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This working paper is submitted by:
Christine MacLeod and Alessandro Nuvolari

Inventive Activities, Patents and Early Industrialization.
A Synthesis of Research Issues

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The Intellectual Property Rights (IPR) elements of the DIME Network currently focus on research in the area of patents, copyrights and related rights. DIME’s IPR research is at the forefront as it addresses and debates current political and controversial IPR issues that affect businesses, nations and societies today. These issues challenge state of the art thinking and the existing analytical frameworks that dominate theoretical IPR literature in the fields of economics, management, politics, law and regulation-theory.
Inventive Activities, Patents and Early Industrialization. A Synthesis of Research Issues

Christine MacLeod
Department of Historical Studies (University of Bristol)

Alessandro Nuvolari
Eindhoven Centre for Innovation Studies (ECIS)

Abstract

The aim of this paper is to provide a roadmap to recent research on the role of patent systems in the early phases of industrialization. Perhaps surprisingly, no consensus has been reached yet as to whether the emergence of modern patent systems exerted a favourable impact on inventive activities. However, the recent literature has shed light on a number of fundamental factors which affect the links between inventive activities and the patent system. The concluding section of the paper outlines some "history lessons" for the current debate on the role of Intellectual Property Rights in economic development.

Contact authors:
Christine MacLeod, Department of Historical Studies, University of Bristol, 13 Woodland Road, Bristol, BS8 1TB, United Kingdom,
Telephone: + 44 117 9287934; E-mail: c.macleod@bristol.ac.uk
Alessandro Nuvolari, ECIS, Eindhoven University of Technology, PAV Q 1.08, P.O. Box 513, 5600 MB, Eindhoven, the Netherlands,
Telephone: +31 2474179; E-mail: a.nuvolari@tm.tue.nl
1. Introduction

Over the last fifteen years or so, intellectual property rights (IPR) have become a subject of growing discussion and debate both in industrialized and in developing countries. One of the chief reasons for this increasing attention has been without doubt the shift towards a strengthening of IPR regimes which seems to have taken place in the global economy since the early 1980s. In the course of the 1960s and 1970s many developing countries were capable to withstand political pressures for the implementation of stricter IPR regimes. However, with the early 1980s, IPR issues were more and more often raised by the US in the context of bilateral trade negotiations with developing countries. This strategy of the US governments was essentially motivated by concerns over the deteriorating competitiveness of American industry, especially vis-à-vis, the newly industrializing countries. One the culprits of this deterioration was identified in the imitation and reverse engineering of US products taking place in these economies. Hence, the campaign for the implementation of stronger IPR regimes (David, 1993, pp. 19-20; see also Granstrand, 2005). Progressively, strong IPR protection was included in the broad "package" of institutional reforms, which advanced industrial economies and international development organizations recommend to developing countries (Chang, 2002).

The TRIPS agreement can be probably regarded as a further stage in this process. Advanced industrial economies have insisted for the introduction of IPR issues within the framework the WTO negotiations. The consequence is that failure to comply with the stricter standards of IPR protection defined in the agreements, may result in trade retaliatory measures. Clearly, this amounts to a growing pressure towards stronger IPR regimes worldwide. As summarized, in the 1999 World Bank Report: “Stronger IPR are a permanent feature of the new global economy” (World Bank, 1998, p. 36)

It should be noted that IPRs (and patent systems in particular) are particularly tricky issues for industrial organization theory. This is due to the fact that many policy implications concerning the optimal design of a patent system (which in the literature are typically addressed in terms of "duration", "height" and "breadth" of the patent) that can be derived from industrial organization models, are very sensitive to a number of specific assumptions concerning the set-up of the "patent race". Accordingly, this type of literature, at least so far, has not been able to produce a set of univocal and clear-cut policy prescriptions (David, 1993; Verspagen, 2003).

Given this state of affairs, some interpreters have been tempted to shed further light on such intricate and controversial issues by looking at the historical evidence concerning the relationship between patent systems and inventive activities. Unfortunately, in many cases, the appraisal of the historical literature, has been rather superficial and inaccurate, leading to dangerous misapprehensions of the history lessons (if there are any) that could be drawn on
the basis of our current knowledge of the process industrialization of western economies (see Chang, 2001 for a critical discussion of this literature).

The aim of this paper is to provide a roadmap to recent research in economic history and history of technology, dealing with connection between the patent system and inventive activities in the early phases of modern economic growth of western economies (in particular we will focus mostly on the British and US experience). As we shall see, the historical record does not lend itself to straightforward and clear-cut interpretations. However, on the basis of the studies carried out over the last twenty years, one can actually work out some cautionary notes on the centrality of a "strong" patent regime for a global economic development strategy.

2. Patent systems and industrialization: Britain

The role of the patent system in the early phases of British industrialization did not become a subject of systematic historical investigation until the mid 1980s. Before that, the theme had been frequently touched upon in most of the works of synthesis providing general appraisals of the origins and nature of the industrialization of western economies. However, these judgments were based on the evaluation of the scattered experience of a handful great inventors, such as Watt, Arkwright, and Crompton. Against this background, it should not come as a surprise that, assessments of the patent system could be very different. Let us just consider two of the most authoritative works of synthesis on industrialization. North and Thomas (1973) gave to the emergence and the progressive operationalization of the patent system, a prominent place in their explanation of the rise of Britain as the "first industrial nation":

Innovation will be encouraged by modifying the institutional environment, so that the private rate of return approaches the social rate of return. Prizes and awards provide incentives for specific inventions, but do not provide a legal basis for ownership of intellectual property. The development of patent laws provides such protection....[B]y 1700...England had begun to protect private property in knowledge with its patent law. The stage was now set for the industrial revolution (North and Thomas, 1973, pp. 155-156).

In passing, we may note that North and Thomas’ argument is frequently put forward in the contemporary debate by proponents of a strong patent protection (Chang, 2001). On the other hand, David Landes remarked that

A number of writers have laid stress on the incentive effect of patent legislation. I am inclined to doubt its significance. (Landes, 1969, p. 64).

The first contribution to consider in a systematic way the connection between the patent systems and inventive activities during the British industrial revolution is

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1 See also North (1981), pp. 164-166.
2 In another reference work on British industrialization, Mathias (1969, p.34) noted that the impact of patent laws on innovation "have proved particularly intractable to analyze or to asses" and refrains from formulating a final balance.
Dutton (1984). The available evidence, according to Dutton, suggests that the British patent system, although requiring the completion of cumbersome and costly bureaucratic procedures and granting a rather imperfect protection against infringements, was nevertheless capable of stimulating inventors' efforts. His judgment is essentially based on a wide-ranging examination of the contemporary literature on invention which seems to indicate that the prospect of the economic exploitation of a patent was explicitly considered by many inventors. Furthermore, Dutton notices also the existence of a group of “quasi professional inventors”, that is individuals with several patents. In Dutton’s view, this suggests that the British industrial revolution was characterized by the emergence of a class of individuals systematically engaged in inventive activities with a view to reaping their economic fruits using patent protection. This group of quasi-professional inventors constituted the backbone of an “infant invention industry”. This process was coupled, at least from early nineteenth century, with the emergence of an extensive “trade in invention”. This means that patent rights become increasingly object of market transactions (selling of patent rights, licensing, creation of commercial partnerships geared at the exploitation of patents). This expanding market for invention providing a wide range of opportunities for the economic exploitation of inventive activities reinforced the formation of the “specialist” invention industry. All in all, Dutton’s conclusion is that the British patent system can be seen as having a strong stimulating effect on the rate of invention. Sullivan (1989) appears to confirm Dutton’s judgment by showing the existence of a structural break in 1757 in the time series of total British patents. According to Sullivan, this discontinuity (which is neatly consistent with the traditional chronology of the British industrial revolution, ie 1760-1830) reflects an acceleration in the pace of invention taking place in the second half of the eighteenth century. At least in part, this acceleration is accounted for by the progressive development of a body of case law related with the protection and enforcement of the rights of patentees. For example, the requirement to specify (normally within two to four months of the patent’s enrolment) was introduced gradually during the first third of the eighteenth century; from 1734 it became standard. Although, initially demanded, it seems, to assist the law officers in discriminating between similar inventions, the specification was not normally scrutinized by any administrative department of government. As a result, many specifications remain vague and opaque (MacLeod, 1988, pp. 48-55). Increasingly, however, they become subjected to a very close examination when a prosecution for infringement reached the law courts. This process culminated in Lord Mansfield decision in the case Liardet vs Johnson (1778) which stipulated that the specification should be sufficiently full and detailed to enable anyone, skilled in the art or trade to which the invention pertained, to understand and apply it without further experiment (MacLeod, 1988, p. 49).

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3 The existence of discontinuity around 1760 was also noted by Bowden (1925, pp. 12-14) and Ashton (1948, pp. 118-120).
In other words, the time-lag between the enactment of the Statute of Monopolies in 1623 (which is commonly regarded as the first British patent law) and the acceleration of inventive activities is to be explained by the time needed for firmly establishing the rights of the patentees within the framework of British legal system (Dutton, 1984, pp. 73-75; Sullivan, 1989, p. 435).

Christine MacLeod’s evaluation of the British patent system in the early phases of the industrialization process is much more cautious (MacLeod, 1988). She draws attention to the frequent heterodox use of patents which continued to take place until (at least) the late eighteenth century. The most typical cases of this behaviour were the use of patents in support of specific government concessions and franchises or for advertising/certifying the specific qualities of a product. Thus, in several industries, and particularly in the medical field, patents were often employed as means for constructing product reputation. Finally we should also consider that patents were also taken by amateur, “gentlemen” inventors, who considered their engagement in scientific and technological activities as an enjoyable diversion. For these men, the granting of a patent was just a mean for achieving a general public recognition for their inventive efforts, rather than the basis for the economic exploitation of a specific invention. Furthermore, MacLeod also notices that a large volume of inventive activities were undertaken outside the coverage of the patent system. Broadly speaking, in the course of the eighteenth century the coverage of patent system remained highly restricted both sectorally (limited to the newly emerging capital-intensive sectors) and to metropolitan areas (chiefly, London, Birmingham, Bristol and Manchester). It would be wrong to assume that this concentration reflected the higher inventive dynamism of these sectors or locations. In the period we are considering, particularly innovative and technologically sophisticated industries such as machine tools, scientific instruments, branches of chemicals, etc. remained characterized by a lasting low propensity to patent (MacLeod, 1988, ch. 6).

The foregoing discussion shows that the study of the role of the patent system is fraught by the difficulties which are inherent in using patents as output indicators of inventive activities. The limitations of patents counts have been starkly summarized by Griliches (1990, p. 1669; see also the discussion in Basberg, 1987): "Not all inventions are patentable, not all inventions are patented and the inventions that are patented differ greatly in 'quality'...". This means that a proper assessment of the links between patent laws and inventive activities requires to move beyond simple "patent counting", and provide an evaluation not

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4 Petra Moser (2005) research on the inventions presented at the Crystal Palace exhibition of 1851 provides an interesting snapshot on the large volume of inventive activities undertaken outside the patent systems in the first half of the nineteenth century. None of the British or American industries she considers had patenting rates (ie, the ratio between patented inventions and total inventions) higher than 50%. The highest value reported by Moser is 36.4% for the US machinery industry.

5 Sullivan (1990) has instead considered patenting activities in the period 1711-1850 as remarkably widespread across all economic sectors. In our view, a careful assessment of the very same data he sets out, reveals that patenting was heavily concentrated in a few key-sectors.
only the volume of inventive activities undertaken outside the coverage of patent protection, but also the actual technological significance of patented inventions.

In this sense, detailed examinations of the contents of patents for specific industries may provide us with important insights. A recent exercise along these lines, has been recently carried out by MacLeod et. al. (2003). They have examined in detail a random sample of 2,009 British patents in steam engineering, for the period 1800-1900. They found that 365 of these patents (corresponding to a sizable 18.1%) were granted to “perpetual motion” machines or other inventions which were not technically feasible. Interestingly enough, 217 of these impossible patents were granted in the period 1860-1900, that is well after the formulation of the principles classic thermodynamics by Clausius and Kelvin in the early 1850s, that scientifically proved the impossibility of a perpetual motion engine.

To sum up, historical research on the British case, seems to suggest that, at least to a degree, the patent system had a positive effect on inventive activities. This judgment is essentially substantiated by Dutton’s group of “quasi-professional” inventors. Notwithstanding this, given the amount of evidence pointing to the significance of non-patented technological progress, the relative contribution provided by the patent system to the general volume of inventive activities in this historical phase, remains a matter open for judgment. Furthermore, in our assessment, we should also not forget the detrimental impact on the rate of innovation of “blocking patents” (see, Kanefsky, 1978, for a discussion of the negative impact of the Watt’s separate condenser patent for innovation in steam engineering).

3. Patents systems and industrialization: the USA

It must be recognized that the first patent system working by what we might consider truly modern procedures was not the British, but the American one (Khan and Sokoloff, 2001). Until the reform of 1852, the British patent system was characterized by a very restricted accessibility, due mostly to the high costs and the cumbersome administrative procedures involved in the process (Khan, 2005, p. 31). On the other hand, in the United States, the patent application process was relatively smooth, involving few straightforward administrative procedures. The US patent fee was $30. For this reason, one could argue that the validity of North and Thomas’ hypothesis linking the acceleration in the rate of innovation and the emergence of patent institutions ought to be examined primarily in the case of the United States.

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6 The sensitivity of patenting to fees was clearly shown in 1852, when the initial fee for a UK patent was reduced from £350 (corresponding to $1,680, see Khan (2005, p.31)) to £25 and the number of patents leapt from 455 issued in 1851 to 2,187 in 1853; following a further reduction to £4 in 1883 the annual total of patents almost trebled from 5,993 in 1883 to 17,100 in 1884.
In a number of recent papers Sokoloff, Lamoreaux and Khan have tackled exactly this issue, examining the relationship between the patent system and inventive activities in the United States in the course of the nineteenth century (see Khan and Sokoloff, 2001 for a general overview). Their contributions are based on an extensive quantitative analysis of the evidence collected from the patent records.

Khan and Sokoloff (1990) examine the issue of the responsiveness of individual inventors to the economic inducements granted by the patent system over the period 1790-1846. They conclude that American inventors sought consistently to secure patent rights for their inventions and that patent protection permitted a quite effective appropriation of economic returns stemming from inventive activities.

Khan and Sokoloff (1998) have compared the British patent system with the American one. Undoubtedly, the British patent system before the 1852 reform was far less effective than the American in protecting the intellectual property rights of the patentee. Furthermore, as he have seen, administrative and monetary costs were considerably higher in Britain than in the United States, and this considerably restrained access to the system. By 1810s, the US surpassed Britain in patenting per capita. Patenting per capita will remain higher in the US than in Britain for the entire course of the nineteenth century (Khan and Sokoloff, 2001, p. 238-239). This evidence, according to Khan and Sokoloff suggests that the rate of innovation was probably lower in early industrial Britain than in the United States. Obviously, this assessment is based on the assumption that patenting per capita reflects the relative volume of inventive activity. However, as Mokyr (2002, p. 295) as aptly remarked, the analysis of Sokoloff and his associates, does not appear consistent with the traditional view of economic historians and historians of technology who have traditionally regarded the period 1790-1850 as a lasting phase of British technological leadership. 7

In related contributions, using data on the licensing and assigning behaviour of a large number of patentees, Lamoreaux and Sokoloff (1996, 1999a, 1999b) argue that in the United States, in the course of the nineteenth century, a solid market for technical innovations structured around the institution of the patent system progressively emerged. Through this well functioning “market for technology”, individual inventors were able to sell the new technical knowledge they had discovered to firms. The existence of this type of market promoted a fruitful division of labour with “technologically creative individuals” (Lamoreaux and Sokoloff, 1999b, p.3) specializing in inventive activities, and firms in the

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7 Recent research shows that these traditional accounts of industrialization may be in need of some revision. For example, according to the recent estimates of Broadberry and Irwin (2006), the United States detained a substantial lead in labour productivity in industry over Britain as early as 1840. Sokoloff (1992) finds a positive significant link between total productivity and the number of patents per capita by US county over the period 1820-1860 which he interprets as providing support to the use of nineteenth US patent counts as good indicators of the volume of inventive activities. For a critical assessment of this exercise, see Atack (1992).
production and commercialisation phases. Hence, the coupled development of the patent system and of the market for technology determined a steady acceleration in the rate of innovation.

Lamoreaux and Sokoloff (2000) consider the case of the American glass industry. In this case too, they found evidence of the existence of a solid market for technologies operating through two channels: i) specialized trade journals disseminating general information and providing detailed descriptions of patent specifications; ii) specialized patent agents who were able to act as intermediaries in the sale of patented technologies. In the same study, Lamoreaux and Sokoloff also notice that a number of locations with high patenting activities were characterized by little glass production. In their view, this finding indicates that “learning by doing” and “localized knowledge spillovers” (two factors that have been prominently put forward to explain the connection between the localization of production and innovation) played a relatively minor role in the technological development of the industry. Geographical clusters of patenting in the American glass industry are instead accounted for by the existence of a more developed market for technologies in those areas. Although Lamoreaux and Sokoloff acknowledge that it is hard to draw robust generalizations, they contend that, by combining the evidence of the glass industry with their findings for the economy as a whole, the proposition that the development of the patent system produced a tidy and fruitful division of labour between innovation and production appears to be confirmed.

As should be clear from this concise summary of their contributions, Lamoreaux, Sokoloff and Khan have elaborated a complex account of technical change in the course of the industrialization of the United States, which is in many respects similar to the one originally proposed for Britain by Dutton. It is worth stressing again that their interpretation, more or less explicitly, downplays the role of learning by doing and of knowledge spillovers in nineteenth-century technical advances.

4. The “Great inventors” approach

The contributions of Sokoloff, Khan and Lamoreaux that we have discussed so far are based on the systematic analysis of patent records. In several instances, their analysis of the connection between the patent system and inventive activities,
relies on patent counts as a synthetic indicator of the volume of inventive activities. Recognizing the general limitations of this approach inquiry, Khan and Sokoloff, have tried to provide additional evidence on the nature and scope of inventive activities, by means of what may be labeled the “great inventors” approach (Khan and Sokoloff, 1993, Khan and Sokoloff, 2004, see also Khan, 2005, ch. 7).

In a nutshell, the great inventor approach consists in a prosopographical investigation of American “great inventors” active in the period 1790-1930.

Khan and Sokoloff’s sample is drawn from a number of American biographical dictionaries, by identifying all the individuals to whom at least one major invention was ascribed. Through their systematic comparison of the inventive activity of their sample of “great inventors” with that of US patentees in general, Khan and Sokoloff demonstrated that there was no fundamental distinction between the behaviour of the “great inventors” and that of the much larger population of US patentees: the inventive activities of both groups were very similar in terms of their sensitivity to market signals. Indeed, what distinguished the “great inventors” was their “entrepreneurial abilities”. They were actually more, not less, finely attuned than the average patentee to economic incentives.

Khan and Sokoloff’s conclusion is that their “great inventors” prosopography has provided a synthetic, but accurate, record of the major contours of inventive activity during the nineteenth century, which corroborates the evidence from the patent records (Khan and Sokoloff, 2001).

MacLeod and Nuvolari (2006) have recently raised concerns on the “great inventors” exercise. The critical issue is that Khan and Sokoloff treat the selection of their “great inventors” as unproblematic. They state only that, “The sample comprises virtually all the best-known antebellum inventors who were first active in the field of innovation between 1790 and 1846”. Their “main source . . . was volumes 1 to 10 of the Dictionary of American Biography. This was supplemented by Who Was Who in America, Historical Volume, 1607-1896 and The National Cyclopaedia of American Biography; additional details were obtained from a number of biographical sources.” (Khan and Sokoloff, 1993, p. 290). On reflection, it is clear that the use of these iconic works of collective biography is unlikely to provide a random or representative sample of inventors. Consequently, a detailed inquiry into the criteria governing the selection of entries in this reference historical works should be a compulsory research step in these type of exercises. MacLeod and Nuvolari (2006) investigate in detail this issue, by considering the representation of inventive activities during the British industrial revolution in the Victorian edition of the Dictionary of National Biography.

9 Prosopography is a technical term which in historical scholarship indicates the study of the common background characteristics of a selected group of individuals.

10 Khan and Sokoloff’s samples of US inventors comprise 160 individuals for the period 1790-1865 and 409 individuals (408 men and one woman) for the period 1790-1930: see respectively Khan and Sokoloff (1993) and Khan and Sokoloff (2004).
Biography (DNB). They construct a sample of “great” British inventors, following a methodology similar to the one adopted by Khan and Sokoloff in their study of great American inventors (they select all individuals alive in the period 1650-1850, who are ascribed with at least one invention in their DNB entry). The analysis of the inventive activities of the 383 “great” British inventors identified by MacLeod and Nuvolari suggest the existence in their sample of a strong bias towards inventors active in very specific technological fields such as steam engineering, navigation, railways, etc. (mostly those associated with the grand narrative of the British industrial revolution). Technologies and industries, such as consumption goods, food and drink production, etc., that recent historical scholarship as shown to be of great economic and technological significance (see Bruland, 2004) did not receive adequate attention by the compilers of the DNB. In broader terms, this raises doubts on the interpretation that Khan and Sokoloff would like to attach to “great” inventors’ evidence. MacLeod and Nuvolari’s conclusion is that, when used as a source in the field of history of technology, biographical dictionaries might actually reveal more about the lenses through which scholars and contemporaries have looked at and judged specific inventions or technologies, rather than about the actual contours of technical progress in a specific historical period.

5. The significance of collective invention

Following the seminal contribution of Bob Allen, recent research is increasingly drawing attention to the critical importance of collective invention settings as critical institutional set-up supporting inventive activities during the early phases of industrialization (Allen, 1983). In collective invention settings, competing firms freely release pertinent technical information on the construction details and the performance of the technologies they have just introduced to one another. Allen has noticed this type of behaviour in the iron industry of Cleveland (UK) over the period 1850-1875. In the Cleveland district, iron producers freely disclosed to their competitors technical information concerning the construction details and the performance of the blast furnaces they had erected. In the words of Allen,

....if a firm constructed a new plant[more specifically, a blast furnace] of novel design and that plant proved to have lower costs than other plants, these facts were made available to other firms in the industry and to potential entrants. The next firm constructing a new plant build on the experience of the first by introducing and extending the design change that had proved profitable. The operating characteristics of the second plant would then also be made available to potential investors. In this way fruitful lines of technical advance were identified and pursued (Allen, 1983, p.2).

Information was normally released through both formal (presentations at meetings of engineering societies and publications of design details in technical journals) and informal channels (such as visits to plants, conversations, etc.). Additionally, new technical knowledge was normally not protected by patents, so

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11 There is an interesting historical parallel between nineteenth century collective invention and contemporary open source software development (see Nuvolari, 2005 for a further elaboration).
that competing firms could \textit{liberally} make use of the released information when they had to erect a new plant.\textsuperscript{12} As a consequence of the proliferation of these “voluntary” knowledge spillovers, in the period considered, the height of the furnaces and the blast temperature increased steadily by means of a series of small but continuous rises. Increases in furnace height and in the blast temperature brought about lower fuel consumption and lower production costs. On the basis of his findings, Allen suggests that the pattern of technical change emerging from collective invention settings is dominated by incremental innovations.

Another important case of nineteenth century collective invention has been identified by Nuvolari (2004). In this case, the technology developed collectively were the steam pumping engines which were used for draining Cornish copper and tin mines. In the wake of their disappointing experience with Watt’s patent for the separate condenser, whose tight enforcement had led to a stagnation of inventive activities during the 1780s and 1790s, Cornish steam engineers typically preferred not take patent for their inventions. Accordingly, the share of patents in steam engineering for the period 1813-1852 fell to under one per cent of the national total. In the very same period, Cornwall became the technologically leading region for steam engineering, with the introduction and development of the high pressure engines. It is also interesting to note that in 1812 Cornish mining engineers and entrepreneurs launched a monthly journal called \textit{Lean’s Engine Reporter} with the intention of facilitating the discovery and rapid dissemination of best-practice techniques.

As in the case of Cleveland blast furnaces described by Allen, the emergence of a collective invention regime was favoured by a specific set of conditions. First, the “empirical” nature of inventive activities (in this period there was no established theory of the functioning of the steam engine) made it particularly fruitful to extrapolate the best design options on the basis of the systematic collection and analysis of information concerning variation in design and performance of a large number of engines. Secondly, the structure of the Cornish mining industry (where mine entrepreneurs usually held shares of different mines) favoured the search of improvements in the average performance of pumping engines (the rapid dissemination of best-practice techniques was clearly the most direct way for raising average performance). At the same time, the systematic publication of the performance of the engines allowed the best engineers to demonstrate their engineering skills and improve their professional reputations and career prospects.

\textsuperscript{12} Note that Allen’s notion of “collective invention” does not refer to the exchange of information between users and producers studied by Lundvall (1988). In fact, Allen is describing an exchange of information among \textit{competing} entities. “Collective invention” also differs from “know-how trading” described by von Hippel (1987). In “know-how trading”, engineers “trade” proprietary know-how in the sense the information is exchanged on a bilateral basis (non-participants to the transaction in question are excluded). Within collective invention, \textit{all} the competing firms of the industry have free access to the potentially proprietary know-how, see von Hippel (1987), pp. 296-297. Cowan and Jonard (2003) have recently proposed a model which analyzes the diffusion of knowledge in collective invention settings.
Although not as systematic as in the "collective invention settings" identified in Cornwall and in Cleveland, but a similar behaviour seems to have taken place in also the nascent civil engineering profession, which was responsible for many of the innovations in transport that we commonly identify with the industrial revolution. Very little of the problem-solving activity that underpinned the engineering of bridges, tunnels, cuttings, embankments, etc. whether for roads, canals or railways is reflected in the patent records. Rather, civil engineers tended to share and publish their solutions, with a view at enhancing their professional reputations (MacLeod, 1988, pp. 104-5). An analogous disregard for the privatisation of intellectual property is also discernible among other innovative groups of this period, such as some of the early developers of machine tools (others members of this group, however, practised secrecy) and the first generation of West Riding textile engineers (Cookson, 1997, pp. 8-9).

It would be wrong to assume that collective invention was just a British phenomenon. In his account of the development of the high pressure engine for the western steamboats in the United States during the early nineteenth century, Louis Hunter has also emphasized the significance of various flows of incremental innovations (Hunter, 1949, pp. 121-180). In the light of the present discussion this passage from Hunter’s contribution is particularly intriguing:

Though the men who developed the machinery of the western steamboat possessed much ingenuity and inventive skill, the record shows that they had little awareness of or use for the patent system. Of more than six hundreds patents relating to steam engines issued in this country down to 1847 only some forty were taken out in the names of men living in towns and cities of the western rivers. Few even of this small number had any practical significance. In view of the marked western preference for steam over water power and the extensive development of steam-engine manufacturing in the West, these are surprising figures. How is this meager showing to be explained and interpreted? Does it reflect a distaste for patents as a species of monopoly uncongenial to the democratic ways of the West, an attitude sharpened by the attempts of Fulton and Evans to collect royalties from steamboatmen? Or, were western mechanics so accustomed to think in terms of mere utility that they failed to grasp the exploitative possibilities of the products of their ingenuity? Or, did mechanical innovation in this field proceed by such small increments as to present few points which could readily be seized upon by a potential patentee? Perhaps each of these suggestions – and especially the last - holds a measure of the truth. At all events the fact remains that, so far as can be determined, no significant part of the engine, propelling mechanism, or boilers during the period the steamboat’s development to maturity was claimed and patented as a distinctive and original development (Hunter, 1949, pp. 175-176).

This passage seems clearly to reveal the existence of another collective invention setting in early nineteenth century steam engineering. Interestingly enough, Hunter, suggests that the litigations related with the patents taken by Robert Fulton and Oliver Evans (mirroring the conflict between Boulton and Watt and Cornish engineers) could be one of the reasons accounting for the negative attitude of western mechanics towards patents (see Hunter, 1949, p. 10 and pp. 124-126 for a short overview of these litigation cases).

The study of paper-making in Berkshire (US) by McGaw (1987) seems also to point to the existence of another American collective invention setting. Finally,
Foray and Hilaire-Perez (2000) suggests that the highly successful silk industry of Lyon was also characterized by collective invention.

As a final consideration, we should note that it is important not to dismiss these cases of collective invention as "curious exceptions". It is worth stressing, once more, that key-technologies that lay at the heart of the industrialization process such as high pressure steam engines, steamboats, iron production techniques, etc. were developed in a collective invention fashion, and consequently outside the coverage of the patent system.

6. Other institutional arrangements supporting inventive activities.

David (1993) has suggested that, in capitalist economies, the institutional arrangements supporting inventive activities may be summarized in terms of three P’s, namely Property Rights (or patents), Patronage and Procurement. In this respect, our recognition of the historical literature suggests that, so far, historical research has focused primarily on the patent system. We believe that is important that historians in their future research efforts devote attention also to the other two P’s. Here we will limit ourselves just to some considerations which suggest that these institutional arrangements alternative to patent protection may have played an important role in supporting inventive activities in the early phases of industrialization.

Perhaps, one the most successful cases of public patronage is the Longitude Act of 1714. The Act established a handsome prize of £20,000 for a method for determining the longitude (which was one of the most teething problems of oceanic navigation). The prize was finally assigned in 1775 to John Harrison for his "perfect clock" after a prolonged discussion. Be this as it may, Harrison's clock is nowadays recognized as one of the most fundamental breakthroughs in marine instrumentation (King, 2004).

Another important case of patronage has been identified by Griffiths, Hunt and O'Brien (1992) in the Royal Society of Arts. In the second half of the eighteenth century the Society promoted inventive activities in a wide range of industries by means of prizes. It should be noted, that, in the interest of dissemination, the Society would have not normally assigned a prize to an invention which was patented. Griffiths, Hunt and O'Brien (1992) find that a large volume of inventive activities in the textile industries can be linked directly with the prize competitions of the Society.

Public procurement also appears to have been crucial ingredient for technological development in the early phases of industrialization. The famous block-making machinery (a complex of machines which permitted the full mechanization of the production pulley-blocks for the Royal Navy ships) was developed by Marc Brunel and Henry Maudslay at the Portsmouth Dockyards, following a contract of public procurement with the Admiralty (Rolt, 1957, pp. 32-33). Another famous case of successful public support for the development of a specific
invention, is the "Congreve" rocket which was developed at the Royal Arsenal in Woolwich by William Congreve (Stearn, 2004). Finally, we can also consider the public support provided by Treasury to Charles Babbage pioneering efforts of constructing a mechanical calculating engine. Although, the project cannot obviously be regarded as fully crowned with success (Swade, 2004).

7. Concluding remarks.

Our survey of historical research suggest that accounts of industrialization which are based on simple and general causal mechanisms linking the emergence of patent systems and market for technologies with an acceleration of inventive activities, may be unwarranted. Following Mokyr (2002), it can be assumed that the origins of industrialization of western economies lay in a revolution in the procedures for the accumulation and dissemination of 'useful knowledge' taking place in the eighteenth and in the first part of the nineteenth century. However, it would be wrong to assume that the emergence of patent systems play a critical or determinant role in such a transition. The evidence discussed in this paper has shown that the institutional arrangements supporting inventive activities in this historical phases were extremely variegated and sophisticated. Further, a large volume of inventive activities was undertaken outside the coverage of patent protection. It is worth remarking once more that this type of inventive activities provided a fundamental contribution to development to some of the key-technologies of early industrialization. When the recent debate on IPR and economic development is considered in this light, one cannot avoid the impression that excessive emphasis has been put on the implementation of strong IPR regimes and that a more sobering and pragmatic approach to innovation policies is actually in order.

References


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