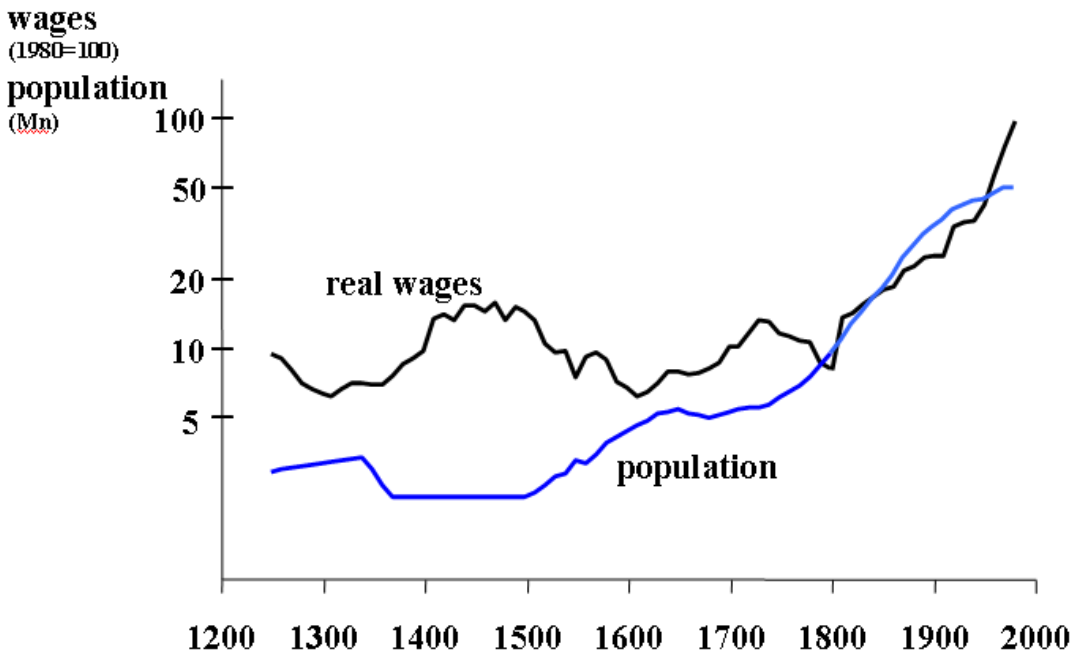


Source: Maddison 2007

Data for Figure 14.2

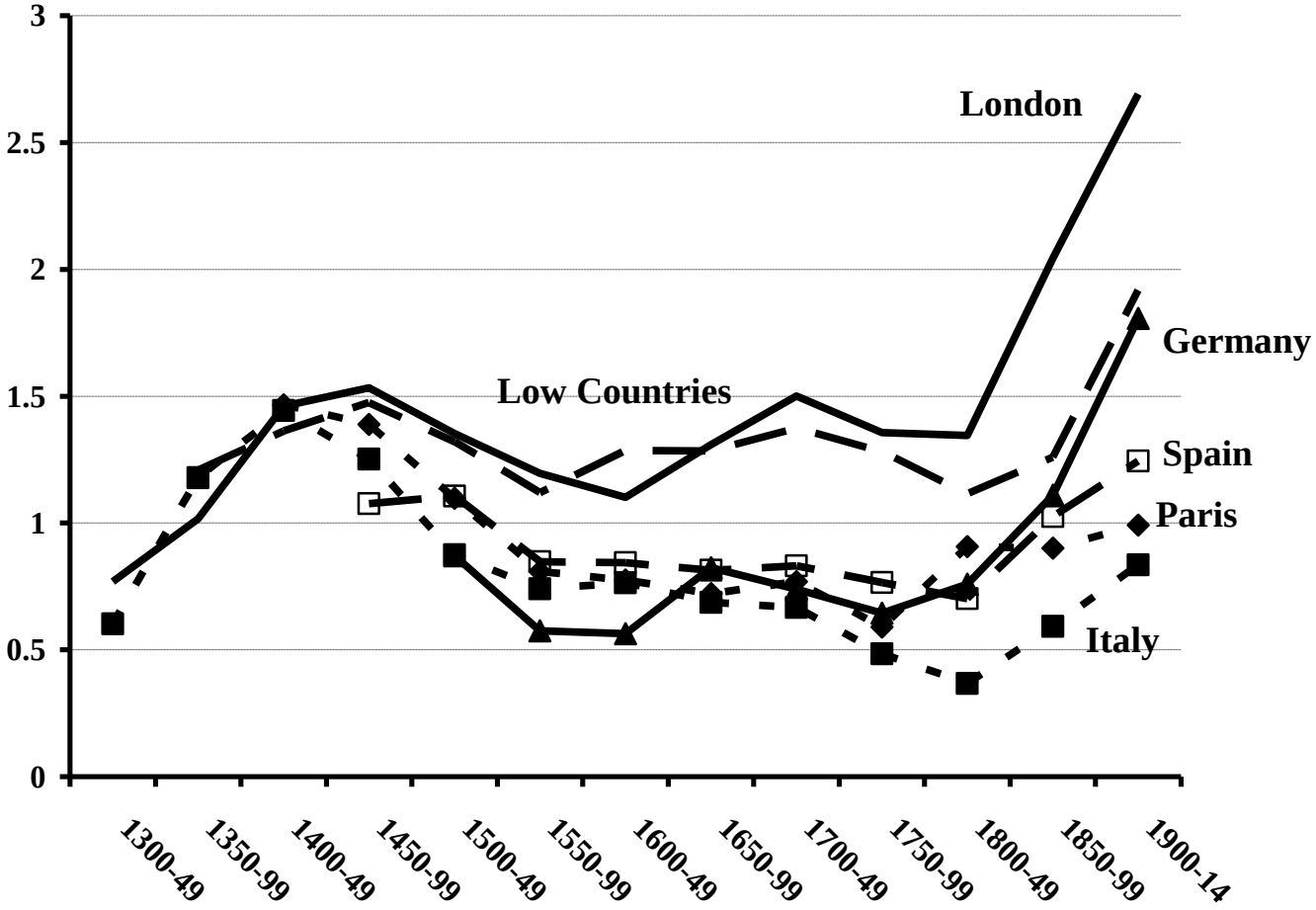
	1000	1500	1820	1950	1973	2000
Rich	425	703	1109	5648	13802	23345
Rest	458	538	578	1094	2072	3816

Figure 14.3: Population and Real Wages: England, 1250 - 1980



Sources: (Clark 2005; E. A. Wrigley & Schofield 1989; McEvedy et al. 1978).

Figure 14.4: Urban Real Wage Europe, Laborers, 14th to 20th Centuries



Source: (Allen 2001)

Data for Figure 14.4

	Low countries	London	Paris	Italy	Spain	Germany	
1300-49			0.77		0.60		
1350-99		1.21	1.02		1.18		
1400-49		1.36	1.46		1.44	1.47	
1450-99		1.47	1.53	1.08	1.25	1.39	
1500-49		1.32	1.35	1.11	0.87	1.10	0.87
1550-99		1.12	1.20	0.85	0.74	0.81	0.58
1600-49		1.29	1.10	0.84	0.76	0.78	0.56
1650-99		1.28	1.31	0.81	0.69	0.72	0.82
1700-49		1.37	1.50	0.83	0.67	0.77	0.74
1750-99		1.28	1.36	0.76	0.48	0.59	0.64
1800-49		1.12	1.35	0.70	0.37	0.91	0.76
1850-99		1.26	2.04	1.03	0.59	0.90	1.11
1900-14		1.92	2.69	1.24	0.83	0.99	1.81

Table 14.1: GDP per capita principal European countries, 1750 - 1913
(1990 "international" Geary-Khamis dollars)

	1750	1820	1870	1913
UK	1485	1707	3191	4921
Denmark		1274	2003	3912
Netherlands	1861	1821	2758	4049
Belgium	1297	1319	2692	3923
France		1230	1876	3485
Germany		1077	1839	3646
Switzerland		1280	2202	4266
Italy	1297	1117	1499	2564
Spain	990	1063	1376	2255
Sweden	1144	1198	1664	3096
Russia			683	939

Source: (Maddison 2007; Broadberry & O'Rourke 2010, p. 2).

Table 14.2: Industrial Structure (% of manufacturing)
United Kingdom, France and Germany, 1870

	UK	France	Germany
Food, drink and tobacco	14	17	19
Textiles, clothing	26	34	30
Metals	18	3	15
Other manufacturing	8	20	20
Construction	7	22	9
Mining	25	3	6
Utilities	2	1	1

Source: (Broadberry, Fremdling, et al. 2010, pp.170–1).

Table 14.3: Output per worker in agriculture, England = 100

	late 18th century England = 100	1910 England = 100	1910 (England 1750=100)
England	100	100	150
Netherlands	98	50	75
France	55	74	111
Germany	41	52	78
Italy	43	32	48

Source: col 2: (Allen 2000, p.20); col 2: (Broadberry, Federico, et al. 2010, p.66); col 3: British from (Allen 2006, p.43).

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