

## 15. Patent Institutions, Industrial Organization and Early Technological Change: Britain and the United States, 1790–1850

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Comparisons of the patterns of technological change in Britain and the United States during early industrialization have long generated controversy. Nowhere has this been more evident in recent years than in the debate about manufacturing productivity growth over the course of the Industrial Revolution in Britain. The traditional view, whose classic statement is generally credited to T.S. Ashton, held that the pace of technological progress in Britain markedly accelerated late in the eighteenth century, and that this acceleration extended across a broad range of industries.<sup>1</sup> This position has been challenged, however, by N.F.R. Crafts, C.K. Harley, and others, who have argued that technological change up to 1860 was much slower than has been thought, especially in labour-intensive industries.<sup>2</sup> Their work implies that the British path of early industrialization, characterized by modest and unbalanced rates of productivity advance, was quite unlike that of the better-documented U.S. case. Scholars of early American industrialization generally agree that productivity grew at an impressive pace and was relatively balanced across manufacturing industries between 1820 and 1860, which helps to explain why U.S. economic historians are well represented amongst those most sceptical of the revisionist case.<sup>3</sup>

The central problem, of course, is whether and, if so, why these first two industrial economies appear to have had such divergent patterns of early industrialization. Because of a common cultural heritage, and of the general coincidence in the timing of when economic growth got under way in the two countries, one might reasonably have expected their paths of development to be similar. Indeed, some might hold that the appearance of stark contrast is an artefact of estimates based on inadequate data. It is not clear, however, that the most constructive reaction is to reject the

implications of the findings out of hand. As economic historians are now rediscovering, our understanding of the sources and processes of growth can be much improved by considering the sources of variation in experience across nations. Some, like Douglass North, argue that such a perspective highlights the crucial importance of institutions to growth and the path of technological change.<sup>4</sup> Other scholars follow H.J. Habakkuk in emphasizing how comparative history enhances appreciation of the significance of factor endowments.<sup>5</sup> This chapter employs such a comparative approach by examining two salient institutional differences between the first two industrial nations, which may have substantially affected their paths of technological development and helped to account for why Britain had slower and less balanced manufacturing productivity growth than the United States during early industrialization. First, we contrast the British and U.S. patent systems, which differed significantly in ways that influenced the nature and direction of inventive activity. Second, we suggest how alternative forms of manufacturing organization in the two countries provide a potentially important source of divergence in their paths of technological change.

In selecting the patent system for such attention, we are inspired by scholars like North and Fritz Machlup who pointed long ago to the patent system as an outstanding example of an institution that had a major impact on the course of technological change and economic development.<sup>6</sup> Although the framers of the U.S. Constitution and statutes were certainly familiar with, and influenced by, the British patent system, they chose to make important departures in the ways in which property rights in technology were defined and awarded. More specifically, they sought to make such property rights available to a much broader class of the population, to ensure that details of new discoveries diffused more rapidly, and to develop trade and commercialization of technology to a greater extent than did the British system. These ends were achieved through innovations such as reserving patent rights to the first and true inventor, the administrative processing of applications, and fees that were set at a low level. Moreover, the fact that the public had ready access to patent specifications promoted the diffusion of inventions and facilitated extensive trade in patented technologies. If the design of the patent system mattered during this era of the onset of economic growth, then these institutional innovations of the U.S. should have led to a broader extension of property rights in new technological information, across both inventors and inventions, than did the British system, and should have affected the relative rate and direction of technological change.<sup>7</sup>

Although our research is still at an early stage, the evidence we have examined thus far is consistent with the predicted effects of the differences between the two patent systems. First, the social and occupational

background of U.S. patentees was much more diverse than in Britain. Second, patenting was more concentrated (unequally distributed) across individuals in Britain than in the United States. Third, when the patent law in Britain was revised in the direction of the U.S. law, the levels of patenting activity increased significantly. Finally, patenting in Britain appears to have been more directed at capital-intensive industries than was the case in the United States. This pattern parallels the contrast between the two countries in the degree of balance across manufacturing industries in productivity growth.

Our second major focus is on alternative organizations of manufacturing in Britain and the United States. The basic point we make is that, relative to the United States, cottage manufacture was much more common in Britain than manufactories operating with centralized production. If cottage manufacturing was less conducive to invention than manufacturing in centralized plants, as we contend, this contrast could help to explain why productivity growth in labour-intensive industries was slower in Britain than in the U.S. Our analysis draws on the findings by Kenneth Sokoloff and David Dollar that the greater prevalence of cottage manufacture in Britain during early industrialization was due to differences in labour market seasonality and factor endowments, but our emphasis here is on the question of whether the difference in the organization of manufacturing production affected the paths of technological development in the two countries.<sup>8</sup>

We hope that this essay makes three types of contributions to the comparative study of early industrialization in Britain and the United States. First, our proposal of several reasons why these two industrial economies could have followed different paths of technological development implies that the revisionist estimates of the patterns of productivity growth during the British Industrial Revolution should be taken as a serious possibility, and highlights the need for further study. Second, by identifying several relevant conditions that could have influenced the path of technological change, we seek to suggest new ways of using the limited sources of information available to obtain a fuller understanding of the records of growth in the two early industrial economies. Finally, by linking the rate and direction of technological change to the patent system and the organization of economic enterprise, we seek to broaden the study of the processes of economic growth, and of the rôle of institutions in particular.

## THE DEVELOPMENT OF PATENT INSTITUTIONS IN BRITAIN AND THE UNITED STATES

The granting of exclusive property rights vested in patents developed from medieval guild practices in Europe. English monarchs frequently used patents to reward favourites with privileges, such as monopolies over trade that increased retail prices of commodities. It was not until the seventeenth century that English patents were associated entirely with awards to inventors, when Section 6 of the Statute of Monopolies (1624) repealed the practice of royal monopoly grants to all except inventors.<sup>9</sup> Although the petition to the Crown was itself a formality, the British patent system retained many features that reflected its origins in royal privilege. Indeed, the evidence presented below suggests that the system restricted access to property rights in inventions in ways that had the consequence of limiting the class of inventors primarily to those who had substantial technical knowledge or were wealthy and well-connected. The structure of the system served to raise the average value of patents, and favoured the invention of high-valued physical capital inputs, such as textile machinery and steam engines.

Patent grants were regarded as a favour from the Crown, and as monopolies that restricted community rights, and thus as rights to be carefully monitored and narrowly construed.<sup>10</sup> This approach was also evident in the legal system, whose protection of property rights in patents was qualified by the hostile attitude of many judges.<sup>11</sup> At the same time, once the patentee had paid the required patent fees, the patent was sealed without any examination into the technical merits of the invention. Patent rights were not limited to original inventors, since importers of foreign inventions were also given exclusive rights. Patents were granted for a term of fourteen years, and could be extended only by a private Act of Parliament.

Towards the 1780s nation-wide lobbies of manufacturers and patentees expressed dissatisfaction with the operation of the patent system, and from 1829 onwards a series of Select Parliamentary Committees explored proposals for reform. However, it was not until 1852 that Parliament approved the Patent Law Amendment Act, which authorized a major overhaul of the patent system.<sup>12</sup> Among other features, the law established a renewal system that required the payment of fees in instalments if the patentee wished to maintain the patent for the full term. Two significant changes in the direction of the American system consisted of lower fees and costs, and the rationalization of patent administration.<sup>13</sup>

The system of patenting in the United States provides a striking contrast to that of Britain. The American patent system was created in accordance

with the Commerce Clause of the Constitution, 'to promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries'.<sup>14</sup> Patents were viewed more as the natural right of the inventor than as monopoly privileges, and the consistent goal of those who shaped the system was to encourage domestic ingenuity, whatever the social class of the inventor. The judiciary recognized the importance of secure property rights in a market economy and were especially concerned about the enforcement of patents as 'the dearest and most valuable' of property rights.<sup>15</sup>

In keeping with the consciously utilitarian purpose of early economic and social policy in America, the patent application process was straightforward, and involved impersonal, routine administrative procedures. For the first few years after the Patent Act of 1790 was passed, patent applications were examined by a tribunal comprising the Secretaries of State (Thomas Jefferson) and War (Henry Knox), and the Attorney General (Edmund Randolph). This practice proved unwieldy and was replaced by a registration system in 1793. Concerns about overlapping patents led a committee headed by Senator John Ruggles to conduct an inquiry into the patent system. As a result, the Patent Act of 1836 instituted significant changes, and in July of that year the U.S. adopted the examination system that is still in use today. Under the new system, each application was scrutinized by technically trained examiners to ensure that the invention conformed to the law, and constituted an original advance in the state of the art.

The American patent system might well be regarded as the world's first modern patent institution. First, its objective was not to grant or limit monopoly rights and privileges, but to promote invention and domestic ingenuity, and to ensure the diffusion of information and innovation. Second, it largely ignored social class and privilege, and routinely granted all inventors the right to property in their discoveries. Later, when the patenting process became more stringent, the criteria for granting the patent depended on the merits of the application and not of the applicant. Third, the administration was straightforward and uncomplicated, and employees of the Patent Office – especially after 1836 – were skilled, specialized professionals. Fourth, the parameters of the patent institution were established by statute, rather than depending on individual discretion, and this led to more predictable rules.<sup>16</sup>

The drafters of the American Constitution and of its patent laws were familiar with European practice, so it might reasonably be inferred that departures from British precedent were self-conscious and deliberate attempts to establish a different system and pursue an alternative path of development.<sup>17</sup> In particular, we suggest that the framers of the U.S. system believed that inventors benefited society, and that inventive efforts were

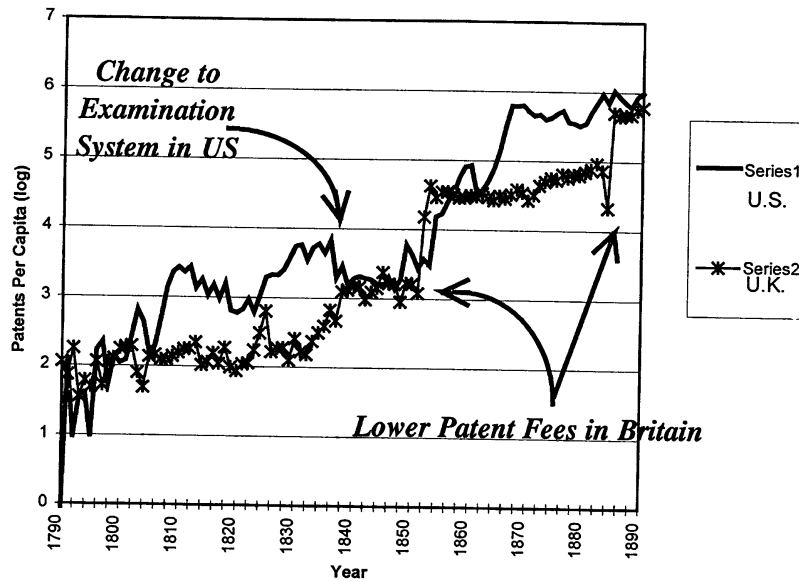
significantly influenced by prospects for material gain. An examination of the legislative history of the first U.S. Patent Act supports the view that early policy makers attempted to establish a system that would enhance rewards to inventors – whatever their social status – and accordingly stimulate inventive activity and economic growth.

Early in 1790 George Washington recommended that the legislature give 'effectual encouragement, as well to the introduction of new and useful inventions from abroad, as to the exertions of skill and genius in producing them at home'.<sup>18</sup> Congress responded with a bill, HR-41, that was designed to meet these objectives, but before the bill was passed, it was subject to several amendments. The most minor of these amendments is suggestive: the phrase 'great seal of the United States', which emulated the British custom, was altered to read simply 'seal of the United States'. Indeed, the patent bill that was approved by Washington in April, 1790, differed significantly from the British system, in ways that favoured the rights of inventors. First, the House deleted Section 6, which had imitated the English policy of granting patents for imported inventions. Second, the Senate extended the initial definition of novelty: the laws still employed the language of the English statute in granting patents to 'the first and true inventor', but unlike in England, the phrase was used literally to grant patents for inventions that were original in the world, not simply within U.S. borders. Third, a section regarding interferences (or conflicting applications) was replaced by a clause which ensured that information about prior inventions was readily available to potential patentees. Fourth, the Senate suggested forcing patentees to work the patent or else to license others to do so, but the House rejected this as an infringement of the patentee's rights. Also, small reductions were made to the fee schedule, which was modest to begin with.<sup>19</sup>

It is perhaps not surprising that American legislators, who wanted to create a system that indeed 'promoted the progress of ... useful arts', chose features which differed from the British system. Whereas British institutions retained a bias towards wealth and privilege that limited access and participation, the establishment of a patent system that encouraged broad participation was in line with the generally more democratic orientation of U.S. institutions. The ability of individuals with rather ordinary backgrounds to secure property rights in incremental inventions, and in small improvements in design and technique, meant that when markets expanded in the U.S. during early industrialization, a broad spectrum of the population was in a position to take advantage of the opportunities that were emerging throughout the economy.<sup>20</sup>

## THE EFFECTS OF INSTITUTIONAL DIFFERENCES ON PATTERNS OF PATENTING

The previous section has described the broad differences in policy and philosophy that characterized the beginnings of the two countries' patent institutions. We focus here on the specific features that were most likely to have influenced the path of technological progress, such as the cost of securing a patent grant, criteria for patentability, public access to the specifications of patented inventions, and restrictions on the transfer of patent rights and on commercial development. The first of these features, the patent fee, highlights one of the most striking contrasts between the British and American systems. After 1793 American applicants paid a fee of \$30 (\$35 after 1861) – a sum that was substantial, but only a fraction of *per capita* income. The application procedure in England, however, was notoriously costly and complex. Patent fees for England alone amounted to £100–£120 or approximately four times *per capita* income in 1860. The fee for a patent that also covered Scotland and Ireland could be as much as £350. Adding a co-inventor was likely to increase the costs by another £24.<sup>21</sup> Complicated administrative procedures added further to the costs: patent applications for England alone had to pass through seven offices, from the Home Secretary to the Lord Chancellor, and twice required the signature of the Sovereign.<sup>22</sup> These much higher costs of obtaining property rights to inventions in England tended to restrict the use of the patent system to inventions of high value, and to individuals who could raise the capital to apply for the patent and had access to information and other privileges that reduced the bureaucratic and political costs. Some might question how sensitive potential patentees were to the costs of securing property rights to inventions, but Figure 15.1 suggests that English inventors were significantly influenced by the administrative and monetary costs.<sup>23</sup> Under the renewal system, registration fees for an English patent fell to £25 in the first year; patentees who extended the term of the patent in the third year paid an additional £50, and £100 more to maintain the patent past the seventh year. Furthermore, under the new system the application procedures were administered by a single 'Great Seal Patent Office'. These changes reduced the costs of obtaining a patent, not least because consolidating the reviews into one office simplified the process considerably. As a result, the number of patents issued jumped from 455 in 1851 to 1384 in 1852 and to 2187 in the following year. In 1883, the initial fee was lowered to £4, although the cost was approximately the same if the patent were taken to term, and applications again surged from 5993 in 1883 to 17100 in 1884.<sup>24</sup> Thus the evidence supports the view that inventors were sensitive to the cost of obtaining patent protection.



Note: In the United States, an examination system was implemented in July 1836, to replace what had previously been a straightforward registration system. In Britain, patent fees were reduced in 1852 and 1883 (see text for details). The figure presents the plot of the log of annual patents issued per million people by year for the two countries. Although the figures prior to 1852 should be regarded as English patents, after that year patents applied to all of Britain.

Sources: For the numbers of patents in the two countries, see U.S. Bureau of the Census (1975), Series W 99; Dutton, *The Patent System*; and *British Parliamentary Papers* (various years).

Figure 15.1. Patents Per Capita in Britain and America, 1790–1890

From the patentee's perspective, the high fees and procedural costs of the British system may have been offset by the lack of any further examination of applications for novelty or utility. It is true, for example, that in the U.S. the introduction of the examination system in 1836 raised the costs that patentees incurred in preparing their patent applications. What is essential, however, is that although a registration system with high patent fees and an examination system both apply filters to the population of potentially patentable inventions, the samples of inventions and inventors that survive the filter are likely to differ in important respects. In particular, the U.S. examination system selected inventions on the basis of novelty and contribution to knowledge, whereas the English registration system favoured applicants who already had access to the substantial capital outlay required to obtain a patent. In markets with complete information, an inventor with a valuable idea would be able to raise sufficient capital, but in general it



might be expected that uncertainty about the value of a new invention, coupled with asymmetric information, was likely to pose significant obstacles. The bias in the English system also affected the distribution of patents, which was more likely to be skewed towards high-value, capital-intensive inventions. The effective result was that a broader segment of the population in the United States was able to secure property rights in a wider array of inventions, which probably generated greater incentives for inventive activity.

As discussed above, the two patent systems also differed in their interpretation of the requirements for novelty in the patent grant and in their policies towards imported inventions. The United States system awarded patents only to the original inventors, who were advised to obtain patent protection as soon as they had reduced their idea to a practical form. In England, patents were granted to importers of inventions from overseas as well as to original inventors, a policy which certainly must have favoured members of the commercial and elite classes, who were more likely to be familiar with developments in other countries. Moreover, this practice implied that individuals with sufficient capital to obtain a patent for foreign technology could legally constrain competitors.<sup>25</sup>

Another effect of the complex English system was to enhance the rôle of middlemen who were positioned to reduce transaction costs for potential patentees. The overwhelming majority of British patentees employed patent agents who provided information and advice, and channelled the invention through the bureaucracy for a charge of £40 to £100 above the patent fees.<sup>26</sup> This industry was oligopolistic in structure, for a small number of agents such as the Newton family, Moses Poole, and Pierre Fontainmoreau dominated the patent agency business. Some of the more active patent agents were at the same time employed by the Patent Office, such as Poole, who obtained over 100 patents in his own name, and allegedly granted his own clients preferential treatment. Between 1816 and 1852, English patent agents obtained 537 patents in their own names, mostly on behalf of their clients. Significantly, patent agents and Patent Office officials were among the most vociferous opponents of the 1852 patent reforms.<sup>27</sup>

One of the reasons why patent agents were more necessary for British patent applicants lay in their access to information. Before the middle of the nineteenth century, inventors could not readily obtain copies, nor see the descriptions and specification of patents that had previously been granted.<sup>28</sup> The patent documents were stored haphazardly in three separate offices, to which an admittance fee was charged. The fee for simply reading a patent was two shillings and sixpence, and the cost of a copy of the patent varied between two and forty guineas in 1829.<sup>29</sup> One rationale for this practice was to prevent foreign competitors from acquiring British technology, but,

whatever the objective, the result was limited access to information and slower diffusion of technology.<sup>30</sup> This policy tended to increase the value of the property rights of those who were able to obtain a patent, and to reduce the likelihood of further developments in the area by other inventors.

The difficulties of gaining access to information and the general complexity of the British system probably influenced the geographical distribution of inventive activity, in addition to favouring the wealthy. The specifications of U.S. patents were quickly and widely diffused through publications, and inventors throughout the country could apply for patents without significant obstacles, because applications could be submitted by mail free of postage. It is, accordingly, not surprising that much of the initial surge in patenting during early American industrialization occurred in rural areas. The English pattern was quite different, for patents were awarded predominantly to residents of cities, particularly to patentees with addresses in London.<sup>31</sup> This extreme geographical concentration partially reflected the difficulty of negotiating from outlying areas the complex procedures required to apply for a patent. It may be expected that the wealthy, who could afford to travel to supervise the process, or to retain agents to do so, were less disadvantaged by their distance from the capital.

Policies that affected the means of appropriating returns from the patent constitute another important feature of the patent institution whose impact might vary across social class, and affect the overall incentives for inventive effort. After obtaining a patent, the patentee typically attempted to pursue profit opportunities, but his ability to derive returns from these strategies partially depended on the patent laws and other aspects of the legal system.<sup>32</sup> These too varied between the two countries. For example, English law limited the number of individuals who could share in the patent rights to a rather small group, whose size could only be increased by a private Act of Parliament. This restriction made it more difficult for inventors to raise capital from outside investors to cover the patent application costs, or to exploit the invention commercially, and one would suppose that it constrained the working class to a greater extent than other groups.<sup>33</sup> In contrast, by the middle of the nineteenth century U.S. inventors were routinely trading patent rights that were divided and subdivided among assignees. This enhanced their ability to raise capital for support of their inventive activity, and to extract material returns from their efforts.<sup>34</sup>

The American legal system further encouraged the evolution of trade in patent rights by protecting assignees and investors against fraudulent patents – unlike the system in England, where payments for invalid patents could not be recovered.<sup>35</sup> The ability to profit thus depended on the legal system and the attitude of the courts, which influenced investors as well as current and potential infringers.<sup>36</sup> Partly because of the registration system, British

judges claimed broad jurisdiction over the determination of the validity of patents, and this may have increased uncertainty regarding property rights, and made it more costly to enforce the patent.<sup>37</sup> In contrast, American judges consistently attempted to implement the spirit of the Constitution and subsequent patent statutes, by protecting the rights of inventors. For example, they refused to interpret the clause that patents should be for 'new and useful inventions' as implying that the courts should determine whether inventions were useful, and instead left the question of utility for the market to decide.<sup>38</sup> In short, in this regard as in others, American patentees submitted their inventions to an arena in which all participants were provided with relatively equal, low-cost access.

## THE COMPOSITION OF INVENTORS AND INVENTIONS

The previous sections have presented descriptions of the historical development of the patent system in Britain and the United States, and discussed specific features that may have affected the levels and direction of patenting, as well as the composition of patentees. In this section, we test this hypothesis for consistency with the evidence. The simplest approach is to compare the rates of patenting *per capita* in the two countries. If one does so, as in Figure 15.1, the data indicate that once the United States government and patent system had had ten years to get organized, patenting *per capita* was markedly and consistently higher in the new republic. The three short intervals during which England rivalled the U.S. in patenting were at the beginning, just after the former had lowered fees, and just after the latter introduced its examination system. Overall, this comparison of patenting *per capita* in the two countries supports our contention that the U.S. patent system led to a higher proportion of inventions being patented than in Britain, if not higher rates of inventive activity as well. Another perspective on the impact of the more restrictive granting of patents in England is provided in Table 15.1. The table presents the distributions of patents in both countries for various sub-periods between 1750 and 1850, classified by the total number of patents that patentees ultimately received over their careers. The distributions are intended to convey a sense of the contrast between the two countries in the degree to which patents were concentrated among a small fraction of the population – whether professional inventors or a class with disproportionate access to the patent system. Indeed, the figures do suggest that patent holding was much more concentrated in England than in the U.S., even among patentees alone. For example, between 1812 and 1829, only 42.9 per cent of English patents were

granted to individuals who received a single patent over their career, compared to 57.5 per cent in the United States. If one considers the much lower patenting rates in England, this disparity with respect to the breadth of participation in the patent system seems all the greater.

Table 15.1. *Distribution of Patents by Patentee Career Total, England and United States, 1750–1850*

Period	1		2		3		4–5		6–9		> 10	
	Patent n	row%	Patents n	row%	Patents n	row%	Patents n	row%	Patents n	row%	Patents n	row%
1750–1769												
England	181	71.0	51	20.0	10	3.9	9	3.5	4	0.6	0	0.0
U.S.	–	–	–	–	–	–	–	–	–	–	–	–
1790–1811												
England	144	52.2	65	23.6	27	9.8	23	8.3	13	4.7	4	1.4
U.S.	263	51.0	98	19.0	62	12.0	39	7.6	36	7.0	18	3.5
1812–1829												
England	75	42.9	33	18.9	23	13.1	19	10.9	14	8.0	11	6.3
U.S.	823	57.5	249	17.4	102	7.1	109	7.6	78	5.5	70	4.9
1830–1842												
England	83	46.1	37	20.6	18	10.0	20	11.1	7	3.9	15	8.3
U.S.	1102	57.4	317	16.5	156	8.1	153	8.0	108	5.6	85	4.4
1843–1850												
England	100	51.8	28	14.5	21	10.9	21	10.9	10	5.2	13	6.7
U.S.	329	60.5	96	17.7	48	8.8	39	7.2	13	2.4	19	3.5
ALL YEARS												
England	583	49.1	214	18.2	99	10.9	82	10.4	48	6.5	43	6.1
U.S.	2517	57.1	760	17.2	368	8.3	340	7.7	235	5.3	192	4.4

Sources: Sokoloff and Khan (1990), 'The Democratization of Invention During Early Industrialization: Evidence from the United States, 1790–1846', *Journal of Economic History*, 50, 363–78, for the U.S. sample. The English sample was drawn from Woodcroft, *Titles of Patents of Invention*.

Moreover, another sharp contrast between the economies is apparent if one looks at how the distributions change over time. In the U.S., the share of all patents accounted for by patentees with only one career patent grows during the initial phase of industrialization (from 46.1 per cent in 1790–1804 to 58.2 per cent in 1823–29), while this share shrinks dramatically in England

during the analogous stage (71.0 per cent in 1750–69 to 42.9 per cent in 1812–29). The divergence in experience may reflect differences across countries both in how broadly the commercial opportunities created by economic growth extended across social classes, and in the capital requirements for securing a patent. Given the severe difficulties in obtaining property rights to their inventions that ordinary citizens in England faced relative to their wealthy countrymen, it is not surprising that such property rights were more concentrated there.

Table 15.2. *Distribution of Patents by Patentee Occupation: All English Patentees and U.S. Urban<sup>a</sup> Patentees, 1750–1850*

	1750–1769 n col%	1790–1804 n col%	1805–1822 n col%	1823–1836 <sup>b</sup> n col%	1836–1850 n col%
<i>Commerce and Professional</i>					
England	131 54.8	110 41.8	74 40.9	89 47.7	70 39.1
U.S.	– –	13 50.0	60 38.7	59 24.6	43 18.6
<i>Engineers/Machinists</i>					
England	7 2.9	28 10.6	26 14.4	37 20.7	47 26.3
U.S.	– –	1 3.9	17 11.0	34 14.2	40 17.3
<i>Artisans</i>					
England	76 31.8	95 35.1	63 34.8	33 18.4	54 30.2
U.S.	– –	9 34.6	48 31.0	80 33.4	67 29.1
<i>Manufacturers/Metal Dealers</i>					
England	17 7.1	26 9.9	17 9.4	17 9.5	5 2.8
U.S.	– –	2 7.7	17 11.0	40 16.7	49 21.2
<i>Other Occupations/None listed</i>					
England	8 3.4	4 1.5	1 0.6	3 1.7	3 1.7
U.S.	– –	1 3.9	13 8.4	27 11.3	32 13.9

*Notes:*

- a. The U.S. figures show the occupations of patentees that were traced from city directories, and therefore refer to urban patentees.
- b. The English figures in the 1823–1836 column pertain to patents filed in 1840, whereas the U.S. figures are based on patents filed through 3 July 1836, when the new U.S. patent law took effect. The occupational category for ‘artisans’ includes manufacturers of non-metal products, and ‘commerce and professional’ includes merchants and gentlemen.

*Sources:* As for Table 15.1.

The same qualitative pattern is evident in Table 15.2, which provides the distributions of patents by the occupation of the patentee for early industrial sub-periods. Occupation data are available for most English patentees, because it was required on applications. For the U.S., however, we are confined to reporting the distribution of occupations for urban patentees alone, because the information had to be retrieved from city directories.

Working with this subset of U.S. patentees underestimates differences in the occupational composition of patentees, because patentees from rural areas and small cities, who accounted for a substantial proportion of all patentees in the United States, were less likely to be from professional occupations. Even so, the distributions reveal that English patentees were more likely to be from the relatively élite classes ('gentlemen', merchants and professionals) than their U.S. counterparts, while the latter were more likely to be artisans, manufacturers, or from a miscellaneous category. The contrast in how this composition changes over time is especially interesting. In the U.S. the professional or élite share of patents falls sharply over the early nineteenth century as other segments of the population take advantage of the expansion of economic opportunities associated with early industrialization; not coincidentally, rates of patenting *per capita* jump during the same period. In England, however, both the occupational composition of patentees and the patenting rates change much more slowly over time. These patterns seem consistent with our view that the operation of the patent system in England discouraged many inventors or would-be inventors from participation in the system. Some of the contrast between England and the U.S. in the distribution of patentees may be attributed to differences in industrial composition, but it is difficult to avoid the conclusion that differences in effective access to the use of the patent system and to commercial opportunities play a rôle in the explanation. The substantial share of English patents going to 'gentlemen' (generally between 20 and 30 per cent over the period) is particularly relevant on this point.

Perhaps the most important question is whether the design of the patent system had an impact on the direction of inventive activity in the two early industrial economies. Given that patented inventions are not generally representative of all inventions, a definitive answer is beyond the scope of this essay. Nevertheless, it is clear that the composition of patented inventions was so affected. One would expect that the much higher costs of obtaining a patent in England would lead to a relatively greater amount of patenting of inventions in capital-intensive industries, both because patents would have been easier to enforce and extract a high return from if they covered substantial capital equipment, and because individuals employed in labour-intensive industries and making incremental advances would have been less able on average to raise the resources needed to file a patent. Indeed, this expectation is borne out in striking fashion. When the patents are classified by final use from 1790 through the middle of the nineteenth century (September 1852 in England and 1846 in the U.S.), only 4.8 and 10.0 per cent respectively of patents in England were in the relatively labour-intensive agriculture and construction sectors, whereas the corresponding figures for the U.S. were 22.3 and 16.7 per cent respectively.

At the other extreme, the relatively capital-intensive manufacturing and transportation sectors garnered 52.4 and 20.9 per cent respectively of English patents, but only 40.1 and 12.8 per cent of those in the U.S.<sup>39</sup>

The contrast between the inventions patented in the two countries is equally apparent at a more disaggregated level. The bias in England toward capital-intensive inventions and industries is reflected in 7.3 per cent of all of its patents between 1750 and 1851 having been for steam and gas engines, as opposed to 3.8 per cent in the U.S. (between 1790 and 1846). Similarly, patents for the textiles sector accounted for just over 15 per cent of English patents, but less than 7 per cent of U.S. patents. When one looks at a labour-intensive industry like footwear, tanning, and general leather goods, however, the relative shares are reversed: 3.2 per cent of all U.S. patents (8 per cent of those in manufacturing), as compared to 2.5 per cent in England (5 per cent of manufacturing patents).<sup>40</sup>

Overall, comparisons of the patterns of patenting and of the composition of patentees yield results that are in accord with our assessment of the effect of differences in British and American patent institutions. It is clear that the British patent system favoured the wealthy and inventors who focused on technologies that were highly capital-intensive or otherwise perceived *ex ante* to be more valuable, while the U.S. system offered property rights in new technology in a manner that was more democratic. Inventions that were incremental, aimed at labour-intensive industries, and discovered by ordinary workers who were confronting problems that were related to their occupation, were accordingly more likely to be patented in the U.S. than in England.<sup>41</sup> The difference in institutions meant, at the least, that commercial opportunities for invention and innovation were less available to undistinguished individuals in England than in the U.S., with possible implications for relative degrees of equality and social mobility.

At a more global level, the British patent system may have led to lower rates of invention (or to different types of inventions), and not just of patenting, if the more restricted provision of property rights meant that the expected returns to inventive activity were lower for a significant group of potential inventors, or for certain types of inventions. There may be yet other reasons why the system was less conducive to technical change than was its U.S. counterpart. For example, the lack of property rights in technological information could have discouraged inventors from publicly promoting their discoveries. Similarly, the limited public access to patent specifications in the British system undoubtedly slowed further the diffusion of new technical knowledge. Slower diffusion of technology would have slowed productivity growth not only directly, but indirectly as well if familiarity with that new knowledge was an input into current and future inventive activity.

## THE RELEVANCE OF DIFFERENT ORGANIZATIONS OF MANUFACTURING

Another institution-based hypothesis for the different records of productivity growth in Britain and the United States focuses on the significance of how firms or production were organized for the generation of technological change. A number of economic historians have recently shown that seasonality in manufacturing was quite pervasive in early industrial England and France, and that forms of organization conducive to part-time or irregular operations, such as putting-out or cottage manufacture, were especially prevalent in many labour-intensive industries well into the nineteenth century. Scholars of the U.S. have pointed out, however, that such forms of manufacturing organization were quite rare in early industrial America, where production was typically carried out in centralized plants which operated full-time throughout the year even before the rise of the mechanized factory.<sup>42</sup> Cottage manufacture has been linked on both sides of the Atlantic to variation over time in the opportunity cost of labour, with seasonal fluctuation in agricultural demand for labour and the household responsibilities of women highlighted as particularly significant sources of this variability. On the basis of this and other evidence, Sokoloff and Dollar have argued that the difference between the two countries in the prevalence of cottage manufacture, as compared to the manufactory organization of production, was at least partially due to the greater importance of crops with highly seasonal labour requirements (like wheat) in England.<sup>43</sup> The logic of this perspective is that cottage manufacture could survive in competition with technically more efficient manufactories, because the flexibility of the former mode of production made it more conducive to the effective harnessing of an offpeak or part-time workforce whose opportunity costs (wages) were low and who divided their labour time between different activities.

Regardless of the reasons for the difference in industrial organization, however, the contrast could have contributed to differences in the two countries' paths of technological change. Indeed, there is a strong theoretical case for why manufacturing based on a centralized plant organization would generate more rapid technical change over time. First, in an era in which much progress was made through improved organization of labour and other inputs, the larger scale of production associated with centralized plants might well have made it easier to identify or implement ways of raising productivity such as increasing the division or intensity of labour or exploiting indivisibilities in capital equipment.<sup>44</sup> Second, the rate of investment in inventive activity might reasonably have been influenced by the organization of enterprise. The centralized plant's greater degree of specialization, as well as its larger scale, would be expected to boost



invention by raising the return to that activity, because the return to an improvement in technology generally increases with the level of output. Third, large centralized plants facilitated the extraction of private returns from property rights in inventions by reducing the costs of monitoring the use of the technology and protecting against infringement. Higher expected returns would presumably induce higher rates of investment in inventive activity. Finally, studies of technological advance during early industrialization suggest that the greater division of labour within centralized plants may have helped to focus attention on how machinery or other changes in production processes could be designed to improve productivity.<sup>45</sup> In short, it is entirely reasonable to expect that cottage production, where workers laboured part-time, on a very small scale, and with relatively simple capital equipment, made for a less favourable environment for invention than centralized production did.

It is obvious that this sort of framework for thinking about how the organization of manufacturing could influence the course of technological change would work, as did our analysis of the difference in patent institutions, in the direction of helping to explain the disparity between the estimates of the records of manufacturing productivity growth for Britain and the U.S. The hypothesis applies with greatest force to the labour-intensive manufacturing industries, where virtually all the difference between the two economies in industrial organization was located, and where Britain's pace of technological advance appears to have been relatively slow.

## CONCLUSION

In comparing the paths of technological change in early industrial Britain and the United States, we could have chosen to discuss the considerable similarities between the circumstances and experiences of these first two economies to industrialize. Focussing on contrasts, as we have done instead, runs the risk of sacrificing the broad perspective, but it also allows us to highlight the stark difference in the records of productivity growth implied by the most recent estimates in the literature. Economic historians have not yet fully grappled with the questions of whether and how these estimates can be improved, and how the divergence between the two economies is to be explained if the qualitative finding of slower and much less balanced productivity growth in Britain than in the U.S. holds up to scrutiny. We believe that the study of the processes of early economic growth has been hampered by the lack of attention to this comparative dimension, and that reconciling or accounting for the evidently divergent patterns is of fundamental importance.

Although we hope to stimulate scholars to undertake the formidable work in the archives which is probably necessary to address the puzzle effectively, the contribution of this essay towards resolving the issues is quite modest. Our intent was to explore how two specific differences in institutions may have had significant influences on the course of technological change in the respective countries. Most of our efforts have been devoted to specifying differences between the British and American patent systems, and to assessing what impact they could have had on the respective courses of technical change. We argue that these differences influenced the compositions of both patentees and patented inventions: the British system favoured the wealthy and highly capital-intensive technologies in the award of patents, while the Americans extended property rights in invention to broader ranges of both new technologies and the population. At the very least, the more limited access of ordinary people in Britain to property rights in their inventions must have served to preserve inequality and reduce social mobility. Moreover, although there were certainly other ways of extracting a return from invention than relying on property rights vested in patents, there are reasons to believe that American patent institutions made for more extensive trade in technologies, higher expected returns to (and levels of) inventive activity, as well as more rapid diffusion of technological information. Given the difficulties of drawing inferences about the volume of invention from data on patent counts alone, this interpretation has yet to be subjected to a systematic empirical test. Nevertheless, it is interesting that one would expect the effects of the different patent institutions to be most pronounced in the labour-intensive industries, and indeed, the productivity growth estimates we have do exhibit the greatest discrepancy in such industries.

The other difference in institutions we discuss concerns how early manufacturing was organized. The contrast between early industrial Britain and the United States in the prevalence of cottage manufacture, as opposed to manufactories or non-mechanized factories, is quite dramatic, and again there is good reason to believe that the organization of production had some effect on the rate or direction of inventive activity. Although this issue also awaits empirical investigation, researchers should be able to take advantage of systematic regional variation in the organization of manufacturing within Britain by examining whether a relationship between the predominant form of organization and the generation of inventions in the relevant industries held across regions.

Although our knowledge of the processes by which technological change accelerated in early industrial Britain and the U.S. has been much improved in recent decades, there is still much that we do not understand. Whether or not the two economies are determined to have diverged substantially in their

records of growth, the influence of institutions like patent systems and industrial organization on the rate and direction of inventive activity in this and other contexts deserves more attention and study by scholars.

## NOTES

1. See T.S. Ashton (1968), *The Industrial Revolution, 1760–1830*, London: Oxford University Press; D.S. Landes (1969), *Unbound Prometheus: Technological Change and Industrial Development in Western Europe from 1750 to the Present*, London: Cambridge University Press; and M. Berg (1994), *The Age of Manufactures, 1700–1820: Industry, Innovation and Work in Britain*, London: Routledge.
2. N.F.R. Crafts and C.K. Harley (1992), 'Output Growth and the British Industrial Revolution: A Restatement of the Crafts-Harley View', *Economic History Review*, 45, 703–30.
3. For examples, see K.L. Sokoloff (1992), 'Invention, Innovation, and Manufacturing Productivity Growth in the Antebellum Northeast', in R.E. Gallman and J.J. Wallis (eds), *American Economic Growth and Standards Of Living Before the Civil War*, Chicago: University of Chicago Press; and P. Temin (1997), 'Two Views of the Industrial Revolution', *Journal of Economic History*, 57, 63–82.
4. D.C. North (1981), *Structure and Change in Economic History*, New York: Norton.
5. In addition to H.J. Habakkuk (1962), *American and British Technology in the Nineteenth Century: the Search for Labour-Saving Inventions*, Cambridge: Cambridge University Press, see S.L. Engerman and K.L. Sokoloff (1997), 'Factor Endowments, Institutions, and Differential Paths of Growth Among New World Economies', in S. Haber (ed.), *How Latin America Fell Behind*, Stanford: Stanford University Press.
6. See North, *Structure and Change*, and F. Machlup (1958), *An Economic Review of the Patent System*, Washington: Government Printing Office.
7. For evidence that inventors were responsive to prospects for material gain, consistent with patent systems making a difference, see K.L. Sokoloff (1988), 'Inventive Activity in Early Industrial America: Evidence from Patent Records, 1790–1846', *Journal of Economic History*, 48, 813–50; B.Z. Khan and K.L. Sokoloff (1993), "'Schemes of Practical Utility": Entrepreneurship and Innovation Among "Great Inventors" in the United States, 1790–1865', *Journal of Economic History*, 53, 289–307.
8. K.L. Sokoloff and D. Dollar (1997), 'Agricultural Seasonality and the Organization of Manufacturing in Early Industrial Societies: The Contrast Between England and the United States', *Journal of Economic History*, 57, forthcoming.
9. The Statute of Monopolies, 21 Jac. c., 1623, was implemented in 1624.
10. *Blanchard v. Sprague*, 3 F. Cas. 648, Mass. (1839), compared the laws toward patents in Britain and America.
11. H.I. Dutton (1984), *The Patent System and Inventive Activity During the Industrial Revolution, 1750–1852*, Manchester: Manchester University Press, chapter 4.
12. Patent Law Amendment Act, 15 & 16 Vict., Chapter 83, 1852.
13. Some had recommended the replacement of the registration system by the American examination system, but this proposal was not accepted, and the British retained the registration system until early in the twentieth century. One of the witnesses before the 1851 Select Committee argued against an examination system because it would 'erode the royal prerogative'. However, the Select Committee decided not to adopt this aspect of the American system more because they felt it would not be possible to find sufficiently skilled examiners. Law Officers did have the right to examine the technical merits of patent applications at their discretion, but there is no evidence that this right was ever exercised. See Dutton, *The Patent System*, p. 61, and *British Parliamentary Papers. Inventions* (1968–70), Shannon: Irish University Press.
14. Article 1, sec. 1, cl. 8 of the United States Constitution authorized Congress 'to promote the progress of science and useful arts, by securing to authors and inventors the exclusive rights to their respective writings and discoveries'. Accordingly, the first Patent Act of April 1790 stipulated that 'upon the petition of any person or persons that he, she, or they,

- hath invented or discovered any useful art, ... it shall be lawful ... to cause letters patent to be made out in the name of the United States'.
15. The phrase is from the landmark Supreme Court case, *ex parte* Wood v. Brundage, 22 U.S. 603 (1824). These sentiments were apparent in the entire body of American law reports: Ames v. Howard, 1 F. Cas. 755 (1833) declared that patents were granted 'to promote the progress of science and the useful arts, an object as truly national, and meritorious, and well founded in public policy, as any which can possibly be within the scope of national protection'. Whitney v. Emmett et al., 29 F. Cas 1074 (1831): 'In England a patent is granted as a favor ... Here a patent is a matter of right.' Pennock v. Dialogue, 27 U.S. 1 (1829), another landmark case, contrasts England and America: 'In the courts of the United States, a more just view had been taken of the rights of inventors. The laws of the United States were intended to protect those rights, and to confer benefits; while the provisions in the statute of England ... are exceptions to the law prohibiting monopolies. Hence, the construction of the British statute had been exceedingly straight and narrow, and different from the more liberal interpretation of our laws.'
  16. Note that Britain passed no major patent statutes between 1624 and 1852 (two minor changes were recorded in 5 & 6 Will. IV, (1835) and 2 & 3 Vict. (1839)). Patent policies were therefore unpredictable, effected on an *ad hoc* basis by the courts, Law Officers, and the Lord Chancellor (H. Harding (1953), *Patent Office Centenary*, London: H.M.S.O., p. 4). As U.S. Supreme Court Justice Baldwin declared in Whitney v. Emmett, 29 F. Cas. 1074 (1831): 'The silence of the [English] law left a wide field open to the discretion of the courts ... But in this country the law is more explicit. The Constitution ... is a declaration of the supreme law of the land ... which leaves no discretion to the judges to assign or presume any other.' In keeping with the consciousness that patents were critical to national policy, reforms in the antebellum period were accomplished and incorporated into U.S. law fairly rapidly, by means of the Patent Law Acts of 1790, 1793, 1800, 1819, 1832, 1836, 1839 and 1842. The 1836 statute set in place the basic system that operated in the twentieth century.
  17. See the discussion in B. Bugbee (1967), *The Genesis of American Patent and Copyright Law*, Washington: Public Affairs Press, p. 145, of the resemblance between the copyright law of 1790 and the Statute of Anne (1710). Note also his conclusion that (p. 157), 'The national patent and copyright systems created in 1790 under the Constitution were founded not only upon English precedents ... but also ... upon a century and a half of distinctive provincial tradition'.
  18. Bugbee, *The Genesis*, p. 137.
  19. See L.G. de Pauw (1977), *Documentary History of the First Federal Congress: vol. 3.- House of Representatives Journal*, Baltimore: Johns Hopkins University Press, pp. 1631-7. Also see Bugbee, *The Genesis*, p. 147: 'It will be observed that certain other provisions which had appeared at one time or another in American intellectual property enactments were omitted from the Federal patent and copyright statutes of 1790 - in favor of the inventor or author ... During the term of a patent or copyright legally acquired from the United States, the property of the creative individual in his production was to be absolute.'
  20. See K.L. Sokoloff and B.Z. Khan (1990), 'The Democratization of Invention During Early Industrialization: Evidence from the United States, 1790-1846', *Journal of Economic History*, 50, 363-78.
  21. See Attorney General (1851), *Hansard's Parliamentary Debates*, vol. cxviii, July 1-August 8, London: T.C. Hansard; Dutton, *The Patent System*; and J. Ruggles (1836), *Senate Committee Report*, reprinted in *Journal of Patent Office Society* (1936), 18(12), 853-63. In 1836, according to Ruggles, the fee for a patent in England alone amounted to \$585, or nearly twenty times that for a patent in the U.S.
  22. If the patent were extended to Scotland and Ireland it was necessary to negotiate another five offices in each country. For descriptions of the patent procedure, see Dutton, *The Patent System*, and C. MacLeod (1988), *Inventing the Industrial Revolution*, Cambridge: Cambridge University Press. Harding, *Patent Office Centenary*, p. 5, calls the system 'quite fantastic'. According to E. Holroyd (1830), *A Practical Treatise of the Law of Patents for Inventions*, London: A. Strahan, pp. 66-7, patent petitions had to be submitted to: the office of the Secretary of State; the Attorney General; office of the Secretary of State for King's Warrant; warrant of the Attorney General; patent office for signature of the Crown; office of the Signet; Lord Keeper of the Privy Seal; office of the Lord Chancellor; Great Seal Patent Office. Officials were not required to justify their decisions. The vast majority of

- patents before 1852 were filed in England – only 16 per cent were extended to Scotland and Ireland as well. Hence the figures for England closely approximate the total amount of patents until 1852, when patents grants began automatically to cover all three kingdoms (Dutton, *The Patent System*, p. 35).
23. According to the Attorney General, a renewal system would 'give poor men an opportunity which they did not at present possess, of protecting inventions till such time as they might be able to derive advantage from them, and at a cost adapted to their means'. See the Attorney General, *Hansard*, p. 1537.
  24. Fees were £4 for the first application; £50 to maintain the patent after the fourth year; and £100 due before the end of seven years. See Patents, Designs and Trademarks Act, 46 & 47 Vict. Chapter 57 (1883).
  25. Under certain conditions, involving a high cost of importing technology from abroad and a low cost of it diffusing once imported, an argument can be made for why the English practice (which was common throughout Europe and probably reflected a tradition of granting royal privileges to first-time investors) would enhance economic growth. In general, however, we think that such cases would have been relatively rare, and that the detrimental effects of restraining competition more than offset the positive ones overall. More research is needed to resolve the issue.
  26. 'The great majority of patents are still however procured through the instrumentality of Patent Agents ... The proportion obtained in the year 1852–53, by Patentees or Solicitors, to that by Patent Agents, was one to fifty' according to J. Coryton (1855), *A Treatise on the Law of Letters Patent*, London: H. Sweet, p. 147. Most British patent agents were located in London, in closer proximity to the patent offices (Dutton, *The Patent System*). In the United States, the Patent Office itself disseminated information and forms. Copies of prior patents could be obtained by writing to the Patent Office, which charged 10 cents per hundred words. The Secretary of State published lists of expired patents in the Washington newspapers. Patent agents could be found in most major cities in the United States, from San Francisco to Boston. Competition among numerous patent agents kept fees low: for instance, in the 1860s Munn and Co., the largest patent agency, charged \$5 for a patent search and \$1 to copy patent claims. Rather than negotiating with a bureaucracy, American patent agents offered advice on the technical merits of the invention, drafted technical drawings, and served as mediators between buyers and sellers of technology. For, as *Scientific American* (November 13 1842, p. 62) – published by Munn & Co – noted, 'we advise every inventor who is able, to make application for himself, and thereby save some expense. There are forms and rules that will require study, but you can soon master them'.
  27. See Harding, *Patent Office Centenary*, and Dutton, *The Patent System*.
  28. Specifications were not generally published in England, according to Holroyd, *A Practical Treatise*, p. 160, until 1852. The various patent offices concerned prohibited extracts of key aspects of the invention (Select Committee, 1829, in *Parliamentary Papers. Inventions*). Trade journals such as the *Repertory of Arts, Manufactures and Agriculture* did publish patent descriptions. However, these published lists tended to be incomplete and the length of time between patent grant and publication varied between five months and five years (D.J. Jeremy (1981), *Transatlantic Industrial Revolution: The Diffusion of Textile Technologies Between Britain and America, 1790–1830s*, Cambridge: Cambridge University Press, pp. 47–9).
  29. Jeremy, *Transatlantic Industrial Revolution*, pp. 46–7. Jeremy also notes that descriptions were filed haphazardly and that searches could take hours. In the 1820s an employee of the Patent Office and a patent agent on his own account, had compiled an index, but it remained 'under Poole's personal control', and probably contributed to the value of his services as a patent agent.
  30. See MacLeod, *Inventing the Industrial Revolution*, p. 51, for a discussion of the development of the specification requirements for patentability and of the basis for limiting access to the specifications of patents.
  31. See MacLeod, *Inventing the Industrial Revolution*, and Dutton, *The Patent System*. Between 1617 and 1852, Londoners consistently received the majority of all patents granted. See Harding, *Patent Office Centenary*, p. 13.
  32. Alternative strategies for extracting material returns from a patented invention included assigning (selling) the property rights in total or in part, licensing the technology, exploiting the patent directly as a sole proprietor or partner of an enterprise that used the invention, or some combination of these approaches.

33. In the 1860s, assignments in England varied between 600 and 700 *per annum*. The law limited the number of assignees to five (twelve after 1832). At least until 1830, it was not clear whether this limit extended to licensees (Holroyd, *A Practical Treatise*, p. 145). This law in effect also restricted financing for inventions, as *Duvergier v. Fellows*, 10 C.B. 826 (1830), indicates.
34. For example, it is noted in B.Z. Khan (1995), 'Property Rights and Patent Litigation in Early Nineteenth-Century America', *Journal of Economic History*, 55, 58–97, that the U.S. Patent Office recorded some 2108 assignments in 1845. See N.R. Lamoreaux and K.L. Sokoloff (1996), 'Long-Term Change in the Organization of Inventive Activity', *Proceedings of the National Academy of Sciences*, 93 (12 November), 12686–92, for an analysis of patent assignments during a later period.
35. If a British patent was useless, the purchaser could not recover his payment: *Hall v. Conder*, 2 C.B., N.S. 22 (1857). Assignees or licensees of American patents that lacked utility were entitled to refunds of their payments. For details see Khan, 'Property Rights'.
36. See MacLeod, *Inventing the Industrial Revolution*, and Dutton, *The Patent System*.
37. According to Lord Coke, an invention should 'not be mischievous to the State' nor 'hurt trade' (Coryton, *A Treatise on the Law*, pp. 60–61). Patents could be invalidated because of inutility, and according to *Hill v. Thompson*, Web. P.C. 237 (1817) 'the utility of an invention is a question for the jury'. Importers of inventions were at times deemed to be of lower status than original inventors, as *In re. Soames' Patent*, 1 Web. P.C. 733 (1843). See Khan, 'Property Rights'.
39. These figures were computed from random samples of English and U.S. patents. The English patents were drawn from B. Woodcroft (1854), *Titles of Patents of Invention: Chronologically Arranged from March 2, 1617 to October 1, 1852*, London: Patent Office, Great Britain, comprising 26.7 per cent of all patents issued between 1790 and October 1, 1851. The U.S. sample includes 29.6 per cent of all patents issued between 1790 and 1846, and is described in Sokoloff, 'Inventive Activity'. The classifications were done by us, but similar qualitative results are implied by the classifications done by the respective patent offices. See Dutton, *The Patent System*, Appendix A, and E. Burke (1847), *List of Patents for Inventions and Designs Issued by the United States From 1790 to 1847*, Washington: U.S. Patent Office.
40. The figures for England were drawn from Dutton, *The Patent System*, Appendix A, while those for the U.S. were computed by the authors from the individual patent descriptions in Burke, *List of Patents*.
41. Indeed, in eighteenth century England 'patenting of mere improvements was frowned upon', as pointed out by MacLeod, *Inventing the Industrial Revolution*, p. 13.
42. For examples of work on England and France, see D. Bythell (1978), *The Sweated Trades*, London: St. Martin's; R.D.M. Snell (1985), *Annals of the Labouring Poor*, Cambridge: Cambridge University Press; G.L. Gullickson (1983), 'Agriculture and Cottage Industry: Redefining the Causes of Proto-Industrialization', *Journal of Economic History*, 43, 831–50; and G. Postel-Vinay (1994), 'The Dis-integration of Traditional Labour Markets in France: From Agriculture and Industry to Agriculture or Industry', in G. Grantham and M. McKinnon (eds), *Labour Market Evolution: The Economic History of Market Integration, Wage Flexibility, and the Employment Relation*, London: Routledge. For a discussion of the experience in the U.S., see Sokoloff and Dollar, 'Agricultural Seasonality'.
43. See Sokoloff and Dollar, 'Agricultural Seasonality'. Gullickson, 'Agriculture and Cottage Industry', makes a similar argument for France.
44. See Sokoloff, 'Invention, Innovation', and Berg, *Age of Manufactures*, for discussion.
45. For example, see Landes, *Unbound Prometheus*.