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The British patent system during the Industrial Revolution, 1700 – 1852

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The industrial revolution marks the genesis of modern economic growth; the transition from a universal regime of Malthusian constraint to an era of rapid economic expansion. Despite its importance, however, the causes of the industrial revolution remain poorly understood. By radically expanding the evidential base between 1700 and 1852, this thesis provides a fundamental reassessment of the contribution of patenting to British industrialisation.

The first half of the thesis analyses the institutional aspects of patenting. The first research chapter examines the administration of the patent system. In 1700, it was difficult for an inventor to navigate the protracted, expensive and politicised petition procedure necessary to obtain a patent. However, with developments in the legal construction of the patent, and the appearance of patent agents in the 1770s, patent protection became significantly easier to obtain. The second research chapter shows that patents were well protected in law and readily enforceable through injunctions.

The first half of the thesis reaches a favourable assessment of the institutional efficacy of the patent system. This makes it plausible to argue that the patent system actively encouraged inventive activity during the industrial revolution. This possibility is explored in the last three chapters. The third research chapter argues that by obliging inventors to eschew secret working and set down written descriptions of their inventions, patents facilitated the codification and diffusion of industrial technology. The fourth research chapter demonstrates that inventors and manufacturers could obtain large returns from working patented inventions. However, arguing that the returns appropriable with a patent encouraged the development of technology assumes that patentees were responsive to economic/commercial stimuli. This hypothesis is supported with a comparative analysis of the English, Scottish and Irish patent indices in the final chapter. The second half of the thesis concludes that the patent system was an important contributory factor to technological development during British industrialisation.

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Declaration

This dissertation is the result of my own work and includes nothing which is the outcome of work done in collaboration except where specifically indicated in the text.
This dissertation is not substantially the same as any that I have submitted for a degree or diploma or other qualification at the University of Cambridge, or any other institution.
The length of this dissertation is under 80,000 words.

Sean Bottomley
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Chapter 1

The British patent system during the Industrial Revolution

This Ph.D dissertation examines the contribution of the British patent system to economic and technological development from 1700 to 1852. This time-span covers the period immediately preceding the 'classic' industrial revolution, the industrial revolution proper (traditionally dated c.1760-1830), and ends with the Patent Law Amendment Act in 1852.[1] The second and third chapters examine the efficacy of the patent system in providing access to enforceable patent protection. The last three chapters consider the role of patenting in the diffusion and development of new technology.

The introduction reviews three broadly related areas of research. The first covers the theoretical and empirical work in economics concerning patents. The second examines the empirical research that has been undertaken on the British patent system prior to reform, and the third at how the role of patenting has been interpreted in the historiography of the industrial revolution.

The literature review highlights a number of important issues. The review of the economic literature emphasises two central arguments in favour of patenting - that it encourages the development, and the diffusion, of technology. This has led some economic historians to suggest that patenting made an important contribution to technological development during the industrial revolution. This view, however, has been challenged by empirical work that queries the utility of the patent system. The aim of this dissertation is to investigate this conflict by reassessing the availability and efficacy of patent protection from 1700 to 1852. The fourth section of this introduction outlines the structure of the rest of the dissertation.

Section 1.1
The economics of patenting

In the last thirty years there has been a marked expansion in research regarding the effects of Intellectual Property Rights (IPR) on competition, innovation and growth. This debate has been prompted by American policy efforts to strengthen both domestic and foreign IPR. Of particular importance was the establishment of the Court of Appeal for the Federal Circuit in 1982, which has greatly improved the enforceability of American patents.[2] Concomitantly, the United States placed IPR at the centre of its trade negotiation agenda, culminating in the 1994 'Agreement on Trade Aspects of Intellectual Property Rights' (TRIPS). TRIPS

1 The Act (15 and 16 Vict. c.83) was passed in July 1852 and came into force in October. The Act enacted large scale reforms, introducing a single patent for the United Kingdom, and a single awarding 'Office of the Commissioners'. The Commissioners, were the Lord Chancellor, the Master of the Rolls, and the law officers from England (the Attorney-General and Solicitor-General), Scotland (the Lord Advocate), and Ireland (the Attorney-General for Ireland and the Solicitor-General for Ireland).

2 In the six years from its establishment in 1982, the Court upheld 89 percent of decisions by appellate courts endorsing patent validity, whereas its predecessor had upheld 30 percent of such decisions in the previous six years. Robert Mazzoleni and Richard Nelson, 'The benefit and costs of strong patent protection: A contribution to the current debate', *Research Policy*, 27, 1998, p.274

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established 'minimum' standards of intellectual property protection amongst World Trade Organisation members, for example, instituting a minimum term of twenty years for patents.[3]

Sponsors of these policy efforts regard them as the logical outcome of two fundamental arguments supporting the creation and maintenance of IPR.[4] The first argument claims that without IPR, the financial inducement to engage in inventive or creative activities will be insufficient for economically rational actors to engage in them to a socially optimal extent. The work of Kenneth Arrow is regarded as the classic exposition of this argument.[5] Arrow made two assumptions about the nature of inventions. Firstly, that the costs of invention are infinitely greater than the costs of imitation (which are assumed to be zero). Secondly, that because inventions are non-rivalrous, one's use of an invention will not diminish another's capacity to use it also. This being the case, Arrow argued that without patent protection firms will under-invest in Research and Development (R&D) because they cannot appropriate a return above the market rate and so recoup R&D expenditure. A patent, however, confers the temporary right to exclude other parties from using the protected invention. As such, patents can be used to earn monopolistic profits and recover the costs of invention. Alternatively, the patent holder can recover costs by licensing the use of the invention to other parties in return for royalties.

Some empirical studies have supported the inference that patent protection subsidises R&D. In one study of Japanese corporations, it was estimated that the cessation of patent protection would result in a 60 percent decline in R&D expenditure by chemical firms.[6] Similarly, Mansfield et al estimated that in 1981, without patent protection, there would have been a decline of 36 percent in US industrial R&D expenditure.[7] The conclusion this suggested to policy-makers was that by improving the efficacy of patent protection, they could encourage further R&D expenditure, in turn fostering faster technological development.

The second fundamental argument in support of patents is that they promote the diffusion and commercialisation of new technology. Broadly speaking this is achieved in three ways. Firstly, without patents, it is supposed that inventors will resort to secret working to recoup returns on inventive activities. Working inventions in secret, however, imposes significant public and private costs. To be effective, secret working necessarily involves obstructing the flow of technical information to other potential users, frustrating further technological progress. In addition, efforts at maintaining secrecy impose limits on production.[8] By allowing an inventor to eschew secret working, patents mean these economic costs can be

3 Lionel Bently, and Brad Sherman, *Intellectual Property law*, (3rd edn. Oxford, 2009), p.353

4 There have been other arguments proposed for strengthening patent rights. It has been proposed, for example, that granting broad patents facilitates the orderly development of technological opportunities. This argument rests on the premise that unless there is a controlling patent, many will perceive and pursue the same opportunity, leading to an over investment in R&D. Edmund Kitch, 'The nature and function of the patent system', *The Journal of Law and Economics*, 20, (1977), p.276

5 In particular Kenneth Arrow, 'Economic welfare and the allocation of resources for invention', in NBER, *The rate and direction of inventive activity: Economic and social factors*, (Princeton, 1962)

6 The study though found considerable sectoral differences. The comparable figure for mechanical firms was only 5 percent. Ove Granstrand, 'Innovation and Intellectual Property rights', in Jan Fagerberg, David Mowery and Richard Nelson, (eds.), *The Oxford handbook of innovation*, (Oxford, 2005), p.282

7 Edwin Mansfield, Mark Schwartz and Samuel Wagner, 'Imitation costs and patents: An empirical study', *Economic Journal*, 91, (1981), p.915

8 Michele Boldrin and David Levine, *Against intellectual monopoly*, (Cambridge, 2008), p.167

avoided.

Secondly, it is a common condition for obtaining the patent that the inventor produce a detailed description of the invention. These descriptions are normally made available through patent offices and public libraries.[9] Properly enforced, the requirement to publish the invention in a patent specification provides other inventors and manufacturers with easy access to the latest technical information.

Thirdly, patents, by defining and delineating property rights in technology, facilitate its license and sale to other users. Conversely, trading secret technology is often very difficult. In the absence of any record of title, the buyer cannot ensure that the technology has not been fraudulently obtained from another party. In contrast, a record of patents and their holders are normally maintained by patent offices. Also, when trading secrets, the buyer cannot ensure that the seller will not publish or sell the invention again.[10] A patent, by providing a defined, verifiable, and enforceable title in technology, can remedy these problems. It means that the buyer can confirm the title of the seller, and legally exclude other parties from using the technology.

Empirical research, however, has begun to query the efficacy of recent policy changes and the reasoning behind them. In 1988, the Japanese enacted new patent reforms.[11] These reforms extended the patent term for some technological sectors and allowed multiple claims for a single patent application. An empirical study, however, found that no statistically significant increase in R&D spending, or inventive output, could be attributed to these reforms.[12] Similarly, a comprehensive study analysed the effects of 271 patent reforms in sixty countries, over a 150 year period. It found that wherever patent protection was already strong, additional patent protection never had a positive impact on innovation, and could even have negative consequences for inventive output.[13] These negative consequences were attributed to strong patent rights allowing holders to exclude other parties from pursuing related or 'downstream' inventions in the protected technology. This problem will be especially acute where technological advance is sequential or requires the use of a number of components. Similarly, strong patent rights have been found to abet litigation, and wasteful attempts to invent around patents.[14]

Arguments for the strengthening of patent rights have been also undermined by the revelation that in many technological sectors patents are not the primary means of appropriating returns from invention. In 2000, Wesley Cohen surveyed the appropriation methods of American firms, delineating three broad strategies:

i. Exploitation of complementary capabilities and lead time
ii. Secret working
iii. Legal mechanisms, including patenting

9 Biagioli notes how stylised these descriptions have now become. The American *Manual of patent examining procedure*, even specifies the type on ink to be used in drawings. Mario Biagioli, 'Patent republic: Representing inventions, constructing rights and authors', *Social Research*, 73, (2006), p.1136
10 Paul Heald, 'A transactions costs theory of patent law', *Ohio State Law Journal*, 66, (2005), pp.480-481
11 Mariko Sakakibara and Lee Branstetter, 'Do stronger patents induce more innovation? Evidence from the 1988 Japanese patent law reforms', *RAND Journal of Economics*, 32, (2001), p.80
12 Ibid, p.78
13 Josh Lerner, '150 years of patent protection', NBER Working Paper No.8977, (2002), p.2
14 Yi Qian, 'Do national patent laws stimulate domestic innovation in a global patenting environment? A cross-country analysis of pharmaceutical patent protection, 1978-2002', *The Review of Economics and Statistics*, 89, (2007), p.436

Although these strategies are not mutually exclusive, Cohen concluded that in the majority of sectors exploiting lead time and protecting secrecy were more important appropriation strategies than patenting and other legal mechanisms.[15] Patenting, however, was found to be important in a minority of industries, particularly pharmaceuticals and certain classes of machinery and computing.[16]

Pronounced sectoral differences in appropriation strategies also existed 150 years ago. Petra Moser undertook an empirical study of the exhibits in four World Exhibitions in the second half of the nineteenth-century, beginning with the 1851 Great Exhibition at Crystal Palace. In this Exhibition only 11 percent of British and 15 percent of American exhibits were patented.[17] There was, however, significant variation in the propensity to patent between different industrial sectors.[18] Moser categorised the exhibits into ten different sectors. The two sectors with the highest patenting rates were manufacturing machinery (29.8 percent) and engines (24.6 percent).[19] In contrast, only 5 percent of mining and metallurgy exhibits and 5.1 percent of chemical exhibits had been patented. These results should be treated with some caution. It is likely that many exhibits were not patented simply because they were ineligible. Zorina Khan notes in a similar study of nineteenth-century fairs, that many exhibits were examples of high-quality workmanship, rather than new inventions, and so lacked sufficient novelty for patent protection.[20] Because Moser does not exclude non-patentable exhibits, the propensity to patent exhibits that *were* patentable is higher than indicated by her figures.

There is, however, no reason to suppose that this influences the apparent variation in the inter-sectoral propensity to patent. Moser's findings are supported by the work of O'Brien, Griffiths and Hunt on British textile inventions in the eighteenth-century.[21] They traced 174 key textile inventions (which as novel advances would have been patentable), of which 44 percent were patented.[22] They employed, however, a broad definition of textile inventions, including developments in dyeing (chemicals in Moser's categorisation) as well as textile machinery (manufacturing machinery in Moser). Therefore this figure of 44 percent masks wide differentiation in patenting rates of different types of textile invention. For this earlier period they found similar results to Moser, with low patent rates for dyes and higher patent rates for textile

15 Wesley Cohen, Richard Nelson and John Walsh, 'Protecting their intellectual assets: Appropriability conditions and why US Manufacturing firms patent (or not)', NBER Working Paper No.7552, (2000), p.10
16 In contrast, a similar Japanese survey in 1999 found legal mechanisms to be more important than the other two appropriation strategies. Ibid, p.13-14
17 Some of the difference in patenting rates can probably be attributed to the higher overall quality of American exhibits. The higher quality would be because the effort for an American to exhibit in Britain would be greater than for a British inventor, meaning it was only worth the additional trouble with an invention they perceived to be of a higher value than their British counterpart. Moser though claims this effect would be minor because of uniform rules of selection. This though does not preclude the possibility of self-selection by Americans prior to exhibition. Petra Moser, 'Why don't inventors patent?', NBER Working Paper No.13294, (2007), p.14
18 These sectors are 'mining and metallurgy', 'chemicals', 'food processing', 'engines', 'manufacturing machinery', 'civil, military and naval engineering', 'agricultural machinery', 'scientific instruments', 'manufactures' and 'textiles'. Ibid, p.37
19 Ibid
20 Zorina Khan, 'Going for Gold: Industrial fairs and innovation in the nineteenth-century', mimeo, 2010, p.12
21 Patrick O'Brien, Trevor Griffiths and Philip Hunt, 'Inventive activity in the British textile industry, 1700-1800', *Journal of Economic History*, 52, (1992), pp.881-906
22 Ibid, p.885

machinery.[23]

Because they use a different data source from an earlier period, O'Brien et al's study provides strong corroborative evidence for Moser's results relating to differences in inter-sectoral propensities to patent. Moser attributes her results to variations in the underlying level of scientific knowledge in different technological sectors. Where the level of scientific understanding made reverse-engineering possible, secret working would be ineffective, forcing inventors to pursue other methods of commercial exploitation, namely patenting. Where, however, scientific knowledge was such that reverse-engineering was not practicable, secret working was preferred. Moser illustrates the phenomenon by analysing the patent rates of American chemical exhibits over four exhibitions between 1851-93. The rates increase rapidly after the introduction of the periodic table in 1869 which, by categorising the known elements by their physical properties, made the reverse-engineering of chemicals into their constituent parts (elements) much easier.[24]

The logic of Moser's argument also implies that the efficacy of the first appropriation method outlined by Cohen, the exploitation of complementary capabilities and lead time, would have declined during the eighteenth and early nineteenth centuries. This strategy relies on recouping the costs of invention during the time between when the invention is commercialised and when competitors are able to market the invention as well. During the early modern period, such a strategy might have been relatively effective. Most technical knowledge, was 'implicit' and experience based, limiting how such knowledge could be expressed and transmitted to competitors.[25] This might have given pre-modern inventors sufficient lead time to recoup the outlay of invention without patent protection. Over time, however, a growing body of scientific and technological knowledge was set down and codified making the adoption of new technology easier, reducing the period of 'lead time'.[26]

Moser also argues that the provision of patent protection influences the direction of inventive activity between sectors where technology can be reverse-engineered and where it cannot. In a comparison of the sectoral distribution of exhibits between countries that awarded patents with those that did not, Moser found that countries without patent laws concentrated in sectors with strong alternative mechanisms for protecting intellectual property, and away from sectors that did require patents.[27] For example, in the two countries without patent systems in 1851, Switzerland and Denmark, scientific instruments constituted 27 percent and 23 percent of their exhibits respectively, whereas the median amongst the other exhibiting countries was 6

23 It should, however, be noted that they do not attribute these differences to the practicability of reverse-engineering, but rather the level of involvement of sponsoring institutions, such as the Society of Arts, in different areas of development. Ibid, p.888

24 In 1851, no US chemical exhibits were patented. At the 1893 World's Fair in Chicago, thirty-two years after the introduction of the periodic table, 16 percent of US chemical exhibits were patented. Moser, Why don't inventors patent?, p.29

25 Stephan Epstein, 'Property rights to technical knowledge in pre-modern Europe, 1300-1800', *The American Economic Review*, 94, (2004), p.382-383

26 Joel Mokyr estimates that the annual number of medical, scientific and technological titles published during the eighteenth-century quintupled. Joel Mokyr, *The enlightened economy: An Economic History of Britain, 1700-1850*, (London, 2009), p. 46

27 The countries without patent laws were Switzerland and Denmark in 1851 and the Netherlands in Philadelphia 1876. Petra Moser, 'How do patent laws influence innovation? Evidence from nineteenth-century world's fairs', *The American Economic Review*, 95, (2005), p.1224

percent.[28] Moser only concerns herself with the 'direction' of inventive activity, and is careful not to speculate on whether patents may have affected overall levels of inventive activity. However, it is worth mentioning that exhibits from sectors that were particularly reliant on patent protection, such as manufacturing machinery and engines, 'were extremely rare in the Swiss data'.[29] In contrast, countries with patent laws had many more exhibits in these sectors.

Moser's work also indicates the need for minimum standards of patent protection. Without effective enforcement mechanisms patents will be of little consequence. Moser highlights Bavaria as a country with particularly 'ill-enforced' patents, and it is noteworthy that, after Switzerland and Denmark, its exhibits had the highest proportion of scientific instruments.[30] That a similar proportion of American and British exhibits were patented, and that they had a similar sectoral distribution, implies that the British patent system did meet these minimum standards as, at the time, the American system was probably the most sophisticated in the world.

This research also relates to the second main argument employed in justifying patent rights, specifically its role in the disclosure and commercialisation of new technology. If patenting is only employed in technological sectors where secrecy is inherently difficult to maintain, and so where technical information might disseminate quickly, awarding the inventor the right to exclude others will inevitably frustrate the flow of technology.[31] This, however, ignores the role of patenting in encouraging the development of technology in the first place. Without patenting, there may have been fewer inventions developed in these sectors to be disseminated later. It also overlooks the possibility of licensing the use of the technology (albeit at a price) to other parties.

This section has established two important research issues for the dissertation. Firstly, the importance of the patent system in encouraging inventive activity needs to be explored, especially in sectors traditionally associated with the industrial revolution, such as manufacturing machinery and engines. The work of Moser suggests that the provision of patent protection may have been significant. Secondly, the role of the patent system in encouraging the diffusion of technology also needs to be considered. This will require examining the role patents had in codifying and diffusing technical information through the availability of patent specifications (a detailed description of the patented invention). It is also important to consider whether patenting encouraged a market for technical information, in the way of partnerships, licensing and assignments.

28 The sector 'Scientific instruments' includes technologies such as optical lenses, watch movements and barometers. These were technologies where methods of production remained 'intuitive' and/or where secrecy could be maintained. It was also a technological sector where commercial production runs were often small. Ibid

29 The Swiss data refers to both the Great Exhibition in 1851 and the Centennial Exhibition in Philadelphia, 1876. Ibid, p.1228

30 Ibid, p.1224

31 Boldrin and Levine, *Against intellectual monopoly*, p.166

Section 1.2
The Historiography of the patent system

After a period of relative neglect, in the 1980s two monographs appeared on the English patent system during the industrial revolution: Harold Dutton's *The patent system and inventive activity during the industrial revolution, 1750-1852*, (1984) and Christine MacLeod's, *Inventing the Industrial Revolution, the English patent system, 1660-1800*, (1988). MacLeod has also worked extensively on the patent system after 1800.[32] Both MacLeod and Dutton argue that the English patent system was deeply flawed. This section will review how they assess the efficacy of the patent system, and their respective views on how it influenced contemporaneous technological and economic development.

Both agree that the administration of the patent system was extremely inefficient even by contemporary standards. The petition procedure for a patent had been established by the Clerks Act of 1535. Rather than provide an efficient and expeditious service, the petition was designed to be convoluted so that the non-salaried government officers could be supported by the fees levied on petitioners.[33] Consequently, obtaining a patent was arduous and time consuming. In the eighteenth-century an inventor had to transmit their petition through ten separate stages, requiring personal attendance in London. MacLeod also emphasises how expensive it was to obtain a patent, arguing that 'the major deterrent to patenting was the expense', reducing the number of patents that would have otherwise been obtained.[34] After this tortuous petition, the inventor received a patent of apparently dubious legal value. Although the English law officers were supposed to examine the application of the petitioner, after 1760 this rarely occurred, restricting the legal cachet of the eventual grant.[35] Neither was any bureaucratic responsibility accepted for the legality of the patent; the rubric of the law officers' report made this explicit.[36] As a result, many spurious patents were awarded, for example, the patent series is littered with awards for perpetual motion.

These legal difficulties were exacerbated by the lack of any statutory definition of what constituted an invention and, until the specification, a legally binding mechanism for defining what had been patented.[37] In 1795 Chief Justice Eyre remarked 'patent rights are nowhere accurately described in our books'.[38] Further,

32 In particular, Christine MacLeod, 'The paradoxes of patenting: Invention and its diffusion in eighteenth and nineteenth-century Britain, France and North America', *Technology and Culture*, 32, (1991), pp.885-910. Christine MacLeod, 'Strategies for innovation: The diffusion of new technology in nineteenth-century British industry', *Economic History Review*, 45, (1992), pp.285-307. Christine MacLeod, and Alessandro Nuvolari, '"Glorious Times", the emergence of mechanical engineering in early industrial Britain, c.1700-1850', *Brussels Economic Review*, 52, (2010), pp.215-237.

33 Christine MacLeod, *Inventing the Industrial Revolution, the English patent system, 1660-1800*, (Cambridge, 1988), p.40

34 MacLeod, *Inventing the Industrial Revolution*, p.76 It should be noted though that MacLeod appears to have subsequently modified her stance, observing that the 'price of a patent was immaterial' when the costs of implementation could be thousands. Christine MacLeod, 'Negotiating the rewards of invention: The shop-floor inventor in Victorian Britain', *Business History*, 41, (1999), p.21

35 MacLeod, *Inventing the Industrial Revolution*, p.45. The law officers were the chief legal advisers to the government and in England there were two, the senior Attorney-General and the junior Solicitor-General.

36 Ibid, p.48

37 Ibid, p.67

38 Ibid, p.62

Dutton claims that there was endemic judicial hostility towards patent grants; conflating them with simple monopolies that were exploitative of the public.[39] In this legal environment, few patentees were willing to risk litigation. Dutton estimates that between 1770-99 only sixteen patents (out of 1,418 awarded in the same period) were litigated.[40] This limited case-load constrained opportunities for the common law courts to generate precedent. This meant that in the absence of any statutory law, besides the ancient Statute of Monopolies, there was almost no legal guidance for inventors facing infringements, seeking to sell their patent, or on any other matter relating to the management of their patent. MacLeod argues that because of these uncertainties, and the costs of pursuing legal action, a patent was 'not worth the parchment it was written on'.[41] Likewise, Dutton argues that it was only when the judiciary began to recognise the social and economic value of patents during the 1830's that the common law courts began to produce precedent applicable to the patents.[42]

Dutton and MacLeod both have serious misgivings about the efficacy of the patent system in protecting inventors. The petition was convoluted and uncertain. The expense of fees and gratuities were exacerbated by the need for personal attendance in London for up to six months. Although the development of patent agents during the nineteenth-century is thought to have improved matters somewhat, Dutton still argues that the inefficiencies of the patent system were such that it spawned 'a vociferous invention interest, which demanded extensive reforms' during the nineteenth-century.[43] Similarly, MacLeod argues that even after 'statutory reforms in 1852 and 1883, it [the patent system] remained expensive and barely fit for purpose'.[44]

Although they agree on the shortcomings of the English patent system, Dutton and MacLeod differ as to the implications for contemporary inventive activity. Dutton argues, counter-intuitively, that the administrative and legal flaws of the patent system had a positive effect on technological development. As long as patenting offered a degree of protection in excess of the next best alternative (i.e. secret working) it continued to provide a significant incentive to inventive activity. Dutton argues that as so few major inventions by-passed the system this must have been the case. Further, the weak legal security of the patent facilitated the diffusion of technology as the infringement of patents was rarely punished.[45]

MacLeod dismisses Dutton's arguments as 'panglossian'.[46] Instead, she argues that secret working was a widely practised alternative to patenting, even in technological sectors where the work of Moser and O'Brien would suggest that patents were most useful. With regard to mechanical engineering, MacLeod and

39 Harold Dutton, *The patent system and inventive activity during the Industrial Revolution: 1750-1852*, (Manchester, 1984), p.77. MacLeod also claims that 'until the 1830s judges and juries appear to have shared a prejudice that patentees were parasitic monopolists, to be unsuited at every opportunity'. MacLeod, 'Strategies for innovation', p.288

40 Dutton does, however, recognise that this figure is likely to be an underestimate. Dutton, *The patent system*, p.71

41 MacLeod, *Inventing the Industrial Revolution*, p.69

42 Dutton, *The patent system*, p.79

43 Ibid, p.34

44 Christine MacLeod and Alessandro Nuvolari, 'Patents and industrialisation: An historical overview of the British case, 1624-1907', Paper for the Strategic Advisory Board on Intellectual Property Policy, (2010), p.4

45 Dutton, *The patent system*, p.205

46 Christine MacLeod, 'The paradoxes of patenting', p.906

Alessandro Nuvolari write 'the most common strategy before 1830 was to work the invention in secret'.[47] This implies that patenting did not offer a degree of protection in excess of secret working until 1830. If patents did not provide inventors with a superior strategy of appropriation then the incentive they provided to inventive activities would have been minimal. Concerning the eighteenth-century, MacLeod and Nuvolari conclude 'without a patent system, it is doubtful Britain would have seen less inventive activity'.[48]

Neither does MacLeod regard patents as an effective means of disseminating technology. Firstly, despite the legal onus on their accuracy, there was no official publication of patent specifications. Commercial publication only began in 1794 with Wyatt's *Repertory of Arts*, but the number of specifications published was apparently limited.[49] It was possible to acquire a copy of the original specification from the court of Chancery in London, but this was an expensive and time-consuming process. Indeed so onerous was it to access specifications, MacLeod claims that secret working was possible *within* the patent system.[50] Secondly, the legal insecurity of patents prevented inventors from contracting assignments or licences with potential users of the invention. Some firms apparently operated on the principle of rejecting all licences for fear of implicitly acknowledging a patent's validity and compromising any subsequent legal action.[51] MacLeod concludes that 'the lack of support offered patentees by the courts was chiefly responsible for the defensive way in which they managed their patents'.[52]

The empirical work of Dutton and MacLeod has established a general orthodoxy that, until judicial attitudes began to change after 1830, patents were for many prohibitively difficult to obtain and enforce. Zorina Khan has incorporated the work of MacLeod and Dutton into a broader comparative and conceptual framework, arguing that the characteristics of patent systems are determined by the contemporary political and social structure. As a democracy, the United States had a 'democratic' patent system where access to patent protection was intended to be universal. Intellectual property rights were enshrined in the first article of the US Constitution giving Congress the mandate to 'promote the progress of science…by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries'.[53] In contrast, as a monarchical and oligopolistic society, Khan characterises the British patent system as socially exclusive. Apparently, 'restrictiveness by class [was regarded] as one of the chief *merits* of higher fees'.[54]

47 Christine MacLeod, and Alessandro Nuvolari, "'Glorious Times", the emergence of mechanical engineering in early industrial Britain, c.1700-1850', *Brussels Economic Review*, 52, (2010), p.227
48 MacLeod and Nuvolari, 'Patents and industrialisation', p.11
49 MacLeod, *Inventing the Industrial Revolution*, p.50
50 MacLeod, 'The paradoxes of patenting', p.898
51 Ibid, p.905
52 Ibid, p.906
53 Khan, *The democratization of invention: Patents and copyrights in American economic development, 1790-1920*, (Cambridge, 2005), p.2
54 Ibid, p.31. Khan bases this argument on the testimony of Samuel Clegg, an inventor, who on being asked by an 1829 Select Committee whether 'do not you think that if it became a habit among that class of people to secure patent rights for those small discoveries at low rates, it would very inconvenient' replied in the affirmative. Clegg's concern, however, was not in restricting access to patents from the working classes. Indeed he often helped broker agreements between working men and capitalists to help the former secure funds and patent their inventions. Instead, as is indicated by the latter half of the question, Clegg wanted to avoid a surfeit of frivolous patents that would be used to pester legitimate manufacturers and frustrate subsequent developments. The issue of high fees, and the reasons for their maintenance, will be discussed in chapter 2. *Report from the Select Committee on state of law and practice relative to patents for inventions*, (Parl. Papers, 1829, III), p.96

These fees undermined the incentive patents normally provide to inventive activity. Also without a method of systematically publishing specifications, the 'further diffusion of new technical knowledge…[was]… undoubtedly slowed '.[55]

The first section of the introduction outlined two main arguments in favour of patenting. The first, 'Arrovian', argument is that patents, by offering monopolistic profits over a limited period of time, incentivise inventive activities. One way of modelling the potential value of patent protection is with the following equation, proposed by Clarissa Long:

$$V^P = r^P - (c^P_o + c^P_d + c^P_e) - r^T - u \quad (1)$$

Here V^P signifies the private value of patent protection. It is equal to the expected rents over the lifetime of the patent (r^P), minus the costs of obtaining, defining and enforcing the patent ($c^P_o + c^P_d + c^P_e$), and minus the income obtainable from trade secret protection and the value of the undisclosed technology ($r^T - u$).[56] r^P includes the full gamut of potential income from a patent including profits from working the patent, licensing its use and assigning shares. In an Arrovian world wherever V^P of a projected inventive activity is positive a rational actor will undertake it and patent the results.

The different historiographical positions can be described using this equation. Dutton and MacLeod agree that the costs of obtaining, defining and enforcing patents ($c^P_o + c^P_d + c^P_e$), were considerable. They do not agree, however, on the value of trade secret protection vis-à-vis patent protection. Dutton argues that the net rents arising from secret working (r^T) were low during the industrial revolution. This was because technology was easy to imitate and 'skilled labour proved to be fairly mobile when the inducements were sufficiently attractive'.[57] This reduced the threshold that projected r^P had to reach for V^P to become positive, and so provide an incentive for inventive activities.

In contrast, MacLeod considers the net rents obtainable from trade secrets to have been significant, even in sectors that might otherwise had relied on patent protection (such as mechanical engineering).[58] Combined with the high costs of acquiring and maintaining an enforceable patent, this means that the condition $r^P < (c^P_o + c^P_d + c^P_e) - r^T - u$ often occurred. In this scenario patenting cannot have provided any incentive for a 'rational' actor to develop an invention as the value of patent rents were lower than the costs of obtaining the patent and the foregone income of secret working.

This is something of a simplification; both Dutton and MacLeod recognise that the attractiveness of secret working varied between industries. Dutton accepts that chemicals were an industry where secret working was supposed to be common,[59] and MacLeod notes that patenting (at least after 1830) was a more attractive proposition for those in mechanical engineering.[60]

55 Zorina Khan and Kenneth Sokoloff, 'Patent institutions, industrial organisation and early technological change: Britain and the United States, 1790-1850', in Maxine Berg, (ed.), *Technological revolutions in Europe*, (Cheltenham, 1998), p.306
56 Clarissa Long, 'Patent signals', *University of Chicago Law Review*, 69, (2002), p.638-639
57 On this point Dutton quotes Richard Roberts, the inventor of the spinning mule, 'no trade can be kept secret long; a quart of ale will do wonders in that way'. Dutton, *The patent system*, p.111
58 MacLeod and Nuvolari, 'Glorious Times', p.227
59 Dutton, *The patent system*, p.110
60 MacLeod and Nuvolari, 'Glorious Times', p.227

On patents and the diffusion of technology, both Dutton and MacLeod agree that before the second quarter of the nineteenth-century, the quality of the descriptions deposited by inventors pursuant to their patents were of a low quality.[61] MacLeod suggests that this may have been intentional. Because the judiciary were avowedly opposed to patents, it was unlikely that a specification would be deemed sufficient in court. Consequently, a patentee could enter an obfuscatory specification and retain an element of secrecy about their invention, without undermining their (limited) chances of success in the event of litigation.[62]

Section 1.3
Patents and the Industrial Revolution

The industrial revolution marks the genesis of modern growth; the transition from a universal regime of Malthusian constraint and episodic development, to one of rapid and sustained economic expansion. This transition is generally considered to have begun in England during the seventy years between 1760 and 1830, the period of the 'classic' industrial revolution.

The industrial revolution has been attributed to a welter of potential causes including profits from the slave trade,[63] new methods of production embodied in the factory system,[64] and new institutional arrangements providing better protection to property rights.[65] There are, however, two broad approaches towards explaining the industrial revolution and the concomitant development of technology. The first can be considered as a 'demand-side' explanation. The technology of the industrial revolution was developed and adopted in England, because it proved profitable to do so. The second can be characterised as a 'supply-side' explanation. This argues that there was a pronounced increase in the supply of new ideas and concepts in Britain and North-West Europe during the Enlightenment. In this interpretation, these new ideas and ways of thinking were the progenitor of industrial technology and revolution. This section examines how these different interpretations of the industrial revolution have influenced historians in assessing the contribution of patents to British technological and economic development.

Section 1.3.1
The demand side

The potential role of patenting in the industrial revolution is considered by Robert Allen in his recent book *The British Industrial Revolution in global perspective*. While Allen recognises that cultural changes may have been a necessary condition for the industrial revolution, he argues that it cannot account for the economic demand for invention, and so is not a sufficient explanation.[66] The pattern of demand for invention

61 Dutton, *The patent system*, p.92
62 Christine MacLeod, 'The paradoxes of patenting', p.897
63 Joseph Inikori, *Africans and the Industrial Revolution in England: A study in international trade and economic development*, (Cambridge, 2002)
64 Paul Mantoux, *The Industrial Revolution in the eighteenth-century: An outline of the beginnings of the modern factory system in England*, (London, 1929)
65 Douglass North, *Structure and change in Economic History*, (London, 1981)
66 Robert Allen, *The British Industrial Revolution in global perspective*, (Oxford, 2009), p.15

was dictated by the unique structure of factor prices in the British economy – expensive wages combined with cheap energy and capital. These factor prices incentivised the development of technologies that substituted capital and fuel for labour which, Allen claims, characterises the most important inventions of the industrial revolution.[67] Although it was possible for an initial idea or concept to emerge outside of Britain, because the commercialisation of these new technologies was economically conditioned ('the decision to incur costs to operationalise a technical idea was an economic one') it was only in Britain that they could be profitably implemented.[68] It was essential that this condition was met as 'inventors spent money to develop ideas…[only when]…their social benefits exceeded the costs of invention.[69] These inventions could only have been developed in Britain, as only there was it profitable to do so.[70]

Allen continues 'when this condition was satisfied, an inventor with an enforceable patent could recoup the development costs through royalties'.[71] Although in general terms Allen does not regard England's institutional infrastructure to have been an important contributor to its economic primacy, his argument does suggest that the expectation of adequate patent protection was an important part of the inventor's economic calculus.[72] Allen adopts a distinction, pioneered by Joel Mokyr, between macroinventions (inventions that embody a radical idea) and microinventions (smaller, incremental improvements). In contrast to macroinventions, Allen does not consider patent protection to have been important for the development of microinventions. This was because microinventions were cheaper to develop and often arose 'on the job'.[73] Allen also suggests that collective invention was of greater significance in the development of microinventions than patenting or other alternatives such as secret working.

To illustrate his position, Allen looked at technological development in three areas, steam engineering, cotton manufacture and coke smelting. In his discussion on steam engineering, Allen argued that the structure of factor prices in the English economy, in particular expensive labour coupled with cheap energy (in the form of coal), ensured that the steam engine would be profitable to adopt. In the development of macroinventions in this sector (for example, James Watt and the separate condenser), Allen argues that inventors only spent time and money commercialising their inventions because they expected to make a return by patenting.[74] In effect, Allen is arguing that patenting was a necessary component in the incentives to develop macroinventions set by pre-existing factor prices.

Allen though, does not consider patenting to have been important in encouraging the subsequent development of microinvention in steam engineering, attributing this instead to a process of collective

67 Ibid, p.141
68 Ibid
69 Robert Allen, 'Why the Industrial Revolution was British: Commerce, induced invention, and the scientific revolution', *Economic History Review*, 64, (2011), p.368
70 Allen, *The British Industrial Revolution*, p.136
71 Ibid, p.142
72 On institutions, Allen summarises his argument thus, 'it would not have been profitable to invent the Industrial revolution in France no matter how good were French institutions. It was the prices that were wrong in France'. Ibid, p.5
73 Ibid, p.149
74 Ibid, p.167

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invention.[75] However, Allen contradicts his own argument concerning microinvention, when detailing the inventive activities of James Watt after he had developed the separate condenser. Allen describes how Watt, at the urging of his business partner Matthew Boulton, developed a number of improvements to the rotary steam engine used for manufacturing. These microinventions were produced to meet market demand and their development involved significant investment of time and money by the partnership.[76] Further, to realise a return, these microinventions were patented.[77] It is difficult to spot in this pattern of microinvention any dissimilarity with Allen's description of macroinvention. It is then an explicit part of Allen's argument that patenting accentuated the incentives for inventors to undertake marco-inventive activities. Further, although confused, it is an implicit part of his argument that patenting was important in the development of microinventions.

Stephen Broadberry also credits the patent system with an important role in encouraging the development of industrial technology. In their analysis of the British textile industry, Broadberry and Bishnupriya Gupta characterise technological development as a two-stage process.[78] Initially, high wage rates in Britain induced the adoption of capital-intensive methods of production.[79] Once established, these methods of production, based on machinery, proved to be more susceptible to subsequent technological improvement than methods based on traditional handiwork. During the second stage Broadberry adopts a Schumpeterian growth model to describe technological development. Here there are two sources of technological progress, one via a process of learning by doing and a second via the scale of resources committed to research and development. The more capital-intensive the sector, the more R&D will pre-dominate, and this second process was 'strengthened in the institutional context of the patent system in England, which provided a stronger incentive to search for improvements in machine-intensive processes'.[80] Without patent protection entrepreneurs could not have protected themselves from other parties pilfering the fruits of their labours, and consequently they would not have invested in the necessary research.[81] In short, Gupta and Broadberry argue that technological progress would have been slower in capital-intensive sectors such as machinery and engines without the provision of patents.[82]

Broadberry appreciates that a formal patent institution is, by itself, insufficient for encouraging the development of technology. For patents to incentivise the development of technology it is 'important that the

75 Ibid, p.168
76 Ibid, p.171-172
77 For example, patent number 1306, was awarded to James Watt for 'applying the reciprocating motion of steam-engines to procure a circular motion round an axis, for working mills and other machinery'. Woodcroft, *Alphabetical Index*, p.599
78 Although Broadberry and Gupta are perhaps a little vague on the exact timing of this two-stage process, they imply that the shift from the first to the second stage occurred no later than 1770. Stephen Broadberry and Bishnupriya Gupta, 'Lancashire, India, and shifting competitive advantage in cotton textiles, 1700-1850: The neglected role of factor prices', *Economic History Review*, 62, (2009), p.295
79 Ibid
80 Ibid, p.297
81 Stephen Broadberry, 'Recent developments in the theory of long run growth: A historical appraisal', Warwick economic research papers no.818, (2007), p.10
82 Broadberry and Gupta, 'Competitive advantage in cotton textiles', p.301

formal rules are underpinned by informal rules that make the system work.[83] However, the historiographical case for whether these informal (or formal) rules were respected is weak. MacLeod, for example, argued that 'patentees…often, after threats of prosecution had no impact, tolerated infringements for years'.[84] Broadberry does discuss the empirical work of MacLeod and Dutton but perhaps understates the extent of their criticisms.[85] Neither does the empirical evidence support Allen's argument concerning the importance of patent protection in the development of macroinvention. In short, current empirical understanding of the patent system does not support (at least until 1830), these demand-side explanations of the industrial revolution.

It is also worth mentioning the arguments of Nobel laureate Douglass North. Although North does not fall neatly into a demand-side interpretation of the industrial revolution, he does adopt a classic 'Arrovian' interpretation of invention and patenting during the industrial revolution. North argues that the social rate of return to inventive activities has always been high, but that historically most societies have failed to achieve a socially optimal amount of inventive activity. This he attributes (like Arrow) to the non-rivalrous nature of invention. Although inventions are costly to develop, they can be duplicated at no cost to the copier. As a result, the inventors' private rate of return will be negligible compared to the social rate of return, and so inventive activities are spurned.[86] North argues that 'the failure to develop systematic property rights in innovation up until fairly modern times was a major source of the slow pace of technological change'.[87] It is only with the introduction of patents that the inventor is secured a return on inventive activities. North claims England solved these problems by passing the Statute of Monopolies in 1624 which instituted a patent system and, by incorporating it into common law, secured intellectual property rights. This gave England a comparative advantage in the development of technology, ultimately leading to industrialisation.[88] Again, such an Arrovian interpretation is no longer tenable in light of empirical work on the patent system.

Section 1.3.2
The supply side

In contrast, 'supply side' interpretations emphasise exogenous developments in ideas, rather than economic pre-conditions, as causative factors in the industrial revolution. Deirdre McCloskey, for example, argues that ways of conceiving enterprise and the bourgeoisie, began to change in North-West Europe during the eighteenth-century. 'Ordinary conversation about innovation and markets became more approving', and

83 Broadberry, 'Developments in the theory of long run growth', p.10
84 MacLeod, 'The paradoxes of patenting', p.896
85 For example, although Broadberry recognises that MacLeod 'emphasised its [the patent system's] shortcomings as much as its advantages', in light of the discussion of MacLeod in section 1.2, this description does not go far enough in assessing her criticisms of the system, especially before 1830. Broadberry, 'Developments in the theory of long run growth', p.27
86 Douglass North, *Structure and change in Economic History*, (London, 1981), p.164
87 Ibid
88 Douglass North and Robert Thomas, *The rise of the Western world: A new Economic History*, (Cambridge, 1973), p.154

allowed both to flourish.[89] McCloskey argues that it was these new ways of thinking about creativity and business that led to the industrial revolution.

Because the industrial revolution had little, if anything, to do with economic incentives, McCloskey regards patents as an irrelevance. Indeed patents, by obstructing knowledge 'spillover', probably impeded the circulation of these new ideas, and the technology that embodied them. McCloskey, however, makes the common error of assuming that patents are synonymous with monopolies.[90] Patents do not constitute economic monopolies, unless (as Charles McManis notes), three conditions are fulfilled.[91]

i) That there is market demand for the invention

ii) That there are no non-infringing substitutes to the invention available

iii) That there are barriers for other parties seeking to introduce non-infringing substitutes

To which list a fourth should be added.

iv) That the patent holder declines to sell licences or shares to other parties

McCloskey's arguments also beg the question of how these new ideas concerning innovation and enterprise were developed. It certainly overlooks the material conditions required for the communication of these ideas.

Mokyr also attributes a causative role in the industrial revolution to new ideas percolating throughout Europe during the eighteenth and early nineteenth centuries. Mokyr argues that during this period there was an intellectual revolution which he labels the 'Industrial Enlightenment'. At its core, the Industrial Enlightenment held that the material condition of man could be improved by increasing the stock of knowledge and making it widely available.[92] Essential aspects of the Industrial Enlightenment were the links created between what Mokyr terms *savants* and *fabricants*, thinkers and makers. This was a European phenomenon, but in Britain, it exhibited a peculiarly practical bent, combining an English concern with empiricism and pragmatism with Scottish political economy.[93] The upshot, Mokyr argues, was a ubiquitous drive for progress that infused every facet of British life.[94]

Mokyr, however, is careful not to dismiss more traditional economic and institutional factors. Rather, Mokyr posits a complex interplay between ideas and the economy and in some ways even supports the 'classical' view of the industrial revolution as a sustained acceleration in output beginning in the 1750s and 60s. He queries the applicability of Total Factor Productivity (TFP) and growth accounting analysis to the period. Economists use TFP as an indicator of innovativeness in an economy. By subtracting resource (land, labour and capital) growth, from aggregate growth, a 'residual' is left which is supposed to be attributable to innovation - TFP. By assuming, however, that all technological developments are in processes, that is inventions for making goods with fewer inputs, TFP ignores improvements in quality (i.e. product

89 Deirdre McCloskey, *Bourgeois dignity: Why economics can't explain the modern world*, (Chicago, 2010), p.7
90 Ibid, p.337
91 Charles McManis, 'A rhetorical response to Boldrin and Levine: Against intellectual monopoly (property) extremism', *Review of Law and Economics*, 5, (2009), p.1087
92 Mokyr, *The enlightened economy*, p.40
93 Ibid, p.37
94 Ibid, p.210

inventions) leading to understatements of 'real' output growth and productivity.[95] Instead, Mokyr argues that a wide variety of microeconomic data 'indicate a marked acceleration if not a discontinuity after 1750' in economic development.[96] To support this he cites data from patents, turnpikes, country banks, bankruptcies and engineering projects which all begin to increase rapidly after 1750. Individually these data indices may not signify a great deal, but combined Mokyr argues that they do indicate the beginnings of a fundamental change in the economy.

As implied by its inclusion in the data cited above, Mokyr argues that one component of Britain's endogenous advantage was its patent system. Mokyr does not support an Arrovian interpretation of the patent system noting that it is inconsistent with the historiography.[97] He emphasises how the convoluted petition process and high fees acted to undermine the inventors' private rate of return. Mokyr also notes how North's claim that the entrenchment of patenting in common law was important in protecting patent rights is undermined by the evidence pointing to regular infringement of patents and the limited legal recourse available to patentees.

However, although current empirical work on the English patent system may preclude a straightforward 'classical' analysis of its role in the industrial revolution, Mokyr does not discount 'the importance of some form of IPR'.[98] Although he regards 'the British patent system [as] deeply flawed' he does consider patenting to have had an incentive effect on inventive activity via a demonstration effect.[99] As long as there were a few lucky patentees who were seen to profit from their endeavours, it would provide a strong signal to other potential inventors. Mokyr notes how many contemporaries considered patenting as an important incentive to their work. Although, from a private welfare perspective, engaging in inventive activity was ultimately inefficient for most inventors, because of the large spillover effects of inventive activity, their efforts were socially efficient.[100] Mokyr concludes that patenting 'provided a more effective… system to reward enterprising and ingenious individuals'.[101]

Another economic historian to have considered patenting during the industrial revolution is Nick Crafts. Like North, Crafts does not fit neatly into the categorisation used here, and is more concerned with explaining why growth rates (traditionally measured) were low during the industrial revolution. His treatment of patenting, however, is informative on the interpretative constraints current empirical understandings of the patent system impose on economic historians of the industrial revolution.

Traditionally, the industrial revolution is seen as heralding the beginning of modern levels of economic growth. However, in his ground breaking book, *British Economic Growth during the Industrial Revolution,* Crafts estimated significantly lower growth rates for the period. Between 1780 and 1801, in the middle of the 'classical' industrial revolution, Crafts calculated that per capita GDP grew by an average of

95 Ibid, p.258
96 Mokyr, *The enlightened Economy*, p.84
97 Joel Mokyr, 'Intellectual property rights, the Industrial Revolution, and the beginnings of modern economic growth', *American Economic Review: Papers and Proceedings*, 99, (2009), pp. 349-355
98 Ibid, p.349
99 Mokyr, *The enlightened economy*, p.409
100 Mokyr, Intellectual property rights, p.353
101 Mokyr, *The enlightened economy*, p.107

0.35 percent per annum. The comparable figure produced by Deane and Cole was 1.08 percent.[102] These new, lower, estimates of growth had interpretative implications for the potential sources of growth, especially TFP. Using his new estimates of aggregate growth, Crafts calculated that TFP growth was only 0.2 percent per annum between 1761 and 1800.[103] Further, Crafts argues that this new TFP figure still overstates inventive activity because increasing skills and hours worked mean an increase in the labour input to be subtracted from aggregate growth.

Crafts argues that in the larger sections of the economy, (with the important exception of agriculture), innovation and productivity gains were limited. This is apparently reflected in the trade figures. In 1851, British exports were dominated by textiles and iron, denoting comparative advantage in their production; outside these two sectors only 5.8 percent of production was exported.[104] Crafts assumes that a country will have a comparative advantage in those goods which intensively uses the factor of productivity which is relatively cheapest.[105] In the case of iron Crafts attributes British comparative advantage to cheap steam power and in cotton to the high productivity of low-grade labour. This implies, however, a relative disadvantage in human-capital intensive goods which Crafts argues means '[it is not]…appropriate to regard innovativeness as pervasive'.[106]

One factor that contributed to modest growth was the extended delay between the discovery of major innovations and their implementation on a scale large enough to influence the macro-economic statistics. Crafts recognises that such a time lag was inevitable. In the twentieth-century, there was a long gap between the introduction of electricity, and its impact on aggregate growth statistics. To explain these time lags Crafts adopts the same distinction between macro and microinvention used by Allen. As mentioned before, macroinventions represent a radical new idea and often emerge without a clear technological precedent. In contrast to Allen, Crafts considers macroinventions as 'essentially exogenous and unpredictable often resulting from strokes of genius or luck'.[107] It follows that, for Crafts, the development of macroinventions in England was largely a matter of chance and unrelated to any intellectual property rights regime.

However, the full potential of productivity gains from a macroinvention can be realised only with a long series of subsequent microinventions. Microinventions are effectively 'tweakings', which improve various parameters of the macroinvention, and make it applicable to an increasing number of scenarios. In contrast to macroinventions, Crafts regards microinventions as largely conditioned by endogenous economic factors. Crafts argues that it was because many endogenous factors in the British economy were *not*

102 Nicholas Crafts, *British economic growth during the Industrial Revolution*, (Oxford, 1985), p.45
103 Ibid, p.82
104 Ibid, p.144
105 Ibid, p.145
106 Ibid, p.87. This does not, however, account for the origins of British low-grade labour productivity and readily accessible steam power
107 Nicholas Crafts, 'Exogenous or endogenous growth? The Industrial Revolution reconsidered', *Journal of Economic History*, 55, (1995), p.757. In contrast, Mokyr does not consider macroinventions to be stochastic. Indeed, Mokyr makes a direct connection between patent systems and the generation of macroinventions. He argues that patent systems encourage inventions that represent ideas of a radical departure, (in other words macroinventions) and so that have a low ex ante chance of success. This is because they reduce the threshold of social surplus at which an invention can be profitable to its inventor. Joel Mokyr, *The lever of riches: Technological creativity and economic progress,* (Oxford, 1990), p.252

conducive to microinvention, that economic and TFP growth were limited. For example, based on evidence from contemporary wills, Crafts argues that the fortunes made from careers in public administration and other 'non-productive' sectors, demonstrate that opportunities for rent seeking continued to attract the best educated.[108]

Another endogenous factor, alleged to have frustrated the development of microinvention was the dysfunctional patent system. Crafts argues that the high fees and low legal cachet of the patent were particularly counter-productive to inventive activity.[109] Consequently, these failings of the patent system undermine attempts to use endogenous innovation growth models that rely on appropriability of rents from making discoveries to explain economic growth, during the industrial revolution.[110] Using Richard Sullivan's econometric work on patent renewals between 1852-76, Crafts calculates that in 1765 the value of patent rights represented a meagre 0.07 percent of physical investment.[111] Crafts concludes that without an effective patent system, the incentives required for the endogenous creation of microinventions were undermined, and so TFP growth was lower than it would have otherwise been.

Research issues

The first part of the literature review on the economics of patenting established that there are two (broad) reasons why patents are regarded as an important policy instrument for encouraging technological development. Firstly, by allowing inventors to exclude (temporarily) other parties from using their protected technology, patents help inventors appropriate a larger return on inventive activities than would otherwise be possible. By augmenting the rate of return to invention, patents provide an additional spur to inventive activities. This, however, varies between technological sectors. Wherever secrecy can be maintained and/or reasonable lead time secured, patenting is a less attractive proposition. Where, however, they cannot, patenting may be the only practicable method of securing a return on the costs of invention. This appears to have been the case with sectors that are often considered to have been central to the industrial revolution,

108 Crafts, 'Exogenous or endogenous growth?', p.764
109 Nicholas Crafts, 'From the eighteenth to the twenty-first century: A perspective on 250 years of British economic growth' Ellen McArthur Lectures, Lecture two of four, 'What were the Real Penalties of the Early Start?', presented Cambridge, 4th November 2009. http://sms.cam.ac.uk/media/848312
110 There are a number of problems with the original work of Sullivan. The key assumption behind work of this kind on patent renewal statistics is that the patentee will renew the patent so long that the cost of renewal is less than the discounted expected income obtained by the renewal. The number of patents for perpetual motion machines that were renewed after three and seven years demonstrate the folly of this assumption. Christine MacLeod, Jennifer Tann, James Andrew and Jeremy Stein, 'Evaluating inventive activity: The cost of nineteenth-century UK patents and the fallibility of renewal data', *Economic History Review*, 56, (2003), p.553. Richard Sullivan, 'Estimates of the value of patent rights in Great Britain and Ireland, 1852-1876', *Economica*, 61, (1994), 37-58
111 Crafts, Exogenous or Endogenous Growth?, p.762. As Crafts recognises in his footnotes the method of this calculation is somewhat crude. Between 1852-76 Sullivan calculates that 10 percent of patents accounted for 90 percent of their aggregate value. Crafts makes the bold assumption that this relationship between patent quantity and value is the same for an earlier period. This premise has been undermined by recent quantitative work by Alessandro Nuvolari, who demonstrated that during the pre-reform patent system, there were a significantly higher proportion of high value patents for the period 1762-1801 than before or after. Alessandro Nuvolari and Valentina Tartari, 'Mr Woodcroft and the value of English patents, 1617-1841', *Explorations in Economic History*, 48, (2011), pp.112-113

engines and manufacturing machinery for example. Secondly, patents encourage the diffusion of technology by obliging the inventor to eschew secret working and publish their invention.

There have been some economic historians of the industrial revolution, especially those who see technological development as primarily an economic and 'demand-side' phenomenon, who accord patenting an important role in encouraging inventive activities. Although Allen and Broadberry both consider English technological development to have been primarily driven by its structure of factor prices, an important component behind the generation of technology was the existence of an 'effective' patent system. Neither, however, discuss the operation of the patent system in detail. This is unfortunate because current empirical understanding of the patent system does not support their interpretation of the contribution of patenting to the encouragement of inventive activity. Both Dutton and MacLeod argue that for many inventors patents were prohibitively difficult to obtain and legally unenforceable. This undermined the incentive to engage in inventive activities usually afforded by patents. It is also supposed to have stymied the diffusion of technology. It is not even clear whether there are the empirical foundations for Mokyr's more tentative suggestion, that patenting was akin to a lottery.

Because of the emphasis placed on the administrative and legal failings of the patent system, the second and third chapters re-appraise the efficacy of the patent system. The second chapter examines the administration of the patent system. In particular, it investigates the argument that for most inventors, due to an immensely convoluted petition procedure, patents were prohibitively difficult to obtain. The third chapter details the development of patent law until 1852. It examines changes in the administration of patent law, developments in the jurisprudence of patenting and the enforceability of patents.

These chapters argue that patents offered inventors more effective protection than previously thought. Although the petition procedure was complicated, the role of patent agents in helping patentees navigate and finance their way through the petition has been understated. The third chapter argues that patents were enforceable, due in large part to the ready availability of injunctions in equity, and the development of judicial precedent at common law. This resurrects the possibility of patenting having an important role in the development of technology during the industrial revolution, as suggested by Allen, Broadberry and others.

The second half of the thesis examines the role of the patent system in British technological development during the industrial revolution. The fourth chapter examines the role of the patent specification, the detailed description of the patented invention. In particular, it will look at how specifications were prepared by inventors and their contribution to the circulation of technical knowledge.

The fifth chapter examines the market in patent rights. The advantage with analysing the market in patent rights is that because of the practical difficulties involved with transferring trade secrets it is possible to differentiate clearly between the advantages of patenting vis-à-vis secret working. The chapter begins by analysing whether the legal infrastructure facilitated the transfer of patent rights. If patentees cannot assign or license their patent to other users, to appropriate returns they will be obliged to commercialise the invention themselves. For those without the necessary funds or manufacturing plant this would have been

particularly arduous. The chapter demonstrates that these transactions were common and, even for modest advances; it was possible to secure returns from selling and licensing patent rights. The chapter also presents findings from quantitative work on joint-stock companies founded to work patents after the Joint-stock Companies Act in 1844, looking in particular at the capital advanced to work patented technology. Finally, it presents three case studies where the inventors sought to appropriate a return from their inventions by selling and licensing the patent rights.

However, to maintain the argument that these returns incentivised inventive activities, it needs to be demonstrated that inventors and patentees were responsive to the commercial and economic opportunity of invention. The sixth chapter examines this problem with an analysis of the Irish and Scottish patent systems, the first analysis of patenting in either country during the industrial revolution. The first half of the chapter describes the Irish and Scottish patent systems which, despite their relative independence, adopted English administrative and legal practice. The second half of the chapter undertakes two statistical exercises using the patent indices of Ireland, Scotland and England. The first exercise is a straightforward analysis of the trends in numbers and sectoral composition of patents awarded in Scotland and Ireland. The exercise suggests that there was a close relationship between industrial development, the commercial opportunity for intellectual property, and growth in the number of patents awarded.

The second exercise looks directly at the responsiveness of inventors and patentees to the commercial opportunity of invention. As the number of jurisdictions in which protection for an invention is sought increases, so do the costs and efforts involved. If patentees were responding to the market opportunity of new technology, one would expect the population of patents that were extended to Scotland and/or Ireland to be of a higher quality than the population of 'England only' patents. This is because the returns needed to recoup the additional costs involved in extending the protection, will only be sufficient on higher-quality inventions. This trend is demonstrated by applying an established indicator of patent quality, indicating that patentees were responsive to the market opportunity of their inventions. As will be outlined in the conclusion, the final three chapters of the thesis conclude that the patent system did have an important and positive role in technological development during the industrial revolution. Finally, there is some terminology used in the thesis that may be unfamiliar to economic or legal historians. Normally, a definition will be provided in the text or in a footnote, although a glossary is also provided at the end of the thesis.

Chapter 2

The English patent administration

Modern day patent systems are normally administered by a single, centralised office, responsible for the awarding and cataloguing of patents.[1] Before the Patent Law Amendment Act in 1852 there was no equivalent to such an administration in the United Kingdom. Rather, patent applications were administered by a slew of government offices, departments and law courts. These offices were not run by technically qualified professionals but by amateur gentlemen who often sub-contracted the clerical work to deputies. To secure an English patent a petition had to pass through ten distinct stages but because Scotland and Ireland maintained separate administrations, an inventor who sought a patent for the United Kingdom had to negotiate this procedure three times. The following two chapters are concerned with the law and administration of patents in England. Chapter 6 discusses the patent systems in Scotland and Ireland.

Historians of patenting do not consider the English patent 'system' to have been efficient. In 1700, negotiating the petition required contacts and a familiarity with Whitehall that few inventors would have had. Earlier in the seventeenth-century, most patents were acquired by those with connections at court.[2] Also, because the petition could last six months, personal attendance was necessary for inventors who lived outside London. The prolonged absence from one's business and personal affairs were compounded by the costs of travelling to, and lodging in, London. MacLeod argues that 'the complex procedure, the enforced sojourn in London, and the exactions of the crown and its officials surely deterred many inventors from securing a patent'.[3] The development of professional patent agency in the nineteenth-century helped alleviate these problems. For a fee of ten guineas, patent agents helped inventors pass their petitions and, Harold Dutton notes that by 1851 agents took care of around 90 percent of all petitions.[4] However, even with the assistance of agents, Dutton still describes the petition as a 'tortuous labyrinth'.[5]

Securing a patent was also tremendously expensive. The cost of lodging and travelling to London has already been mentioned, but there were also fees to be paid at every stage of the petition. Richard Sullivan calculates that these fees cost around £91 in 1830, four times GDP per capita.[6] That these fees had

1 Matters are more complicated in Europe, where patent protection can either be obtained through the auspices of the national patent system, or through the European Patent Office. On the legal and commercial considerations involved with choosing either course of action see Lionel Bently, and Brad Sherman, *Intellectual Property law*, (3rd edn. Oxford, 2009), p.373.
2 Christine MacLeod, *Inventing the Industrial Revolution, the English patent system, 1660-1800*, (Cambridge, 1988), p.29
3 Ibid, p.76
4 Harold Dutton, *The patent system and inventive activity during the Industrial Revolution: 1750-1852*, (Manchester, 1984), p.86
5 Ibid, p.35
6 Sullivan uses Feinstein's estimate of £19 for GDP per capita. Richard Sullivan, 'England's "Age of Invention": The acceleration of patents and patentable invention during the Industrial Revolution', *Explorations in Economic History*, 26, (1989), p.434

to be incurred before patent protection was acquired placed poorer inventors in a precarious position. If they had to secure funds from a capitalist to fund the petition, they jeopardised their secret in the course of negotiations.[7]

Yet despite the 'absurdly cumbersome' petition procedure, by the second half of the eighteenth-century, the invention, or proposed patent, was rarely examined.[8] In theory, every petition was examined by the law officers and in the first half of the eighteenth-century this was typically the case. One law officer was even admonished for the thoroughness of his reports.[9] With the increase in petitions though, it became impossible for the law officers to examine every one and from the 1760s, a favourable report was granted as a matter of course. Without any examination of the proposed patent, or its legality, the value of the eventual grant was necessarily reduced. Indeed, Dutton argues that 'the market value of a patent depended upon a successful case at law'.[10]

This chapter investigates the administration of the patent system. Section 2.1 presents a detailed description of the petition procedure from 1700 to 1852 which, barring one major innovation, remained largely unchanged. Section 2.2 describes the administration of the patent system between 1700-67; the third administration from 1768 to reform in 1852. The discussion of the patent administration has been split into two time periods for three reasons. Firstly, by 1768 the law officers had abandoned systematic examination. Secondly, the nature of the sources changes. In particular, many of the documents relating to petitions from before 1768 survive in the State Papers. Afterwards, however, they do not and other sources (especially parliamentary papers) have had to be used. Finally, it is around this time that the number of patents awarded begins to increase. During the 1750s, only 92 patents were awarded, yet in the 1790s there were 647. It is in response to this growth that the operation of the patent administration began to be 'regularised'.

Section 2.1
The petition procedure

The origins of the patent system were medieval, letters patent being an administrative tool by which the monarch awarded grants. The English patent rolls (a register of the grants) survive from 1201.[11] The petition procedure had been laid down by the 1535 Clerks of the Signet and Privy Seal Act. The Act deliberately established a convoluted petition procedure that included a myriad of different offices. This was because officials in the sixteenth-century were unsalaried and had to be maintained with fees levied on those who used their services. The Act, as acknowledged in the preamble, was designed to secure sufficient business for each office so they could be properly financed.[12] Despite its complexity, the only significant change to the

7 Christine MacLeod, 'The paradoxes of patenting: Invention and its diffusion in eighteenth and nineteenth-century Britain, France and North America', *Technology and Culture*, 32, (1991), p.893
8 Dutton, *The patent system*, p.34
9 Christine MacLeod, 'The 1690s patent boom: Invention or stock-jobbing', *Economic History Review*, 39, (1986), p.552
10 Dutton, *The patent system*, p.179
11 Patent Rolls, London, National Archives, C 66/1 to C 66/5726
12 MacLeod, *Inventing the Industrial Revolution*, p.40

petition prior to reform in 1852 was the introduction of the specification, which became standard practice during the 1730s.

The petition proceeded as follows:

1st stage. At the first stage the inventor's petition, along with an affidavit, were submitted. Before 1782, these were submitted to either one of the two Secretaries of State.[13] In 1782, when their responsibilities were divided between the Foreign Office (for foreign affairs) and the Home Office (for domestic affairs), the petition and affidavit were submitted to the latter.

The petition provided the title of the proposed patent. Before the introduction of the specification, these could be quite lengthy. The petition also had to state the name(s) of the petitioner(s), their addresses and the circumstances on which the petition for a patent was founded i.e. whether the petitioner was the original inventor or an importer. If the invention affected the revenue, the Lords of the Treasury reserved the right to prepare the petition, although this practice fell into disuse.[14]

To provide legal verification of the assertions contained in the petition it was necessary to enter an affidavit sworn before a Master in Chancery, or a Master extraordinary outside of Chancery. The affidavit also needed to state whether the petitioner intended to apply for a Scottish and/or an Irish patent, as this decided the time allowed for entering the specification at the final stage. After the Letters Patent for Inventions Act (1835), the affidavit was replaced by a sworn declaration.

2nd stage. Once a reference to the petition was signed by the Secretary of State, the petition, with the reference, was taken to the chambers of the Attorney or Solicitor-General (the law officers).[15] The law officers were expected to examine the claims in the petition and in the early period, the examination could be thorough. The law officers might also forward the petition to the Privy Council or other interested government bodies for examination. As the number of petitions increased, however, the law officers became much less conscientious in this task, and from the mid-eighteenth century, in the absence of caveat opposition (which will be described in section 2.3.2), a favourable report was awarded as a matter of course.

3rd stage. The law officers' report was returned to the Secretary of State to receive the King's Warrant.[16] The warrant was signed by the monarch and countersigned by the Secretary of State.

4th stage. With the warrant completed, the petitioner took it to the Patent Bill Office, which operated under the direction of the law officers. Here the Bill for the patent was prepared by the Office's engrossing clerk. The Bill contained the entirety of the patent precisely as it was to be worded. The Bill was signed by the law officer.

5th stage. The Bill was returned to the Secretary of State (for the third time). Here it received the royal signature (for the second time), and the sign manual, affixed at the start of the Bill. With the sign manual the bill was now entitled the 'The King's bill'.

6th stage. Once prepared, the King's bill was taken to the Signet Office. Here the clerks of the Signet prepared and issued the Signet bill to the Lord Privy Seal.

7th stage. The Signet bill was taken to the Privy Seal Office to obtain the Privy Seal Bill.

8th stage. The Privy Seal bill was taken to the Letters Patent Office (not to be confused with the Patent Bill Office mentioned in stage 4). This was in Chancery, and under the sole direction of the Lord Chancellor. It was here that the patent itself was prepared, sealed and enrolled. Before going to Chancery, the bill once had to go to the Hanaper Office but this requirement had been dispensed with by at least 1829.[17]

9th stage. After the patent had been prepared, it was taken to the Lord Chancellor to receive the Great Seal. There was a public seal day on Friday every week but, for an additional fee, the bill could be sealed on any other day. Once sealed, the patent and Great Seal were put into a case and delivered to the petitioner.

10th stage. The final stage was when the patentee submitted a detailed description of his patented invention termed the specification. The specification became a universal requirement from 1734 (although in the nine years before 1742 it was waived if the description in the petition was particularly thorough). From around 1800, if applying for only an English patent, an inventor was awarded two months to enrol the specification. If applying for English and Scottish patents they were awarded four months and if applying for patents in England, Scotland and Ireland, six months.[18] The additional time was awarded because if the specification for the English patent was enrolled before the sealing of the Scottish or Irish patents, these patents would be invalid. The specification could be enrolled in one of three Chancery offices, the Enrolment Office, the Petty Bag Office or the Rolls Chapel.[19]

As the Signet Office and Privy Seal Office were in the same building it was usual for a clerk in the

13 Before 1782, there were two Secretaries of State, one the head of the Northern Department, the other the head of the Southern Department. They shared responsibility for domestic affairs, and divided foreign affairs geographically. Peter Jupp, *The governing of Britain, 1688-1848*, (Abingdon, 2006), p.29

14 This practice was last mentioned by a State Paper outlining the petition process in 1733. State Papers, London, The National Archives, SP 36/30, fol.374-376

15 These were the private chambers of the law officers, not a public office. Despite holding public office, the law officers could continue to represent private clients. Because of their professional expertise relating to patents for inventions they were often employed to represent clients in patent cases. Rose Melikan, 'Mr Attorney-General and the politicians', *The Historical Journal*, 40, (1997) p.55-56

16 During the reigns of Queen Anne (1702-14) and Queen Victoria (1837-1901), the Warrant would have been entitled the Queen's Warrant. This also applies to The King's Bill at the fifth stage of the petition.

17 *Report from the Select Committee on state of law and practice relative to patents for inventions*, (Parl. Papers, 1829, III), p.49

18 It appears that this system was being abused by the end of the period, with virtually all petitioners claiming they intended to apply for patents in Scotland and Ireland when only a fraction actually did. Of 440 English patents in 1840, only 14 were not awarded six months within which to enter the specification. In the same year, however, there were only 177 patents awarded in Scotland and 66 in Ireland. Also before 1810 there was no standard practice with regard to the length of time patentees had in which to enter their specification. In 1780 every patentee was given four months to enter their specification, whereas in 1790 the norm was one month only (although a few were given two months). Bennet Woodcroft, *Chronological Index of patents, 1617-1852*, (London, 1854)

19 The most detailed description of the petition procedure is in William Hindmarch, *The law and practice of letters patent for invention*, (London, 1846), Chap.12. Also see *Report from the Select Committee on state of law and practice relative to patents for inventions*, (Parl. Papers, 1829, III), pp.48-51 and *Report of the Committee (appointed by the Lords of the Treasury) on the Signet and Privy Seal Offices*, (Parl. Papers, 1849, XXII), p.viii. For an outline of the procedure in the first half of the eighteenth-century see State Papers, London, The National Archives, SP 36/30, fol.374-376

Signet Office to transmit the signet bill directly. Besides this, the petitioner was responsible for transmitting the petition.[20] Obtaining a patent in the eighteenth-century was time-consuming. The diary of one inventor indicates he spent five months in London petitioning for his patent.[21] The petition could be further delayed for a host of reasons. If, for example, the monarch was ill or out of town the petition had to wait. During the period of George III's mental illness, it took months for petitions to receive the royal signature. However, the time required to obtain a patent did decline during the nineteenth-century. In 1829, John Farey reckoned it took an average of two months to obtain a patent, although one agent claimed it was possible to have a patent sealed inside two weeks.[22] By 1849, the reported average had fallen again to between three and five weeks.[23] Nonetheless, it remained a bureaucratic and intricate procedure. The following section examines the administration of patents between 1700-67 and, in particular, the requirements and accessibility of obtaining patent protection.

Section 2.2
The patent administration, 1700-1767

Between 1700-67 very few patents were awarded, only 522. This however, was a period that experienced important technological advances such as the Newcomen engine, Kay's flying shuttle, Wedgwood china and Darby's coke smelting.[24] This section examines the administration of the patent system between 1700-67, and starts to analyse why so few patents were awarded during a period that experienced some important technological developments.

MacLeod notes that in the seventeenth-century many patentees relied on connections at court as an entrée to the patent administration. Traces of this courtly influence lingered into the eighteenth-century as well. An example of interference from the highest authority is shown by the 1728 petition of John Payne. Although Payne obtained a favourable report from the law officers in July, the King refused to sign the Warrant. In a letter to the Attorney-General, Lord Hardwicke, Payne complained, 'you intimate his majesty will not sign a warrant for my invention on account that it is apprehended it will interfere with Woods [a royal favourite] patent for making iron with pit coals'.[25] Exasperated at the lack of reply, Payne wrote again a week later, 'I was just now with Mr Preverace [probably his lawyer] and he tells me, have nothing from you since my last, in answer to Mr Woods patent and I am now much wanted in my family affairs in the country, by my long stay here on this affair' (sic).[26] He queried whether he should 'have occasion…to use the interest of my friends with his majesty which the Duke of Montagu, Lord Chancellor Dodington and several of my

20 William Hindmarch, *The law and practice of letters patent for invention*, (London, 1846), p.527
21 Arthur Gomme, 'Patent practice in the eighteenth-century: The diary of Samuel Taylor, threadmaker and inventor, 1722-1723', *Journal of the Patent Office*, 19, (1937)
22 *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.18
23 *Report of the Committee (appointed by the Lords of the Treasury) on the Signet and Privy Seal Offices*, (Parl. Papers, 1849, XXII), p.30
24 It should be noted, however, that the first two advances were patented, and only Darby never obtained a patent.
25 State Papers, London, The National Archives, SP 36/7, fol.84
26 State Papers, London, The National Archives, SP 36/7, fol.86

friends in town have promised me'.[27] Clearly, this lobbying was effective as the State Papers contain a subsequent letter addressed to Hardwicke ordering that the patent be granted 'by his majesty's command'.[28] After all this, Payne still had to wait until October for the favourable report of the Commissioners of the Salt Office.[29]

Payne's experience demonstrates the travails faced by the prospective patentee. The reference of the petition to the Salt Office indicates a mercantilist concern with protecting tax revenue. MacLeod cites the example of the Excise Commissioners vetoing a petition for tallow candles on the grounds that they paid less duty per pound than wax candles.[30] Attorney-General Northey also approved a petition for fermenting the wash from sugar, as 'the same will greatly increase your majesty's revenue, so it will be of great benefit and advantage'.[31] Another consideration of importance was the balance of payments and trade. Lord Hardwicke noted of William Howton's petition for extracting the lixiviate salt of ashes, that it would 'save considerable sums of money sent abroad to purchase the said commodities from the Baltick and elsewhere'.[32] These last two comments indicate that mercantilism offered opportunities as well as dangers. Petitioners often appealed to a wide range of mercantilist interests proclaiming, for example, the employment potential of new advances. Martin Bedwell, for example, claimed his engine was 'so contrived that the invalids in hospitals, forts and garrisons may be employed in spinning and weaving linen cloth'.[33]

Payne's experience also demonstrates the practical difficulties involved with obtaining a patent. Payne (who was from Somerset) spent an extended period away from his business in London. He arrived in London in June and only obtained the patent in November.[34] It cannot be supposed that there were many men with the resources to spend five months away from their place of business. Of 393 patents awarded between 1700-60, 273 provide residency information. Of these 273 patents, in 160 (58.6 percent) at least one patentee was from the metropolitan counties (Middlesex, Surrey, Essex and Kent).[35] Although London was the commercial and manufacturing centre of England, this figure is much larger than the capital's share of national population or GDP.[36] Another inventor from the provinces who managed to secure a patent was Samuel Taylor. His diary entries survive from the time when he was attending his petition and again demonstrates the practical difficulties involved. It took Taylor five days to travel from Manchester to London

27 Ibid. The Duke of Montagu was the Colonel of the Horse Guards and Master of the Great Wardrobe. Edward Metzger (2004), 'Montagu, John, second duke of Montagu (1690–1749)', Oxford Dictionary of National Biography (online edn.), http://www.oxforddnb.com/view/article/19025, accessed 10th September 2011.
28 State Papers, London, The National Archives, SP 36/7, fol.96
29 State Papers, London, The National Archives, SP 36/7, fol.97
30 MacLeod, *Inventing the Industrial Revolution*, p.24
31 State Papers, London, The National Archives, SP 34/15, fol.163
32 Hardwicke Papers, London, British Library, Vol.36141, fol.303
33 State Papers, London, The National Archives, SP 36/10, fol.111. Similarly, Benjamin Joules claimed in his petition for wickering glass bottles 'that the said art practised in Great Britain…would employ multitudes of poor people who now for want of work are become a great burden on their respective parishes'. State Papers, London, The National Archives, SP 35/12 p.63
34 Bennet Woodcroft, *Patents for invention: Reference Index, 1617-1853*, (London, 1855)
35 Ibid
36 However, this spatial concentration persisted for a long time. In 1930, almost forty percent of independent inventors resided within five miles of London (and Birmingham). Tom Nicholas, 'Independent invention during the rise of the corporate economy in Britain and Japan', *Economic History Review*, 64, (2011), p.1017

on horseback.[37] Once in the capital, he spent five months until the patent was eventually sealed in February 1723.

Taylor's diary contains detailed accounts of the expenses involved and these can be divided into three parts. Firstly, there were the official fees that were paid in the various offices. These were normally levied as charges for submitting the various forms required. For example, Taylor had to pay £2 2s. 6d. for the Secretary of State's reference to the law officers.[38] There were also stamp duties to be paid. For the patent itself, a duty of £6 was charged.[39] Using Taylor's diary, Arthur Gomme calculated that the official fees for a patent amounted to £64 6s. 2d. Taylor's petition was also subject to caveat opposition which put him to a further £4 10s. of expenses. Secondly, there were the charges that had to be paid to solicitors and clerks. The solicitor would have been employed to assist with the petition, especially with the caveat hearing. Solicitor's fees cost at least ten guineas and another £8 was paid out by the solicitor in gratuities to clerks, deputies and porters.[40]

Thirdly, there were the expenses of travel, lodgings and entertainment. Over the five months, this amounted to around £40. The diary entry for the 16th February provides an indication of this type of expenditure.

	£.	s.	d.
Paid coffey att Chancery coffee house		1	3
Wine att Bull tavern		2	0
Paid Lord Chancellor secretly	1	1	0
Paid his gentleman	1	1	0
Paid coach to Lord Chancellors		1	0

The third item of expenditure, 'Paid Lord Chancellor secretly', is particularly intriguing. At this moment, Taylor's petition had passed through the Signet and Privy Seal Office, and was at the Great Seal Office (under the jurisdiction of the Lord Chancellor), awaiting the final preparation of the letters patent. It is impossible to be sure why this secret payment was made but the Lord Chancellor of the time was the notoriously corrupt Earl of Macclesfield. He was later impeached by the House of Lords in 1725 and imprisoned until payment of a £30,000 fine.[41] It is quite possible that the Earl was extorting a gratuity from the supplicant Taylor to seal his patent. The total sum spent by Taylor was £128 19s. 5d. This represents a considerable expenditure, calculated as a multiple of average earnings this would equate to around £222,000 in 2010 prices.[42] These direct financial costs were compounded by the indirect costs of being away from

37 Gomme, 'The diary of Samuel Taylor', p.209
38 Ibid, p.222
39 Ibid, p.223
40 Ibid
41 Macclesfield, for example, was found guilty of taking 'presents' of cash when selling Masterships in Chancery. Andrew Hanham (2004), 'Parker, Thomas, first earl of Macclesfield (1667–1732)', Oxford Dictionary of National Biography (online edn.), http://www.oxforddnb.com/view/article/21341, accessed 11th August 2011
42 There are several methods of translating historical monetary values into a modern-day equivalent. The one used here calculates the value of the goods or service as a multiple of the average contemporary wage. So if the cost of a patent was ten times the annual income of an average worker in 1723, the modern value is calculated as the annual income of an average worker today, multiplied by ten. This is particularly useful in indicating the relative value of commodities in terms of labour. Lawrence Officer and Samuel Williamson (2011), 'Purchasing Power of British Pounds from 1245 to Present', MeasuringWorth, www.measuringworth.com/ppoweruk/, accessed 28th May 2012

one's family and business for five months.

Although few patents were awarded, there was one important development in the administration of patents, the introduction of the specification. The specification was the detailed written description of the patented invention. It was submitted to one of three offices in the Court of Chancery within a specified time after the patent was granted, usually several months. The specification submitted by John Naismith for his 1711 patent is regarded as the first specification proper, although there are previous instances of petitioners submitting more detailed descriptions.[43] Although introduced in 1711 it took two decades for the specification to become standard practice. Between 1711-33, only twenty-seven specifications were required from 156 patents. Between 1734-42, however, thirty specifications were ordered from forty-four patents, and it was only waived if the description in the petition was particularly thorough.[44] Thereafter it became a universal requirement.

There is some debate on why the specification was introduced. Possibly, it was to help disseminate the invention. Conceiving the patent and specification as operating in this manner represents a significant conceptual development. Mario Biagioli argues that it is only with the written requirement that there is a shift away from patents as early modern privileges to patents as intellectual property rights. In a system of privileges, the consideration on which the grant is made is one of 'utility', that the invention is of direct economic benefit. This section has already discussed how the law officers examined the potential economic benefit of new inventions. In contrast, with the introduction of the specification, the consideration of the grant is supposed to change. Now the patent is awarded for disclosing the invention via the specification. Indeed Biagioli claims it underpins any modern intellectual property rights regime, 'it is the specification requirement that makes the patent system defensible in political terms'.[45] MacLeod, however, argues 'it [the specification] was certainly not for the purpose of disseminating inventions by disclosure'.[46] Instead, she argues that the specification 'was introduced on the government's initiative, to make discrimination between superficially similar inventions easier'.[47]

Before it became obligatory, it was left to the law officer to decide whether a specification was necessary. This decision was usually made when they were preparing their initial reports at the second stage of the petition process. The reports suggest that there were initially two reasons for the law officers' ordering a specification. In some reports, the specification was ordered at the request of the petitioner. They were apparently concerned that their patent would be pre-empted by another party pirating their invention before they had secured protection. To maintain secrecy they requested that they only provide a description of the invention *after* the patent had been sealed, in the form of a specification. An agreement was made with the law officers that if they failed to enter such an instrument, they would forfeit their patent

43 MacLeod, *Inventing the Industrial Revolution*, p.49
44 Woodcroft, *Chronological Index of patents*, (London, 1854)
45 Mario Biagioli, 'Patent republic: Representing inventions, constructing rights and authors', *Social Research*, 73 (2006), p.1130
46 MacLeod, *Inventing the Industrial Revolution*, p.51
47 Ibid. Instead Hulme suggested that the specification was introduced as a discriminatory tool at the suggestion of the patentees themselves. Edward Hulme, 'On the consideration of the patent grant, past and present', *Law Quarterly Review*, 12, (1897), p.316

This rationale appears in the earliest reports where a specification was ordered. For example, in his 1711 petition John Naismith claimed 'the petitioner thinks it not safe to specifie in what the new invention consists but proposes that so soon as the patent shall be passed, the same shall be by him ascertained under his hand and seal to be inrolled in the High Court of Chancery' and a specification was ordered.[48] By 1734, however, this rationale had disappeared. Increasingly, law officers regarded the description of the invention contained in the petition as 'insufficient'. In these cases, the law officer would state in his report that the petitioner had to enter a specification as a condition of the patent. In his report on the petition of William Fallowfield in 1726 the Earl of Hardwicke reported,

> but that particular nature of the said invention, or the materials with which it is performed, not being described in the said petition or in the affidavit annext, I humbly apprehend that a clause should be inserted in the said letters patent obliging the petitioner particularly to describe and ascertain the nature of the said invention by writing under his hand and seal.[49]

Later, in 1734 John Willes reported, 'in regard the petitioner has not fully described the nature of his invention it will be proper that a clause should be inserted in his patent to oblige him to describe it more fully by an instrument in writing to be enrolled in the High Court of Chancery…as hath been usual in like cases'.[50]

It is clear then that the law officers sought fuller descriptions of inventions from patentees than had been hitherto provided in the petition. Further, from 1734, unless the description in the petition was particularly thorough the specification was required of all patentees. This, however, only moves the explanation back one stage. Why did the law officers decide to demand fuller descriptions? Edward Hulme suggested it may have been to assist the law officers in discriminating between petitions for ostensibly similar inventions.[51] This may have been part of the reason, but the law officers were hardly inundated with petitions, and it does not preclude the possibility that the specification was introduced for the purpose of disseminating the invention as well. This was not entirely unprecedented; patents from the sixteenth-century refer to the need 'to secure the memory of this invention'.[52]

Significantly, there was a concomitant decline in the extent to which the law officers examined the petition with a view to deciding the 'pubic good'. This suggests that the consideration on which the patent was awarded had changed in the manner outlined by Biagioli. This trend can be seen clearly in the Hardwicke Papers by comparing the reports of the first Earl (law officer between 1720-33) with those of his second son Charles Yorke (law officer between 1756-62).[53] The reports of the first Earl were often extensive.

48 State Papers, London, The National Archives, SP 34/15, fol.163
49 Hardwicke Papers, London, British Library, Vol.36141, fol.437
50 State Papers, London, The National Archives, SP 36/34, fol.41
51 Hulme, 'On the consideration of the patent', p.316-317
52 Helen Mary Gubby, 'Developing a legal paradigm for patents: The attitude of judges to patents during the early phase of the Industrial Revolution in England (1750s-1830s)', (unpublished Ph.D thesis, Erasmus University of Rotterdam, 2011), p.156
53 Philip Yorke, the first Earl of Hardwicke, was Solicitor-General between 1720-24, and Attorney-General between 1724-33. Peter Thomas (2007), 'Yorke, Philip, first earl of Hardwicke (1690–1764)', Oxford Dictionary of National Biography (online edn.), http://www.oxforddnb.com/view/article/30245, accessed 15th Sept 2011. His son, Charles Yorke, was Solicitor-General between 1756-62, and Attorney-General between 1762-63. John Cannon (2004), 'Yorke, Charles (1722–1770)', Oxford Dictionary of National Biography (online edn.), http://www.oxforddnb.com/view/article/30237, accessed 15th September 2011

For example, in 1725 he examined the petition of James Christopher Le Blon, for the art of weaving tapestry upon the loom, 'a secret never known or practised before', even though there was not any caveat opposition.[54] Upon investigation, Hardwicke advised that the patent should be awarded on the grounds that it 'will employ vast numbers of poor weavers and other people in this kingdom' and it 'will bring in considerable sums of money from abroad for tapistry', although he refused Le Blon's request to incorporate his enterprise.[55] In contrast, the reports of his son are formulaic and cursory. He never considered whether the patent would be in the public interest, however defined, and he never forwarded a petition to another government body such as the Excise Commissioners (as was common during his father's tenure).[56]

This development cannot be attributed to any large increase in the number of petitions the law officers had to examine. During the first Earl's fourteen years as a law officer, an average of eight and a half patents were awarded every year. During his son's seven year tenure, the average was eleven. Instead, it appears that the 'public good' was no longer a criterion by which a patent petition was decided and had been replaced with the specification. Consequently, as the next chapter will show, the accuracy of the description in the specification became an important factor in patent litigation.

The travails of Samuel Taylor and John Payne indicate the difficulties of obtaining a patent in the first half of the eighteenth-century. Both spent months away from their business to conduct their petitions, at great expense, in London. Further, both came perilously close to failing, one from caveat opposition, the other from royal interference. The administration of patents was clearly politicised and probably corrupt. If they had failed to acquire the patent, all their time and money in petitioning would have been wasted. As a result, it is little wonder that there were so few patents in the first half of the eighteenth-century and it is difficult to quibble with MacLeod's argument that the rigours of the petition deterred many inventors from petitioning for a patent.[57]

Although few patents were awarded, the patent system did see one important change. The public good disappeared as the consideration on which the patent was granted and, as will be examined further in the following chapter, was replaced by the specification. Initially, the specification was introduced as an ad hoc measure to protect petitioners from piracy of their invention, before they had had their patent sealed. Within the space of two decades, however, it became a mandatory condition of the grant.

Section 2.3
The patent administration, 1768-1852

This section is divided into three subsections. The first examines patent administration in the context of the English civil service. It demonstrates that although there were extensive reforms in the civil service, the personnel and operation of the patent administration remained largely unchanged and belonged resolutely to

54 Hardwicke Papers, London, British Library, Vol.36141, fol.171
55 Hardwicke Papers, London, British Library, Vol.36141, fol.172-174
56 Hardwicke Papers, London, British Library, Vol.36222, idem
57 MacLeod, *Inventing the Industrial Revolution*, p.76

what Gerald Aylmer has termed the 'old administrative structure'.[58] What these reforms did achieve was contribute to a growing awareness amongst inventors and manufacturers that the patent system could be administered in an efficient and 'modern' manner. Section 2.3.2 examines the specific complaints of these groups, as voiced in parliamentary committees, analysing in particular the high costs of petitioning and the system of caveats.[59] It argues for a more nuanced assessment of patent administration after 1768 than proposed by Dutton and MacLeod. In some respects, it worked well. Caveat hearings, which affected a large minority of petitions, were thought to be well organised and provided a measure of security to the eventual grant. Costs, however, remained high and many inventions were never patented. Section 2.3.3 discusses the role of patent agents. It establishes that agents performed a variety of important functions, alleviating some of the problems discussed in the previous section. In particular, agents were able to assume the responsibility of managing the petition on behalf of inventors.

Section 2.3.1
The patent administration and Whitehall

After the 1750s, there was an explosion in the number of patents awarded. In the 1740s, 82 patents were awarded. Later in the 1790s 647 patents were awarded, and in the 1840s 4,581.[60] Yet despite this growth, there was no fundamental change in the administration of the patent system. In analysing the early modern civil service, Aylmer proposed six distinguishing characteristics of 'the old administrative system':

i) Entry to office by means of patronage, patrimony or purchase
ii) Tenure for life or pleasure
iii) Office treated as private property
iv) Employment of deputies by part time or absent office holders
v) Remuneration by means of fees and gratuities, rather than a salary
vi) Office regarded as a private right or interest.[61]

Although Aylmer was primarily concerned with describing the civil service in the seventeenth and eighteenth centuries, these characteristics can still be applied to the administration of patents until 1852. This was despite large-scale reforms in Whitehall, initiated by reorganisation of the Treasury in 1776.[62] These reforming efforts were maintained well into the 1830s as part of a wider campaign against 'Old Corruption'. In the major departments of state large numbers of under-employed, fee-maintained positions were replaced with a professional cadre of salaried clerks. The professionalisation of Whitehall also eroded the tendency to

58 Gerald Aylmer, 'From office-holding to civil service: The genesis of modern bureaucracy', *Transactions of the Royal Historical Society*, 30, 1980, p.92
59 A caveat was a form submitted to a particular office. The form requested that the holder be given notice of any patent petition that was applicable to the area of interest, as defined by the caveat, that passed through the office. Notice being received the holder could then decide to oppose the petition if he felt it conflicted with one of his inventions. Hindmarch, *The Law of Letters Patent*, p.504
60 Woodcroft, *Chronological Index*, (London, 1854)
61 Aylmer, 'The genesis of modern bureaucracy', p.92
62 Jupp, *The governing of Britain*, p.139

regard office-holding as a private right.

Offices involved with the administration of patents did not escape notice entirely. For example, an 1849 Treasury report investigating the Signet and Privy Seal Offices, noted that their operation was governed by the Offices of the Clerks of the Signet Act, passed in 1817. The Act did institute some changes, but they proved to be of limited importance. For example, although a salary scale was introduced in the Privy Seal Office, the clerks continued to collect gratuities. Further, the clerks only had enough work to occupy them for an hour a day.[63] Things were much the same in the Signet Office. Although the Act had abolished two of the four Signet clerks, the remaining two only had to work on alternate months. The report also noted that the First Clerk of the Signet, a Mr Bentinck, had never attended the office since his appointment in 1801 and relied entirely on a deputy to perform his duties.[64]

This informal, semi-private bureaucracy was prone to internal wrangles, especially over the allocation of fee income. Instructive is the three year dispute between the Clerk of the Patents to the law officers, David Johnstone, and the Clerk of Inventions to the law officers, Moses Poole (himself a partner in the largest patent agency firm). Johnstone held the 'principal office', but due to the growth in patents for inventions, Poole was in receipt of a considerable fee income. In 1839 Johnstone attempted to supplant Poole, claiming he had no permanent appointment, and that as a new Attorney-General had been appointed he was entitled to subsume Poole's duties (and the fees to which the position was entitled).[65] Although the details of the dispute do not survive, it was only resolved in 1842 when the Attorney-General instructed Johnstone to 'restore Mr Poole to that position and station in which you found him'.[66] The dispute between Johnstone and Poole demonstrates that the patent administration remained part of the 'old administrative system' as outlined by Aylmer. These offices were still treated as private property and the clerks were clearly more concerned with securing the fees and gratuities they provided, than in performing an expeditious service.

Section 2.3.2
Costs and caveats; the functionality of the patent system

For all its faults, however, by the standards of the Georgian civil service the patent 'system' was not particularly dysfunctional, and was not generally a cause of complaint. The restructuring and rationalisation of the Treasury, though, set a template for how bureaucracies could be organised, and led to demands for reforms throughout the civil service, including the patent administration. Further, the increase in the number of patents brought more people into contact with the system. In particular, from the 1820s there was an increasing number of professional inventors with a commercial interest in the operation of the patent

63 *Committee on the Signet and Privy Seal Offices*, (Parl. Papers, 1849), p.v
64 Ibid, p.iv
65 Lord Lyndhurst to Samuel Shepherd, Notebook of James and Moses Poole, London, British Library, BJ00 54889, inserted papers
66 Attorney-General Pollock to David Johnstone, Notebook of James and Moses Poole, London, British Library, BJ00 54889, inserted papers

system.[67] These two trends contributed to the growing agitation for patent reform.

In 1849 and 1851, there were three Select Committees that investigated the workings of the patent system.[68] Many witnesses evinced a low regard for the petition procedure. Before the 1851 Select Committee, Charles May, an industrialist, complained, 'I think that the present patent law, as regards the granting of patents is about as disgraceful a state as it can be'.[69] Likewise, Charles Barlow, a patent agent stated that the granting of patents was 'considered to be on a more unsatisfactory basis than the law of patents of any other country'.[70] Others were more positive in their précis, but they were in the minority. Another patent agent, William Carpmael, claimed 'the law generally speaking works well; the time occupied in the process of obtaining a patent is objectionable, otherwise the practice works well'.[71] These sort of generalised comments abound in the parliamentary papers. This section will examine two of the most significant and contentious issues highlighted by the committee reports, the caveat system and the costs of obtaining patent protection.

A caveat was a form submitted to a particular office requesting that the holder be given notice of any patent petition that passed through the office which was applicable to an area of interest as defined by the caveat. Upon receipt of notice, the holder could chose to oppose the petition at a hearing if they believed it conflicted with one of their inventions. In the absence of systematic examination of petitions, the caveat system was important because it provided the only means by which the claims of the petitioner might be investigated.[72]

A caveat could be entered at the following stages of the petition.

2nd stage. Caveats could be entered at the private chambers of the Attorney-General and/or the Solicitor-General. Caveats at this stage were 'general', meaning that they referred to a general class of technology. As such, a caveat holder could expect notice of every application passing through the chambers that related to their specified area of interest. Any hearing was heard before the law officer.

4th stage. Caveats could also be entered at the Patent Bill Office. Here (and at every subsequent stage) caveats were 'specific'. A 'specific' caveat was entered in opposition to a particular petition. Hearings at this stage were also held before the law officer.

6th stage. Caveats could be entered at the Signet Office. Hearings at this stage were referred back to the law officer.[73]

7th stage. Caveats could be entered at the Privy Seal Office. Hearings at this stage were held before the Lord Privy Seal.[74]

8th stage. A specific caveat could be entered at the Letters Patent Office (under the jurisdiction of the Lord Chancellor) to stop a patent receiving the Great Seal.[75]

At the Privy Seal and Signet Offices, caveats were redundant by the nineteenth-century. The last caveat entered at the Privy Seal Office was in 1803.[76] Opposition at the three other stages was more important. At the Great Seal Office in 1849, Thomas Ruscoe, the chief clerk, reckoned there were about five caveats entered with his office every year, although caveat opposition at this stage had been more common the eighteenth-century.[77] At a time when there were about 500 patents a year this represents only a small proportion of the petitions that would have passed through the office. However, the examination at this stage constituted a substantive legal proceeding, primarily concerned with determining the novelty of the prospective patent. Because the Privy Seal had already entered Chancery, the resultant patent could be ante-dated from when the Privy Seal had been entered. By doing so, the caveat hearings could be held in public without invalidating the patent on the grounds of prior publication. In addition, because the hearings were held in Chancery, both sides had to be attended by legal counsel.[78] Normally, the Lord Chancellor decided the validity of the proposed patent himself, or otherwise the matter was referred back to the law officers.[79] At the Patent Bill Office, the clerk estimated that one in twenty petitions were opposed in 1849.[80] With around 500 patents awarded each year, this implies that there were at least twenty-five oppositions at this stage every year (there were of course more petitions than patents).

The large majority of caveats and oppositions though, occurred at the second stage of the petition with the law officers. The hearings before the law officers, as before the Lord Chancellor, were primarily concerned with establishing the novelty of the proposed patent. Because a public hearing would have constituted a publication of the invention, and so invalidate any subsequent patent, the hearings were held in the private chambers of the law officer and the two sides seen separately. The opposition was called first to describe their invention, and then the petitioner was called to describe their own.[81] Occasionally the law

67 William Cornish, 'Personality rights and Intellectual Property' in William Cornish, Stuart Anderson, Ray Cocks, Michael Lobban, Patrick Polden and Keith Smith, *The Oxford History of the Laws of England, Volume 13, Fields of Development, 1820-1914*, (Oxford, 2010), p.938

68 *Report of the Committee (appointed by the Lords of the Treasury) on the Signet and Privy Seal Offices*, (Parl. Papers, 1849, XXII), *Report and minutes of evidence taken before the Select Committee of the House of Lords appointed to consider of the Bills for the amendment of the law touching letters patent for inventions with appendix and index*, (Parl. Papers, 1851, XVIII), *Report and Minutes of evidence taken before the Select Committee of the House of Lords appointed to consider the Bill to extend the provisions of the Design Act, 1850, and to give protection from piracy to persons exhibiting inventions in the Exhibition of 1851*, (Parl. Papers, 1851, XVIII)

69 *Report and Minutes of evidence taken before the Select Committee of the House of Lords appointed to consider the Bill to extend the provisions of the Design Act, 1850, and to give protection from piracy to persons exhibiting inventions in the Exhibition of 1851*, (Parl. Papers, 1851, XVIII), p.25

70 *Committee on the Signet and Privy Seal Offices*, (Parl. Papers, 1849), p.69

71 *Select Committee of the House of Lords*, (Parl. Papers, 1851), p.29

72 Caveats were used throughout the period, Samuel Taylor, whose diary was discussed in section 2.2, encountered caveat opposition. Gomme, ' The diary of Samuel Taylor', p.219-220

73 Hindmarch, *The law of letters patent*, p.527

74 Ibid, p.528

75 Hindmarch reported that it was once possible to enter a general caveat at this stage. The practice was abolished by Lord Brougham during the early 1830s. Ibid, p.531

76 *Committee on the Signet and Privy Seal Offices*, (Parl. Papers, 1849), p.14

77 Ibid, p.23 Caveat opposition at this stage declined after 1800, when it was decided that caveat holders would pay expenses to petitioners they had vexatiously opposed. *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.49

78 The cases were also reported upon in the same manner as legal cases. For example *Henson* v *Alcock* (1832), Peter Hayward, *Hayward's patent cases, 1600-1883: A compilation of the English cases for those years*, (13 vols, Abingdon, 1987), Vol.2, p.183-186

79 Hindmarch, *The law of letters patent*, p.532-535

80 *Committee on the Signet and Privy Seal Offices*, (Parl. Papers, 1849), p.4

81 In the Hardwicke papers some of the first Earl's private notes from caveat hearings survive, and they indicate that

officers would consult expert opinion; Isambard Kingdom Brunel and Michael Faraday were both called upon to assist with the hearings.[82] If the law officer saw no similarity between the two inventions, then the petition was allowed to proceed. If the law officer considered the inventions to be the same there were three available courses of action. If the two sides were both petitioning for an invention, it was the normal course to order the two sides to join together and petition for a joint patent. Secondly, where possible, the title of the proposed patent was altered to exclude whatever had been presented by the caveat holder. Otherwise, if the invention was already in use, the petition could not be passed and the favourable report was withheld.

The only reliable source for the number of caveat hearings the law officers held is an 1849 parliamentary return.[83] It provides the number of oppositions entered with the Attorney and Solicitor-General between 1838-47. It also gives the number of caveat hearings, the number of reports stopped or altered, and the number of reports granted. This provides a unique quantitative handle on the degree of scrutiny to which the patent petition could be subjected. The second column in table 2.1 shows the number of petitions examined by the law officers every year. The third column shows the number of caveat oppositions that were entered, and the fourth column the number of hearings. The fifth column shows the number of reports withheld (in effect a refusal to grant the patent). The sixth column shows the number of petitions that had to be amended as a result of caveat opposition (but which still received a favourable report), and the seventh column shows the number of petitions that were passed unaltered. The final column shows the number of patents awarded in that year.

Table 2.1. Petitions before the law officers, 1838-1847

Year	Petitions	Oppositions	Hearings	Reports withheld	Petitions amended	Reports granted	English patents awarded
1838	480	154	127	25	38	417	394
1839	526	191	162	15	26	485	411
1840	567	210	157	13	34	520	440
1841	562	172	218	19	12	531	440
1842	524	187	158	11	18	495	371
1843	515	164	133	15	13	487	420
1844	662	222	194	23	15	624	450
1845	774	244	226	13	17	744	572
1846	650	201	179	18	10	622	493
1847	733	319	223	29	20	684	493
Total	5993	2064	1777	181	203	5609	4484

Table 2.1 shows that 2,064 caveat oppositions were entered on 5,993 petitions. However, because there could be multiple oppositions and hearings on the same petition, this does not mean that a third of petitions were

these proceedings were substantially the same as those described in the 1851 Select Committee some 130 years later. See for example Hardwicke's private notes on the Samuel Taylor caveat hearing from 1722. Hardwicke Papers, London, British Library, Vol.36134, fol.89

82 *Committee on the Signet and Privy Seal Offices*, (Parl. Papers, 1849), p.32

83 *Number of letters patent for inventions, sealed in each of the ten years, ending 31 December 1847, together with the fees paid*, (Parl. Papers, 1849, XLV)

opposed. Of these 2,064 oppositions, 181 (8.8 percent) resulted in the petition being refused and 203 (9.8 percent) in the petition being amended.[84] In total, 6.4 percent of all petitions were either refused or amended by the law officers as a result of caveat opposition at the second stage of the petition.[85] An unknown proportion of petitions would have been refused or amended at the fourth and eight stages of the petition as well.

This belies MacLeod's description of the petition procedure as 'one of simple registration'.[86] A minority of petitions (maybe a quarter), which were presumably the more contentious, were subjected to an investigation by the law officers or the Lord Chancellor. The consensus in the parliamentary papers was that caveat hearings before the law officers worked well. One lawyer noted, 'they are men who have been drilled up to a point of the highest possible standing…and the feeling of everybody would I think be that of perfect confidence if the investigation remained in their hands'.[87] Similarly, William Carpmael, remarked, 'that which unquestionably is the best portion of our system of granting patents at the present time, the Attorney and Solicitor-General'.[88] Caveat opposition also acted as a preventative check to illegal grants. One lawyer claimed that 'the knowledge that a person maybe stopped before the Attorney-General, prevents persons trying to play tricks which would otherwise be attempted'.[89] Finally, caveats endowed some cachet to the eventual grant. In an 1851 Select Committee, on being asked 'what part of the present system is that which you think gives such an efficient protection to the patentee?' the patent agent Frederick Campin replied 'I think these stages, the Report, the Bill and the Great Seal, where we could have opposition'.[90]

There were, however, a number of complaints levelled against the caveat system. One agent, Paul

84 Of these 203 alterations the most common was that the proposed title of the patent be changed (156 instances). This meant that the proposed scope of the patent was too large, and probably encroached on pre-existing technology. The second outcome was when the patent 'went over' (forty-seven instances): when the two sides in a caveat opposition case were ordered to join their petitions together. Because the original petitions could not be changed to include the extra name, a new petition had to be re-submitted. Evidence of Thomas Webster, lawyer. *Committee on the Signet and Privy Seal Offices*, (Parl. Papers, 1849), p.40

85 It should also be noted that there is a disparity in the numbers between the Attorney-General and Solicitor-General. The Attorney-General was the more senior position, and it appears that they had the heavier case-load – 3,668 petitions in the ten years compared with 2,325 for the Solicitor-General. It also appears that the petitions they received were the more contentious receiving a higher proportion of oppositions to petitions, 38.2 percent compared to 28.5 percent for the Solicitor-General. Further the resultant hearings were more likely to result in withdrawn or amended petitions; 21.3 percent to 14.6 percent. There are two possible explanations for this difference. Firstly, it could be that the Secretary of State, who forwarded the petition to the law officers, made a decision based on the potential contentiousness of the projected patent. In the more doubtful cases they may have preferred to forward the petition to the more senior and experienced Attorney-General. This would explain why there was a higher proportion of oppositions to petitions forwarded to the Attorney-General, and why more of the hearings resulted in amended of withdrawn petitions. This would imply that there was at least an element of scrutiny of the petition at the first stage. Secondly, it could be that the junior Solicitor-General was more cautious in intervening in petitions and more willing to follow the dictum that the legality of any grant can ultimately be decided by the law courts. This, however, does not explain why they received fewer petitions in the first place. It should also be stressed that this issue was never discussed in the parliamentary papers or various patent treatises. Ibid

86 MacLeod, *Inventing the Industrial Revolution*, p.41

87 *Select Committee of the House of Lords*, (Parl. Papers, 1851), p.128. There were, as ever, dissenting voices. Benjamin Rotch, another lawyer complained, of 'the very worst tribunal that perhaps ever sat to judge of anything which is the tribunal before the Attorney-General'. *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.118

88 *Select Committee of the House of Lords*, (Parl. Papers, 1851), p.74

89 *Inventions in the Exhibition of 1851*, (Parl. Papers, 1851), p.23

90 *Committee on the Signet and Privy Seal Offices*, (Parl. Papers, 1849), p.33

Rapsey Hodge, accused his colleagues of entering large numbers of broadly defined caveats with the law officers. These were designed to generate multiple notices of petitions which were then opposed, 'in order to get a fee for buying off their opposition'.[91] If this practice did occur it cannot have been a lucrative one. Few oppositions were dropped before the hearing (only 287 between 1837-48) and the deposit for the hearing (£5) was forfeited if the opposition was unsuccessful. As the majority of oppositions were unsuccessful, bona fide inventors should have been reasonably confident of disposing with such speculative opposition.

A more plausible complaint was that caveat oppositions were used to delay inventors in obtaining a patent. The petition could not proceed until any caveat opposition had been defeated and, because of their other official business, the law officers were often obliged to delay the hearings. Caveat oppositions were also used to infer information about the proposed patent. Although, by the nature of the hearing, it would be impossible to ascertain exactly what the invention was, it would be possible to work out what it was not - whatever the caveat holder submitted to the hearing. There were reportedly occasions where, armed with this information, an opponent had been able to deduce what the invention was and publish their own version before the patent had been sealed. One engineer, Richard Prosser, complained that the 'first and original inventor is often superseded' by means of this tactic.[92] Although this testimony was contradicted by the patent agent William Newton, who claimed he had not encountered a single instance of this in twenty-seven years of practice, it was clearly a prospect inventors feared.[93] Consequently, many inventors suspended development of their invention until the patent had been sealed. John Farey, the engineer, claimed 'it is a common practice of manufacturers…[to]…destroy all the models, and every vestige of them, and even send away the workmen who made them on some distant embassy' to avoid having the invention unscrupulously published.[94]

The caveat demonstrates the need for a balanced appraisal of the administration of patents. That it exposed the invention to greater risk of piracy before protection was secured, it can be considered an institutional failing. It also exacerbated the propensity of inventors to suspend development while the patent was being solicited. One author of a patent treatise bemoaned that the caveat, 'which has illegally crept into the system, is the grand source of all the frauds which torment real inventors'.[95] However, the caveat ensured that the public could challenge patent petitions, and introduced an element of security to the eventual patent that would have been missing otherwise. Perhaps most telling was the Treasury report which, despite recommending wide ranging reform to the patent system, concluded 'it has not appeared to us that any better course can be devised than a reference to the Attorney or Solicitor-General' for the scrutiny of petitions.[96]

Another contentious issue, mentioned in section 2.2, were the costs involved with petitioning for a patent. Measured as a proportion of average earnings Samuel Taylor's 1723 patent cost the equivalent of

91 *Select Committee of the House of Lords*, (Parl. Papers, 1851), p.84
92 Ibid, p.318
93 *Committee on the Signet and Privy Seal Offices*, (Parl. Papers, 1849), p.28
94 *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.18
95 Richard Godson, *A practical treatise on the law of patents for inventions and of copyright: To which is added a supplement*, (London, 1832), p.49. Godson was wrong to suppose that the caveat had somehow 'crept in'. As we have seen in the case of Payne caveat opposition was possible in the first half of the eighteenth-century.
96 *Committee on the Signet and Privy Seal Offices*, (Parl. Papers, 1849), p.ix

£222,000 in 2010. In real terms, the costs of patent protection remained high until 1852, although with the development of patent agents (who began practising in the 1770s), inventors were no longer required to travel to London to petition for the patent. In nominal terms, official fees remained stable throughout the period. An 1808 solicitor's bill shows that official fees cost £97 14s. 6d.[97] Later, in 1846, official fees came to £95 0s. 6d.[98] The full break-down of these fees, along with the various stages at which they were incurred, are included as an appendix to this chapter. In addition to these official fees, however, there were a raft of extra fees that could be incurred. Firstly, if the patent was to be shared, a charge was levied for every additional name included on the patent. In 1846, this cost £18 12s. 10d. for every extra name.[99] Secondly, if the patent was to be extended to the colonies and the Channel Islands, another £4 2s. 6d. was charged. Thirdly, for 'expedition' in the processing of the petition, offices levied additional charges. In the Privy Seal Office (where there was only enough business to occupy the clerks an hour a day), obtaining the Privy Seal Bill on the same day as when the Signet Bill was entered cost £1 11s. 6d.[100] In total the various fees for expedition cost £5 3s. 0d. There were also agency fees, normally ten guineas, for conducting the petition.[101]

The introduction of the specification created an additional item of expenditure. Patentees invested considerable sums in hiring technical assistance in preparing the specification as they knew in the event of legal action it would be closely scrutinised. In his evidence to the 1829 Select Committee, Moses Poole testified that he had known charges for preparing the specification to have been as high as £200, and reckoned the average to be around £20.[102] The reported average was the same in 1851, but again there were a minority of cases where the costs could be tremendous. One specialist stated, 'in lace machinery I do not know that I ever charged for actually drawing the specification less than fifty guineas'.[103] Similarly, Charles May claimed 'I should think that there have been patents [specifications] in which hundreds of pounds may have been spent in addition to the fees'.[104]

Patentees also had to pay fees when submitting the specification to Chancery and these varied according to the length of the specification and whether drawings were attached. There were three Chancery offices in which the specification could be entered: the Enrolment Office, the Petty Bag Office and the Rolls Chapel. In all three offices, a stamp duty of £5 had to be paid on every specification, with an additional £1 for every skin of parchment.[105] In addition to this, the Rolls Chapel Office charged six pence per folio of ninety words, the Enrolment office twelve pence a folio, and the Petty Bag Office fourteen pence a folio.[106] Because specifications varied so much in length, it is difficult to provide a representative figure for the

97 William Hands, *The law and practice of patents for inventions*, (London, 1808), p.49-54
98 Hindmarch, *The law of letters patent*, p.612-614
99 Ibid
100Ibid
101 James Harrison, *Encouraging innovation in the eighteenth and nineteenth centuries: The Society of Arts and patents, 1754-1904*, (Gunnislake, 2006), p.221
102 *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.17
103 The witness also claimed he had known one specification to cost £3,000 to draw up, but this may be exaggerated. *Inventions in the Exhibition of 1851*, (Parl. Papers, 1851), p.11
104 *Select Committee of the House of Lords*, (Parl. Papers, 1851), p.369
105 Hindmarch, *The law of letters patent*, p.616
106 Ibid, p.615

average cost of entering a specification. Frederick Campin claimed one specification had cost £100 to enter and that 'they seldom be less than twenty pounds'.[107]

The sheer variety of official fees, extra fees, specification fees and agency fees makes it difficult to present an 'average' cost for an English patent in the first half of the nineteenth-century. The only convenience is that these costs varied little over time. It is more useful to think in terms of what would be the minimum cost of an enforceable patent. Official fees (ignoring any extras) cost £95. Patent agency fees cost ten guineas. Specifications (at a reasonable minimum) cost £20 to enter and another £20 to prepare. This gives a total cost of £145. In 1806, in terms of average earnings in 2010, a patent cost around £117,000 in modern terms, and £107,000 in 1846. The real cost, however, did fall by a third during the 1790s as a result of inflation. In 1790, the cost, again in 2010 prices, would have been equivalent to £178,000.[108]

There was considerable dispute over the sagacity of maintaining such high fees. In 1829, the consensus leaned towards their retention.[109] Samuel Clegg, inventor of the gas meter, even claimed, 'I think it would be better if it was more'.[110] High patent fees were considered to be an insurance against spurious grants. Moses Poole, the patent agent asserted, 'I do not think it is too dear…it prevents patents being taken out for too trifling objects'.[111] It might have been possible to guard against injudicious grants by introducing a systematic technical examination of patent applications (as was the case in the United States after 1836).[112] Few considered an examination board objectionable on principle, but were concerned about the practicalities. The manufacturer John Taylor feared there would be great trouble in choosing the members, and there might 'be a good deal of jealousy as to their decisions'.[113] John Farey also objected to examination by 'assessors', because inventors would resent the additional disclosure.[114]

Twenty years later, during the 1849 and 1851 Committees, more witnesses were arguing that there needed to be a reduction in fees. This was because many thought the costs of patenting placed protection beyond the means of mechanics and other working men and as a result, many inventions were not being worked. Charles May, an industrialist claimed, 'I know well that the cost of a patent does really obstruct the taking out a great deal of patents for useful inventions'.[115] Similarly, one patent agent stated that if fees were reduced, 'there would be a greater inducement to invent; and many schemes which are now in abeyance, would be immediately brought forward'.[116] Concomitantly, opinions had begun to change on the issue of technical examination. Although there was still some lingering suspicion of a board of examiners, there was

107 *Committee on the Signet and Privy Seal Offices*, (Parl. Papers, 1849), p.21
108 Lawrence Officer and Samuel Williamson (2011), 'Purchasing Power of British Pounds from 1245 to Present', MeasuringWorth, www.measuringworth.com/ppoweruk/, accessed 28th May 2012
109 This is not to suggest that there was unanimity on this point. Richard Roberts, the inventor of the self-acting mule, claimed 'foremen…are the most likely men to invent' but that the expense of patents often checked their 'disposition to invent'. *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.186
110 Ibid, p.95
111 Ibid, p.84
112 Khan, *The democratization of invention*, p.55
113 *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.7
114 Ibid, p.23
115 *Inventions in the Exhibition of 1851*, (Parl. Papers, 1851), p.18
116 *Select Committee of the House of Lords*, (Parl. Papers, 1851), p.157

widespread support for a consultative body to assist the law officers.[117]

This suggests that there was (some) logic to the administration of patents. As long as there was a reluctance to submit petitions to systematic technical examination, to protect against fraudulent and speculative grants, high fees and caveat oppositions, with the convoluted petition procedure this entailed, were the preferred alternatives at least until 1829.[118] Table 2.1 also shows that the successive stages of the petition did weed out impracticable or undeveloped inventions. Of 5,609 favourable and unamended reports granted by the law officers, 1,125 (20 percent) failed to obtain the patent. Consequently, criticism of the administration was relatively muted before the 1829 Select Committee.

Later, however, as tolerance for high fees and the petition procedure waned, more patentees accepted the alternative of at least some form of systematic investigation. This is not to suggest that there was unanimity regarding the effects of expensive patents in 1851 (or indeed on most matters relating to patent reform). Many felt that funds were readily available for inventors seeking to patent their inventions (although without protection, the inventor ran the risk of having the invention stolen). William Carpmael claimed, 'I have not at the present moment an invention for which a manufacturer or a capitalist is required to carry it out'.[119] Also, if inventors did not want to obtain loans, it was possible to obtain a favourable report on the petition at the second stage and then 'offer his project for sale or assistance, without exposing himself to the risk of fraud, which risk is inseparable from so doing when the preliminary steps towards securing the Invention by patent have not been taken'.[120]

It is useful to consider the effects of the Patent Law Amendment Act in 1852 and what it implies about the affordability and efficacy of the pre-reform patent system. The Act dissolved the separate English, Scottish and Irish patent administrations and introduced a single British patent, on which the fees were reduced. Patents could now be obtained at an initial cost of £25, followed by £50 after three years and £100 after seven.[121] Because an inventor could secure patent protection for the whole of the United Kingdom at a much lower cost there was a massive increase in the number of patents awarded. In 1851, 455 patents were awarded in England.[122] In 1853 there were 2,187 patents awarded in the United Kingdom.[123]

117 For example, Thomas Webster considered the operation of a consultative body that would report to the law officers, 'most beneficial'. *Select Committee of the House of Lords*, (Parl. Papers, 1851), p.103
118 For example, in 1822 the lawyer Richard Godson endorsed the maintenance of the petition procedure as 'it secures the public from imposture and the Crown from deceit and prevents the evils arising from an illegal privilege'. Godson, *Treatise on the law of patents*, p.137. Ten years later Godson was much more critical of the petition and argued that 'the office for the patents should be remodelled. The Attorney-General of the day should be at the head of it, with power to appoint a sufficient number of officers to do the work'. Richard Godson, *A practical treatise on the law of patents for inventions and of copyright: To which is added a supplement*, (London, 1832), p.47
119 *Inventions in the Exhibition of 1851*, (Parl. Papers, 1851), p.9
120 Thomas Browne, *A treatise on the laws and practice relating to patents of invention and the registration of designs* (Manchester, 1849), p.15
121 Khan, *The democratization of invention*, p.34
122 Before 1852, however, it was possible to insert more than one invention into a patent, and many inventors did so. The industrialist Charles May claimed he would wait until 'I have got half a dozen [inventions] together' before obtaining a patent. Without counting the number of separate inventions in each patent it is difficult to make a direct comparison. Also, strictly speaking, this is not an accurate comparison because it excludes patents that were awarded in Scotland and Ireland but for which protection was not obtained for England. However, including these patents only adds four to the total for 1851. *Inventions in the Exhibition of 1851*, (Parl. Papers, 1851), p.34
123 Pasquale Federico, 'Historical patent statistics', *Journal of the Patent Office Society*, 46, (1964), p.113

This demonstrates that the high costs of the pre-reform patent system resulted in many inventions not being patented. The question is whether these additional patents, which would not have been patented but for the 1852 reforms, were of a lower technical/commercial quality than those that would have been patented anyway. This appears to be the case. Before 1852, 5.4 percent of patents were not specified within six months. This may have been because the patent was obtained prematurely and the invention could not be accurately specified in time, or because after six months the patentee realised the invention was not worth specifying. As was mentioned above, the minimum cost of entering a specification in England was reckoned to be £20, excluding the consultancy fees. Between 1853-76, however, the percentage of unspecified patents was 34 percent.[124] This was despite fixing the fees charged for entering a specification at £5, regardless of its length, and providing inventors with six months to submit.[125] That the proportion of unspecified patents increased six-fold, despite a considerable reduction in the fees charged, shows that many of these post 1852 patents were being acquired for less valuable or more speculative ideas.

The 1852 reform then led to a reduction in the overall 'quality' of patented inventions. In sectors where the propensity to patent was high before 1852 (such as manufacturing machinery, and engines), because many inventions in these sectors were patented anyway, the 'residue' of unpatented technology would have been of a lower quality. Therefore, the reduction in the overall 'quality' of patents would have been more pronounced than in other sectors. However, in sectors where secret working offered an effective means of maintaining protection, such as mining and chemicals, the propensity to patent was low before reform. In these sectors, it is more likely that high patent fees dissuaded inventors from patenting high value inventions.[126] This has two implications. Firstly, *if* the specifications of pre-reform patents were widely disseminated, that high-quality inventions were not patented means that high fees frustrated the circulation of new technology. This will be discussed in chapter 4. Secondly, *if* funds for the patent were difficult to obtain for inventors without sufficient private means, then patents could not have provided any incentive to those individuals or parties to invent. This second issue, specifically the role of agents in procuring funds for clients, will be discussed in the following section.

Section 2.3.3
Patent agents

Before reform in 1852, the growth in patent numbers did little to alter the formal operation of the English patent system. It did, however, ensure that there was sufficient business to sustain specialised patent agents, a development of great practical importance for inventors. Patent agents were professionals who assisted inventors in conducting the patent petition. The first agents were normally officials in the patent administration who used their position to assist the petitions of their private clients.[127] An example of this

124 Christine MacLeod, Jennifer Tann, James Andrew and Jeremy Stein, 'Evaluating inventive activity: The cost of nineteenth-century UK patents and the fallibility of renewal data', *Economic History Review*, 56, (2003), p.556
125 John Hewish, *Rooms near Chancery Lane. The Patent Office under the Commissioners, 1852-1883*, (Leighton Buzzard, 2000), p.27
126 Petra Moser, 'Why don't inventors patent?', NBER Working Paper No.13294, (2007), p.37
127 There were also a number of lawyers who acted as patent agents. Harrison, *Encouraging innovation*, p.210

was Moses Poole who combined his position as Clerk of Inventions to the law officers (held from 1817 to 1852) with his private business as a patent agent. By the second quarter of the nineteenth-century, most patent business was transacted by agencies that were formal partnerships between administrators directly involved with the petition and those from technical backgrounds. The largest firm, with around half the market, was the partnership between Moses Poole and William Carpmael.[128] Among their competitors were Abbott and Wheatley, with the former retaining a position at the Petty Bag.[129] By 1849, there were around twenty patent agents in London alone.[130]

Initially, the main activity of agents was assisting inventors petitioning for a patent and, as most held positions in the patent administration, they were ideally placed to do so. By employing an agent, it was no longer necessary for an inventor to transmit their petition through the various offices in person, and indeed, without caveat opposition, there was very little for an inventor to do.[131] One agent testified, 'the only acts the inventor is obliged to perform himself, are the making of an affidavit…paying his money…and afterwards, making out, acknowledging and signing the specification…all the rest may be done by his attorney, or patent agent'.[132] All of this could be done by post. The only occasion where personal attendance was required was if the specification was entered at the Enrolment Office (rather than the Petty Bag Office or the Rolls Chapel).[133] Consequently, and because the fees were cheaper, the majority of specifications were entered at the Rolls Chapel.[134] Conducting the petition on behalf of inventors may appear a rudimentary service but its significance should not be understated. When one considers the travails of inventors such as Samuel Taylor and John Payne in the first half of the eighteenth-century, the relative convenience of being able to conduct the petition by post, especially for those resident outside London, becomes obvious.

By 1849, virtually all inventors employed an agent. Thomas Ruscoe, clerk at the Great Seal Office, observed, 'there are patents passed by the patentees themselves, but few'.[135] Because of their significance in helping inventors obtain patent protection, it is important to consider when agents began operating. The available evidence indicates that agents had begun practising, at the latest, by the 1770s. Before the 1849 committee on the Signet and Privy Seal Offices, Moses Poole reported that he had inherited his position as Clerk of Inventions in the Patent Office of the law officers on his father's death in 1817, and that his father had held the office since 1776.[136] On being asked 'did your predecessor practise as a patent agent', he replied

128 William Carpmael claimed 'I have certainly more than half the current inquiries after patents'. *Inventions in the Exhibition of 1851*, (Parl. Papers, 1851), p.9
129 Another example of this type of firm is 'Ray, Blunt and Johnstone'. Johnstone was the Clerk of Patents to the Law Officers. Harrison, *Encouraging innovation*, p.209
130 *Committee on the Signet and Privy Seal Offices*, (Parl. Papers, 1849), p.15
131 Petitioners sometimes chose to attend the hearing before the law officers in person, although there was no obligation to do so as they could be represented by an agent or attorney.
132 *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.16
133 Hindmarch, *The law of letters patent*, p.543
134 Woodcroft, *Patents for invention: Reference Index*, (London, 1854)
135 *Committee on the Signet and Privy Seal Offices*, (Parl. Papers, 1849), p.25
136 This also provides further evidence on the nature of the patent administration. It is telling that Poole inherited his position from his father, and that he was able to combine his public position with private activities that presumably led to conflicts of interest. Ibid, p.52

'my father always did', meaning that his father was acting as an agent from the late 1770s.[137] This testimony is corroborated by a collection of lists and letters held in the British Library regarding an 1827 Parliamentary request for information and statistics on the patent system.[138] It appears, from a statement taken from an Officer of the Rolls Chapel, that James Poole (the father) had himself inherited the patent agency business from a Mr Lamb who, as was his father, a 'clerk to the Attorney-General and in the habit of acting as agents for patentees'.[139] This implies that there had been two generations of patent agents prior to Poole's 'inheritance' in 1776. There do exist some passing references to 'agents', as opposed to solicitors or legal counsel, in the Hardwicke papers as well. For example, in reporting a caveat hearing on the petition of Francis Hawksbee and Benjamin Lund in 1727, Hardwicke noted, 'I have been attended by the agents of all parties and have council as well on behalf of the said company and copartners [the Company of Copper miners]'.[140] However, while Moses clearly regarded his father as his predecessor in the agency business (and so presumably fulfilled functions similar to himself), the evidence on earlier agents, and what precisely they did, is much weaker.

In the 1750s, when an average of nine patents were awarded every year, there may have been enough business to make it worthwhile for officials to moonlight as agents. Thereafter, however, when the number of patents began to increase rapidly, specialised patent agents begin to appear.[141] The chronology suggests that specialised patent agency developed in response to this increase. From the 1770s, however, by making the patent grant significantly easier to obtain, agents would been contributing to the general increase in patents.

As the number of patents increased, so too did the variety of services agents provided. Firstly, given their familiarity with extant patents, agents provided inventors with technical advice. Before an inventor sought a patent, they advised on the patentability and novelty of the invention. William Carpmael claimed 'that in six out of every seven that come before us we advise them not to take out patents', although how many chose to heed this advice is unclear.[142] An advertised list of charges made by Professor Millington during the 1820s indicates he charged a guinea for these oral opinions.[143] The advice provided could be quite specific, as indicated by the correspondence between Carpmael and Henry Fox Talbot, an early photographer. In one letter, Carpmael warned Talbot that 'the use of the Sulphuret of Gold or of Silver would be an infringement of Mr Elkingtons last patent'.[144] Also, because official catalogues of extant patents were

137 Ibid, p.54

138 This does not appear on the British Library Integrated Catalogue, although there is an index number provided. The author was H Holden. Lists and letters relating to the enrolment of specifications, London, British Library, DW En A 46931.

139 The position held by the Lambs was Patent Clerk to the Attorney-General. This should be distinguished from the position held by the Pooles who were Clerk of Inventions in the Patent Office of the Attorney-General. The office held by the Pooles was created 'upon the increase of the patents for inventions', although the precise date of creation is unclear. Notebook of James and Moses Poole, London, British Library, BJ00 54889, p.2

140 Hardwicke Papers, London, British Library, Vol.36141, fol.516.

141 Tom Nicholas has also established that between 1894 and 1930 there is a correlation between the number of patents obtained, and the number of practising patent agents. Tom Nicholas, 'Independent invention', p.1017

142 *Inventions in the Exhibition of 1851*, (Parl. Papers, 1851), p.10

143 Harrison, *Encouraging innovation*, p.221

144 Larry Schaaf, (2003), William Carpmael to Henry Fox Talbot, 15th March 1842, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012

not published, agents provided clients with their own lists.[145] A published example indicates that these lists were tolerably accurate. Andrew Pritchards' *A list of all the patents for inventions* listed 6,277 patents granted between 1800-40, whereas the later, authoritative, index printed by Woodcroft lists 6,312.[146]

Secondly, they maintained contacts throughout Europe, helping inventors acquire protection abroad. This was especially important in countries such as France before 1844, where it was impossible to subsequently patent the invention in another country without vitiating the previous patent. So if an inventor had obtained a patent in France, and afterwards wanted to patent the same invention in say Belgium, they could not do so without vitiating their French patent. However, by employing an agent to obtain the Belgian patent on their behalf, the inventor could avoid this restriction.[147] Some agents maintained extensive networks. In his notebook, Moses Poole inserted some brief notes on patent practice in foreign countries and the contacts he maintained. As early as the 1820s Poole had representatives as far afield as Sweden and Russia.[148] Inventors regularly availed themselves of foreign patents. In 1851 the patent agent William Carpmael claimed, 'I can say that a large proportion of patents we take out in England, we take out abroad…I should think fully half'.[149] This might be thought hyperbole but in 1847, at least 110 French patents were obtained by English inventors.[150] It is indicative of the disorganised English patent administration that the agency fee for applying for a foreign patent was, exclusive of postage, five guineas, half the charge for applying for an English patent.[151]

Thirdly, as was mentioned in the discussion on costs, agents maintained contacts with capitalists and manufacturers on behalf of inventors. This was to help inventors secure funding, and potentially business partners. The engineer Samuel Clegg noted in 1829 'if a workman has discovered anything…likely to be beneficial, there is no difficulty in procuring anyone to join him in the expense of taking out a patent for it'.[152] Later, in 1835 Clegg mentioned that he had often been engaged in advising 'capitalists who have consulted me whether they should lay out their money in [patented inventions]'.[153] This shows that it was possible for

145 For example, when Henry Fox Talbot obtained his 1841 patent, his patent agents Poole and Carpmael wrote to him 'to inform you that we have a correct General List of all Patents which have been granted from the year 1690 to the present day with references shewing where the Drawings and Specifications may be seen. This List is open for inspection at all times from the hours of 10 to 4, and is an object of great importance to those who are about to take out Patents, since it enables them to ascertain what has been done, and prevents the risk of interfering with the Inventions of other Patentees'. Ibid.

146 Andrew Pritchard, *A list of all the patents for inventions in the arts, manufactures granted in England during the present century including those now in force*, (London, 1841)

147 *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.70

148 Notebook of James and Moses Poole, London, British Library, BJ00 54889, pp.170-171

149 *Inventions in the Exhibition of 1851*, (Parl. Papers, 1851), p.13

150 In France, foreign inventions could be patented. If there was, however, a pre-dated foreign patent, the French patent would expire on the same day as the foreign one. Because of this the French patent index contains details of foreign patents that had been obtained for the same invention. Possible instances where the French patent was obtained first have been omitted. Also, it is possible that English inventors, to circumvent this restriction, hired French patent agents to acquire the French patent on their behalf. Consequently, the figure of 110 given in the text should be regarded as the absolute minimum. *Catalogue des brevets d'invention pris du 1er Janvier au 31 Decembre 1847*, (Paris, 1848)

151 Harrison, *Encouraging innovation*, p.221

152 *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.96

153 Quoted in Dutton, *The patent system*, p.93

poorer inventors to obtain the funds needed for a patent via an agent.[154]

Finally, patent agents were responsible for editing and managing many of the most important technical journals of the day. In the 1820s the *Repertory of Arts*, the *London Journal of Arts and Sciences* and the *Mechanics' Magazine* were all edited by patent agents.[155] Later competitors such as the *Practical Mechanics Journal* and *The Patent Journal* were also edited by agents, and this was a task for which they were suited.[156] As will be discussed in section 4.2, these magazines published many patent specifications and agents could carry copies of the specifications that they had prepared without having to pay the fees to obtain an office copy. It was also relatively easy for them to prepare lists of recently awarded foreign and domestic patents.

Patent agents then fulfilled a number of roles.[157] They helped inventors navigate the petition process and, in the absence of official lists of prior grants, prepared their own for the use of clients. This was highly significant. As discussed in section 2.1, England did not maintain a professional, centralised, patent office. In its absence, it was essential that there were professionals, familiar with the workings of the convoluted administration, to help inventors obtain patent protection. They also helped English inventors obtain foreign patents, and foreigners obtain English patents. Finally, they assisted inventors in the working of their inventions, especially in securing funds for the patent.

Conclusion

By the time of the Patent Law Amendment Act in 1852, patent reform was long overdue. Although the multi-stage petition weeded out some unsuitable inventions, the more documents and forms that had to be produced during the petition, the greater the likelihood of clerical errors occurring. Such errors could prove greatly troublesome and in one case, *Nickels' Patent* (1841), the patent was ultimately lost because of a mistake in copying the King's Warrant.[158]

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154 This service was particularly important to foreign inventors. Carpmael reported in his testimony to an 1851 committee, 'we constantly receive inventions from America, from France, Belgium, Holland, every part of Europe where the parties wish us to find manufacturers or capitalists to take them up'. *Inventions in the Exhibition of 1851*, (Parl. Papers, 1851), p.9

155 Dirk Van Zyl Smit, 'The social creation of a legal reality: A study of the emergence and acceptance of the British patent system as a legal instrument for the control of new technology', (unpublished Ph.D. thesis, University of Edinburgh, 1980) p.129

156 The *Practical Mechanics' Journal* was edited by the patent agents Messrs William and J.Johnson. *Practical Mechanics' Journal*, (Volume 4) 1850, Frontispiece. The *Patent Journa*l was edited by patent agents Messrs Barlow, Payne and Parken. *Patent Journal*, (Volume 9) 1850, pg.7

157 There were, however, some who regarded patent agents with suspicion. One John Prince complained in a letter to Lord Brougham (responsible for the 1835 act), 'the policy of the law has been defeated by a junta of patent agents who have ascertained by what devices the invader of a patent can be upheld'. Agents allegedly frustrated efforts to reform the patent system so that inventors would be obliged to employ their services in obtaining patents. There may be some truth in this. In the parliamentary investigations, patent agents were the most consistent apologists for the patent system. However, as we have seen, agents made an income from a wide range of services related to patents such as on technical advice, specifications, foreign patents and not just from the petition process. It would seem more likely that they would welcome an increase in the number of patents as it would increase their volume of business, even if it meant a decline in the charge they could make for passing individual patents. Quoted in Dutton, *The patent system*, p.95

158 Chancery. Hayward, *Patent cases*, Vol.3, p.842

In addition, the high costs of patents depressed the propensity to patent, viz. the boom in patents after the fees were reduced in 1852. However, these 'new' patents were not generally of the same quality as the old ones. In the aftermath of reform, the proportion of unspecified patents increased six-fold. It is also worth reiterating that the proportion of British and American exhibits that were patented at the Great Exhibition of 1851, just prior to reform, were very similar (even though American patents cost only $30 or £5 to obtain).[159] For workmen who may have been in a position to invent, the costs of patent protection are likely to have dissuaded some from engaging in inventive activities. They were, however, by no means excluded. Carpenters, plumbers, weavers and machinists are all regularly listed as occupations in the patent series. It was possible for them to obtain protection, either by obtaining finances through the good offices of patent agents, or by obtaining the more limited protection of a favourable law officers' report. Overall, the high costs of patenting probably had a minor, but certainly negative, effect on inventive activity.

However, the petition procedure was not entirely without merit. The system of caveats provided the public some insurance against fraudulent patents and provided inventors with a grant of greater legal cachet. In addition, patent agents were able to alleviate some of the failings of the administration. Section 2.2 emphasised the immense practical difficulties attached to obtaining patent protection before 1768. However, with agents to transmit these petitions on behalf of inventors a significant obstacle to obtaining patent protection was removed. This may appear a rudimentary service but its significance should not be understated. When one considers the travails of inventors such as Samuel Taylor and John Payne in the first half of the eighteenth-century, the convenience of employing agents to conduct the petition becomes obvious. This is highly significant. It has been claimed in the historiography that patent agents only began to practice in the nineteenth-century, and even then their role in making patent protection accessible has been understated.[160] Instead, from c.1770, the patent petition did not represent an important bureaucratic obstacle. Agents also helped consolidate the security of the eventual grant by providing technical assistance and access to draughtsmen for the specification. Finally, they provided inventors with an entrée to a host of manufacturers and capitalists who could assist with the commercial development of the invention. As will be argued in chapter 5, this was of great significance.

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159 Khan, *The democratization of invention*, p.54

160 MacLeod, *Inventing the Industrial Revolution*, p.40

Appendix 2.1
Official patent fees, 1808 and 1846

	Hands (1808) £.	s.	d.	Hindmarch (1846) £.	s.	d.
Declaration at the Public Office (1st stage)	[Not required in 1808]			0	5	0
Reference of a petition by the Secretary of Statement to the law officers (1st stage)	2	2	6	2	2	6
Report of the law officers (2nd stage)	4	4	0	4	4	0
For the Queen's warrant to the law officer to prepare a bill for a patent at the Home Office (3rd stage)	9	1	0	7	13	6
For preparing a bill and docket, transcripts of the bill and stamps, and stamping the Queen's warrant at the Patent Bill Office (4th stage)	20	18	6	15	16	0
For procuring the sign manual to the bill at the Home Office (5th stage)	9	1	0	7	13	6
For signing, sealing and passing a bill at the Signet Office (6th stage)	3	19	6	4	7	0
For signing, sealing and passing a bill at the Privy Seal Office (7th stage)	4	12	6	4	2	0
For preparing the recepi and docket, engrossing sealing and enrolling the patent and entering the docket stamps and box at the Patent Office in Chancery (8th and 9th stage)	43	15	6	48	17	0
	97	14	6	95	0	6

Chapter 3

English patent law

In essence, a patent represents the right to exclude others from employing the protected subject matter. However, without legal protection this right has no corporeal existence. As a fundamentally legal construct, to be of any value, a patent must be supported by the wider legal infrastructure. Consequently, it is essential to consider the legal framework in which patenting operated. The introduction to this chapter will review the historiography of patent law from 1700 to 1852.

The historiography structures the development of patent law into three periods. The first period, lasting until 1753, was when the Privy Council was primarily responsible for adjudicating patent disputes, although the court of Chancery also retained a limited, equitable, jurisdiction.[1] In the absence of any significant statutory law, besides the Statute of Monopolies (1624), patent law was fluid and uncertain. This uncertainty was exacerbated by the fact that neither the Privy Council nor Chancery yielded to decisions or precedents established by previous cases. The paucity of binding legal authorities apparently meant patentees could never be certain of their rights and their enforceability.

The beginning of the second period is marked by the transference of jurisdiction in patent disputes to the common law courts in 1753. The equitable jurisdiction of Chancery was unaffected. In contrast to Chancery and the Privy Council, in common law, precedent - that is the decisions and reasoning adopted in previous cases – was employed when deciding new cases. Where the precedent was from a senior court, it was considered to be binding (*stare decisis*), otherwise it was 'merely' authoritative. As MacLeod observes, it was 'only from the time when the Privy Council relinquished jurisdiction that a case law on patents began to develop'.[2] However, although the development of patent law by judicial precedent was now theoretically possible, this was apparently 'a slow process'.[3] As in the first half of the eighteenth-century, the continued absence of an established corpus of patent law is supposed to have undermined patent rights.

The failure of common law to generate significant legal precedent has been attributed to judicial 'prejudice' and 'hostility' towards patenting. Harold Dutton argued that these attitudes are apparent in the court reports, citing one instance where Chief Justice Kenyon pronounced himself, 'not one of those who greatly favour patents'.[4] Although vague on how he defines 'hostility' or 'prejudice', Dutton is clear on how it manifested itself - as an unfeasibly strict interpretation of the law, 'allowing no error, however immaterial'.[5]

1 Christine MacLeod, *Inventing the Industrial Revolution, the English patent system, 1660-1800*, (Cambridge, 1988), p.58
2 MacLeod, *Inventing the Industrial Revolution*, (Cambridge, 1988), p.61
3 Ibid
4 Harold Dutton, *The patent system and inventive activity during the Industrial Revolution: 1750-1852*, (Manchester, 1984), p.77
5 Ibid. Helen Gubby has argued persuasively that 'prejudice' and 'hostility', are inappropriate (and subjective) terms for assessing judicial attitudes. Instead, she argues that what Dutton interprets as hostility on the parts of Kenyon, Ellenborough and others, can be attributed to a rigid, formalistic, approach to the law and judicial decision-making.

For example, in 1810 Chief Justice Ellenborough found a patent for *improvements* in flageolets (a musical instrument similar to a flute) invalid, asserting that the patent title should have referred to the singular *improvement* as only one new note had been produced.

It is thought that one reason for this hostility to patenting was because the judiciary did not recognise any moral or economic rationale for the patent system. Some members of the judiciary subscribed to what MacLeod terms the 'providential' view of invention.[6] This attributed the creation of new inventions not to human ingenuity but to God who held a stock of inventions that were to be revealed as and when he dictated. In this view, there was no need for human 'creativity' or endeavour to be encouraged by the promise of patent rights.[7] Rather as Lord Camden, Lord Chancellor between 1766-70, expressed it: patentees 'forget their Creator' by monopolising 'his noblest gifts and greatest benefits'.[8] There were others who purportedly rejected the idea of patenting on more pragmatic grounds. Dutton interpreted Lord Loughborough's declaration that 'we must never decide private rights upon any idea of public benefit' as rejecting any connection between economic growth and patented inventions.[9]

There was also a more specific suspicion of patentees and monopolies originating from Stuart abuse of the system. With origins in the medieval period, letters patent were an administrative tool by which royal grants were awarded. In terms of legal precedence, they were second only to acts of state, as the lawyer Thomas Foster observed in 1851 'all grants from the Crown are matters of public record…and are next in dignity to the acts of the state'.[10] During their long struggle with Parliament, the Stuarts exploited patents as a way of generating revenue. In response, Parliament passed the Statute of Monopolies to impose limits on the royal prerogative. The Statute failed in its immediate goal, and the Long Parliament of 1640 was forced to suppress the entire system.[11] The subsequent re-emergence of patenting was tarred by the system's 'implication in the excesses of London's burgeoning early stock market'.[12] MacLeod argues that the outcome of these abuses and misadventures was that 'until the 1830s judges and juries appear to have shared a prejudice that patentees were parasitic monopolists, to be unsuited at every opportunity'.[13] Zorina Khan similarly claims that 'patent rights were regarded as…monopolies that restricted community rights'.[14]

The result of this hostility, it is argued, was that little precedent applicable to patents was generated by the common law courts before 1830. Dutton argues that 'a great deal of the uncertainty seems to have

Helen Mary Gubby, 'Developing a legal paradigm for patents: The attitude of judges to patents during the early phase of the Industrial Revolution in England (1750s-1830s)', (unpublished Ph.D thesis, Erasmus University of Rotterdam, 2011), p.47

6 Christine MacLeod, *Heroes of invention: Technology, liberalism and British identity, 1750-1914*, (Cambridge, 2007), p.9

7 Ibid

8 MacLeod, *Inventing the Industrial Revolution*, (Cambridge, 1988), p.221

9 Dutton, *The patent system*, p.79-80

10 Thomas Foster, *A treatise on the writ of scire facias*, (London, 1851), p.237

11 MacLeod, *Heroes of invention*, p.33

12 Ibid, p.35

13 Christine MacLeod, 'Strategies for innovation: The diffusion of new technology in nineteenth-century British industry', *Economic History Review*, 45, (1992), p.288

14 Zorina Khan, and Kenneth Sokoloff, 'Patent institutions, industrial organization and early technological change: Britain and the United States, 1790-1850' in Maxine Berg, and Kristine Bruland, (eds.) *Technological revolutions in Europe*, (Cheltenham, 1998), p.295

arisen because of the excessively hostile attitude of some judges'.[15] This uncertainty was exacerbated by two further factors. Firstly, the absence of significant statute law gave the judiciary considerable freedom of manoeuvre in deciding cases. Secondly, if a patentee lost his case it would seriously undermine any subsequent attempts to enforce the patent right. MacLeod even claims that 'defeat was usually sufficient to annul a patent *de facto*'.[16] In the absence of any clear legal guidance, patentees could not be certain whether their patent grant would survive the rigours of trial. As a result, patentees were supposedly reluctant to go to court. Dutton estimated that between 1770-99 only 1.1 percent of patents were disputed in court compared with 2.3 percent in the 1840s.[17] The reluctance of patentees to risk their patents in court resulted in fewer court cases and so fewer opportunities for the formation of legal precedent. MacLeod concludes that 'even the spate of hard-fought patent cases at the end of the eighteenth-century did little to establish a solid core of judicial wisdom'.[18]

The third phase of patent law began around 1830, as judicial hostility was replaced by a growing appreciation of patenting's role in encouraging invention, making the development of patent law possible.[19] Dutton claims this change can be substantiated by calculating the percentage of cases that were won by patentees. He finds that between 1800-29 patentees won only 31 percent of cases at common law, whereas between 1840-49 patentees won 76 percent of common law cases.[20] Dutton interprets this as unambiguous evidence of a shift in judicial attitudes, concluding 'a change in the attitudes of judges did take place [and] that it occurred some time in the early 1830s'.[21]

There is however, disagreement concerning the wider technological/economic implications of this legal uncertainty. Dutton recognises that his interpretation of patent law implies insecure patent rights, undermining their commercial value, 'the uncertain and unpredictable interpretation of the law reduced the bargaining power of patentees prior to 1830 and forced them to compromise at unfavourable terms of trade'.[22] This, however, is not supposed to have dissuaded inventors from obtaining patents. Rather, Dutton argues that as inventors were by nature risk-takers, they rarely considered the possibility of legal action, asserting that only 'a few inventors may have been reluctant to patent their inventions because of the decisions made by judges'.[23] This would also imply that inventors and patentees were not 'rational' in appraising the potential commercial opportunity of new technology.

MacLeod agrees that legal insecurity diminished the value of patents, but takes a less sanguine view of the consequences. Legal insecurity of patent grants is supposed to have precluded more sophisticated methods of financial exploitation, 'the lack of support offered patentees by the courts was chiefly responsible

15 Dutton, *The patent system*, p.77

16 MacLeod, *Inventing the Industrial Revolution*, p.60

17 Dutton, *The patent system*, p.71

18 MacLeod, *Inventing the Industrial Revolution*, p.61

19 Dutton, *The patent system*, p.79

20 Ibid, p.78

21 Ibid, p.81

22 Ibid, p.195

23 Ibid, p.178

for the defensive way in which they managed their patents'.[24] This had particularly adverse consequences for the dissemination of technology. Although it is in the exclusionary nature of the patent right that it will obstruct the dissemination of technology, this obstruction can be alleviated if patentees assign or license the use of their invention to others. However, due to the insecurity of their rights and the hostility of technology users, MacLeod claims that licensing was often impracticable. It was reportedly the policy of some firms to reject any licensing offers from patentees, for fear of implicitly recognising the validity of the patent.[25]

In outline, the historiography presents a structured argument. Firstly, that until 1830 judges and juries were biased against patents and that there was no recognised rationale for awarding patents. Secondly, that until judicial attitudes changed the development of patent law and precedent was tortuously slow. In the absence of any universally recognised corpus of legal wisdom relating to patents, any patentee choosing to enforce their rights faced tremendous legal uncertainty. Thirdly, this legal vulnerability, the outcome of judicial bias and an absence of constructive patent law, precluded many patentees from pursuing licensing or assignment agreements.

This chapter is primarily concerned with the first two parts of this argument. Section 3.1 will briefly describe the institutional structure of equity and common law. Section 3.2 relates to the first part of the historiographical orthodoxy, analysing judicial attitudes towards patents. Although this section supports the historiography in that the rights of patentees mattered little to the Privy Council, it finds no evidence of judicial hostility to patenting in the equity and common law courts before 1830. Section 3.3 re-examines the operation of patent law in both the Privy Council and Chancery before 1753. It finds that the case-load of the Privy Council had been in decline long before 1753, and that Chancery held the primary jurisdiction of patent cases (potentially in conjunction with the common law courts). Section 3.4 analyses the development of patent law in the common and equity law courts after 1753, looking at the development of legal precedent but also the passing of relevant legislation. Consistent with the finding in the two previous sections, this section argues that the development of patent law began long before 1830. The third part of the historiographical argument will be examined in chapter 5.

Section 3.1
The equity and common law courts

During this period, the English legal system was largely defined by the institutional separation of equity and common law. The three senior courts adjudicating common law were the Court of King's Bench, Court of Common Pleas and the Court of Exchequer. Four judges sat on each of these three courts and together the twelve judges superintended the litigation that gave form to the body of common law to which the rest of the system responded. Sir William Blackstone, the renowned eighteenth-century law commentator, regarded the senior common law judges as the 'living oracles of the law', their decisions forming 'the principle and most

24 Christine MacLeod, 'The paradoxes of patenting: Invention and its diffusion in eighteenth and nineteenth-century Britain, France and North America', *Technology and Culture*, 32, (1991), p.906
25 Ibid, p.905

authoritative evidence'.[26] Much of this chapter examines the decisions and legal reasoning of these three courts (along with Chancery).

The court of Chancery, the chief judge of which was the Lord Chancellor, was primarily responsible for the administration of equity law. In contrast to the strict adherence to legal precedent that characterised common law, equity was founded on the recognition that constructing a system of legal rules that might achieve the ends of justice appropriate to the circumstances of every case was impossible. Blackstone argued that as equity depended on the particular circumstances of each case, no established rules or fixed precepts could be laid down without altering its very essence.[27] However, because it was adjudicated by its own court, equity was forced to develop its own system of rules and forms of procedure. In time, this meant that the classical notion of equity was abandoned, and in practice something akin to common law came to predominate. In the large majority of cases Lord Chancellors decided not by equitable appeals to 'natural' law but in accordance with a settled pattern of equitable practice. For example Lord Hardwicke, Lord Chancellor from 1736 to 1756, regularly refused what he recognised to be the equitable rule because he was not prepared to 'break in on an established rule, and make a precedent of bad consequence'.[28]

In relation to patents, Chancery provided patentees with three remedies not ordinarily available at common law. Firstly, it provided patentees with injunctive relief. An injunction was a legal instrument that could be obtained by a patent holder, and imposed upon an infringer of their patent. The injunction forced the infringer to halt immediately the activity that was alleged to be infringing the patent, otherwise they could be found in contempt of court. Secondly, patentees could obtain an account from the alleged infringer of the profits made from these activities and, in the event of the infringement being proved, they could be awarded the profits. Finally, equity offered the remedy of discovery, the opportunity to inspect the works of the defendant and establish whether the patent was being infringed.[29]

Section 3.2
The legal construction of patents

This section is divided into three subsections. The first examines the attitudes of the Privy Council to patenting, as evidenced by the criteria employed in the Council in deciding the legality of patent grants. The second subsection re-assesses the evidence for judicial bias against patenting in the equity and common law courts. It concludes that there was no anti-patent bias. The third subsection establishes that instead of judicial bias there was a well established judicial rationale for patenting.

26 Blackstone cited in David Lieberman, *The province of legislation determined, legal theory in eighteenth-century Britain*, (Cambridge, 1989), p.44
27 Blackstone cited in Ibid, p.75
28 Ibid, p.82
29 Gubby, 'Developing a legal paradigm', p.30

Section 3.2.1
Patents in the Privy Council

The Privy Council originates from the earliest days of the monarchy. During its Tudor heyday the Council accumulated significant judicial and executive powers although the Civil War and Restoration saw the Privy Council decline from its position as the pre-eminent executive body of the nation.[30] Nevertheless, the Privy Council remained an important judicial and executive authority, intimately linked to matters of state; its members drawn from the highest echelons of society and government.

Cases in the Privy Council began when a patentee, or another interested party (often a craft guild), petitioned the Privy Council with a grievance. Generally, the petition was heard by a committee of the Council or referred to one of the law officers. In July 1719, for example, the Privy Council received a petition from the Company of Silk Throwsters lobbying against the patent awarded to Thomas Lombe for his silk spinning machinery.[31] The hearing was held the following February, where the Council decided that as the silk had 'hitherto [been] imported from Italy and now by the said engines made in great perfection in England', the patent could stand.[32]

The reasoning behind this decision indicates the mercantilist preoccupations of the Council. The Privy Council was an authority directly concerned not only with judicial matters but also with the governance of the country and its nascent empire. In contrast to the common and equity courts, concerns regarding the public interest permeated the Privy Council's decision making in patent disputes. To give another example in 1721, two separate parties applied for patents for similar inventions relating to the smelting of iron at almost the same time. While observing that Mr Forrest had 'the preference to your Majesty's favour in respect to his priority of application' the application from Messrs Brown and Wright was preferred because, as the Attorney-General reported on 'the point principally referred I was of opinion that the petitioners [Brown and Wright] said invention might be most serviceable to the Publick'.[33] The law officer also reported that the patent should be awarded to Brown and Wright as they had already 'built several works for that purpose it is likely to prove so beneficial to the Nation in General by preserving the Wood and Timber which is now consumed in such large quantities by the present method'.[34] On the grounds of public utility, the Privy Council proceeded to disregard any right Forrest had with regard to priority of application and awarded the patent to Brown and Wright. Mercantilist concerns also informed the Privy Council's decision to approve the petition of Lewis Paul in 1738, noting that one of the particular benefits of his new machine was that it could be worked 'not only by children of five or six years old, as is alleged in the petition, but even by persons that are quite blind'.[35] Finally, in 1779, the Judicial Committee reported on Wilkinson's patent that 'if permitted to remain in force it will not only be prejudicial to his majesty's subjects

30 Peter Jupp, *The governing of Britain, 1688-1848*, (Abingdon, 2006), p.23
31 Company of Silk Throwsters to Privy Council, London, National Archives, PC 2/86, fol.294
32 Privy Council report, London, National Archives, PC 2/87, fol.144
33 Attorney-General to Privy Council, London, National Archives, PC 1/3/102, fol.2
34 Ibid
35 Privy Council Registers, London, National Archives, PC/2/94, fol.233

but detrimental to the public service as the providing of iron ordnance will thereby become a monopoly'.[36]

The invariably hostile opinion of the trade guilds was also sought on patent matters. In 1716, the Attorney-General informed the Clockmakers' Company that the Privy Council had referred a patent petition for a repeating clock to him. At a hearing the company attempted to demonstrate that a watch of similar construction made by a Mr Quare, (whose application for a patent had been blocked by the company in 1695), pre-dated the new clock.[37] The hearing was unconvinced and the patent granted. However, in 1717 they presented another petition to the Privy Council, alleging that the patent was prejudicial to the public and that it was not a new invention. This time the Council revoked the patent, swayed by the Clockmakers' argument 'that if every improvement in the art were to be patented, patents will soon be as innumerable as the alterations within forty years past'.[38]

In the Privy Council, the rights of patentees were of secondary importance compared to consideration of the 'public good'. The public good was informed by classic mercantilist concerns such as revenue, trade balance, employment and the guilds. Section 2.2 also established how these fluid and ill-defined mercantilist priorities influenced the law officers' decision when reporting on petitions for patents, at least before the 1730s. The risk and uncertainty of the patent grant was exacerbated by the fact that decisions in the Council were not binding authorities in the adjudication of subsequent disputes. So long that the Privy Council retained jurisdiction of patent disputes a case law could not develop.

Section 3.2.2
Judicial bias in the law courts

When, however, jurisdiction passed to the common law courts the development of judicial precedent was supposedly stymied by judicial hostility to patenting.[39] Much of the case for judicial 'bias' relies on Dutton's statistical work on patent court cases. Using two contemporary collections of patent cases, Dutton calculated the percentage of cases decided in favour of patent holders. This was supposed to indicate the extent of judicial bias. Dutton also counted the number of patents that were litigated, interpreting this as an indicator of the willingness of patentees to enforce their rights in court.

There are, however, interpretative ambiguities with these statistics that are not confronted by Dutton. Concerning the percentage of cases won by patentees, Dutton's implicit assumption that a patentee losing a case is evidence of anti-patent bias is mistaken; there are clear examples of where the patentee had acted fraudulently and deserved to lose. For example, in *Smith* v *Dickenson* (1804) the patentee had stolen and patented an invention for girthing saddles from the original inventor. The court ordered that the patent be

36 Wilkinson's case is unique in that it occurred after 1753, when the Privy Council was supposed to have relinquished its jurisdiction. It is unclear why the Privy Council agreed to hear this case and they were clearly reluctant to do so. Wilkinson was given four years after the petition of the Board of Ordnance had been submitted to pursue his case at equity or common law until the Privy Council finally intervened. Committee of Privy Council to Privy Council, London, National Archives, PC 1/11/150, fol.2
37 Edward Hulme, 'Privy Council law and practice of letters patent for invention from the Restoration to 1794', *Law Quarterly Review*, 33, (1917), p.620
38 Ibid, p.621
39 Dutton, *The patent system*, p.77

awarded to the plaintiff, (the original inventor), along with £300 damages.[40] Neither can one necessarily expect a 50:50 split in decisions in a non-biased legal system. The majority of disputes were reportedly settled before they came to court, normally with the patentee licensing the use of the patent to the defendant(s) in return for their dropping the case.[41] Often these licence fees would have cost less than legal fees which, with the possibility of paying damages, meant that only those defendants with the strongest cases would persist in going to court, potentially skewing the percentage of cases found in their favour.[42]

One type of case where there is a reasonable degree of information relating to pre-trial proceedings are those that proceeded on writ of *scire facias*. This writ was obtainable for a private party on application to the law officers, ordering a case to be pursued by the Crown to annul a patent. Viewed in isolation these cases might be interpreted as evidence of rampant anti-patent bias, of twenty-nine such trials between 1770 and 1852 only one was won by the patent holder.[43] However, the writ was expensive to solicit and not demandable as a matter of right, even for a patentee seeking to revoke another, later, patent for the same invention as theirs.[44] Due to the expense and difficulty involved with obtaining the writ, only those with the strongest cases would have chosen to persevere and commence proceedings against patentees, explaining the distribution of verdicts. This indicates how, in the absence of more conclusive evidence on the whole population of pre-trial proceedings, it is impossible to interpret verdict statistics in the same manner as Dutton.

There are also interpretative ambiguities with the second dataset presented by Dutton. He argues that the low percentage of patents litigated in court demonstrates the reluctance of patentees to pursue legal action, for fear of having their rights revoked. However, this low litigation rate could equally be interpreted as indicating the security of the patent, meaning that there was little room for legal doubt in most disputes. It might also be interpreted as evidence of patentees successfully reaching agreements with infringers prior to trial.

Finally, the evidence used by Dutton for this work was limited to cases listed in Bennet Woodcroft's *Reference Index*.[45] However, the index does not provide information relating to the verdict. Rather, to obtain the verdicts, judging from his bibliography, Dutton used two contemporary collections of patent cases.[46] This

40 Court of Common Pleas. Peter Hayward, *Hayward's patent cases, 1600-1883: A compilation of the English cases for those years*, (13 vols, Abingdon, 1987), Vol.1, p.527

41 *Report and minutes of evidence taken before the Select Committee of the House of Lords appointed to consider of the Bills for the amendment of the law touching letters patent for inventions with appendix and index*, (Parl. Papers, 1851, XVIII), p.280

42 It was reckoned to cost, on average, £600 for a defendant to contest a patent in court. *Report from the Select Committee on state of law and practice relative to patents for inventions*, (Parl. Papers, 1829, III), p.149

43 The case was *Rex* v *Mill* (1850) in the Court of Common Pleas. Hayward, *Patent Cases*, Vol.6, p.129-135

44 A £1,000 bond had to be entered with the law officers for the writ to be prosecuted. Sidney Billing, and Alexander Prince, *The law and practice of patents and registration of designs*, (London, 1845), pp.155-157

45 After the Patent Law Amendment Act of 1852, the new clerk to the commissioners of patents, Bennet Woodcroft compiled four indexes of patents for inventions obtained between 1617 and 1852. One of these indexes, the *Reference Index*, provided references for court cases relating to patents. Alessandro Nuvolari, and Valentina Tartari, 'Bennet Woodcroft and the value of English patents, 1617-1841', *Explorations in Economic History*, 48 (2011), p.99

46 It should be stressed that Dutton never states this. I have assumed this to be the case, as it accounts for the discrepancy between the number of cases derived from the *Reference Index* and the two collections of court cases. These are Thomas Webster, *Reports, and notes of cases on letters patent for inventions*, (London, 1844) and William Carpmael, *Law reports of patent cases*, (3 vols, London, 1843)

presumably explains why although the *Index* lists 384 patent cases from between 1770 to 1849, Dutton has only used 257.[47]

Despite the problems involved with interpreting these statistics, Dutton's exercise has been repeated here, albeit with a larger source base. In addition to the sources used by Dutton, *Hayward's patent cases*, a thirteen volume work containing facsimiles of reports of all major patent cases between 1660 and 1883, has also been used. Another forty verdicts were located in contemporary patent journals using the references listed in Woodcroft's *Reference Index*. Also, the online *Times* catalogue, and an edited version of Lord Mansfield's court notebooks, have provided some additional cases.[48] This enlarged source base accounts for some of the variation between Dutton's figures and my own.[49]

Table 3.1 provides new statistics relating to patent cases. The figures in parentheses are the equivalent figures as derived from Dutton.[50] These new statistics show that Dutton consistently under-counted both the number of litigated patents, and the proportion of cases won by patentees before 1830. Between 1770-99, Dutton counted twenty-one cases, with only eight being won by patentees. However, using this broader range of sources, I have found thirty-nine cases for this period with nineteen cases won by patentees. For the period 1800-29, a similar pattern emerges. Dutton claims that of fifty-three cases only eighteen were won by patentees whereas I have counted ninety-seven cases with 48 percent of cases returning verdicts in favour of patentees.

Table 3.1 Patent case statistics, 1770-1849

Period	No. of cases	% Won by patentees	No. of patents awarded	No. Litigated	% Litigated
1770-99	39 (21)	48% (38%)	1418	34 (16)	2.4% (1.1%)
1800-29	97 (61)	48% (34%)	3510	78 (50)	2.2% (1.4%)
1830-49	265 (175)	59% (69%)	6854	201 (142)	2.9% (2.1%)

The interpretative ambiguities of this data were discussed previously. However, even if we accept Dutton's interpretation, it is clear from table 3.1 that his assertion of anti-patent bias cannot be sustained on quantitative evidence. It also shows that patentees were not as reluctant to pursue legal action as was suggested by Dutton.[51]

Dutton also argues that there is strong qualitative evidence for anti-patent bias, citing instances from the court records where the judiciary apparently reveal this bias. One example mentioned earlier is

47 Dutton, *The patent system*, p.78

48 James Oldham, *The Mansfield manuscripts and the growth of English law in the eighteenth century*, (2 vols, London, 1992)

49 There are two additional points that ought to be made concerning the criteria for inclusion in these patent case tables. Firstly, to be included the case had to involve a patent currently in force, excluding those cases concerning patent applications. Secondly, the patent had to be *materially* involved in the proceedings, i.e. that the central dispute at trial was the validity, infringement or ownership of a patent.

50 Dutton, *The patent system*, p.71 and 78

51 The case statistics presented here cannot be regarded as comprehensive. Without a thorough search of the Chancery order books or the indices of the common law courts, any statistical work will omit an unknown proportion of patent cases.

Bainbridge v *Wrigley* (1810) where Chief Justice Ellenborough held a patent for a flute void for referring to the plural *improvements*, when only one new note had been produced. Ostensibly this might appear unreasonable; the mistake innocuous and of little practical importance. Significantly though, the error was not in the specification but in the actual title of the patent. The accuracy of the patent title was essential because, as Ellenborough noted, any error meant 'the consideration on which his Majesty was induced to grant his patent was not truly stated' vitiating the grant.[52] It was also of direct practical importance that the title be as accurate as possible, otherwise it would infringe on the rights of caveat holders.[53]

Neither does it appear that Ellenborough was unduly officious in adjudicating other patent cases. In *Watson* v *Pears* (1809), defence counsel argued that the patent was void because it bore the date 10th May 1808 and contained the proviso that the specification should be enrolled 'within one calendar month next and immediately after the date thereof'. However, the specification had been enrolled on the 10th June 1808 which, it was claimed, was not within the set time period. Ellenborough, held the patent valid, stating 'the rule of good sense has been established, that such words shall be construed according to the meaning of the parties who used them'.[54]

Dutton also quotes an instance in *Hornblower* v *Boulton and Watt* (1799) where Lord Kenyon pronounced himself 'not one of those who greatly favour patents'.[55] Dutton however, ignores the context of the statement. In the same speech Kenyon concluded the case by stating he had 'no doubt in saying, that this is a patent for a manufacture' and like the three other judges ordered a verdict be found for Watt.[56] Instead, the court records establish that the judiciary recognised the role of patenting in encouraging invention long before 1830. For example, Justice Grose observed in *Hornblower* v *Boulton and Watt*, 'the aim of the Legislature is obvious…it was to encourage ingenious artificers…to invent and bring forward new manufactures…by holding out to them the reward of the 14 years' monopoly'.[57] Similarly, in *Arkwright* v *Nightingale* (1785), Lord Loughborough stated 'the law has established the right of patents for new inventions; that law is extremely wise and just'.[58] Accordingly, there was no confusion between patents and monopolies; Chief Justice Eyre observed in *Boulton and Watt* v *Bull* (1795), 'Sir Edward Coke…says little or nothing of patent rights as opposed to monopolies'.[59]

Section 3.2.3
The patent as contract

That there was no anti-patent bias amongst the judiciary is also consistent with contemporaneous intellectual and legal developments. By at least the last quarter of the eighteenth-century it was beginning to be

52 Court of King's Bench. Hayward, *Patent cases*, Vol.1, p.554.
53 The caveat holder was informed of petitions on the strength of the proposed title of the patent contained in the petition. If the proposed title was misleading a caveat holder might not receive notice of a patent that would affect their interests.
54 King's Bench. Hayward, *Patent cases*, Vol.1, p.547
55 King's Bench. Dutton, *The patent system*, p.77
56 'Court of Error', Hayward, *Patent cases*, Vol.1, p.402
57 Ibid
58 Common Pleas. Carpmael, *Law reports*, Vol.1, p.49
59 Common Pleas. Hayward, *Patent cases*, Vol.1, p.389

recognised that patents, by incentivising the efforts of inventors, were beneficial to society. Adam Smith, for example, had a horror of almost any monopoly, claiming that monopolistic trading companies, such as the East India Company, 'corrupt[ed] the morality of their members'.[60] However, he accepted the rationale behind offering temporary monopolies for inventions. Later, Jeremy Bentham argued it was essential that the legal system intervene to protect inventors as 'such exclusion cannot otherwise be put upon anybody but by the hand of the law: hence the necessity and the use of the interposition of law to secure to an inventor the benefit of his invention'.[61]

This third subsection examines the judicial rationale for the patent grant, which was founded on the idea of the social contract. The social contract was envisaged as incorporating two separate relationships, one between the governors and the governed, and the second between the people themselves.[62] Analogously, the patent was conceived as embodying a social contract between the inventor/patentee and the public. In this schema, the public awarded the 14 year patent grant in return for the specification. As described in the second chapter, the specification was a detailed written description of the patented invention, a copy of which had to be deposited in one of three offices at the court of Chancery.

From at least the 1780s this contractual conceptualisation of the patent grant was ubiquitous in the legal literature and court records. In *Turner* v *Winter* (1789) Justice Buller stated, 'the consideration which the patentee gives for his monopoly, is the benefit which the public are to derive from his invention after the patent is expired; that benefit is secured to them by means of a specification of the invention'.[63] This raison d'être was consistently invoked throughout the period. In *Cartwright* v *Eamer* (1800), Baron Eldon stated 'the patent is to be regarded as a bargain with the public and the specification therefore to be construed on the same principle of good faith as that which regulates all other contracts'.[64] Later in *Derosne* v *Fairie* (1835), Lord Abinger summed up, 'the law requires, that a man, as the price of monopoly which he obtains for fourteen years for any invention, shall enable the public, after the monopoly has ceased to have full and distinct account of the whole of that invention'.[65]

It is generally thought that the specification was introduced to help the law officers discriminate between petitions for similar inventions.[66] Limited to the role of administrative arbiter, MacLeod argues the 'specification was of limited legal significance in the first half of the eighteenth-century'.[67] This state of affairs apparently changed with Lord Mansfield's decision in *Liardet* v *Johnson* (1778). Apparently, for the first time an inventor lost his patent due to the insufficiency of his specification. The specification was now a binding instrument on which the legality of the patent was dependent. This was because the specification was now seen as the vehicle by which the public were to be informed of the invention, and the consideration on

60 Donald Coleman,'Adam Smith, businessmen, and the mercantile system in England', *History of European Ideas*, 9, (1988), p.166
61 Werner Stark, *Jeremy Bentham's economic writings,* (3 Vols, London, 1952), Vol.1, p.263
62 Patrick Atiyah, *The rise and fall of contract*, (Oxford, 1979), p.39
63 King's Bench. Hayward, *Patent cases*, Vol.1, p.327
64 Court of Chancery. Ibid, p.416
65 Court of Exchequer. Ibid, Vol.2, p.613
66 MacLeod, *Inventing the Industrial Revolution*, p.51
67 Ibid, p.49

which the patent was granted. MacLeod writes 'for the first time, the recognised quid pro quo for the award of a patent was the disclosure of the invention'.[68] This sudden change in the purpose of the specification left patentees vulnerable; they could not have anticipated that the specification would become such an important document. Further, patentees were slow to adopt the exacting legal requirements with which the judiciary assessed their specifications. The situation was compounded by the prohibition of amendments to the specification once it was entered. MacLeod continues that after *Liardet* the specification came to represent the 'fulcrum of judicial uncertainty'.[69]

The introduction of the specification was discussed in section 2.2. On the basis of the law officer's reports, it was argued that the specification was not introduced to help the officers discriminate between different petitions. Rather, it was suggested that the specification, although initially introduced at the behest of petitioners so they would not have to reveal their invention before they had patent protection, soon replaced the 'public good' as the consideration on which the patent was awarded. If this was the case, though, the courts would have been enforcing sufficiency standards in the accuracy of the specification long before *Liardet*.[70] Although the legal records before 1778 are sparse, this appears to be the case. In 1731, Trinity House petitioned the Privy Council to revoke Robert Hamblin's patent for 'distinguishing lights'. Most significantly, they claimed that the specification was deficient on the grounds that no method of actually distinguishing one light from another had been described. The Privy Council accepted this recommendation, annulling his patent amongst other reasons because, 'he hath not performed the Condition in the Letters Patent, whereby he is required to enrol a Specification thereof; the Instrument enrolled by him not ascertaining the Nature of the Invention'.[71] The issue also arose at common law ten years before *Liardet*. In *Yerbury* v *Wallace* (1768), the patentee lost because an accurate description of his invention was not given in his 'description of it pursuant to his patent'.[72] Finally, contemporary writers emphasised the importance of accurate specifications, and its legal significance. In 1774 William Kenrick, wrote that a secure patent was 'dependant on a precise mode of specification'.[73]

There is not the evidence to claim that the specification was conceived as the contractual consideration of the patent ab initio. However, the contractual conceptualisation of the patent that was

68 Ibid
69 Ibid, p.62
70 It should also be stated that *Liardet* has been misreported. Firstly, Liardet did not lose the case. *Liardet v. Johnson* (1780) shows that Liardet won both trials in 1778. This means that earlier trials cannot have afforded the opportunity for elucidating this doctrine in the manner previously suggested. Chancery. Hayward, *Patent cases*, Vol.1, p.195. Secondly, Mansfield's notes for the first 1778 trial survive, confirming that Liardet won. Interestingly, however, the notes show how important the accuracy of the specification was during counsel arguments. Either both sides managed to anticipate the importance Mansfield would attach to the specification (unlikely considering this was supposed to be unprecedented), or it was commonly known that the validity of the patent would rely upon the accuracy of the specification. King's Bench. Oldham, *The Mansfield Manuscripts*, Vol.1, p.749-50. Thirdly, the case was virtually ignored by contemporaries, suggesting that nothing especially novel occurred. John Adams, and Gwen Averley, 'The patent specification, the role of *Liardet* v *Johnson*', *The Journal of Legal History*, 8, (1988), p.162
71 *London Gazette*, 2nd May 1732, p.1
72 King's Bench. Oldham, *The Mansfield Manuscripts*, Vol.1, p.733
73 William Kenrick, *An address to the artists and manufacturers of Great Britain*, (London, 1774), p.38. Kenrick was a popular novelist and satirist, who was particularly critical of Dr Johnson. Johnson returned the favour, noting archly 'he is one of the many who have made themselves publick, without making themselves known'. James Boswell, *The life of Samuel Johnson*, (4 Vols, London, 1823), Vol.2, p.11

apparently first elucidated in *Liardet* had jurisprudential antecedents stretching back fifty years. The timing of these developments are significant. Mario Biagioli notes that it is only with the written specification requirement that patents begin to transmute from royal privileges into something akin to modern intellectual property rights.[74]

It is also apparent from court records and patent treatises that with the introduction of the specification, the patent grant was conceptualised in terms analogous to the modern intellectual property right. Biagioli argues that with the rise of the specification requirement there will be a concomitant decline in utility requirements.[75] It is useful to differentiate between two broad types of utility, termed here as 'private' utility and 'public' utility. Private utility, concerns the workability or technical 'excellence' of the patented invention. In contrast, public utility was not so much concerned with the efficacy of the invention itself, but with its wider social and economic benefits. Early modern privileges were awarded with reference to public utility, and section 2.2 established this was the case in the early eighteenth-century. The rise of the patent as contract, where the public interest was fulfilled by disclosure of the secret, should have meant the decline of public and private utility requirements. Zorina Khan, however, suggests that the English patent grant retained stringent utility requirements throughout the period, claiming 'the law specified that patents were to be granted for inventions that were new and useful, and courts did not hesitate to enforce both of these conditions'.[76] If this was the case then it would undermine the argument that the specification formed the consideration on which the patent grant was awarded.

It initially appears from patent treatises that private utility did remain an important consideration in the legality of the patent. In 1846, the lawyer William Hindmarch asserted that 'utility of an invention is a condition required by the common law'.[77] However, the legal practicalities of these requirements, specifically the criteria by which utility was assessed, were minimal. Khan claims that the utility requirement was not decided by any technical or economic criteria, and 'was regarded as unrelated to the commercial success of the patented invention'.[78] This is not supported by the legal record. Market demand was regarded as direct proof of utility. In *Gibson* v *Brand* (1841), Chief Justice Tindal observed 'the defendant says, the invention is of no utility…[but]…the demand that is made for it would seem to establish that'.[79] Neither was the utility requirement significant. Hindmarch continued that a plea against the utility of a patent 'cannot be sustained unless there is a total want of utility'.[80] Likewise, Henry Lund noted 'the law protects the slightest amount of useful ingenuity'.[81]

Because of these minimal requirements, it is difficult to isolate a case where the patent was lost on

74 Mario Biagioli, 'Patent republic: Representing inventions, constructing rights and authors', *Social Research*, 73, (2006), p.1130
75 Biagioli, 'Patent republic', p.1154
76 Zorina Khan, *The democratization of invention: Patents and copyrights in American economic development, 1790-1900*, (Cambridge, 2005), p.34
77 William Hindmarch, *The law and practice of letters patent for invention*, (London, 1846), p.133
78 Khan, *The democratization of invention*, p.34
79 Common Pleas. Hayward, *Patent cases*, Vol.3, p.774
80 Hindmarch, *The law of letters patent*, p.274
81 Lund, *Law relating to letters patent*, p.7

these grounds. For example, in *Manton* v *Parker* (1814) it would appear that want of utility explains why Manton lost; as Chief Justice Gibbs summed up 'the evidence is pretty strong…the utility of this invention, and the purpose of this patent, wholly fail…that of itself would be an answer to this action'. [82] But, in this instance Chief Justice Gibbs defined utility with regard to the specification, saying of the invention 'that to make it of utility there must be a deviation from the specification, the patent is in that case wholly void', i.e. that the invention was useful, but that the specification did not set out the means by which it could be carried out.[83] That the lexicon of utility considerations survived should not obscure the fact that private utility requirements were little more than a relic from the Stuart era and of negligible legal relevance during this period.

On the subject of public utility, MacLeod claims that the 'benefit of the public' persisted as an important consideration until the end of the eighteenth-century.[84] True, it was occasionally invoked by counsel, but never with success. In *Arkwright* v *Nightingale* (1785) defence counsel attempted to argue against Arkwright's patent because, 'by the statute against monopolies, no patent is to prevail that is generally inconvenient or against the public trade'.[85] Lord Loughborough quashed this argument, 'we must never decide private rights upon any idea of public benefit…nothing could be more essentially mischievous than that questions of property between A and B should ever be permitted to be decided upon considerations of public convenience'.[86] Later, in *Rex* v *Arkwright* (1785) counsel again tried to argue 'that the grant is prejudicial and inconvenient to his majesty's subjects in general'.[87] Justice Buller disagreed stating 'the law is well settled; you cannot upon that consequential issue attack the defendant'.[88]

Although the public interest, as defined by economic and social criteria, disappeared as a legal consideration with the introduction of the specification, there was one administrative development that affected the rights of patentees. During the Napoleonic Wars, a clause was inserted on all military and naval patents obliging the patentee to supply the patented article to the government at reasonable prices.[89] Later it was reintroduced for all patents at the instigation of the second Earl of Rosslyn (an old soldier), when Lord Privy Seal between 1829-30.[90] This clause was probably onerous for a minority of patentees and evidence from the 1851 Select Committee suggests it could be abused. One witness, Joshua Westhead, testified that 'it is felt a hardship by inventors that at present the Boards of Admiralty and Ordnance do not pay them for the use of their inventions', giving an example where the Admiralty had refused to pay £20,000 of a £25,000 royalty it owed to one patentee.[91] There was one court case relating to the clause, *Walker* v *Congreve* (1816).

82 Common Pleas. Hayward, *Patent cases*, Vol.1, p.577
83 Ibid, p.576
84 MacLeod, *Inventing the Industrial Revolution*, (Cambridge, 1988), p.31
85 Common Pleas. Carpmael, *Law reports*, Vol.1, p.48
86 Ibid, p.47 and p.50
87 King's Bench. Anon, *The trial of a cause instituted by Richard Pepper Arden Esq; his Majesty's Attorney-General by Writ of Scire Facias to repeal a patent granted on the 16th December 1775 to Mr Richard Arkwright*, (London, 1785), p.30
88 Ibid, p.33
89 Bennet Woodcroft, *Patents for invention: Reference Index, 1617-1853*, (London, 1855)
90 *Report of the Committee (appointed by the Lords of the Treasury) on the Signet and Privy Seal Offices*, (Parl. Papers, 1849, XXII), p.13
91 *Select Committee of the House of Lords*, (Parl. Papers, 1851), p.351-352

The case proceeded on a motion of contempt for the original injunction that Walker had obtained, restraining the defendant Congreve.[92] Although a verdict was returned for the plaintiff, the Lord Chancellor dissolved the injunction so that Congreve could 'proceed in supplying the demands of service'.[93] However, the government never chose to dispute the validity of the patent and Congreve was ordered to hand over any profits.[94] Walker then was able to profit from government supply without incurring any financial risk.

Chapter 2 argued that the administrative history of specifications, with the concomitant decline in the examination of the petition by the law officers, implied that the specification soon became the consideration on which the patent was granted. The contractual conceptualisation of the patent probably did not appear fully formed but was certainly established long before *Liardet* v *Johnson* (1778). The evidence in this section supports this argument. Patent rights were clearly dependent on accurate specification viz. *Yerbury* v *Wallace* (1768) and *Hamblin's Patent* (1731). Accordingly, private and public utility requirements declined in legal import (although did not disappear due to the government usage clause).

Although the patent remained, technically, a royal grant, in practice it was more akin to the modern intellectual property right, the consideration of which was the specification. This is illustrated by the writ of *scire facias*, mentioned before. Helen Gubby argues that the patent still constituted a royal prerogative as 'a prosecution brought in the name of the crown was necessary for the formal revocation of the grant', in reference to this writ.[95] This, however, overlooks the fact that the prosecution had to be instigated and paid for by a private party. Indeed the practice of the writ encapsulates the argument made here, that in formal legal terms the patent remained a royally endowed privilege but that in practice it constituted a contract between the inventor and the public. The corollary of this was that patents were adjudicated in a manner analogous to property rights. For instance, in *Hesse* v *Stevenson* (1803) Chief Justice Alvanley observed that 'it is said [every] right of possession and possibility of interest, is taken out of the bankrupt and vested in the assignees, yet that the fruits of a man's own invention do not pass. I cannot frame to myself an argument why that interest should not pass in the same manner as any other property acquired by his personal industry'.[96]

This section also demonstrated that there is no qualitative or quantitative evidence for judicial bias against patents. This however raises further problems with the historiography. Dutton attributed the slow development of legal precedent to the uncertain legal status of the patent and judicial bias. However, if as has been argued here, patents rested on solid jurisprudential foundations there would need to have been a more thorough judicial elucidation of patent law at an earlier period than previously thought. The following section will look at the administration and development of patent law in the half century before the Privy Council apparently relinquished its jurisdiction over patent cases. Section 3.4 will consider the development of patent law after 1753.

92 The defendant was Sir William Congreve, inventor of the eponymous Congreve rocket.
93 Chancery. Hayward, *Patent cases*, Vol.1, p.714
94 Ibid
95 Gubby, 'Developing a legal paradigm for patents', p.242
96 Common Pleas. Hayward, *Patent cases*, Vol.1, p.463

Section 3.3
Patent law, 1700-1753

The state of patent law during this early period is obscure. The first researcher to work on the subject was Edward Hulme a century ago, since when it has only been revisited by MacLeod. Both thought that the Privy Council retained the primary jurisdiction of patent cases until 1753. There were two ways in which disputes involving patents could be heard by the Council. Firstly, patentees could have those suspected of infringing their patent summoned to the Council and tried for contempt of the royal grant. Secondly, patents could be annulled by the signature of six Privy Councillors. Parties opposed to patents could instigate proceedings in the Council to secure the necessary quorum, and have the patent revoked. The Privy Council also intervened in disputes relating to petitions for patents.

Although there were cases at common law before 1753, for example *Edgeburry* v *Stephens* (1691), neither MacLeod nor Hulme consider common law to have been an important authority in patent law until the Privy Council surrendered its jurisdiction. The timing is of great significance. As was discussed in section 3.2.1, the Privy Council was primarily concerned with protecting with what it perceived to be the public interest, rather than the rights of patentees. If the Privy Council only relinquished its jurisdiction to the common law in 1753, this implies that the security of patent rights in the first half of the eighteenth-century was weak, seriously undermining their value.

However, there survives no direct evidence relating to this apparent change in jurisdiction. MacLeod recognises that if there was any relinquishment of authority, 'in the light of earlier controversies, it was a curiously unremarked transference of authority'.[97] Hulme notes that in 1753 Walter Baker petitioned the Privy Council to have a patent belonging to a Dr James annulled on the grounds that the patented medicine had been invented by someone else in 1734. Yet despite producing forty three affidavits verifying his version of events to James's one (his own) the law officers rejected Baker's evidence, claiming that it was not 'pertinent'.[98] Presumably incensed, Baker prosecuted James for perjuring his affidavit to the Privy Council and petitioned the Council for its clerk to attend King's Bench with James's original affidavit.[99] While the law officers decided on the merits of the request, 'the petitioner Mr Baker clandestinely got away from the Attorney-General's Office several material affidavits filed there on occasion of the original petition' and printed them as a pamphlet. Baker was refused permission for the clerk of the Council to attend and there were no further proceedings.[100] Hulme claims that it was this débâcle that prompted the Privy Council to surrender its jurisdiction.

In the absence of direct evidence though Hulme's suggestion can only be regarded as speculative. Conversely, the case-load of the Privy Council had begun to decline long before 1753. Between 1660-99

97 MacLeod, *Inventing the Industrial Revolution*, p.59
98 Privy Council Registers, London, National Archives, PC 2/103, fol.321
99 Ibid, fol.422
100Hulme, 'Privy Council Law', p.625. There is a copy of the pamphlet in the British Library. Walter Baker, *The affidavits and proceedings of Walter Baker*, (London, 1754)

there were twenty-five cases relating to patents and petitions for patents in the Privy Council, while in the next thirty years there were eleven cases, and between 1730-53 just three.[101] Further, there is not a single instance after 1670, of a patentee enforcing their rights in the Privy Council.[102]

For patentees taking legal action to enforce their patents, the Council had been an irrelevancy long before 1753.[103] This is significant for two reasons. Firstly, as has been discussed, the legal priorities of the Privy Council, if extensively enforced, would have seriously undermined the security and value of patents. Secondly, it means that patentees must have enforced their patent rights in the jurisdiction of another authority besides the Privy Council. An alternative mentioned by MacLeod was Chancery, the court responsible for administering the law of equity.

Patentees could obtain court orders compelling parties to refrain from the infringement of their patent or be found in contempt of court. These orders were called injunctions and were founded in the law of equity. As such, they were only obtainable from Chancery.[104] MacLeod though, argues that Chancery remained wedded to maintaining a jurisdiction based on classical equity. As mentioned in section 3.1, in classical equity, decisions depended entirely on the particular circumstances of each case. Because previous cases did not have an informative role in subsequent decisions, MacLeod claims that Chancery did not provide adequate security to patentees, commenting 'equity courts were rarely guided by precedent…fears of the expense were compounded by the arbitrariness of the courts'.[105] Consequently, MacLeod suggests that few patentees prosecuted infringers before 1815, and especially before 1770.[106]

In practice, however, the classical notion of equitable law was not strictly applied. As equity was adjudicated by its own court, it had been obliged to develop its own system of rules and forms of procedure. Further, during the seventeenth-century there was a constitutional dispute over the extent to which equity could interfere with common law. In response to criticisms that it threatened English liberties and the security of the common law, Chancery desisted from applying classical notions of equity. MacLeod then is mistaken to refer to the 'arbitrariness of the courts'. Rather, as was discussed in section 3.1, the overwhelming majority of cases were decided not by equitable appeals to 'natural' law, but in accordance with a settled pattern of Chancery practice. With a more secure and predictable legal environment, this raises the possibility of patentees regularly seeking to enforce their rights in Chancery. To investigate how often patentees sought injunctions before 1753, a search of Chancery pleadings was undertaken in the National

101 The data for the quantitative work on cases in the Privy Council is based on Hulme, and corroborated with my own work in the Privy Council Registers. I found no new cases in the Privy Council Registers. Edward Hulme, 'Privy Council law and practice of letters patent for invention from the Restoration to 1794', *Law Quarterly Review*, 33, (1917).
102 Ibid
103 This is not to suggest that the events outlined by Hulme were of no consequence. It might be that prompted by the Dr James débâcle, the Privy Council formally recognised the status quo and decided to refer all subsequent cases to the common law courts.
104 The Court of Exchequer also operated an equitable jurisdiction. However, there do not appear to be any patent cases either in this period, or up until 1852 occurring in the equity side of Exchequer. MacLeod does provide a detailed example of a case in Exchequer, *Stanyforth's Case* (1741), but it appears that this occurred on the common law side. MacLeod, *Inventing the Industrial Revolution*, p.67
105 Ibid, p.61
106 Ibid, p.68

Archives. The pleadings were the initial stage of proceedings in Chancery. For an injunction, these would have been instigated by the patentee submitting a bill of complaint, outlining the case for an injunction. If the defendant failed to answer the bill in full, an interim injunction would automatically ensue.

This work has not been done before, probably because of the difficulties in using Chancery records. From 1600 to 1800, there were some 750,000 suits in Chancery.[107] However, because the catalogue lists pleadings by case name and year, it was possible to search for cases by the surnames of patentees for the years in which their patent would have been in force. To keep the number of potential cases down to a manageable number, only a quarter of patents granted between 1700-53 were searched for in Chancery (81 from 322).[108] These patents were not chosen at random. Rather, they were chosen on the basis of whether the patentee had an unusual surname. This method was adopted so as to reduce the number of pleadings that had to be searched. If, for example, injunctions relating to Thomas Smith's 1725 patent had been searched for, this would have necessitated checking approximately 800 cases where the plaintiff had the surname 'Smith', between 1725-39.[109] An example of an unusual surname used for this exercise was 'Fallowfield'. In February 1727, a William Fallowfield obtained a patent, and a search in Chancery records for between 1727-41 produced two pleadings where a Fallowfield had been a plaintiff, although neither related to William Fallowfield's patent.[110] There is no reason to suppose that a 'Fallowfield' would be more (or less) inclined to obtain an injunction than a 'Smith', and so it is unlikely that this method yields any significant bias.

This method, however, excludes patents that would have been assigned in their entirety (which, as will be discussed in section 5.3, was common). If a patent was assigned then any subsequent cases would not be in the name of the original patentee, but in the name of the assignee. Without a register of patent assignments, the only way of finding all injunctions would be by searching hundreds of thousands of pleadings, an impossible task. Also, to find all the potential injunctions relating to these patents the search should have terminated in 1767 (fourteen years after 1753). However, because the primary concern of the exercise was to establish how often patentees used Chancery before the supposed change in jurisdiction in 1753, the search terminated then. This means that this search will undercount the number of injunctions obtained for these patents.

Using this method twenty-five separate bills of complaint requesting an injunction were found relating to seven different patents. Because injunctions were only searched for a quarter of patents, this implies that there were around 100 bills of complaint entered at Chancery in the first half of the eighteenth-century (although, for the reasons mentioned, this constitutes an underestimate). That patentees were using Chancery to enforce their patents should come as no surprise after the preceding discussion on the limited

107 Henry Horwitz, *Chancery equity records and proceedings*, (Kew, 1998), p.xi
108 Bennet Woodcroft, *Chronological Index of patents, 1617-1852*, (London, 1854)
109 Clearly 1725 to 1739 is a fifteen year period, but the patent term was only fourteen years (if not extended by parliament or the Privy Council). Fifteen years were checked though as it is only possible to search by year, not by date in Chancery records. Also, as the patentee in an injunction case Smith would have instigated the proceedings, and so would have been the plaintiff (who was always named first in the case name). Accessed 12th July 2010, http://www.nationalarchives.gov.uk/
110 These cases were *Fallowfield* v *Aston,* (Geo I and II), London, National Archives, C11/1737/34 and *Fallowfield* v *Peacock,* (1737), London, National Archives, C11/2581/14.

role of Privy Council. It also means that the practice of injunctions for patents assumes an importance hitherto unsuspected, and this now needs to be appraised.

There were three types of injunction, available at different stages of legal proceedings. At the first stage was the *ex parte* injunction, equivalent to the modern interim injunction.[111] This would be automatically awarded if the initial bill of complaint, requesting a 'grant unto your orator his majesty's most gracious writ or writs of injunction', was not answered by the defendant in time, and if the patent had been in force for a couple of years.[112] If the defendant lived within twenty miles of London, they had four days after service of subpoena to appear before court or answer, and if outside twenty miles, eight days to answer.[113] This was a stringent time period. It often took months for a defendant to submit a reply which, assuming the defendant was promptly subpoenaed, means patentees had almost immediate access to injunctive relief. Once awarded the interim injunction would remain in place until dissolved by a court order.

The injunction appears to have had some inhibitory effect on those subpoenaed. After the search in pleadings (C11), subsequent orders relating to these cases were sought in the order books (C33). The order books record any orders or judgements made relating to a particular case. For seven of the pleadings there were no orders, suggesting that either the defendant submitted to the interim injunction without opposition, or that the two parties quickly came to an agreement.

For eighteen of the pleadings orders do survive. To have an interim injunction lifted, the defendant had to enter 'full and perfect' answer to the grievances outlined in the plaintiff's bill of complaints. The conditions for a 'full and perfect' answer were fairly strict, and many defendants had to obtain orders for more time to enter an answer. Similarly, many of the orders are for the referral of the answer to a Master in Chancery to decide if the answer was indeed 'full and perfect'.[114] These pre-trial proceedings could take many years. For example, the first order relating to *Kay* v *Mills* was in Michaelmas Term 1744[115] yet the case took nearly three years to come to trial in Easter Term 1747.[116]

The second type of injunction was the temporary injunction, awarded only after a hearing before the Lord Chancellor. Of the twenty-five initial pleadings only two came to such a hearing, *Kay* v *Mills* (1747) and *Sage* v *Harrison* (1750). That such a low proportion of cases were heard is to be expected in light of the discussion on pre-trial proceedings in section 3.2.2. It can be inferred from the order books that parties often reached an extra-judicial agreement. For instance, there are some cases where after years of orders, the cause was on the verge of being heard, whereupon the case disappears from the order books. This implies that an agreement had been reached just before the hearing. In *Kay* v *Bearcroft* (1746), for example, the day before

111 Tomás Gómez-Arostegui, 'What History teaches us about copyright injunctions and the inadequate remedy-at-law requirement', *Southern California Law Review*, 81, (2008), p.1228
112 *Sage* v *Harrison*, (1748), London, National Archives, C12/1873/22, fol.1. *Ex parte*, was the legal term denoting a motion or order granted on the request of one party, without the other party being present. Irving, *English Law Dictionary*, p.163
113 Robert Eden, *A treatise on the law of injunctions*, (London, 1821), p.57
114 For example, in *Kay* v *Smith* (1742), the answer of the defendant was referred to Master Spicer, who was to report within '4 days'. *Kay* v *Smith*, (1742), Chancery Order Books, London, National Archives, C33/377, fol.381
115 *Kay* v *Mills*, (1747), Chancery Order Books, London, National Archives, C33/383, fol.28
116 Ibid, fol.697

the hearing, the defendant was awarded another day to produce witnesses relating to the case – yet after this, there is no record of a hearing.[117] It is worth recalling that the maintenance of the interim injunction would have provided patentees with at least one major advantage in these pre-trial negotiations. Other evidence suggests that patentees could wield the injunction or the threat of injunction to intimidate infringers. For example, in the petition of the Company of Silk Throwsters, opposing an extension to the term of Thomas Lombe's patent for silk throwing machinery, they complained of being 'threatened by Sir Thomas Lombe with prosecutions for so doing under pretence of infringing upon his sole right of using and enjoying his invention; and have thereupon been obliged to desist'.[118]

Intriguingly, in both hearings the same order was made. The patentees were awarded a temporary injunction lasting twelve months but, to obtain a permanent injunction, were ordered to try their right in the common law courts. In *Kay* v *Mills* (1747), the order was made that the plaintiff's bill be retained for twelve months and that in the meantime they were to bring an action against the defendants. Both sides were 'to be bound by the event of such tryall of such action as to the validity of the said letters patent'.[119] Where the right of the plaintiff was disputed, ordering a trial at common law was also standard practice in copyright cases.[120]

From 1700 to 1852, when the patentee submitted a bill of complaint, the award of the *ex parte* injunction was the standard order wherever a patent had been in force for several years, or where it had already been tried successfully at law.[121] This was also the case with temporary injunctions. In *Beeston* v *Ford* (1829), for example, despite expressing 'great doubt whether this specification will be supported', Lord Lyndhurst still granted a temporary injunction as the 'rule of law in these cases has been laid down by Lord Eldon to be that where a patentee has for a number of years enjoyed the exclusive possession of a patent the Court…will grant an injunction until the trial at law'.[122] Even if the temporary injunction was refused, it was still unusual for the court not to order the defendant to maintain accounts while the case went to trial.

Neither were there any notable developments in the award of perpetual injunctions. A century after *Kay* v *Mills*, Lord Cottenham observed, 'he recollected no instance in which the court had not adopted the course of directing the trial of an action' to obtain a perpetual injunction.[123] It is unclear how often the case would be pursued to common law. During the eighteenth-century Tomás Gómez-Arostegui notes that 'final injunctions were relatively uncommon before 1789. Most copyright cases terminated after the entry of a

117 Chancery Order Books , London, National Archives, C33/385, fol.422
118 *The case of the Silk Throwsters Company*, (Parl. Papers, 1732), fol.1
119 *Kay* v *Mills*, (1747), Chancery Order Books, London, National Archives, C33/383, fol.698
120 Gómez-Arostegui, 'Copyright Injunctions', p.1233
121 In the second quarter of the nineteenth century *Hill* v *Thompson* (1818) was normally cited on this issue, although it does not appear to have marked any important divergence from prior practice. Hindmarch, *The law of letters patent*, p.315. It is also worth mentioning, however, that Lord Cottenham, Lord Chancellor from 1836 to 1841 and then from 1846 to 1850, was noticeably parsimonious in granting *ex parte* and temporary injunctions. He summed his position up in *Electric Telegraph Company* v *Nott* (1847), 'if there be a doubt as to the validity of the legal right it becomes the Court to be extremely cautious in administering its equitable jurisdiction by way of injunction… because if the legal right ultimately fail…the Court then has interfered without authority'. Chancery. Hayward, *Patent cases*, Vol.5, p.426
122 This is also clear evidence of previous practice influencing judicial decisions in equity. Chancery. Hayward, *Patent cases*, Vol.2, p.12
123 Hayward, *Patent cases*, Vol.3, p.951

temporary injunction, typically because the defendant acquiesced'.[124] The similarities in practice between copyright and patent injunctions imply the same may have been true for patent injunction cases.[125]

This research has two implications. Firstly, it shows that patentees had reliable access to injunctive relief throughout the period. The patent is essentially the right to exclude others from using the patented invention. Injunctions ensured that this right was relatively straightforward to enforce; patentees did not normally have to pursue a case all the way to a trial. Secondly, that patentees were ordered to go to common law to obtain a permanent injunction *before* 1753, suggests that the common law courts did have jurisdiction over patents in the first half of the eighteenth-century. This conclusion is supported by evidence from two other sources. Firstly, during pleadings in Chancery, defendants occasionally argued that the patentee's right had to be established at common law before the interim injunction could be awarded. In *Pope* v *Mount* (1733), counsel argued 'the Question whether these defendants are or ought to be prohibited by the said Letters Patent from making selling or manufacturing such paper as aforesaid is a question properly triable at law and not proper for…a Court of Equity'.[126] Secondly, there are some contemporary judicial comments suggesting a sizeable common law case load relating to patents for invention. For instance, in 1684 Justice Withins referred to 'the cause of new inventions, upon which letters patent actions are brought by every day's experience'.[127]

There is one problem with asserting that the common law courts had the authority and jurisdiction to try the validity of patents before 1753, only one case from this early period was cited afterwards. This was *Edgeberry* v *Stephens* (1692), which established that inventions could be imported from abroad and patented. If there were cases at common law in this period why did they not help form a core of applicable legal precedent in the first half of the eighteenth-century? This can probably be attributed to poor law reporting. Considering the centrality of precedent and procedure the failure of common law to provide a mechanism for publishing the record of the facts and legal arguments involved in a case represented an important institutional failing. One contemporary authority stated this was 'the bane and scandal of the law considered as a science founded on principle'.[128] It was only in 1756, when James Burrow began publishing cases in King's Bench, that law reports began to improve.[129]

This section has proposed that there needs to be a re-appraisal of the structure and practice of patent law in this period. The jurisdiction of the Privy Council had been in decline long before 1753. Rather

124 Gómez-Arostegui, 'Copyright Injunctions', p.1233
125 For a full description of injunctions for copyright Gómez-Arostegui, 'Copyright Injunctions', p.1128-1233
126 Chancery. *Pope* v *Mount* (1733), London, National Archives, C11/513/43, fol.2. Similarly in *Kay* v *Mills* (1747), defence counsel argued 'that the right of the plaintiff to the inventions shall not be established without a previous tryall of the validity of the said patent at common law', C11/2322/13, fol.2.
127 This is quoted in MacLeod, *Inventing the Industrial Revolution*, p.69. MacLeod rightly points out that this must be something of an exaggeration, as there simply were not the number of patents awarded to generate the case-load implied by Withins. However, it is unclear why Withins felt moved to make such a statement, unless there was some grain of truth in it. Chief Justice Jeffreys (the infamous hanging judge) also spoke in 1684 of 'all the actions that have been brought upon that Statute of Monopolies, by the patentees of new inventions, as there have been multitudes in my Lord Hale's time, and at all times'. MacLeod, *Inventing the Industrial Revolution*, p.68
128 Michael Foster quoted in David Lieberman, *The province of legislation determined, legal theory in eighteenth century Britain*, (Cambridge, 1989), p.236
129 Gubby, 'Developing a legal paradigm for patents', p.37

patentees were enforcing their rights in the equitable jurisdiction of Chancery which provided patentees with a degree of security and legal certainty. Whereas the Privy Council was mainly concerned with the interests of the government and the public, Chancery offered accessible and enforceable injunctive relief. Common law could also have offered patentees further enforcement options.

The subsequent influence of patent law in this early period is more difficult to divine. Based on the decline of the Privy Council, the basic legal structure that administered patent law until 1852 was probably established by the end of the seventeenth-century. Similarly, the practice of injunctions does not appear to have changed considerably between 1700 to 1852. Most significantly, the development of the specification as the consideration of the patent grant began during this period. However, while this basic structure had been established, the actual practice and standards of patent law remained unclear in the middle of the eighteenth-century. Not one case in common or equity law from between 1700-53 was later cited in the second half of the eighteenth-century and it is the continued elucidation of patent law which the rest of the chapter outlines.

Section 3.4
The development of patent law, 1754-1852

As discussed in the introduction, the historiographical consensus is that it was not until the 1830s that there was any significant development in legal precedent and patent law. MacLeod argues 'that even the spate of hard-fought patent cases at the end of the eighteenth-century did little to establish a solid core of judicial wisdom'.[130]

However, the failure of the common law courts to generate sufficient legal precedent was attributed to judicial bias.[131] As has been discussed at length there was no anti-patent bias. Instead, there a recognisably modern conception of the patent, based on the specification requirement. There was also a settled structure of patent law. This means the evidence for the lethargic development of judicial precedent must be re-assessed. This section is divided into four subsections. It begins by examining the doctrinal and precedental development of three important areas of patent law. The first subsection considers legal developments relating to patentable subject matter, the second novelty requirements and the third the development of legal precedent regarding the sufficiency of specifications. The fourth subsection examines the one important legislative effort to change patent law during this period, the 1835 Letters Patent for Inventions Act.

Section 3.4.1
Subject matter

Dutton supports his claim for the slow development of precedent by asserting that it was 'not until the 1842 case *Crane* v *Price*, that patentees could be sure of what the courts meant, namely that methods and processes were suitable for a patent'.[132] If the patentability of process inventions was only established at

130 MacLeod, *Inventing the Industrial Revolution*, p.61
131 Dutton, *The patent system*, p.77
132 Ibid, p.75

common law in 1842 this would certainly indicate a sclerotic pace of development in patent law. It appears, however, that Dutton has misinterpreted the case. The issue, as stated by Chief Justice Tindal, was not the patentability of processes in isolation but the patentability of a novel combination of two previously known processes: whether 'the combination of the two together (the hot blast and the anthracite)…whether such combination can be the subject of a patent'.[133] On the basis of previous authorities Chief Justice Tindal held this was so, 'it falls within the doctrine laid down by Lord Eldon, that there may be a valid patent for a new combination of materials previously used, or even for a new method of applying such materials'.[134] This demonstrates that the legality of patenting processes, and of novel combinations of pre-existing processes, had been established in court long before *Crane* v *Price*.

This was despite the limited statutory definition of what form a patented invention could take. The Statute of Monopolies limited itself to the phrase 'new manufacture', which at the time had been understood to mean an entirely new industry. The vagueness of the Statute's terminology, combined with the obsolescence of its original meaning, gave the judiciary carte blanche to define patentable subject matter. In the absence of reported cases it is difficult to divine whether patents for methods were legal in the first half of the eighteenth-century. There were, however, numerous patents awarded for methods, for instance the patent awarded in 1727 to John Wayt for his 'method to save coals or other fuel, in boiling brine and making it into salt'.[135] The first reported case where issues of subject matter were disputed was *Dolland* v *Champness* (1766). Significantly, the defence counsel argument 'that a patent for a mere method could not be sustained' was rejected and the patentee won.[136] In addition, the first reported cases concerning chemical processes demonstrate that they could be patented too. This was established in *Roebuck* v *Stirling* (1774), and was not subsequently challenged.[137]

These cases give no indication that the decisions represented a divergence from previous practice. However, in the absence of a widely reported and definitive legal declaration on the subject, there would always be a degree of uncertainty as to what could be patented. It was not until the Boulton and Watt cases at the end of the eighteenth-century that the opportunity for such an exposition arose. Tellingly, in *Boulton & Watt* v *Bull* (1795), defence counsel did not dispute the admissibility of methods for patents, acknowledging that 'the word manufacture is descriptive either of the *practice of making a thing by art*, or of the thing when made'.[138] Instead they argued that the specification only described 'unorganised principles', which he could not have 'invented'. When plaintiff's counsel were asked by Justice Heath for a precedent substantiating the patentability of methods, they cited *Dolland* v *Champness* (1766).[139] Despite this precedent and agreement between counsel on the matter, two of the four judges adjudicating the case still rejected the patentability of methods of manufacture, highlighting the uncertainty faced by patentees in the absence of a defining legal

133 Hayward, *Patent cases*, Vol.4, p.122
134 Chancery. Ibid, p.123
135 Patent no. 488. Bennet Woodcroft, *Alphabetical Index of patentees of invention, 1617-1852*, (2nd edn. London, 1969), p.600
136 Common Pleas. Carpmael, *Law reports*, Vol.1, p.29
137 House of Lords. Hayward, *Patent cases*, Vol.1, p.325-328
138 Common Pleas. Ibid, p.379
139 Ibid, p.378

statement. Heath ignored the precedent of *Dolland*, 'I asked in the argument for an instance of a patent for a method and none such could be produced' describing Dolland's invention as an 'improved machine'.[140] Instead Heath conflated 'method' with 'principle' and asserted that patents were only applicable to vendible manufactures 'because it precludes all nice refinements'.[141] Heath suggested that if Watt had wanted comprehensive protection he should have obtained an individual patent for each variation of his 'method'. Justice Buller adopted a similar argument, equating principle with method, 'I think it impossible to support a patent for a method only, without having carried it into effect and produced some new substance'.[142]

In contrast, Justice Rooke dismissed the 'verbal objection' that Watt's specification described any 'newly discovered natural principle as to steam'. Rather, Rooke argued that the invention was 'a new mechanical employment of principles already known' and that such 'patents for a method or art of doing particular things have been so numerous according to the lists left with us, that method might be considered as a common expression in instruments of this kind'.[143] Chief Justice Eyre agreed observing 'undoubtedly there can be no patent for a mere principle, but for a principle so far embodied and connected with the corporeal substances as to be in a condition to act, and to produce effects in any art, trade, mystery or manual occupation, I think there may be a patent'.[144] He also observed that many patents existed for new methods of manufactures which were 'beyond all calculation important to commercial activity…and in my apprehension it is strictly agreeable to the spirit and meaning of the Statute'.[145]

Because the decision of the court was split, the case proceeded on appeal where Lord Loughborough supported the status quo, maintaining that Boulton and Watt should retain sole use of their 'method'. After this decision Boulton and Watt managed their patent aggressively, obtaining numerous injunctions against infringers who used their separate condenser.[146] One of those subpoenaed was Jabez Hornblower. Because his engine had a different layout from that of Watt's, he challenged the injunction.[147] Again, the patent was contested because it was alleged to be for a principle. On this occasion, however, all four judges agreed that the patent was for a method and that such a method was good in law.[148]

Due to the significance of the invention, and the contentiousness of the patent, the Watt cases were widely reported, providing the opportunity to establish definitively the judicial precedent that methods were

140 Heath's summing up in *Boulton & Watt* v *Bull* probably affords better evidence of judicial bias against patents than anything produced by Dutton. Ibid, p.385
141 Ibid, p.378
142 Ibid, p.387
143 Ibid, p.383
144 Ibid, p.391
145 This statement also supports the claim made in section 3.2, that the judiciary understood the connection between patenting, invention and economic development. Ibid
146 Boulton and Watt obtained at least fifteen injunctions between 1794 and 1800. These were (with their National Archive shelfmark) *Boulton* v *Hawkins* C12/1552/24, *Boulton* v *Pasmore* C12/463/32, *Boulton* v *Reed* C12/1546/8, *Boulton* v *Bull* C12/1730/17, *Boulton* v *Vivian* C12/1730/16, *Boulton* v *Rosewarme* C12/1986/15, *Boulton* v *Oxnam* C12/213/16, *Boulton* v *Daniell* C12/213/31, *Boulton* v *Hornblower* C12/213/11, *Boulton* v *Paley* C12/956/13, *Boulton* v *Daniell* C12/463/21, *Boulton* v *Reed* C12/233/11, *Boulton* v *Fenner* C12/966/3, *Boulton* v *Thackeray* C12/1552/25, *Boulton* v *Carpenter* C12/232/27. Boulton and Watt Injunctions, London, National Archives, C12.
147 Richard Hills, *James Watt*, (3 Vols, King's Lynn, 2006), Vol.3, p.205
148 Common Pleas. Hayward, *Patent cases*, Vol.1, pp. 401-406

patentable. The Watt cases formed the legal foundation by which it was held that while abstract scientific principle could not be patented, processes or methods arising from their application could. The Watt cases were frequently cited and the distinction between 'principle' and 'process' remained the basis of definition on the matter until changes in 1977.[149]

With these fundamentals secured there was much subsequent elaboration. There was, for example, some debate over the patentability of adapting pre-existing methods to new applications, and whether this constituted a development worthy of protection. In *Brunton* v *Hawkes* (1821), Chief Justice Abbott found a patent void on the grounds 'that man cannot be entitled to a patent for uniting two things instead of three, where that union is affected in a mode well known and long practised for a similar purpose'.[150] This decision was subsequently cited in *Losh* v *Hague* (1839), where Lord Abinger observed 'the law on the subject is this: that you cannot have a patent…for applying it to an operation which is exactly analogous to what was done before'.[151] This interpretation is consistent with modern patent law, which holds that for an invention to be patentable it must involve an 'inventive step', i.e. that it would not be obvious to a person skilled in the art.[152] Towards the end of the period, however, interpretations of what constituted different or 'non-obvious' use were relaxed. In *Steiner* v *Heald* (1851), Justice Patteson found the application of a method used to extract garancine from *fresh* madder to the extraction of garancine from *spent* madder to be patentable.[153]

The legal reasoning in the Boulton and Watt cases also shows that judicial decisions were informed by the subject matter of pre-existing patent grants, and this process is similarly evident in decisions regarding the patentability of 'improvements'. The Statute of Monopolies, by referring only to patents for 'new manufacture', did not provide explicit legislative sanction for such patents. It was noted in section 3.2.1 that the Privy Council annulled Clay's patent in 1717 on the grounds that his invention was a mere improvement. Similarly, in 1725 one lawyer quoted Lord Coke, that 'if the substance was in *esse* before, and a new addition thereunto, though that addition make the former more profitable, yet it is not a new manufacture in law'.[154] However, as Britain developed technologically it was no longer feasible to expect patents to be awarded for entirely new industries and as patent numbers grew so too did the number awarded for what might be considered improvements.

The patentability of improvements was definitively established at common law in *Morris* v *Branson* (1776). Defence counsel claimed that the patented invention, a set of needles to be applied to a stocking frame, was an improvement of a previous patent, and 'though that addition makes the former more profitable, yet it is not a new manufacture in law'.[155] Lord Mansfield, however, overruled this argument stating, 'if the objection to the patent on the grounds of the inventions being only an addition to an old machine were to

149 Dirk Van Zyl Smit, 'The social creation of a legal reality: A study of the emergence and acceptance of the British patent system as a legal instrument for the control of new technology', (unpublished Ph.D. thesis, University of Edinburgh, 1980), p.89
150 King's Bench. Hayward, *Patent cases*, Vol.1, p.816
151 Exchequer. Hayward, *Patent cases*, Vol.3, p.141
152 Lionel Bently, and Brad Sherman, *Intellectual Property law*, (3rd edn. Oxford, 2009), p.490
153 Exchequer. Ibid, Vol.6, p.377
154 'Gentleman of the Middle Temple', *Readings upon the Statute law*, (5 Vols, London, 1723 to 1725), Vol.4, p.241
155 Oldham, *The Mansfield Manuscripts*, Vol.1, p.745

prevail that objection would go to repeal almost every patent that was ever granted' and found in favour of the plaintiff.[156] This case was subsequently cited as precedent allowing patents for 'improvements'. By the time of *Boulton and Watt* v *Bull*, (1795), Justice Buller could state 'since that time [in *Morris* v *Branson*] it has been generally received opinion in Westminster Hall, that a patent for an addition is good.[157]

Thus from an early period it had been established at common law that improvements and methods could be patented. The decisions in *Morris* v *Branson* and *Boulton and Watt* v *Bull* represent legal confirmation of standards of patentability applied during the patent petition. Nonetheless, it was still important to anchor this practice in common law, as evidenced by the opinions of Justice Heath and Justice Buller in *Boulton and Watt* v *Bull*. Once these fundamentals were established the courts continued to elaborate on them. Indeed the trend of judicial precedent moved in favour of the rights of patentees vis-à-vis the public.

Section 3.4.2
Novelty requirements

The trend whereby the precedent of patent law imposed fewer demands on patentees is also evident in the second area of patent law considered here: novelty requirements. In English law, it was not the first inventor alone who had the sole right to patent an invention. It was possible to import and patent an invention as long as it was new in the United Kingdom. It was also possible to patent a previously secret invention. The fundamental requirement was to be the first 'publisher' of an invention. These limited novelty requirements originated from the Elizabethan period when England was a technological laggard and it was hoped that the provision of patents would encourage the importation of continental technology.[158] In this sense the decision in *Edgeberry* v *Stephens* (1692), holding that an importer of an invention could also patent it, was only confirmatory of prior practice.[159] Legally, the status of the first 'inventor' and the first 'importer' were almost identical. In *Berry's Patent* (1850), a patentee of an imported invention sought an extension to their patent. Although, the proposed extension was challenged on the grounds that the first importer did not have the same rights as the first inventor, Lord Brougham overruled this argument, stating that the importation of inventions provides 'a benefit to the public incontestably, and, therefore, they render themselves entitled to be put upon somewhat, if not entirely, the same footing as inventors'.[160]

The right to claim a patent for an imported invention was reviewed at common law in *Beard* v *Egerton* (1846). This case regarded the infringement of the daguerreotype, an early and popular form of photography. The defence claimed that the French Chamber of Deputies, by paying Monsieur Daguerre an annual pension of 6,000F for the secret of the invention, had made such a publication of the invention as to debar Daguerre and his agents from patenting the invention in the United Kingdom. 'The defendants therefore submitted that it would be a fraud upon the French nation and the world at large if a monopoly of

156 Carpmael, *Law reports*, Vol.1, p.34
157 Hayward, *Patent cases*, Vol.1, p.388
158 MacLeod, *Inventing the Industrial Revolution*, (Cambridge, 1988), p.13
159 King's Bench. Hayward, *Patent cases*, Vol.1, p.389
160 Judicial Committee of the Privy Council. Ibid, Vol.6, p.30

the invention could be subsequently secured by patent in this country'.[161] This argument was, however, rejected by Justice Cresswell declaring, 'the circumstance of the invention being well known and in common use in a foreign country is no bar to the validity of a patent here'.[162]

Consistent with the primary importance of publication in the British patent system, it was possible to patent an invention that had been previously used in secret. This was confirmed at common law in *Dollond* v *Champness* (1766). Although the patented invention had already been invented by a Dr Hall some thirty years before 'it was holden that as Dr Hall had confined it to his closet…and the public were not acquainted with it Dolland was to be considered the first inventor'.[163] Likewise, in *Forsyth* v *Riviere* (1819), Chief Justice Abbott declared 'the law not requiring that the patentee should be literally the first inventor…it is sufficient if the patentee be the first publisher'.[164]

Of course, prior public use of an invention would invalidate any subsequent patent, and the definition of 'public' use or publication was strict. In *Carpenter* v *Smith* (1841), Lord Abinger annulled a patent for a lock as it had been used on a gate before the patent was granted; 'public use means this, that the use of it shall not be secret, but public; and in that sense I must say, that if you think the lock used by Mr Davies is a lock which combines the same thing…I think that is a public use of it'.[165] However, the authority of this verdict was overlooked ten years later in *Hancock* v *Somervell* (1851). At trial it was established that a Mr Goodyear had marketed and sold a new type of rubber (or caoutchouc) before Hancock had patented its manufacture. Indeed, Hancock had only been able to discover the new process of manufacture by experimenting on a sample of Goodyear's rubber. Summing up Judge Williams held that 'if you should find that the material was in public use, but that, notwithstanding it were so, the invention remained still a matter to be discovered, why then in my opinion the plaintiff's case would not be affected'.[166] This was a lenient interpretation of patent law. The judge claimed that the process of manufacture was not discoverable by the rubber itself, yet it had already been established that this was precisely how Hancock had uncovered the process. Hancock won, barring Goodyear from selling his own rubber composition.

This circumvention of apparently relevant precedent was not an isolated occurrence. In *Bloxam* v *Elsee* (1825), it was established that when the invention (a machine for making paper) was being developed, a Mr Donkin had been employed to assist in improving the machinery.[167] As a result, Justice Bayley ordered the patent to be annulled: 'it is laid down, that if a servant make an improvement, his master is not entitled to take out a patent for it'.[168] Twenty years later this matter was revisited in *Allen* v *Rawson* (1845), where again it was established that an employee had suggested improvements to machinery later patented by the plaintiff. However, because these suggested improvements did not concern the 'principle' of the machine, it was

161 Chancery. Ibid, Vol.5, p.223
162 Ibid, p.234
163 Common Pleas. Ibid, p.166
164 King's Bench. Ibid, p.788
165 Exchequer. Ibid, Vol.3, p.755
166 King's Bench. Ibid, Vol.6, p.333
167 King's Bench. Ibid, Vol.1, p.887
168 Common Pleas. Ibid, p.888

decided that *Allen* could be 'determined without the assistance of the doctrine of *Bloxam* v *Elsee*'.[169] Chief Justice Tindal concluded 'I think it is too much that a suggestion of a workman, employed in the course of experiments, of something calculated more easily to carry into effect the conceptions of the inventor, should render the whole patent void'.[170] These decisions confirm the realignment between the rights of patentees and the public that was occurring in the second quarter of the nineteenth-century.

Section 3.4.3
The specification

This realignment is also evident in the third area of patent law examined here, the specification. As the consideration on which the patent was granted, the criteria of sufficiency were strictly enforced. In *Turner* v *Winter* (1789), Justice Buller held that any 'slight defects in the specification will be sufficient to vacate the patent'.[171] Also, until 1835, once entered at Chancery a specification could not be altered. If defects were realised after entry there was no available remedy. *Turner* v *Winter* was cited on a regular basis, for example , in *Hill* v *Thompson* (1818), Justice Dallas commented 'in that case, as in a great variety of others, instances may be found to show the strictness of the law, as bearing upon this point, either in regard of omission or of superfluous addition, or of uncertainty or insufficiency in quantities proposed'.[172] It is clear from the 1829 Select Committee on patents that patentees felt vulnerable due both to the strict requirements of the specification, but also at what they perceived to be the technical illiteracy of the courts in deciding these cases. Mark Isambard Brunel stated 'I might as well toss for the fate of a patent; it is an intricate question for a jury, and in many cases it is quite unintelligible to them'.[173] Others, however, were more circumspect, the engineer John Farey observing 'from my experience in the proceedings of courts, I have not been inclined of late years to complain of the administration of the patent law'.[174]

In time however, minor mistakes were excused in the specification. In *Crossley* v *Beverley* (1829), Lord Tenterden stated, 'it is a hard case to set aside the whole patent because there is some little matter in it which is not quite right' and the patentee won.[175] Later in *Neilson* v *Harford* (1841), Lord Abinger held, 'if the patentee sufficiently describes the mode of operation but makes a mistake in a matter known to everybody acquainted with the subject…such a matter does not invalidate the patent'.[176]

Similarly, the requirement that the specification had to describe the best method of using the invention without the help of experiments was relaxed. In *Rex* v *Wheeler* (1819) Chief Justice Abbott was unequivocal on this point; 'a specification which casts upon the public the expense and labour of experiment

169 Ibid, Vol.5, p.37
170 Ibid
171 King's Bench. Ibid, Vol.1, p.328
172 Common Pleas. Ibid, p.736
173 *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.174
174 Ibid, p.151. In general patent agents were more bullish regarding the efficacy of patent law. Moses Poole commented sanguinely, 'I have no particular views, I do not see any defect in the present law; perhaps the specification might be made more sure'. Ibid, p.82
175 King's Bench. Hayward, *Patent cases*, Vol.2, p.22
176 Chancery. Ibid, Vol.4, p.487

is bad'.[177] Over time, however, the judiciary began to appreciate that it might not always be possible to state an invention in such terms as to preclude the need for experiment to divine the most beneficial way of working an invention. In *Neilson* v *Harford* (1841), Baron Parke, while insisting that 'if experiments were necessary to produce any degree of benefit under the specification then…the patent is void', recognised that 'in order to make the greatest improvement, unquestionably many experiments are necessary'.[178]

The relaxing of the requirements imposed on the patentee may be attributed to a growing familiarity amongst the judiciary of the practical demands of invention and specification. At the beginning of the nineteenth-century, it was often difficult to communicate new technology on paper with accuracy and the decisions mentioned above indicate an increasing sensitivity to these problems.[179] This appreciation of the technical demands of accurately specifying an invention may be attributable to the career paths of senior judges - many had once been law officers. For example, the three most senior judges in common law were the Chief Justice of the King's Bench, Chief Justice of the Common Pleas and Chief Baron of the Exchequer. Between 1800-52, of the twenty-two judges who held one of these positions, sixteen had previously been a Solicitor and/or Attorney-General.[180] In the course of their tenure they would have inevitably acquired a degree of technical knowledge from the petitions they reported on and the caveat hearings they decided.[181] The developments in patent law might also be related to the growing esteem in which inventors were more popularly held. MacLeod notes that by the mid-nineteenth century the public accorded many inventors and engineers 'heroic' status. During the campaign for patent reform, *The Times* declared inventors, 'the elect of the human race'.[182] It is possible that the judiciary were influenced by these cultural trends as well.

Section 3.4.4
The "Letters Patent for Inventions Act" 1835

Although these precedental developments benefited patentees, there was increasing agitation for statutory reform of patent law and the patent system. The direct legislative basis of the patent system rested on a single clause of the Statute of Monopolies (1624). The judiciary though proved adaptable in their interpretation of related legislation. For instance, in *Boulton and Watt* v *Bull* (1795), Chief Justice Eyre invoked the example of Hartley's Patent to support the patentability of methods.[183] In 1777, the British parliament had awarded Mr Hartley an extension on his patent term of thirty-one years. Significantly the patent was for a 'method of applying iron plates to cover the wood-work of buildings and ships, so as to prevent the access of fire' and

177 King's Bench. Ibid, p.800
178 Exchequer. Ibid, Vol.4, p.424-426. Later in *Bridson* v *Benecke* (1849), Lord Langdale 'thought that even the best mechanic would have to make some trial or other of a new invention before he succeeded; but the specification ought to be so drawn, that when such experiment was fairly made it should succeed'. Chancery. Ibid, p.912
179 Cornish, 'Personality rights', p.949
180 Many senior judges in the eighteenth-century had also served as law officers. However, because there were fewer patent petitions, they would have held far fewer caveat hearings. Details relating to the careers of these judges was obtained from Henry Matthew and Brian Harrison (eds.), *Oxford Dictionary of National Biography*, (Oxford, 2004)
181 Between 1838-47 the Attorney-General averaged 115 caveat hearings every year, the Solicitor-General 62. For more details see table 2.1.
182 MacLeod, *Heroes of invention*, p.183
183 Common Pleas. Hayward, *Patent cases*, Vol.1, p.390

Eyre chose to interpret this as a general legislative sanction for the patentability of methods.[184] Nonetheless, the equitable verdict was occasionally precluded by this lack of positive statutory law. In *Minter* v *Williams* (1835), it was established that the defendant had 'exposed to sale', chairs identical to the patentee's. However, defence counsel noted that 'in statutes, where it is intended to make the exposing to sale a specific offence express words are used'.[185] Because this phraseology was omitted by the Statute of Monopolies the judges were forced to declare that there had been no infringement.

The only significant piece of legislation regarding patent law between 1624 and 1852 was the "Letters Patent for Inventions Act" passed in 1835. Although championed by Lord Brougham (Lord Chancellor until 1834) the result was a fairly limited piece of legislation that remedied a number of specific flaws rather than overhaul the entire system. Perhaps the most important change introduced by the act was the disclaimer to the specification. This permitted the patentee to disclaim any portion of the specification that would otherwise render it invalid.[186] As discussed in section 3.4.3, the prohibition on changes to the specification was a source of great trouble for patentees. The judiciary approved of this change. In *Morgan* v *Seaward* (1836), Justice Alderson noted 'by application that part of the patent might be struck out and then the other part of the patent would stand good…that is an improvement introduced into the patent law by Lord Brougham and a good one it is'.[187] However, the introduction of disclaimers confused the issue of infringement. If the patent would once have been invalid but was afterwards amended in accordance with the act, would a party be liable for an infringement of a patent before the disclaimer had been entered? Lord Abinger in *Perry* v *Skinner* (1837), held that this was not so, 'the act would be unjust if it made a man who was acting consistently within the law at a certain time, subsequently a wrong-doer by relation'.[188] This judgement, however, implied that a patent was only in force from the time when the disclaimer was entered, and not when the original patent was sealed. In *Stocker* v *Warner* (1845), the defence cited Lord Abinger on precisely this point. Their argument, however, was rejected by Justice Erle stating 'where a disclaimer is entered as to part of a patent, the amended patent has all the incidents of a valid patent from the date of the original grant'.[189] Similarly in *Rex* v *Mill* (1850), Chief Justice Jervis impeached the authority of *Perry* v *Skinner*, 'I think on the construction of the Act the disclaimer must be read as part of the patent from the time when the patent is granted'.[190] The disclaimer undoubtedly strengthened the position of patentees at law. Before they had been in danger of having their entire patent invalidated for minor mistakes in the specification. This law, by allowing patentees to disclaim parts of their specification, removed this vulnerability.

The Act also introduced changes in the pre-trial proceedings which were designed to benefit patentees. Before 1835, when an action was brought for the infringement of a patent, the only plea available

184 *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.174
185 King's Bench. Hayward, *Patent cases*, Vol.2, p.458
186 The disclaimer, however, did not permit the patentee to enlarge or re-draft the specification.
187 Exchequer. Ibid, p.767
188 Exchequer. Ibid, Vol.3, p.212
189 Common Pleas. Ibid, Vol.5, p.216
190 King's Bench. Ibid, Vol.6, p.132-134

to the defendant was the general issue. This meant that the defendant pleaded against every individual allegation made by the patentee in his initial declaration, placing the onus on the plaintiff to prove every part of their case. The Act prevented defendants from pleading the general issue, obliging them to place all matters into separate pleas.[191] The new pleadings, however, failed to reduce the scope of trials. Defendants, prevented from pleading the general issue, simply challenged every argument made by the plaintiff. In *Rubery* v *Barrs*, (1843), the Attorney-General bemoaned 'it has been, as I predicted it would, nearly an epitome of every objection that ever was taken in any patent case'.[192]

A further change to the pleadings was the requirement that defendants provide full details of any objections to the validity of a patent before trial. However, as Justice Cresswell observed, 'it is difficult to lay down any general rule as to the particularity required in notices of objection in this nature', and there was little consistency in the application of this rule. There was confusion over what information was required in the objections. For example, were defendants obliged to name parties supposed to have used the invention before it had been patented? In *Bulnois* v *MacKenzie* (1837), it was held that the defendant was not obliged to give the names and addresses of those who were alleged to have used the invention before the patent[193] whereas in *Jones* v *Berger* (1843) the defendants were ordered to divulge this information.[194] This was in turn rejected by Justice Henderson in *Russell* v *Ledsam* (1843) who stated, 'on consideration of the matter, however we think that we ought to abide by the cases of *Heath* v *Unwin* and *Bulnois* v *MacKenzie* and that no particulars…should be required'.[195] This decision effectively rendered the fifth clause of the Act nugatory.

Regarding pre-trial proceedings the legislation was a failure. The novel introduction of detailed objections only served to make proceedings more convoluted and time-consuming, securing no advantage to anyone. There were then limitations to the efficacy of patent law during this period. Despite the best efforts of the judiciary, the statutory basis for much of this period was limited, and occasionally prevented the 'equitable' verdict. The Letters Patent for Inventions Act was only partly successful in remedying some of these shortcomings, and suffered from poor legislative draughtsmanship. Considering the limited statutory base of the patent system, however, it is remarkable that the legal system was able to generate such a wide-ranging and effective body of judicial precedent concerning patents. This was the view of the judiciary at the end of the period. In *Household Iron Company* v *Neilson* (1843) Lord Brougham declared patent law to be a 'matter of as perfect certainty, as thoroughly known, and as little drawn into doubt in Westminster Hall…as any branch of the law most commonly known and frequently administered by our Courts'.[196]

191 This brought patent litigation into line with new restrictions on pleading the general issue at common law, introduced a year earlier. The new pleadings were introduced in the hope that by obliging defendants to elucidate their defence in separate pleas, the dispute could be defined and clarified prior to trial. Baker, *English Legal History*, p.90
192 Common Pleas. Hayward, *Patent cases*, Vol.5, p.171. The new pleadings also failed to clarify disputes for other types of trials, and in 1852 common law pleadings were reformed once again. Baker, *English Legal History*, p.90
193 Common Pleas. Hayward, *Patent cases*, Vol.3, p.32-34
194 Common Pleas. Ibid, Vol.4, p.695
195 Exchequer. Ibid, Vol.2, p.281
196 House of Lords. Ibid, Vol.4, p.527. Brougham, however, was apparently 'vain' and 'self-seeking', and in light of his own efforts at patent reform, this comment might be taken with a pinch of salt. Michael Lobban (2008), 'Brougham, Henry Peter, first Baron Brougham and Vaux (1778–1868)', Oxford Dictionary of National Biography (online edn.), http://oxforddnb.com/view/article/3581, accessed 23rd October 2012

This period then experienced a rapid accumulation of legal precedent. Major cases at common law in the second half of the eighteenth-century formed important precedent that were cited on a regular basis. The patenting of additions and improvements, which had once been vulnerable, certainly in the Privy Council, were after *Morris* v *Branson* (1776), legally secure. Further, the patentability of manufacturing methods and chemical processes was established at law before 1800. Perhaps the one area where patentees were vulnerable was the specification. The criteria adopted by the judiciary was very strict, although this was partly because of the emphasis placed on the specification as the consideration on which the patent was awarded. However, the criteria by which the specification was assessed became more relaxed by the second quarter of the nineteenth-century.

Conclusion

A close reading of contemporary court cases, patent treatises and law tracts, demonstrates that there was a considerable expansion and elucidation of patent law from the second half of the eighteenth-century onwards. This is not attributable to any change in jurisdiction, rather it was a function of the increase in the number of patents awarded and a growing appreciation of the technical demands of the specification and invention amongst the judiciary. In general this elaboration was to the benefit of the patentee. Although patentees complained of the uncertainty of the law before the parliamentary select committees, by the end of the period the rights of patentees were being privileged over the rights of the public. Also significant, many of these cases were reported, in the second half of the eighteenth-century by newspapers and law reports and in the nineteenth-century by a literature and magazines specifically concerned with patenting.

The argument presented in this chapter challenges every major point in the traditional narrative of patent law during this period. Firstly, the structure of the administration of patent law was different from that which has been previously suggested. The jurisdiction of the Privy Council in patenting had begun to decline before 1700 and was of marginal importance long before 1753. Rather the equity and common law courts had jurisdiction over patent cases throughout this period. In particular, where a patent had been in force for some years, or had already been enforced with success, the equity courts provided patentees with rapid and effective injunctive relief from the activities of infringers.

Secondly, whereas it has been claimed that there was endemic judicial bias against patenting before 1830, here it has been proposed that the judiciary accepted a recognisably 'modern' rationale for the patent system from, at the latest, *Yerbury* v *Wallace* in 1768, and this was founded on the specification requirement. This implies a sophisticated conceptualisation of the patent grant. Rather than representing a privilege that could be arbitrarily revoked, the patent grant was a property right comparable to the modern patent grant as 'intellectual property'. This is supported by how patent cases were adjudicated by principles of law imported from analogous areas of law, especially copyright and land.

Thirdly, the outcome of these conceptual developments was a rapid accumulation and elaboration of legal precedent. For example, whereas Dutton suggested that it was only in 1842 that the legality of patents

for methods was established at common law, here it has been demonstrated that this had been established forty-six years earlier in *Boulton and Watt* v *Bull* (1795). Even then the decision in this case was confirmatory of previous practice.

This is not to suggest that the operation of patent law was universally beneficial to patentees and inventors. In particular, the strictness with which the specification was assessed until c.1825 was productive of much trouble and insecurity for patentees. Similarly, despite the best efforts of the judiciary, the lack of useful statutory law produced confusion and inconsistency. However, on balance the structure of patent law, the ready access to injunctive relief, the legal rationale for the patent grant and the development of legal precedent all served to consolidate the security and certainty of the patent. As will be discussed in chapter 5 it also facilitated the assignment and licensing of patents, serving to maintain the value of the patent right during the industrial revolution.

Chapter 4

Patents and the diffusion of technology

Chapter 1 discussed the potential role of patents in enabling the diffusion of new technology. In theory, this can be achieved in three ways. Firstly, by compelling an inventor to produce and submit a written description of their invention (in return for the patent right), the patent system ensures the latest technical information is available to other inventors and manufacturers. Secondly, the promise of a legally enforceable right to exclude other parties from using an invention encourages inventors to eschew the uncertainties and limitations of secret working as an alternative strategy to maintaining a monopoly. Thirdly, by defining and delineating property rights in technology, patents facilitate the licence and sale of technology to other users.

This chapter is concerned with examining these first two processes and currently there is some uncertainty as to whether the pre-reform patent system facilitated either. Dutton and MacLeod agree that before the second quarter of the nineteenth-century specifications were normally of a poor quality, revealing little about the invention. When they were first introduced, in the absence of any official or judicial guidance, it is unlikely that many patentees understood the purpose of the specification or how detailed it was expected to be.[1] Later, during the first quarter of the nineteenth-century, MacLeod argues that as a specification was unlikely to be deemed sufficient in court, patentees could enter an intentionally obfuscatory specification and retain the trade secret, while exposing the validity of their patent to little additional risk.[2] It was only with the growing availability of specialised technical and legal assistance in the 1830s and 40s that the general quality of specifications began to improve.[3]

Neither was any administrative effort made to disseminate the specification, once deposited. Before 1852 there were no official series of published specifications and those that did appear in print were published by the commercial press. Only a fraction of specifications though, were apparently printed. MacLeod estimates that the *Repertory of Arts*, the only periodical publishing specifications between 1794 and 1820, carried just a quarter of the total entered at Chancery.[4] Instead, to consult a specification, one had to search the three Chancery offices where it could have been deposited (the Enrolment Office, Rolls Chapel or Petty Bag Office) in person. Substantial fees were levied for providing office copies and, to protect their income, officers prohibited visitors from writing personal extracts. Such were the problems involved with consulting specifications, MacLeod claims that 'it was quite feasible…for a patentee to attempt to work his

1 Christine MacLeod, *Inventing the Industrial Revolution, the English patent system, 1660-1800*, (Cambridge, 1988), p.50
2 Christine MacLeod, 'The paradoxes of patenting: Invention and its diffusion in eighteenth and nineteenth-century Britain, France and North America', *Technology and Culture*, 32, (1991), p.898
3 Harold Dutton, *The patent system and inventive activity during the Industrial Revolution: 1750-1852*, (Manchester, 1984), p.92
4 Christine MacLeod, 'The paradoxes of patenting', p.897

patent in secrecy'.[5]

This chapter re-examines the dissemination of technology as embodied in the specification and is divided into two sections. Section 4.1 will look at the technical quality/accuracy of the submitted specification and the availability of these office copies. Section 4.2 will look at the publication of specifications in contemporary technical magazines, and the circulation of this literature. The following chapter will discuss how the market for patent rights also helped to disseminate technology.

Section 4.1
The preparation of specifications and the Chancery offices

The previous chapter discussed how the patent was perceived as a contract, where in return for the patent, the inventor provided the public with a definitive written statement of the patented invention. It is generally thought that this contractual conceptualisation of the patent was first promulgated by Lord Mansfield in *Liardet* v *Johnson* (1778). However, it was argued that the patent was conceived as a contract before that date. Although, first introduced at the behest of petitioners anxious to secure themselves against piracy before their patent was sealed, it is apparent from the law officer reports that the specification soon began to transmute into the condition on which the patent was granted

However, there are two practical problems with arguing that the specification was the condition on which the patent was awarded (at least before 1778). Firstly, if the legal status of the specification was so important, why did so many inventors apparently enter misleading specifications? Secondly, if the specification was intended to inform the public, why was it virtually withheld from them? This section will begin by discussing how patentees prepared their specifications, examining in particular their quality and accuracy. If the specifications entered were obfuscatory and misleading then their subsequent dissemination, rather than inform the efforts of other inventors and potential users, would have misdirected and frustrated them. The section will then describe the administrative practice of the offices in Chancery where specifications were kept and their availability to the public.

MacLeod argues that misleading specifications were intentionally submitted because, counter-intuitively, off the strictness with which their sufficiency was assessed. Because it was so unlikely that a specification submitted to court would be deemed sufficient, inventors could enter an intentionally elusive description without undermining their (limited) chances of success in litigation.[6] It would also have the advantage of retaining to them an element of secrecy regarding the nature of their invention. Certainly, in the first few decades after the specification was introduced misleading descriptions were submitted. For example, in 1760 David D'Escherny reported a conversation with a London chemist where he 'asked him why the manner of making up and giving his Remedy was not in the Office in a right Method', whereupon 'he smiled and with great assurance told me, "can you imagine we will pay near eighty pounds for a patent

5 Christine MacLeod, 'Strategies for innovation: The diffusion of new technology in nineteenth-century British industry', *Economic History Review*, 45, (1992), p.289
6 MacLeod, 'The paradoxes of patenting', p.898

and set all the Apothecaries in Town to work'".[7]

Over time, however, inventors became far more diligent in their preparation of the specification *because* of the legal emphasis placed on its accuracy. In 1769 James Watt took great pains preparing his specification, corresponding extensively on the matter. His correspondence with Dr William Small makes his motivation clear: 'as I have been informed that some patents have been defeated because the specification was not clear enough to enable other people to execute the scheme, I have added descriptions of the machines with drawings'.[8] This comment also confirms that the specification requirement was enforced at law prior to *Liardet*. Later, before the 1829 Select Committee, on being asked as to the likelihood of misleading specifications being entered, the engineer John Farey stated, 'I am certain there has not been one case in a hundred where the patentee has shown the least disposition to conceal anything…[he] would be stupid to attempt concealment, for such attempts must prove abortive'.[9]

That inventors responded this way is quite logical. The supposition on which MacLeod argues inventors were supposed to enter misleading descriptions - that they had no realistic chance of having their specification accepted in court - was disproved in section 3.2.2, where it was established that before 1830 patentees won half their court cases. Because defendants invariably impugned the sufficiency of the specification this shows that courts were not hell-bent on rejecting every specification (although sufficiency criteria were strict). Because patentees had a reasonable chance of passing their specification through court, any patentee intentionally entering a weak specification was undermining the enforceability of their patent, without cause.

Further, as was discussed in section 2.3.2, inventors incurred large fees hiring professional assistance to ensure that their specifications were accurate. In the 1829 Select Committee, it was reported that the charges for preparing the specification could be as high as £200, although the average was nearer £20.[10] The work of James Harrison shows that from the last quarter of the eighteenth-century, there was a milieu of qualified technical advisers, providing inventors with technical help in developing their nascent invention and preparing their specification. Harrison quotes Samuel More, the Secretary to the Society of Arts between 1769-99 complaining 'no man in the United Kingdom is so often consulted upon patents as I am and who gets nothing by it'.[11] The use of professional draughtsmen to assist in preparing the specification also militated against the deposit of intentionally misleading descriptions. Such professionals had no interest in concealment and would have been in danger of their reputations if the description proved deficient.

7 David D'Escherny, *Reflections upon patents, relating to the abuses of that noble privilege and proposing the means to reform them,* (London, 1760), p.6. This may have been Dr James, who sold a fever powder, apparently curing, gout, rheumatism, scurvy and a host of other ailments. James was probably less concerned with having an enforceable patent (if he had, he would have entered a proper specification), but with using the patent as a marketing device. Lionel Bently, 'Patents and trade secrets in England: The case of *Newbery* v *James*', mimeo, (2012), p.4

8 On the advice of Dr William Small though, Watt omitted the drawings, which may have contributed to his subsequent legal troubles. Boulton and Watt Papers (on microfilm), James Watt to William Small 28th Janurary 1769, Cambridge, University Library, Part 1, Reel 1, Item 4.

9 *Report from the Select Committee on state of law and practice relative to patents for inventions*, (Parl. Papers, 1829, III), p.139

10 Ibid, p.17

11 James Harrison, *Encouraging innovation in the eighteenth and nineteenth centuries: The Society of Arts and patents, 1754-1904,* (Gunnislake, 2006), p.109

Perhaps the one factor that did frustrate the entry of accurate specifications was the limited time period the inventor had in which to prepare it. Before 1830, patentees normally had to enter their specification within two to four months after the patent had been sealed. The engineer John Farey complained that he was 'frequently obliged to keep people working day and night, I have sat up all night many times myself' to prepare the specification on time.[12] From 1830, however, patentees began to disencumber themselves by claiming it was their intention to apply for patents in Scotland and Ireland, giving them another two or four months to prepare.[13]

There is little reason then to suppose that the specifications entered by inventors were purposively unclear (at least after c.1760), although until professional assistance became widely available there were some inventors who were unsure on what information was necessary to complete a sufficient specification, viz. Watt's ultimate failure to provide drawings with his specification for the separate condenser. However, with the development of patent agents and technical consultants in the last quarter of the eighteenth-century, it would have been a negligent inventor who unwittingly entered a faulty specification. Indeed the judicial emphasis placed on the accuracy of the specification had precisely the effect intended, i.e. to oblige inventors to enter as full and precise a description of their invention as possible.

Once completed, specifications could be deposited into one of three Chancery offices: the Petty Bag, the Enrolment Office or the Rolls Chapel. Conveniently, each maintained calendars of the specifications and other instruments entered in their office, and which the public were free to consult.[14] Small fees were levied for consulting the original specifications. In 1846 (as in 1803, the earliest date for which a record of the fees charged survives), the Rolls Chapel and the Enrolment Office both charged a shilling for a search and inspection, while the Petty Bag charged 3s. 6d.[15] It was, however, expensive to acquire copies of specifications from these offices, especially on long ones with numerous technical drawings. The Clerk of the Petty Bag, Francis Abbott, stated that office copies could cost up to £40, probably beyond the budget of all bar publishers and the most determined (and resourced) private individuals.[16] Further, to protect the income from fees (the clerks in these offices were unsalaried) the taking of extracts was forbidden, although consultations were allowed to continue over a number of days.[17]

It was then quite cheap to consult specifications and, before 1820, many felt that they were *too* readily available, especially for foreigners. In 1793 a Bill was introduced to the Commons to allow the filing of secret specifications, as 'such inrollment copies thereof may be obtained by foreign agents and emissaries

12 *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.29

13 Chapter 2 discussed how patentees were given six months to prepare their specification if, in their affidavit, they claimed it was their intention to apply for Irish and Scottish patents, as well as an English one. Of 180 English patents in 1830, 144 claimed it was their intention to apply for Scottish and Irish patents as well, and so were given six months to enter the specification. In the same year, however, only seven English patents were also awarded in Scotland and Ireland. Bennet Woodcroft, *Chronological Index of patents, 1617-1852*, (London, 1854)

14 John Collier, *An essay on the law of patents for new inventions*, (London, 1803), pp.195-198. As mentioned above, patent agents also maintained lists for the use of their clients.

15 For fees in 1803 see John Collier, *An essay on the law of patents for new inventions*, (London, 1803), pp. 198-200. The fees for 1846 are from William Hindmarch, *The law and practice of letters patent for invention*, (London, 1846), p.615

16 *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.60

17 Ibid, p.61-62

and transmitted to foreign countries…to the disadvantage of the trade of this kingdom'.[18] In 1801 when Matthias Koop was petitioning to be allowed to enter a secret specification, James Poole warned that 'foreigners or any other persons may obtain copies…by paying certain accustomed fees, which are small'.[19] This concern persisted to an 1820 attempt at wholesale reform of the patent system, where it was proposed that specifications could only be consulted after a party had entered an 'affidavit and motion in court'.[20]

Concomitantly, specifications in the offices were regularly consulted, and (despite the expense) copies ordered. In 1767, Wedgwood ordered a partner to obtain a copy of Count de Laucaquais's specification, 'letting the cost be what it will'.[21] Later, in 1832 William Carpmael wrote, 'it is constantly the practice, as soon as a new and useful invention comes out, for persons in the particular branch of trade to which it relates to get copies of the specification, with a view to take opinions of scientific individuals acquainted with the law to ascertain whether the specification is…sufficient'.[22] For those resident outside London it was possible to spare oneself the expense of travelling to Chancery by engaging a friend or agent to peruse specifications on your behalf. In 1816, James Poole was charging 3s. 6d. to consult a specification on behalf of a client.[23]

Subsequently, these office arrangements came to be viewed as unsatisfactory, a development that can probably be attributed to the wider Treasury reforms and the rationalisation of government administration. In 1851 Bennett Woodcroft had claimed that 'the specification is virtually withheld from the public', although this was hyperbole on Woodcroft's part.[24] Specifications were easy to find (thanks to the office calendars, and lists maintained by agents), and cheap to consult. The only major expense was incurred when someone sought an office copy of the specification and, as shall be discussed in the next section, fair copies of most specifications could be found in technical magazines and periodicals after 1794. Finally, because a specification would be closely scrutinised in the event of legal action, the large majority of patentees were diligent in entering accurate descriptions of their inventions.

Section 4.2
The publication and distribution of specifications

Before reform in 1852 no government attempts were made to publish or disseminate patent specifications beyond the Courts of Chancery in London, Edinburgh and Dublin. If a patent was only obtained in England,

18 *A Bill intituled an Act for securing the rights of patentees in certain cases from the encroachments of foreigners*, (Parl. Papers, 1793) p.2
19 *Report from the Select Committee to whom the petition of Matthias Koop, respecting his invention for making paper from various refuse materials, was referred*, (Parl. Papers, 1801, III) p.7
20 *A Bill to prevent the inconvenience arising from the facility of procuring copies of specifications inrolled by grantees of letters patent, for the sole working and vending of new manufactures within this realm*, (Parl. Papers, 1820, I) p.5
21 Dutton, *The patent system*, p.185
22 William Carpmael, *The law of patents for invention, familiarly explained*, (London, 1832), p.45
23 Notebook of James and Moses Poole, London, British Library, BJ00 54889, p.49
24 *Report and minutes of evidence taken before the Select Committee of the House of Lords appointed to consider of the Bills for the amendment of the law touching letters patent for inventions with appendix and index*, (Parl. Papers, 1851, XVIII), p.228

no description was sent to Edinburgh or Dublin. Some specifications, however, were printed in contemporary technical magazines. Depending on the number, quality and circulation of these reproductions, specifications could have constituted an important source of technical information during the industrial revolution. As mentioned in the introduction to this chapter though, MacLeod does not consider the publication of specifications to have been remotely comprehensive, estimating that the *Repertory of Arts* only printed a quarter of specifications after 1794.[25] In contrast, Alessandro Nuvolari has argued that there was 'a considerable amount of technical information embodied in patent specifications…in the public domain'.[26]

After the Patent Law Amendment Act in 1852, the first Superintendent of Specifications (Bennet Woodcroft) organised the cataloguing of all pre-reform patents into four indexes, the *Chronological Index*, the *Alphabetical Index*, the *Subject Index* and the *Reference Index*. The indexes contained the same patents (i.e. all those awarded in England between 1617 and 1852), but each was organised differently and provided supplementary information to the others. The *Reference Index* catalogued each reference to a patent in, broadly speaking, four types of literature. Firstly, Woodcroft included references from contemporary technical encyclopaedias such as the *Engineers' and Mechanics' Encyclopaedia*, and *Ure's Philosophy of Manufactures*.[27] Secondly, he included references from contemporary technical magazines and periodicals such as the *Repertory of Arts* and *Mechanics' Magazine*. Thirdly, he included references in contemporary treatises on the patent system such as *Godson on Patents* and *Hindmarch on Patents*. Finally, he included references to patents in legal and court reports such as the *Common Bench Reports* and *Jurist*.[28]

Central to the question of the contribution of patent specifications to the dissemination of technology is the speed with which they appeared in print. If they appeared quickly not only would it ensure that the latest technology was widely available (rather than by the time it had become obsolete), it would also forestall any attempt at secret working. Consequently, it is unclear how useful some of the literature catalogued in the *Reference Index* would have been. Many of the specifications published in the encyclopaedias, patent treatises and law reports were published some time after they had been deposited and so were presumably obsolete and/or had been disseminated through other channels. Neither did many of these publications (particularly the patent treatises and the law reports) provide much more than a cursory description of the invention.

Neither criticism, however, can be made of the contemporary technical magazines. These were published on a regular basis and were largely devoted to patenting and industrial technology. This suggests that they were important contemporary sources on these matters and this inference is supported by testimony from the parliamentary committees. Before the 1829 Select Committee, John Taylor, a manufacturer, stated 'I

25 Christine MacLeod, 'The paradoxes of patenting', p.897
26 Alessandro Nuvolari, and Valentina Tartari, 'Bennet Woodcroft and the value of English patents, 1617-1841', *Explorations in Economic History*, 48, (2011), p.102
27 For the full list of references used by Woodcroft see: Bennet Woodcroft, *Patents for invention: Reference Index, 1617-1853*, (London, 1855), pp.v-vii
28 There is one other publication used in the Woodcroft Index, 'Rolls Chapel Reports', which has proved impossible to categorise as no record to any publication with this title survives in the British Library. Judging from the *Reference Index* itself though it appears to have been an index of documents that were entered with the Rolls Chapel until around 1835. Bennet Woodcroft, *Patents for invention: Reference Index, 1617-1853*, (London, 1855)

think [specifications] are most extensively published in periodical works which are devoted to the purpose and I believe they find a sufficient sale and more within the reach of those who want this kind of information'.[29] This means it is vital to quantify how often specifications were published in these magazines. The *Reference Index* lists the following journals, with the years of publication (as found in the *Index* and the Cambridge university library integrated catalogue).

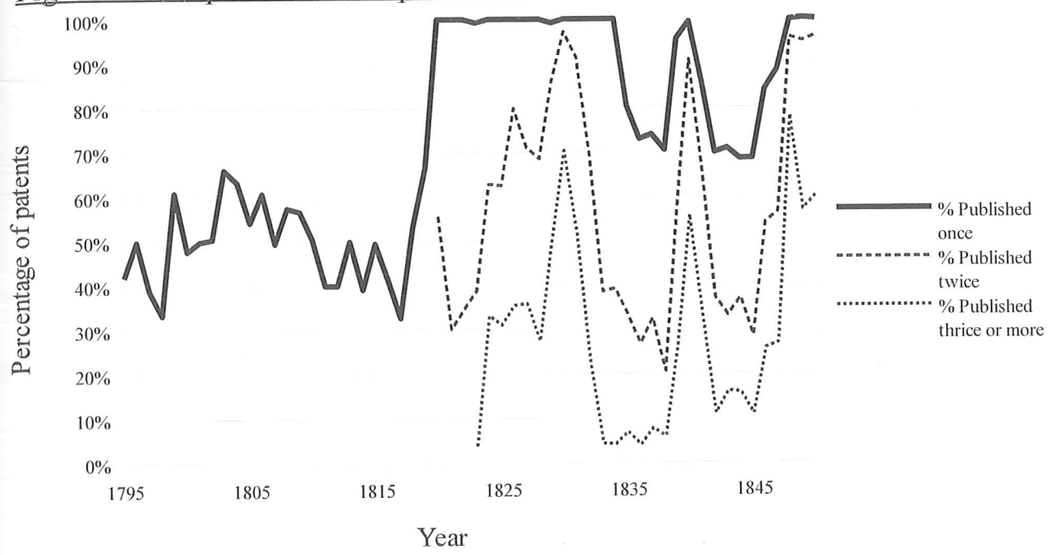
Repertory of Arts	(monthly)	1794 – 1862	
London Journal of Arts and Sciences	(monthly)	1820 – 1866	
Mechanics' Magazine	(weekly)	1823 – 1893	(re-named '*Iron*' in 1873)
Register of Arts and Sciences	(weekly)	1824 – 1832	
Engineers' and Architects' Journal	(monthly)	1837 – 1866	
Inventors' Advocate	(weekly)	1839 – 1841	
Artizan	(monthly)	1843 – 1872	
Record of Patent Inventions	(weekly)	1843	
Patent Journal	(monthly)	1846 – 1851	
Practical Mechanics' Journal	(monthly)	1848 – 1869	

To quantify how often they were published in these magazines, the number of references to each patent's specification (where the patent was granted between 1795 and 1850) was counted using Woodcroft's *Reference Index*. Because the *Record of Patent Inventions* only appeared for a matter of months (and so presumably did not have a significant circulation) it was excluded from this exercise. Also, as one of the apparent advantages of these magazines was that they could publish the specification soon after it had been deposited, it would have been preferable to impose a time limit within which a reproduction would have appeared to be counted in this exercise (for example that it appear within three years of the deposit of the original). However, calculating this for every reproduction would have been very time-consuming. A partial solution to this problem, which has been adopted, was to exclude specifications that appeared in magazines that were first published after the specification had been deposited. For example, a specification entered in 1800 that subsequently appeared in the *Mechanics' Magazine* is not included here. Therefore the maximum number of references a patent granted before 1820 can accumulate is one, as only the *Repertory of Arts* was published before that date. As will be seen below, however, this is a minor problem because these magazines were generally prompt in publishing specification.

Figure 4.1 shows the percentage of patent specifications that were either published once, twice or at least three times for every year between 1795 and 1850.

29 *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.11

Figure 4.1 The publication of specifications, 1795-1850



The graph shows five important things. Firstly, before 1820, the proportion of specifications published by the *Repertory of Arts* was not a quarter, as claimed by MacLeod, but a half. Even if the *Repertory* was the only accessible source for specifications between 1795 and 1820 (which, as was established in the discussion of the Chancery offices, it was not), this means that the chances of successfully working a patent in secret was half that suggested by MacLeod. Secondly, after 1820, the specification or an abstract of a specification was printed for almost *every* patent. Consequently, the chances of successfully working a patented invention in secret were effectively nil. Thirdly, this also means that if a misleading specification was submitted, it would be inevitably exposed by publication.[30] Fourthly, if specifications before 1830 were such poor quality, why did the *Repertory* and the *London Journal* publish so many, and for such a long period of time? Specifications were clearly a valuable source of technical information, otherwise they would not have been published at all. Finally, many specifications were published more than once. With the introduction of the *London Journal of Arts and Sciences* in 1820, in eighteen of the following thirty-one years at least half of all specifications were published twice. This means that if one magazine produced a substandard abstract or reproduction it was often possible to consult another publication. This also raises an important supplementary point. In his recent work on the *Reference Index*, Alessandro Nuvolari demonstrated that the number of references each patent garnered in the *Index* could be used as an indicator of the relative

30 Editors were not averse to impugning the sufficiency of a specification they chose to publish. For example, in 1820 the editor of the *London Journal of Arts and Sciences* commented on a specification deposited by William Hudson for manufacturing boot legs without seams, 'it is much regretted that inventors so often neglect to avail themselves of the experience and practical knowledge of those who are conversant with inventions and patents'. *London Journal of Arts and Sciences*, Volume 1, pg.23

importance of the patented invention.[31] This also means that the more important the patented invention, the more likely it was to be published multiple times.

Unfortunately, Woodcroft's *Reference Index* omits publications from the eighteenth-century, with which it would have been possible to trace the publication of eighteenth-century specifications in a similar manner. Specifications and descriptions of patented inventions did, however, find their way into print during the eighteenth-century. *The Philosophical Transactions of the Royal Society*, the foremost scientific journal of the day, contained numerous descriptions of new inventions and improvements, many of which were patented. Overleaf, for example, is a plate published in the *Transactions* for Walter Churchman's horse powered pumping engine, patented in 1733.[32] Two other patentees, who have already been mentioned, had descriptions of patented inventions appear in the *Transactions,* John Dollond whose refracting lenses were patented in 1758, and John Payne whose steam engine was patented in 1736.[33] Without trawling through all the contemporary scientific journals it is impossible to be sure what proportion of patented inventions were published during the eighteenth-century. It may not have been large though, mainly because the book and publishing trade remained relatively small until the last quarter of the eighteenth-century.[34]

Returning to the publication of specifications during the nineteenth-century, making generalised comments on the 'quality' of reproductions in these magazines is problematic. Some magazines, (for example the *Inventors' Advocate*) adopted an editorial policy of providing short descriptions of as many specifications as possible rather than publish a more detailed selection. Others, notably the *Repertory*, did set out to provide full specifications complete with drawings, although this necessarily limited the number they could carry. Printing specifications in full also became increasingly difficult as their average length grew, a trend probably attributable to increasing technical sophistication and the growing difficulty in distinguishing one's own improvement from the state of the art. By the end of the period some specifications were so large that it was impossible for a commercial publication to re-print them in full. In 1850, William Radley and Frederick Meyer entered an 18,000 word behemoth, of which the *Patent Journal* could only carry 4,500 words.[35] Similarly, the increasing number of technical drawings attached to patents meant it was difficult for magazines to publish anything but a selection of them as well.

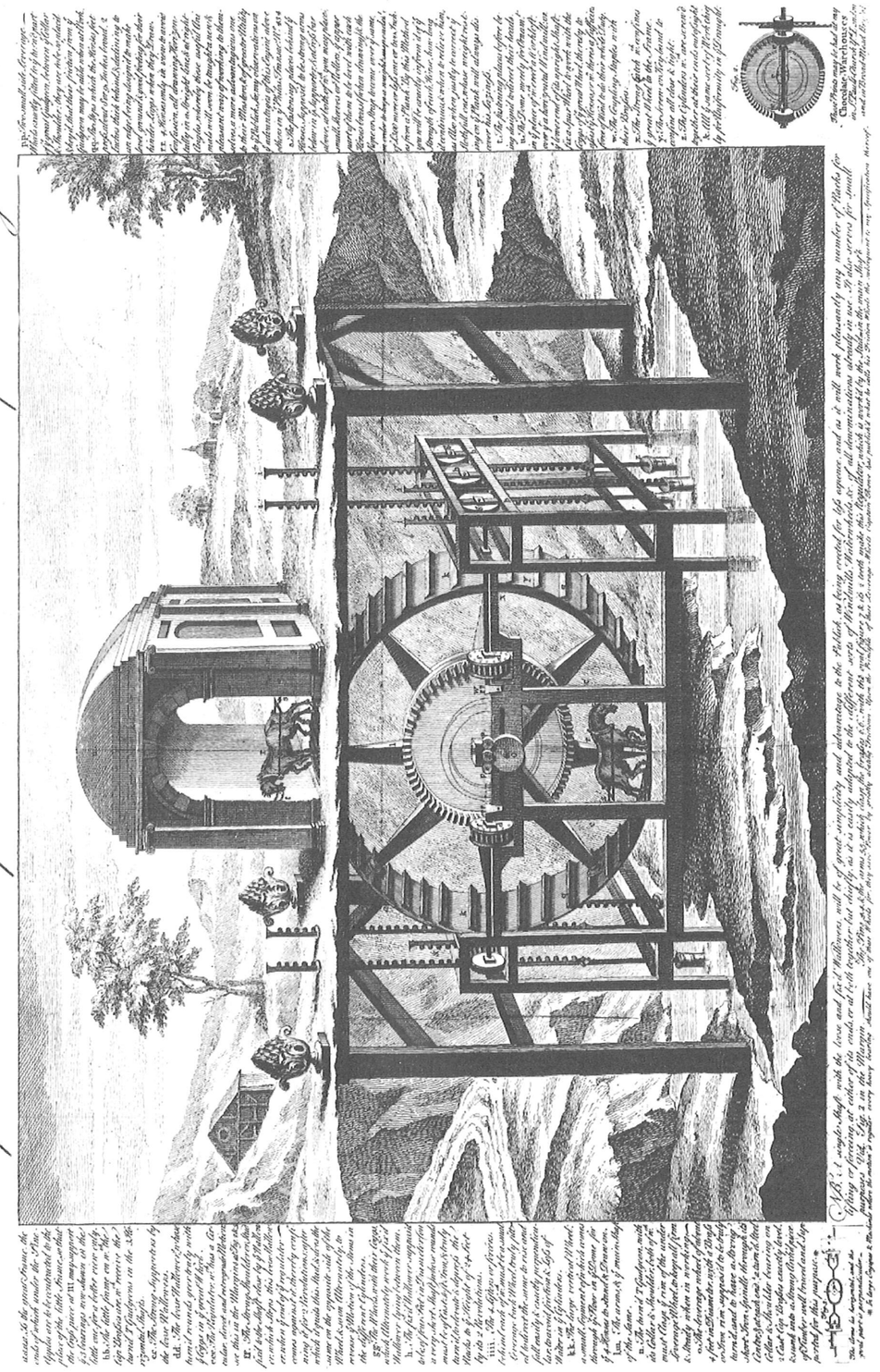
31 Nuvolari and Tartari, 'Value of English patents', p.106

32 Patent no.539 (1733). Walter Churchman, 'An account of a new engine for raising water, in which horses or other animals draw without any loss of power (which has never yet been practised) and how the strokes of the pistons may be made of any length, to prevent the loss of water, by the too frequent opening of valves, with many other advantages altogether new; the model of which was shewn to the Royal Society on the 28th November, by Walter Churchman, the inventor of it', *Philosophical Transactions of the Royal Society*, 38, (1733-34), pp.402-404

33 Patent no. 721 (1758). John Dollond and James Short, 'An account of some experiments concerning the different refrangibility of light', *Philosophical Transactions of the Royal Society*, 50, (1757-58), pp.733-743. John Payne, 'A narrative of a new invention of expanding fluids, by their being conveyed into certain ignified vessels, where they are immediately rarefied into an elastic impelling force, sufficient to give motion to hydraulopneumatical and other engines, for raising water, and other uses', *Philosophical Transactions of the Royal Society*, 41, (1739), pp.821-828

34 William St Clair, *The reading nation in the romantic period*, (Cambridge, 2004), p.19

35 The patent was awarded for 'treating fatty, oleaginous, resinous, bituminous, and cerous bodies' Patent no.13081. Bennet Woodcroft, *Alphabetical Index of patentees of invention, 1617-1852*, (2nd edn. London, 1969), p.464



In the Select Committees some witnesses expressed concern over the quality of the reproductions. In 1829, for example, Francis Abbott claimed that important specifications were not always published due to space considerations, 'and they frequently do not take those with drawings because they then save the expense of plates'.[36] In contrast, David Brewster, the scientist and principal of St Andrews University, noted

> There is the *Repertory of Arts* and other journals with the same object and also various scientific journals, which would enable any man of industry and talent in a very short time to make himself acquainted with previous inventions and discoveries…the specifications of almost all valuable inventions have appeared in the *Repertory of Arts* and other similar works so that very little labour would be necessary to complete a catalogue of them.[37]

To analyse the quality of printed specifications in more detail twenty patents were randomly chosen from 1800, twenty patents from 1810, and so on to 1850.[38] For every patent in the exercise, the original specification (if one was entered) was consulted. From the specification a word-count was estimated, and the entry date noted as well as any accompanying drawings or figures.[39] Then, for each of the 120 patents, every individual reproduction of the specification in these magazines (as recorded in the *Reference Index*) was consulted. In total there were 203 references for 111 specifications.[40] For every reproduction a word-count was estimated, along with the publication date, and whether there were any accompanying drawings. Based on the word-count each reproduction of the specification was classified as either a full specification (where the reproduction contained 80 percent or more of the original's word-count), as an extended abstract (where the reproduction contained 50 and 80 percent of the original), as a short abstract (where the reproduction contained 20 and 50 percent of the original) or as a 'notification', where less than 20 percent of the original appeared. The discussion of the results will begin by considering the *Repertory of Arts* and the *Mechanics Magazine* (leaders in their respective monthly and weekly markets) in some detail, and will then make some overall comments about the publication and availability of printed specifications.

In 1800, 1810 and 1820 of the sixty patents chosen, fifty-five had specifications entered. Of these fifty-five specifications, twenty-five appeared in the *Repertory*. All bar two of these reproductions appeared in full (i.e. with at least 80 percent of the word-count of the original). Also, of the eleven specifications that had technical drawings appended, in every instance the *Repertory* reproduced them in full. This must have represented a considerable cost to the magazine's proprietors. In 1826 for 'cheap print', it cost approximately

36 This statement is somewhat undermined by Nuvolari's finding that important inventions did tend to be published more often. Also, as clerk of the Petty Bag, Abbott had a direct pecuniary interest in people going to Chancery to consult specifications, rather than relying on copies in magazines. *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.60

37 *Select Committee of the House of Lords*, (Parl. Papers, 1851), p.227

38 The patents were chosen by dividing the number of patents awarded in that year (for example 96 in 1800), by 20 (resulting in 4.8 for 1800). The resulting figure was then used to chose which patents in that year were used. For example, in 1800 approximately every fifth patent in the series was chosen: 2369, 2374, 2379, 2384, 2388, 2393, 2398, 2403, 2407, 2412, 2417, 2422, 2426, 2431, 2436, 2441, 2445, 2450, 2455 and 2460.

39 The word-count for each specification was estimated by counting the number of words in the first 10 lines. Then the number of lines in the entire specification was counted. These two figures were multiplied. The resultant figure was then divided by ten to produce the estimated word-count. The same method was used in estimating word-counts from the published specifications.

40 The deadline for entering a specification came some months after the patent was sealed, and a specification was not always entered. This may have been because the inventor failed to finish a sufficient specification on time, or because they had come to realise that the invention was not worth paying the specification fees for.

£4 to £6 to prepare a picture for printing.[41] Later in 1851, Woodcroft estimated the cost of printing fifty-two specifications, with engravings for the drawings and a print run of 1000, at £161 10s. or about £3 2s. a specification.[42] Perhaps most impressive was the speed with which the specifications were prepared for publication. Fourteen of them appeared within a year of their deposit, and another six within three years. This means that although the *Repertory* was not able to publish every specification that was submitted, those it did publish, were often a verbatim copy.

Despite the general increase in the size of specifications (and in the total number submitted) the *Repertory* continued to print a sizeable proportion. Between 1830-50, of the sixty patents in this exercise, fifty-six had specifications submitted. Twenty-one of these were reproduced in the *Repertory*. Twelve appeared in full with another five appearing as extended abstracts (three were reproduced as short abstracts and one as a notification). Also, of the twelve deposited with technical drawings, nine appeared in the *Repertory*. Again it is noteworthy how, quickly the *Repertory* published these substantial reproductions: sixteen of the twenty-one specifications appeared within six months of the original submission.

It is also worth considering the *Mechanics' Magazine* in detail as well. This is because its circulation, at 16,000 per week in the 1830s, was the largest of any of the magazines considered here. It also published a significant number of specifications, 890 between 1830-41, about a third of the total deposited.[43] Unlike the *Repertory*, the *Mechanics Magazine* preferred to produce short abstracts and notifications of submitted specifications, albeit in quick time. Of the sixty patents used in this exercise from 1830, 1840 and 1850, thirty-five had specifications reproduced in the *Mechanics Magazine*. All bar five appeared as short abstracts or brief notifications (i.e. with less than half of the original word-count reproduced). However, all thirty-five appeared within two months of the original being deposited in Chancery.

Although the variety of these publications make more general comments difficult to make, the divide between the quality of reproductions appearing in the monthly *Repertory*, and the weekly *Mechanics' Magazine* appears in the rest of the market. Monthly publications tended to carry fewer specifications, but normally in full and with the appended technical drawings, whereas weekly magazines carried a much larger number of specifications, albeit in less detail. Nevertheless, a substantive description of almost every specification appeared in print, of the fifty-six specifications entered in 1830, 1840 and 1850 used in this exercise, all bar seven appeared in print either in full (twenty-three), or as an abstract (twenty-six). Significantly, the magazines also listed the office where the original specification had been deposited, making it easier for manufacturers and inventors, to consult office copies. These magazines also printed specifications with extraordinary speed. Excluding the comparatively tardy *London Journal*, of 115 different reproductions of these fifty-six specifications, ninety-seven appeared within two months of the specification being deposited.

Finally, it is necessary to examine the distribution and circulation of these magazines. The *Repertory* and *Mechanics' Magazine* were considered to be in the first rank of importance in their respective monthly

41 St Clair, *The reading nation*, p.513

42 *Select Committee of the House of Lords*, (Parl. Papers, 1851), p.245

43 Nuvolari and Tartari, 'Value of English patents', p.101

and weekly markets. In 1797, the printer Charles Timperley listed the *Repertory* as amongst the twelve 'principal periodicals', just three years after it had been introduced.[44] It was selling 1,000 copies a month, whereas the top-selling monthly periodicals in the 1790s, the *Monthly Review* and the *Monthly Magazine*, each sold around 5,000 copies. Similarly, *Philosophical Transactions* had a circulation of 750 in 1768.[45] In the weekly market, Timperley included the *Mechanics' Magazine* in a list of the most prominent weekly publications in 1837, which had a combined sale of 200,000.[46] The *Mechanics' Magazine* contributed around 16,000 to that total.[47]

Ostensibly these figures may appear unimpressive. Joel Mokyr thought the 16,000 sold by the *Mechanics' Magazine* limited its distribution to a 'labour aristocracy'.[48] Contemporaries reckoned total readership of a book or magazine by multiplying circulation by four, that is for every sale the book or magazine would be read four times.[49] Books and journals bought for libraries, however, had much larger readership multipliers, and gave a larger population access to these publications.[50] From the last quarter of the eighteenth-century there was rapid growth in the number of literary societies, reading rooms and libraries throughout the United Kingdom. The catalogues of some of the more permanent of these libraries survive.

Eighteen catalogues, the first from the Brechin Library produced in 1811, the last from Keswick in 1849, were consulted at the Munby Collection in Cambridge.[51] Although the *Repertory* was a costly magazine to subscribe to, in 1800 a year's subscription cost £1 6s. for twelve issues, it was clearly popular.[52] Nine of the eighteen libraries considered it useful enough to be maintaining their subscription at the time of the catalogue. Seven of the nine had series of the *Repertory* stretching back to its introduction in 1794. Also striking is the popularity of the *Mechanics' Magazine*. After its introduction in 1824, six out of eight libraries were receiving copies at the time of the catalogue. This may be because, at 13s. a year for fifty-two issues (in 1856), it was a relatively cheap publication.[53] Unfortunately, most of the catalogues pre-date the introduction of the other magazines, so it is impossible to gauge their distribution in libraries.

Although the sample is small, and probably only representative of the more permanent and better resourced facilities, the *Repertory* and *Mechanics' Magazine*, were clearly popular with libraries. The Mechanics Institutes, which, unlike other libraries, were specifically concerned with technical instruction and

44 Charles Timperley, *A dictionary of printers and printing*, (London, 1839), p.795
45 St Clair, *The reading nation*, p.572
46 Timperley, *Dictionary of printers*, p.952
47 Joel Mokyr, *The enlightened economy: An Economic History of Britain, 1700-1850*, (London, 2009), p.238
48 Ibid
49 St Clair, *The reading nation*, p.235
50 Ibid
51 Here is the full list of catalogues, with the name of the library and the year the catalogue was produced. Brechin Library (1811), Manchester New Circulating Library (1813), Liverpool Lyceum Library (1814), Paisley Canal-Street Relief Library (1817), Liverpool Athenæum Library (1820), Salisbury and Wiltshire Reading Society (1820), Birmingham Library (1822), Belfast Society for Promoting Knowledge (1822), Birmingham Artisans Library (1823), Macclesfield Subscription Library (1823), City Library of Norwich (1825), Stirling Public Library (1828), Tavistock Public Subscription Library (1839), York Subscription Library (1842), London Athenæum Library (1845), Beccles Public Library (1847), Newcastle Literary & Philosophical Society (1848), Keswick Library (1849).
52 Timperley, *Dictionary of printers*, p.805
53 In the same year a subscription to the monthly *Practical Mechanics' Journal*, *London Journal of Arts and Sciences* and *Artizan* cost 12s. For the *Civil Engineer and Architect's Journal* the cost was £2 4s. W Traice, *Hand-book of Mechanics' Institutions with priced catalogue of books suitable for libraries*, (London, 1856), p.74

the diffusion of technology, were also regular subscribers to these magazines. The first Institute was founded in 1821, and five years later the Society for the Diffusion of Useful Knowledge surveyed the provisions made for reading in the Institutes. The replies of twenty-eight Institutes survive, but disappointingly only seven returned copies of their catalogues. However, all subscribed to the *Mechanics' Magazine* and four to the *Repertory*.[54] The *Repertory* and the *Mechanics' Magazine* then were widely distributed amongst libraries and Mechanics Institutes.

Overall, manufacturers and inventors were satisfied with the distribution of these works. In 1829 the engineer John Farey, proclaimed 'the excessive rapidity and extensive spread of new ideas, by our periodical publications' as one of the most important advantages British manufacturing enjoyed over its American and continental rivals.[55] In a similar vein the manufacturer John Taylor stated that specifications were 'most extensively published in periodical works which are devoted to the purpose, and I believe they find a sufficient sale and are more within the reach of this who want this kind of information'.[56]

Conclusion

Much of this chapter has been devoted to describing and quantifying the publication of patent specifications. It has established that specifications were regularly published. Specifications appeared in the eminent *Transactions of the Royal Society* almost as soon as they were introduced. With publication of the *Repertory* beginning in 1794, the large majority of specifications appeared in print. So many specifications would not have been printed over such a long period of time, unless they were a valuable source of technical information and there was interest in this material. At the very least, if there was not the demand, commercial pressures would have halted their publication. Instead this press, certainly the *Repertory* and the *Mechanics' Magazine,* were amongst the most important and popular periodicals in the first half of nineteenth-century.

This should not come as a surprise. Patent specifications, as found in these periodicals, embodied the latest technology. Further, during a period when reliable technical information was not always readily available and/or verifiable, the legal emphasis placed on the accuracy of the specification ensured that inventors entered specifications that were full and accurate. After 1760 they were increasingly conscientious in their efforts and section 2.3.2 detailed the (occasionally vast) sums that patentees paid for professional consultants in the preparation of specifications. Patents and specifications then were essential in codifying and diffusing the most advanced industrial technology, especially after 1794.

The publication of specifications also helped patentees secure orders and/or licences for their invention. For example, in 1843 Henry Fox Talbot, pioneer of photography, was approached by a prospective

54 These Institutes were Ayr, Kilmarnock, Hackney, Leeds, Shropshire, Stockton and Sunderland. Unlike the libraries used in the previous exercise, the catalogues of these seven Institutes were probably representative of the holdings elsewhere. This is because the larger Institutes, such as Manchester, had not finished cataloguing their libraries when they returned the survey. Archives of the Society for the Diffusion of Useful Knowledge, London, University College, SDUK/22
55 *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.132
56 Ibid, p.11

licensee, who having 'perused the specification' sought an exclusive licence for Birmingham.[57] Earlier in 1775, Boulton and Watt received an order for an engine in Holland after their correspondent had 'seen in one of your periodical papers that you have obtained an exclusive right for a new invented fire Engine'.[58]

Perhaps the most telling indicator of the value of these publications are in the comments made by foreigners. In 1810 the head of the US Patent Office was warning applicants to check 'well the dictionaries of arts and sciences, the *Repertory of Arts*, and other publications'.[59] Similarly in 1851 William Weddinge, member of the Prussian patent commission, advised inventors to check 'the *London Journal of Arts and Sciences,* the *Mechanics' Magazine,* the *Repertory of Arts*' to ensure the novelty of their inventions.[60] In the first half of nineteenth-century, the patent system (and the magazine trade it spawned) was responsible for generating a vast amount of detailed and reliable technical information that was widely distributed.

The one factor that did frustrate the diffusion of technology by patents, as mentioned in chapter 2, were the high fees charged to obtain them. This dissuaded many inventors from obtaining patents (as shown by the large increase in patents after the reduction in fees). Although the 'quality' and development of many of these new patents is questionable, in technological sectors where the propensity to patent was especially low, such as chemicals, some high quality inventions were never patented and so were never specified.

The publication of specifications in the first half of the eighteenth-century is unlikely to have been remotely as important. Very few were entered, many were of a poor quality, and the publishing trade remained relatively small. It is possible though that later in the century, as the publishing trade grew, and the number and quality of specifications improved, specifications became an important contributor to the circulation of technical information although, without a thorough trawl of the contemporary scientific and mechanical journals, this can only be a speculation. It is worth stressing, however, that the ready availability of specifications in Chancery means that the possibility of secretly working a patented invention, as suggested by MacLeod, would have been difficult to sustain for any length of time. Although the Chancery offices were later criticised, during the eighteenth-century there was great concern that the provisions in these offices made specifications *too* readily available, especially for foreigners.

57 Larry Schaaf, (2010), Benjamin Marrian to Henry Fox Talbot, 20th March 1843, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 12th March 2012.
58 J Huichelbos van Liender to James Watt 11th May 1775, in Jennifer Tann, (ed.), *The selected papers of Boulton and Watt, 1775-1825*, (London, 1981), p.90
59 Quoted in Mario Biagioli, 'Patent republic: Representing inventions, constructing rights and authors', *Social Research*, 73, (2006), p.1149
60 *Select Committee of the House of Lords*, (Parl. Papers, 1851), p.295

Chapter 5

The market in patent rights

Chapter 1 outlined two main arguments for awarding patents: that they incentivised the development, and the diffusion, of technology. Three ways in which patents promote the diffusion of technology were discussed, that they encourage inventors to eschew secret working, oblige the inventor to produce a detailed description of their invention and, by defining and delineating property rights, facilitate the license and sale of those rights to other users. The previous chapter analysed the role of the patent system in disseminating technology via the specification requirement and the subsequent availability of these descriptions. It demonstrated that the strict enforcement of the specification requirement from c.1760, obliged inventors to enter comprehensive and accurate descriptions. Once entered, these descriptions could be consulted in Chancery or, after 1794, found in a widely circulating technical literature. This also ensured that secret working within the patent system was largely impracticable.

This chapter is partly concerned with examining the third avenue of diffusion, the licensing and sale of patent rights to other users. The chapter is also concerned with examining how patents encouraged the development of technology. The classic theoretical exposition of the incentives to inventive activity furnished by patents was by Kenneth Arrow and is worth re-covering.[1] Arrow begins with the premise that those engaged in inventive activities are economic actors, driven by the rational pursuit of profit. Arrow, also makes two assumptions about the nature of inventions. Firstly, the costs of invention are infinitely greater than the costs of imitation (which are assumed to be zero) and secondly, because inventions are non-rivalrous, one party's use of an invention will not diminish another's capacity to use it as well. This being the case, in the absence of patent protection, firms and private individuals cannot appropriate a return above the market rate, and so recoup their costs of invention. Therefore individuals and firms will under-invest in research and development, and a socially optimal amount of inventive activity will not be achieved.

The second and third chapters of the thesis examined the relative availability and enforceability of patent rights during the industrial revolution. The second chapter argued that from the 1770s patent protection was easier to acquire than previously thought. The third chapter argued that with the introduction of the specification patents were founded on a relatively secure legal foundation and that consequently they were enforceable at law. These are significant conclusions. If patent protection had been prohibitively difficult to obtain and enforce it would have undermined any potential incentive they provided to inventive activities. Instead, because of the provision of enforceable patent rights, the possibility of patents actively promoting the development of technology during the industrial revolution is re-opened. To examine whether this actually occurred, it is necessary to consider whether inventors could use patents to appropriate returns

1 Kenneth Arrow, 'Economic welfare and the allocation of resources for invention', in NBER, *The rate and direction of inventive activity: Economic and social factors*, (Princeton, 1962)

from their inventive activities and if so how.

To this end, chapter 5 focuses on the market for patent rights, that is the transfer of patent rights by their holders to other inventors, entrepreneurs and manufacturers. As will be discussed in section 5.2, these transfers can take three forms: the sale of the patent in its entirety, the sale of a share in the patent (normally pursuant to a partnership) and the licensing of the patent to other users. Such transactions encourage the development and diffusion of technology in four ways:

i) Not all inventors are able or willing to commercialise their inventions themselves. Instead, by selling or licensing their patent, inventors can appropriate a return on their inventive activities without incurring the risk and trouble of going into business. This also extends the incentive to engage in inventive activities beyond those who have the capacity to implement the invention themselves.
ii) By selling a portion of the patent as part of a partnership agreement, an inventor can secure investment capital and/or access to manufacturing plant, to help commercialise the invention. Without sufficient capital, it will be more difficult to turn an invention to profit.
iii) Patents, by defining and delineating property rights in an invention, facilitate their exchange with other users. Consequently, the ability to sell and license patent rights would have an important role in the physical dissemination of technology.
iv) Licences also assist the development of technology. When patented technology is improved upon, any subsequent improvements cannot be implemented without the licence of the patent holder of the original invention. Where licences are unlikely to be acquired the incentive for other parties to improve on patented technology will be diminished for the duration of the original patent.

Thus, an analysis of the market in patent rights provides an entrée into the returns that inventors could appropriate, the availability of capital to work new inventions, and the ways in which technology was physically disseminated and developed.

Focusing the analysis of this chapter on the market in patent rights also yields two additional benefits. Firstly, it tests the argument proposed in chapter 3. Insecure and ill-defined patent rights would be a lot more complicated to exchange. If these types of transaction were unusual, it could imply that they were precluded by the legal difficulties involved (or that they were not valuable enough for parties to go to the trouble of exchanging them).

Secondly, arguing that patents were an important contributor to the development of technology requires demonstrating that alternative strategies of appropriating returns from inventions (secret working) were not always as conducive to technological development and diffusion i.e. that without the provision of patent rights there would have been less inventive activity. Although secret working is inherently difficult to research, as was discussed in the introduction, the challenges involved with trading secret technology often prevent transfers. Firstly, there is no clear record of title in secret technology, meaning there is no insurance against the secret having been fraudulently obtained and/or that the transferor will not sell the secret to another party. In contrast, patents were defined by their specification, information relating to which was

available through Chancery and periodicals. Secondly, it is possible that other parties will have acquired information relating to the secret, and it is difficult to guarantee that they will not use or sell the secret themselves.[2] Thirdly, it is difficult to secure financing or outside assistance to support secret working. Naturally, another party will be wary of forwarding capital, or engaging in a partnership, without being familiar with the technology. However, for the inventor revealing it in the course of negotiations jeopardises the secret.[3] A patent circumvents these problems by providing a transparent, defined and verifiable property right.

By analysing the market in patent rights it is possible to distinguish clearly the advantages of patenting an invention, rather than working it in secret. This is not to say that secrets were never transferred. Although it was not possible to assign a secret directly, an equivalent effect could be achieved if a transferor revealed the secret to another party, while undertaking not to continue using the secret, or to sell it to another party. Anecdotal evidence from the court records show that these types of agreements were contracted. For example, in the 1780s the recipe for 'Velno's Vegetable Syrup' was sold for £6,000.[4] However, the enforceability of these agreements, and the general law of confidence in this period, was very uncertain. In *Williams* v *Williams* (1817) for example, Lord Eldon dissolved an injunction preventing the defendant revealing the secret, saying 'the Court ought to struggle to prevent this sort of secret'.[5] Consequently, the transfer of trade secrets appears to have been largely confined to medicines and chemicals.[6] As explained in section 1.1, these were technologies peculiarly suited to secret working. Moser has explained that before the development of the Periodic Table, it was difficult to reverse-engineer chemicals.[7] Also, efforts at maintaining the secret normally impose severe restrictions on production. In these sectors, however, secrecy was less costly and easier to maintain because profitable production runs did not have to be very large. One particularly successful apothecary manufactured 1.6 million doses over an eighteen year period, ostensibly a large amount.[8] However, this equates to less than 250 doses a day.

The chapter is divided into seven sections. The first provides a historiographical review of work on the commercialisation of patented technology and on the licensing and assigning of patent rights. Section 5.2 discusses the development of law regarding the transfer of patent rights, and how this influenced the strategies adopted by patentees in the management of their patents. Section 5.3 presents a quantitative exercise that estimates how often patent rights were assigned and/or licensed. It also discusses some of the practicalities involved with the transfer of patents and the consultative role of patent agents. Section 5.4 presents a case study of an inventor who sought to license his invention, Henry Fox Talbot the inventor of an early form of photography. Section 5.5 presents a case study of a partnership formed to work a patented

2 Paul Heald, 'A transactions costs theory of patent law', *Ohio State Law Journal*, 66, (2005), pp.480-481
3 Ibid, p.497
4 Tanya Aplin, Lionel Bently, Philip Johnson, and Simon Malynicz, *Gurry on confidence: The protection of confidential information*, (2nd edn. Oxford, 2012), p.41
5 Ibid, p.44
6 There is one case, *Smith* v *Dickenson* (1804), that was mentioned in section 3.2.2, where the technology involved was not a chemical or medicine but an apparatus for girthing saddles. Ibid, p.41
7 Petra Moser, 'Why don't inventors patent?', NBER Working Paper No.13294, (2007), p.29
8 Lionel Bently, 'Patents and trade secrets in England: The case of *Newbery* v *James*', mimeo, (2012), p.2

invention, the celebrated steam engineers Boulton & Watt. Section 5.6 discusses the role of patents in helping inventors obtain capital, and in particular the foundation of joint-stock companies to that end. Section 5.7 presents a case study of a joint-stock company that was founded to work patented technology, the Electric Telegraph Company.

Section 5.1
The historiography of the market in patent rights

Harold Dutton and Christine MacLeod have both examined the assignment and licensing of patents in some detail, although they reach very different conclusions. MacLeod argues that the insecurity of patent rights dissuaded many inventors from pursuing licensing and assignment agreements. In contrast, Dutton argues that despite the legal insecurity of patents, there was a significant and well-developed market in patent rights.

Dutton's argument is based partly on an analysis of the working histories of patents involved in court cases. He found that 22 percent of patents litigated in court between 1830-49 had been assigned. Similarly, of seventy-five extension applications examined by the Judicial Committee of the Privy Council between 1835-52, nineteen patents had been assigned (25 percent).[9] Dutton argued that these figures suggest a relatively high proportion of patents were assigned. However, patents contested in court (and for which extensions were sought) are generally more valuable than uncontested patents. This is because the more valuable the patent, the greater the likelihood of two parties finding it worthwhile to contest its validity (or alleged infringement) in court. Similarly, it is more likely that two parties will find it worthwhile to assign (or license) a valuable patent than a less valuable patent. Consequently, it is difficult to infer accurately the proportion of all patents that were assigned or licensed from only those that were litigated.[10]

More useful is Dutton's case study on patenting in pin manufacturing between 1800-35. Here all important inventions, bar one, originated outside the industry.[11] The developers of these inventions generally sought to sell or license them to pin manufacturers, albeit with varying degrees of success. Instructive is the example of Lemuel Wright who began developing pin manufacturing machinery in 1820. In 1822, when his technology was still a secret, he attempted to sell six machines for £900, with a fixed royalty of £30 per annum, to a pin manufacturer.[12] The firm, however, found Wright's terms unacceptable. This was partly because, anxious to maintain his secrets, Wright was unwilling to exhibit the machines to them until after they had been purchased, whereas the firm was, unsurprisingly, anxious to find out what they were being asked to buy. Negotiations also failed because the manufacturer would not have patent protection, and

9 Dutton, *The patent system*, p.125. From 1835, it was possible for patentees to petition the Judicial Committee of the Privy Council for an extension to their patent term, and a hearing was arranged. The grounds on which the extension were normally sought was that the patent holder had not obtained a recompense commensurate with the value of the invention. Whether or not the petition was opposed, it was customary for the Attorney-General to attend the hearing on behalf of the Crown, and represent the public interest. It was, however, an expensive procedure, and as the figures from Dutton suggest, rarely attempted. William MacPherson, *The practice of the Judicial Committee of Her Majesty's Most Honourable Privy Council*, (London, 1860), p.247

10 Dutton, *The patent system*, p.125

11 Ibid, p.126

12 Ibid, p.129

Wright would not guarantee to sell the machines to their competitors. It was only when Wright patented the machine that he was able to make a return by selling the patent to another firm for £3,775 in 1829.[13] The experience of Wright exemplifies the advantages of contracting patent rights over trade secrets.

Conversely, MacLeod, argues that the nascent market in patent rights was smothered by a hostile legal environment before 1830. In particular, she argues that the insecurity of patent rights often made them impossible to transfer, 'the lack of support offered patentees by the courts was chiefly responsible for the defensive way in which they managed their patents'.[14] Some firms apparently refused all licence offers to avoid implicitly confirming the validity of the patent, preferring instead to retain the option of challenging the patent's validity in court.[15] The proprietors of Edward Howard's patented vacuum pan (used in sugar refining), reputedly worth £40,000 per annum, felt obliged to insure themselves against licensees challenging the validity of the patent by returning two-fifths of the royalties to them as shares.[16] Consequently, before 1830, MacLeod argues that secret working was preferred, even in those sectors where it was difficult to maintain technological secrets, for example 'in the field of industrial production machinery…the most common strategy before 1830 was to work the invention in secret'.[17]

MacLeod argues that it was only with changes in judicial attitudes towards patents, and the concomitant development of case law after 1830, that the legal footing of patents became sufficiently secure to facilitate these types of exchanges. However, the process whereby inventors were 'empowered to manage their intellectual property through more public transactions with greater confidence in the availability of some legal sanction on enforcement', was unfinished until 1852, 'when the Patent Amendment Act simplified and cheapened the system'.[18]

The historiography thus presents a mixed case for the market in patent rights during the industrial revolution. Although there are problems with Dutton's quantitative analysis of the working history of litigated patents, his qualitative work on the pin industry indicates that the market in patent rights may well have been significant. It also demonstrates the problems involved with exchanging trade secrets. MacLeod, however, has argued that the legal insecurity of patents frustrated efforts at transferring patent rights. Instead she argues that secret working was widely practised both outside and inside the patent system. Matters improved thereafter, but for many the 'habits of secrecy had become ingrained'.[19] However, some of the components on which MacLeod bases her argument have already been challenged. Section 4.1 demonstrated that the specifications entered by patentees, at least after 1760, were accurately and diligently prepared. Further, these specifications were available either through Chancery or in print. This would have at least

13 Ibid

14 Christine MacLeod, 'The paradoxes of patenting: Invention and its diffusion in eighteenth and nineteenth-century Britain, France and North America', *Technology and Culture*, 32, (1991), p.906

15 Unfortunately, the names of these firms, and the sectors they worked in, are not provided. Ibid, p.905

16 Ibid

17 Christine MacLeod, and Alessandro, Nuvolari, '"Glorious Times", the emergence of mechanical engineering in early industrial Britain, c.1700-1850', *Brussels Economic Review*, 52, (2009), p.227

18 Christine MacLeod, 'Strategies for innovation: The diffusion of new technology in nineteenth-century British industry', *Economic History Review*, 45, (1992), p.300

19 Ibid, p.304

fore-stalled attempts at secret working within the patent system. Similarly, chapter 3 examined the legal status of patents and the development of patent law. It demonstrated that from the first half of the eighteenth-century patents were an established legal grant, anchored in a settled structure of adjudication. The absence of judicial bias and the concomitant development of legal precedent undermines MacLeod's supposition that more sophisticated methods of financially exploiting patents were prevented by a hostile and decrepit legal system. It is possible, however, that there was something specific to the law of transferring patent rights that rendered these transactions insecure and hazardous. The following section will examine the practicability of transferring patent rights by outlining the development of the law of assignments and licences. It will also examine how the law influenced the ways in which patentees managed their patent rights.

Section 5.2
The law of transferring patent rights

To begin, some definitions. An assignment was when the patentee sold the patent. When the patent was assigned in its entirety, the original patentee surrendered all interest in it to the assignee. Partial assignments, however, were when a patentee only assigned a share of the patent to another party (or parties). This was normally made as part of a wider agreement to work the patent in partnership (although to work the patent in partnership did not necessarily require any assignment of the patent). Partnerships were often formed between an inventor and a manufacturer. Perhaps the best known example of this type of partnership was Boulton & Watt, although there are other famous examples such as Strutt, Need & Arkwright and Hancock & MacIntosh.[20] In contrast to assignments, licences conferred no legal or financial interest in the patent. Rather, they constituted an agreement by the patentee to waive the right of exclusivity to the invention in return for some form of consideration, normally a royalty.

There were two legal instruments by which patent rights could be licensed: deed or contract, whereas an assignment had to be made by deed.[21] The primary difference between deeds and contracts was that for a contract to be valid, both sides were required to exchange something in 'consideration' (i.e. anything of value). In contrast, deeds are a legal instrument by which rights are granted and do not require consideration from the grantee (although in practice something is normally exchanged with the grantor). Regarding patents, the only other significant difference between contract and deeds was the applicability of estoppel to the latter. Estoppel means that when an agreement is transacted by deed, both sides verify the pertinent facts on which the deed is founded. In so doing neither side can subsequently deny the veracity of these facts. The applicability of estoppel to deeds assigning patent rights was expressly decided in *Oldham* v *Langmead* (1789), where Lord Kenyon held that the original patentee, in signing the deed by which he assigned the plaintiff the patent, was estopped from later disputing the validity of the patent.[22]

Oldham v *Langmead* was subsequently cited in *Bowman* v *Taylor* (1834), where it was confirmed

20 Dutton, *The patent system*, p.141
21 William Hindmarch, *The law and practice of letters patent for invention*, (London, 1847), p.234
22 King's Bench. Peter Hayward, *Hayward's patent cases, 1600-1883: A compilation of the English cases for those years*, (13 vols, Abingdon, 1987), Vol.1, p.352

that, when a licence was transacted by deed, licensees were estopped from disputing the validity of the patent.[23] The principle of estoppal, however, only applied to transfers made by deed. In *Chanter* v *Leese* (1839), the plaintiff sought to demonstrate that the defendant was estopped from challenging the validity of a patent that had been licensed to him. Chief Justice Tindal quashed this argument, 'there is no assignment of the patents by deed…the whole matter rests in contract, the defendant is not…estopped from showing…that one of the six patents is void'.[24] It was possible, however, to make it an express term of the contract that the licensee could not impeach the validity of the patent, referred to today as "no challenge clauses". These were apparently common, in 1846 Hindmarch observed that clauses 'respecting the validity of the patent [were] frequently' inserted into licences.[25] It was then a relatively simple matter for patentees to insure themselves against subsequent challenges to the validity of their patent from licensees. They could either grant the licence by deed, or with a contract containing a no challenge clause. But it is also difficult to account for the behaviour of those firms that apparently refrained from entering licence agreements, to avoid affirming the legality of the patent.[26] If the patentee assented to a contract that omitted the no challenge clause, these firms could have acquired a licence while retaining the option of challenging the patent later.

Possibly their concern related to the recovery of licence fees paid for a patent that was subsequently found to be invalid. In *Taylor* v *Hare* (1805), the plaintiff had sought to do precisely this, but his claim was rejected by the judges, Justice Heath stating 'there never has been a case…in which a plaintiff, having received benefit from a thing which has afterwards been recovered from him, has been allowed to maintain an action for the consideration originally paid'.[27] Significantly, the licence contract was enforced independently of the validity of the patent. In *Neilson* v *Fothergill* (1841) the defendant had withheld a year's licence fee claiming that the patent was invalid. Lord Cottenham rejected these arguments, 'I find that you owe a year's rent as to which you can have no defence, because it is not due by virtue of the patent right but by virtue of the contract'.[28] That in the event of the patent being declared void they could never recover their royalties must have acted as a discouragement to potential licensees. If, however, the court had held the reverse to be true, that a licensee could dispute the legality of the patent and recover their licence fees, this would have set a more obstructive precedent.[29] Where large royalties had been paid, the prospect of recovery would have offered a powerful incentive for licensees to challenge the validity of the patent (where the terms of the contract allowed them to do so).

Neither did the licence confer any legal interest in the patent. This had two important implications. Firstly, licensees could not bring action against competing infringers, meaning that the patentee had to do

23 King's Bench. Hayward, *Patent cases*, Vol.2, p.365-366. Later in *Neilson* v *Fothergill* (1841), Lord Cottenham declared, 'the authority of *Bowman* v *Taylor* is a settled principle of law, and proceeds on the same footing as that of landlord and tenant'. Chancery. Hayward, *Patent cases*, Vol.4, p.387
24 Exchequer. Ibid, Vol.3, p.281
25 Hindmarch, *The law of letters patent*, p.243. The legality of these clauses were upheld in *Baird* v *Neilson* (1842). House of Lords. Hayward, *Patent cases*, Vol.4, p.506
26 MacLeod, 'Paradoxes of patenting', p.905
27 Common Pleas. Hayward, *Patent cases*, Vol.1, p.532
28 Chancery. Ibid, Vol.4, p.383
29 This scenario does not apply to transfers made by deed as the licensee would have been estopped from pursuing this course of action.

this on their behalf. The lawyer Thomas Browne wrote that as 'a licensee cannot sue for an infringement, the patentee or his assigns should by the licence, covenant to sue all parties infringing'.[30] Because of the obligation to bring action against infringers, if patents were insecure (and liable to be lost in court action), patentees would be reluctant to grant licences. This confirms the point made earlier in the chapter, that patents needed to be secure and enforceable at law to facilitate their transfer. Secondly, all patents contained a proviso whereby if more than five people held a share in the patent it would be annulled automatically, (in 1832 the proviso was changed to limit the number of people to twelve).[31] If the licence had conferred a legal interest, patentees would have been limited in the number of licences they could have sold without transgressing the terms of the patent.[32]

Besides this proviso, there were no legal restrictions imposed on the assignment or licensing of patents. For example, a patentee could negotiate any form of consideration in return for a licence or assignment.[33] This yielded a huge range of licences that could be tailored to the nature of the technology and/or the business requirements of the contracting parties. The simplest arrangement was for patentees to charge a flat annual rate, for instance Richard Hare charged an annual royalty of £100 for the use of his 1791 patent for 'applying to use the essential oil of hops'.[34] For 'product' inventions it was also common to vary the licence fee according to the output produced under licence. Samuel Wright, for example, licensed production of his encaustic tile, patented in 1830, at the rate of 2s. per square yard. Similar calculations were made for 'process' inventions. For example, in the sugar-refining industry many of the most important inventions, such as Howard's vacuum pan, were licensed by the long hundredweight, (112 lb) produced.[35] For 'process' inventions it was also possible to calculate the licence according to the size and/or number of machines to which the process was applied. In the textile industry, Thomas Turner observed in 1851 that 'a quarterly rent is common where the patent is for a process or machinery as for each loom or each spindle'.[36] Similarly, for his screw propeller, Bennet Woodcroft charged a royalty of 5s. per horsepower of the engine which turned the propeller.[37]

Patent holders also enjoyed great latitude in negotiating other facets of a licence or assignment. For example, it was possible to grant 'exclusive' licences, where the licensee enjoyed the sole right to exercise the patented invention. These exclusive licences had two important uses. Firstly, they were used to circumvent

30 Thomas Browne, *A treatise on the laws and practice relating to patents of invention and the registration of designs*, (Manchester, 1849), p.53
31 William Carpmael, *The law of patents for invention, familiarly explained*, (London, 1832), p.41
32 There does appear to have been some uncertainty regarding this issue at the beginning of the nineteenth-century. In 1802 Moses Poole had had to seek counsel's opinion on the matter on behalf of a client although he was advised that 'it does not seem to me that permissive licences to use his invention, though granted to ever so many distinct individual will interfere with the proviso recited in the clause'. Notebook of James and Moses Poole, London, British Library, BJ00 54889, p.7
33 Hindmarch, *The law of letters patent*, p.243
34 Common Pleas. Hayward, *Patent cases*, Vol.1 p.531
35 *Report and minutes of evidence taken before the Select Committee of the House of Lords appointed to consider of the Bills for the amendment of the law touching letters patent for inventions with appendix and index*, (Parl. Papers, 1851, XVIII), p.151
36 Thomas Turner, *The law and practice of patents and registration of invention and design in manufacture,* (London, 1851), p.68
37 Judicial Committee of the Privy Council. Hayward, *Patent cases*, Vol.5, p.380

the proviso entered into patents that they could only be held by a limited number of partners.[38] Exclusive licences, contracted for with a friendly patentee, allowed companies with six or more owners to enjoy exclusive rights to inventions. Secondly, it was possible to grant exclusive licences that were limited to a particular location. This was common for patents for consumer products, and allowed each licence holder a monopoly within their own locality. The logic of these agreements is revealed in the letter of a licensee who objected to the licensing of a nearby rival as 'if I can expect him as a competitor in Calotype I shall of course be extremely cautious in entering into expenditure…for the greater my success and the larger my number of portraits, the stronger his inclination would naturally be to become my rival'.[39] It was obviously preferable for the patentee to have one profitable licensee than two unprofitable ex-licensees.

Partnerships involved a much closer professional relationship than between patent holder and licensee. Most importantly, each member was personally liable for the entirety of the debts incurred by the partnership, a substantial commitment. Indeed, because it was not always clear where the interests (and debts) of an individual ended and those of the partnership began, this commitment could be larger than implied by the immediate activities of the enterprise. Neither was it easy to extricate oneself from a partnership; ownership was transferable only with the unanimous consent of all the other partners. Manufacturing, however, was considered to be an activity that required the financial commitment of its managers and partnerships were the most common form of business organisation .[40]

Partnerships were also a common business form in the working of patents. Normally, these partnerships involved the patentee, who provided access to the patent (and technical expertise in the invention), with one or more manufacturers who provided capital and a manufacturing base with which to implement the invention. There is not, however, a significant amount of case law regarding partnerships and patents. This is probably because partnerships were usually formed by contract whereas patents had to be assigned by deed. Consequently, there could be no 'implicit' assignment of shares in the patent made by the partnership contract. In the absence of any specific assignment the patent would remain the sole property of the original patentee, insulating it from subsequent legal action involving the partnership. For example, in *Birch* v *Wood* (1843) the defendants tried to avoid paying damages for infringing a patent.[41] The defence demonstrated that Birch (the patentee) had been in partnership when he obtained the patent in 1837 and that the expense of obtaining the patent was paid for by partnership funds. In 1839 Birch had left the partnership and assigned to his partners his share of the business. After this assignment the partnership continued to receive royalties and damages from infringers. On this basis the defendants argued the patent had been assigned to the partnership. Subsequently, the partnership had gone bankrupt and been dissolved.

38 Carpmael, *The law of patents*, p.41
39 Larry Schaaf, (2010), Richard Beard to Henry Fox Talbot, 21st April 1842, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 12th March 2012.
40 Philip Cottrell, *Industrial finance, 1830-1914: The finance and organisation of English manufacturing industry*, (London, 1980), p.34
41 Liverpool Assizes. Hayward, *Patent cases*, Vol.4, pp.652-654. It was unusual for a patent case to go to the Assizes for two reasons. Firstly, to obtain an injunction required an application to the equitable jurisdiction of Chancery, in London. Secondly, the best witnesses and experienced counsel were to be found in London. *Select Committee of the House of Lords*, (Parl. Papers, 1851), p.315

Consequently, the defendants argued, they were no longer liable for damages. Justice Cresswell, however, noted that the patent had never been specifically assigned by Birch to any of his partners and that therefore the defendants were still accountable for the infringement payments but to Birch.

The law concerning the licensing and assignment of patents was permissive, providing patentees and other parties the freedom to tailor their licences in accordance with their business requirements and the nature of the technology. The only apparent restriction was that an interest in the patent could only be assigned to a limited number of partners, although this could be circumvented by awarding such a partnership or joint-stock concern an exclusive licence. The law also provided reasonable protection for patentees in these agreements. In transactions made by deed other parties were estopped from challenging the validity of the patent, and no challenge clauses entered into contracts were enforceable in court. Similarly, without a specific instrument of assignment, none could be implied by a partnership contract.

In formal terms then the law did little to impede the exchange of patent rights, indeed by offering reasonable security to the rights of patentees it actively encouraged them. There was, however, one important way in which the operation of the legal system did frustrate the exchange of patent rights, the length of time consumed in legal action. During legal proceedings, pre-existing contracts involving the patent were supposed to be honoured. In *Collinge* v *Bowman* (1834) it was held that while the validity of the patent was being disputed, licence holders were obliged to continue paying royalties.[42] However, while the validity or enforceability of a patent was being disputed, other parties were naturally reluctant to purchase or license a patent, especially as such payments were not recoverable. If it had been possible for patentees to prosecute legal action quickly, this would not have been a concern - but this was not always possible. One case, *Heath* v *Unwin,* began in 1842 and was only resolved in the House of Lords in 1855, by which time the patent had expired.[43] It is unknown what the direct and indirect costs of this case were to Heath, although it can be inferred from extension cases in the Privy Council that the losses in foregone licences could be substantial. For example, Charles Derosne was only able to grant two licences for his 1830 patent for refining sugar before legal action finished in 1835, earning only £200. However, in the following eight years he granted another twenty-eight licences, earning £7,920.[44]

If the indirect costs of legal action were substantial, so too were the direct costs. For the 1829 Select Committee, John Farey provided a detailed costing for the plaintiff from the case *Crossley* v *Beverley* (1829), full details of which are provided in table 5.1.[45] In total Crossley spent £718, close to the £600 reckoned to be the average spend for both parties in a patent case.[46] This represented an enormous outlay, in this one case Crossley spent five times what it would have cost him to obtain the patent in the first place.[47] When the fees

42 Chancery. Hayward, *Patent cases*, Vol.2, p.372
43 Ibid, Vol.4, p.206-229
44 Judicial Committee of the Privy Council, Ibid, Vol.2, p.653-654
45 *Report from the Select Committee on state of law and practice relative to patents for inventions*, (Parl. Papers, 1829, III), p.149
46 This excludes the costs of models prepared for the court, which were reckoned to have cost another £100. Ibid
47 In terms of average earnings, a method of translating historical values into their current ones used in chapter 2, Crossley's costs in this one case amounted to nearly £600,000 in 2010 prices. Lawrence Officer and Samuel Williamson (2011), 'Purchasing Power of British Pounds from 1245 to Present', MeasuringWorth,

are broken down, however, it can be seen that the 'fixed costs' of going to court were a fraction of the overall costs. Instead large sums were spent on procuring witnesses (£217 in total), and documentary evidence (£220) costs that, strictly speaking, were not essential to bringing the case.

Table 5.1
Plaintiff's legal costs in *Crossley* v *Beverley* (1829)

	£.	s.	d.	£.	s.	d.
Counsel's Fees				172	17	0
Witnesses to facts from the Country	98	14	6			
in Town	10	4	6			
Scientific witnesses in support of the specification	111	2	0			
Coffee-house expenses for witnesses	17	9	6			
	237	10	6	237	10	6
Office copy of the specification	15	16	0			
Examining the same	2	3	4			
	17	19	4	17	19	4
Expenses of collecting evidence, including subpoenas, journey to Leeds, Agents Charges, &c				40	0	0
Drawings				4	4	0
Court Fees				24	14	0
Proceedings in the Action, Special Jury, Briefs, Documentary Evidence, Letters, Attendance, &c				220	15	10
				718	0	8

Crossley was an assignee of the original inventor, and presumably felt no need to establish his credentials as the inventor. Rather, it must be that Crossley invested such large sums protecting his patent because he perceived it be in his financial interest to do so, i.e. that the patent was valuable and worth protecting, and the same must be presumed of the defendant. The following section supports this inference by demonstrating that the more valuable the patent, the more likely it was to be litigated. Significantly, it was also possible for the successful plaintiff to reclaim substantial amounts in costs and damages, in this instance Crossley was able to recover £432 from the defendants.[48]

On balance the law and administration of patents provided substantial support to inventors who sought to exchange their patent rights. Firstly, as was argued in chapter 3, patents were relatively secure, and were founded upon a sophisticated rationale, where the patent was perceived as embodying a contract between the public and the inventor, and this had been established, at the latest, by the time of *Yerbury* v *Wallace* in 1768. Secondly, this section has demonstrated that the law of licensing and assigning patent rights was permissive and did not encourage parties to upset patent rights. Thirdly, although legal costs appear

www.measuringworth.com/ppoweruk/, accessed 28th May 2012
48 *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.149

forbidding, the fixed costs of court action were not so high. Rather, much of the expense was incurred because the patent was a valuable right worth protecting. It was also possible for a successful patentee to recover a large share of their costs from the defendants. The most important constraint placed on the exchange of patent rights was the length of time it occasionally took for a legal dispute to be settled, which resulted in foregone licence and assignment fees.

Section 5.3
The market in patent rights

While legal action was expensive, the costs were often borne because patent rights were valuable. Further, the transaction of patent rights were facilitated by the operation of patent law. This suggests that licensing and assigning patent rights would have been common and this section continues with the analysis of the market in patent rights by estimating how often these transactions occurred.

Qualitative evidence from the nineteenth-century, suggests that assignments and partnerships were common, although the latter was apparently preferred. Frederick Campin the patent agent claimed, 'inventors do not sell their inventions, but they join capitalists with them'.[49] In these cases it was common for the profits to be equally divided. As with assignments, licensing was also common. John Farey observed that 'in general patentees are very eager to grant licences to anyone who applies for them at any sort of fair price'.[50] There was a sound reason for such willingness to license others. Farey continued that if a patentee did refuse a licence and the suitor subsequently used the invention anyway, 'the patentee would I believe get only nominal damages'.[51] Accordingly, it was rare for patentees to refuse licences. In 1824 one lawyer wrote that 'it is almost universal for patentees to grant licences to persons desirous of using the invention…the terms of course may be indefinitely varied'.[52] Likewise John Millington professor of mechanics at the Royal Institution reported in 1829 that he 'never knew an instance of a refusal'.[53]

It is important that patentees did grant licences. If an inventor developed an improvement to a product or process for which a patent was already in force, the improvement could only be used under licence. In a reported caveat hearing, held before the Lord Chancellor in 1812, the proprietor of a patent for steam engines challenged the passing of a patent for improvements to his engine as an infringement.[54] Although Lord Eldon decided to grant the patent, he noted that the new patent holders would not be able to employ their improvements on the original steam engine without the licence of the engine's patent holders. As such the holder of the original patent had the power to stymie any subsequent developments by refusing to grant licences for the new improvements.

Regular licensing will also have facilitated the diffusion of technology, although this depended on

49 *Select Committee of the House of Lords*, (Parl. Papers, 1851), p.113
50 *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.143
51 Farey, however, did not cite a supporting case. Ibid
52 Robert Rankin, *An analysis of the law of patents*, (London, 1824), p.98
53 *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.102
54 Lord Chancellor (caveat case), *Fox Ex parte* (1812), Hayward, *Patent cases*, Vol.1, p.561

the royalties charged. In 1851 the sugar refiner John Farrie was asked whether 'it is within your experience that the effect of the existing patent law is seriously to restrict the use of a patented article, or it is merely to leave the use of it free to the public, but at a higher cost than they would otherwise have to pay?' replying 'it is the latter'.[55] Farrie continued, however, that in the case of Howard's Patent (referred to in section 5.1), because of the royalties charged, only a quarter of refiners chose to adopt the invention before the patent expired. Thereafter, however, it was universally adopted.[56] In general it was thought the granting many cheap licences was more lucrative in the long run, than granting a few on stiff terms. William Cubbitt the President of the Institution of Civil Engineers noted, 'people will not pay heavy premiums for using the patent right, but they will wait till the patent has expired…[but where]…the cost is trifling they will sell thousands'.[57]

Regrettably, no register of patent assignments or licences was maintained before 1852 meaning that quantitative work on the frequency of patent transactions can only be estimated using other sources. Here court records will be used in an exercise similar to the one undertaken by Dutton. In the course of litigation it is possible to infer a reasonable amount about the working history of a patent. To enforce a patent it was necessary to submit proof of title and, if the patent had been assigned (wholly or partially), it was necessary for the patent holder to submit proof of assignation. It is also possible to infer whether a patent had been assigned by checking if the name of the plaintiff in the case name was different from that of the original patentee. However, no record was usually made of whether the patent had been licensed unless it was pertinent to the case. As such using this method will underestimate the proportion of patents that were licensed. This method will also underestimate the proportion of patents transferred because court cases normally occurred towards the beginning of the patent term. Dutton estimated that 69 percent of patent cases occurred in the first seven years of the patent.[58] This means that if a patent was assigned or licensed after the case had been heard, but had not been before, it will be excluded. This is doubly significant because, as was mentioned in the previous section, parties would delay exchanging patent rights until a case had been decided. As such this method will underestimate the overall propensity for patents to be assigned or licensed.

There are, however, two ways in which this method will overestimate the proportion of patents that were transacted. Firstly, this is because assignments and licences can be a cause of litigation themselves. For example, a licensee paying royalties would have an interest in invalidating the patent, and through working the invention they would have a keen appreciation of the patent's defects. However, they could only have challenged the patent if they held a licence contract that omitted the no challenge clause. Secondly, section 5.2 discussed how expensive it was for both sides to contest a patent in court. Consequently, it is likely that litigated patents were of a greater value than the average run. Similarly, the more valuable the patent, the more likely it is for others parties to purchase a licence, or share in the patent. This means that the proportion of patents that were assigned or licensed cannot be directly inferred from those patents that were litigated. Instead it is necessary to control for the variance in quality between the two sets of patents (those patents that

55 *Select Committee of the House of Lords*, (Parl. Papers, 1851), p.150
56 Ibid
57 Ibid, p.217
58 Derived from Dutton, *The patent system*, p.186

were litigated and those that were not) by applying Alessandro Nuvolari and Valentina Tartari's indicator of pre-reform patent quality.[59] Their raw indicator (WRI) is taken as the number of references listed for each patent in Woodcroft's *Reference Index*. As described in section 4.2, this *Index* provides references in the contemporary legal and mechanical literature for every patent awarded between 1617 and 1852. The lowest WRI figure is zero, where the *Index* only provided the office in which the specification was lodged.[60] The highest raw value was twenty-three, for the patent awarded to Cornelius Whitehouse for making gas tubes in 1825. However, the average number of references received by patents increased over time. To control for this, the WRI score of each patent was adjusted by dividing it by the average number of references received by patents in the same time cohort, producing a time-adjusted score (WRI*).[61] The patent with the highest WRI* score was James Watt's 1769 patent for the separate condenser (26.17).

Nuvolari tested the reliability of the WRI* indicator by comparing the quality of four populations of 'important patents', as defined elsewhere in the historiography, with all other patents awarded between 1700 and 1841. This was done by employing the Fligner-Policello test, a non-parametric test of stochastic equality. The test reveals the probability that a random patent selected from the population of 'important patents' will have a higher quality (as denoted by WRI*), than a random patent selected from the excluded remainder. Nuvolari found that in all cases relating to the four populations of important patents, the hypothesis of stochastic equality could be rejected at the significance level of 1 percent.[62] This means that the WRI* indicator may be regarded as a robust indicator of the technical quality of an invention.

By allotting every litigated patent a value derived from the *Reference Index* it will be possible to see how much the quality of these patents varied from those patents that were not litigated. However, the WRI indicator has had to be slightly adapted here. The *Reference Index* (and Nuvolari's WRI measure), included references to the court cases. As the intention is to compare WRI scores of the population of patents in court cases with those that were not, these legal references had to be omitted to make the comparison fair. Further, not all court cases are referenced in the *Reference Index* (especially earlier cases) so to ensure that there is comparability *within* the set of litigated patents, the references to court cases in Woodcroft had to be removed. Consequently the raw WRI measure has been adjusted to omit these 'additional' references, and is shown as WRI (law) to distinguish it from Nuvolari's WRI measures.

Finally, it will be noticed that the number of patents used here (221) is less than the number of patents used in chapter 2, (313). This is partly because the set used here omits patents awarded after 1841 as this is when Nuvolari's WRI measure ends. It also omits those cases where it was impossible to match definitively the patent in court with its records in the *Reference Index*, meaning the patent could not be allotted its WRI value. Finally, there are a few cases where, besides the verdict, the report or reference is so sparse, it is unlikely that any licence or partnership would have been recorded.

59 Alessandro Nuvolari, and Valentina Tartari, 'Bennet Woodcroft and the value of English patents, 1617-1841', *Explorations in Economic History*, 48, (2011)
60 Ibid, p.103
61 These time cohorts were 1617-1701, 1702-21, 1722-41, 1742-61, 1762-81, 1782-1801, 1802-11, 1812-21, 1822-31 and 1832-41. Ibid, p.103
62 Ibid, p.106

Table 5.2 is divided into three parts. The first part is for where the final court case involving a particular patent occurred between 1770 and 1849. The first column shows the WRI (law) band. The second column shows the number of patents from that band that were litigated in court. The fourth column shows the percentage of these patents that had been either entirely or partially assigned. The sixth column shows the percentage of patents that had been licensed. The seventh column shows the total number of patents from that band granted in those years.

The next two parts are organised on the same lines as the first but which present the results for the periods 1770-1829 and 1830-49 separately. These have been prepared for two reasons. Firstly, it is to test the argument of MacLeod that assignments and licensing were relatively unusual before 1830. Secondly, as was discussed above, the average, unadjusted, WRI measure (which has had to be adopted here) varies over time making it difficult to compare raw WRI scores between 1770 and 1849. To allow for this, results from patents litigated between 1770 and 1829 (when average WRI scores were lower) have been shown separately from those between 1830-49 (when scores were higher).

Table 5.2 The working history of litigated patents, 1770-1849

WRI (law)	Total no. in court	No. Assigned	% Assigned	No. Licensed	% Licensed	Total no. awarded
1770-1849						
1 – 2	58	30	52%	6	10%	5790
3 – 4	95	35	37%	22	23%	3762
5 +	68	47	69%	17	25%	674
Total	221	112	51%	45	20%	10226
1770-1829						
1 – 2	30	10	33%	3	10%	3113
3 – 4	38	17	45%	4	11%	1551
5 +	22	16	73%	7	32%	269
Total	90	43	48%	14	16%	4933
1830-1849						
1 – 2	28	20	71%	3	11%	2538
3 – 4	57	18	32%	18	32%	2207
5 +	46	31	67%	10	22%	402
Total	131	69	53%	31	24%	5147

Reassuringly, it can be seen that litigated patents were of a disproportionately higher value than the full population of patents, even when legal references are omitted from the WRI score. For example, although patents with a WRI (law) score of 5+ account for only 6.6 percent of patents awarded between 1770 and 1849 they account for 30.1 percent of patents that were litigated.

The first part of table 5.2 shows three important things. Firstly, it shows that assignments were common, even in the lowest WRI band. Overall, of the fifty-eight litigated patents with a WRI (law) score of 1 or 2, thirty had been either entirely or partially assigned at the time of the last court case. It is worth reiterating that this undercounts the total number of litigated patents that would have been assigned during

the fourteen year term because court cases were normally concluded in the first seven years. These figures are also much larger than those presented by Dutton, who found that overall only 19 percent of contested patents had been assigned, compared with 51 percent here.[63] There are two reasons for this difference. Firstly, Dutton only counted those patents that were assigned in their entirety. Secondly, the court records used here are often more detailed.

Secondly, licensing appears to have been less common, with only 20 percent of contested patents reportedly being licensed. As was discussed before, however, this method underestimates the extent of licensing vis-à-vis assignments, not least because licences (unlike assignments) did not have to be submitted to court unless the licence itself was a source of dispute. Further, licences were often contracted after the final court case. In 1851, the lawyer Matthew Hill noted that 'the defendant taking a licence is a very common determination of patent disputes'.[64]

Thirdly, the probability that a patent would be assigned or licensed normally increases with its WRI (law) score. Overall 52 percent of patents with a WRI (law) score of one or two were assigned whereas 69 percent of those with a score of 5+ were. However, the percentage of patents with a WRI score of 3 or 4 which were assigned is, at 37 percent, lower than would be expected. The licensing figures though, are consistent with 10 percent of patents with a WRI (law) score of 1 or 2 being licensed, 23 percent with a score of 3 or 4 being licensed and 25 percent of those with a score of 5+ being licensed.

When the results for the periods 1770-1829 and 1830-49 are separated, these patterns persist. Although there was an increase in the overall proportion of patents that were assigned or licensed between the two periods, this increase was small. Of the ninety patents that were litigated before 1830, 48 percent had been assigned (and 16 percent licensed), compared to 53 percent of patents between 1830-49, (and 24 percent licensed). These increases can probably be attributed to improvements in communications, rather than any significant changes in the legal environment.

The court records indicate that assigning patents was common, even when they were of a lower quality as denoted by their WRI (law) scores. They also suggest that licensing was less common, although this exercise is unlikely to provide an accurate estimate of the total proportion of patents that were licensed. In the absence of any register of assignments and licences though, this is likely to be the most satisfactory method of estimating the incidence of these exchanges. Also, despite the limitations of this method, no significant difference appears in the assignment and licensing rates before and after 1830, demonstrating that alleged judicial hostility to patents did not debar the expansive working of patented technology before that date.

Unfortunately, there are not the court records to extend this exercise to before 1770. This does not mean, however, that assignments and licences were not possible before then. John Kay, for example, worked his flying shuttle with two partners.[65] Licensing operations could also be quite sophisticated and ambitious in

63 Dutton, *The patent system*, p.125
64 *Select Committee of the House of Lords*, (Parl. Papers, 1851), p.28
65 Upon the expiration of Kay's patent in 1747, Kay held a four-fifteenths share of the patent, a Mr Smith a three-fifteenths share, and a Mr Carter eight fifteenths. *Kay* v *Mills*, (1748), Chancery Order Books, London, National Archives, C33/389, fol.450

scale. For example, when Thomas Newcomen began to develop his steam engine he entered into a partnership with Thomas Savery. Together they commercialised Newcomen's engine under the auspices of Savery's patent (which had been extended to 1733). Upon Savery's death in 1715, his share of the partnership passed to a syndicate which through a national network of agents, erected and licensed the use of Newcomen engine's.[66] Although they charged up to £350 a year in royalties, when the patent expired the syndicate had been responsible for erecting about 100 engines.[67]

The court records also indicate that the licensing and assigning of patents could be very lucrative for their proprietors. Especially remunerative was James Beaumont Neilson's patent (obtained in 1828) for the hot blast process, used in iron manufacture.[68] Neilson discovered that by heating the air which was pumped into the blast furnace, the fuel efficiency of the blast could be improved and raw coal could be used as a fuel instead of coke. After experiments at the Clyde ironworks, Charles MacIntosh and John Wilson joined in partnership with Neilson, in return for a three-tenths and a one-tenth share respectively.[69] The patent was licensed at 1s. a ton and thirteen years later in *Neilson* v *Thompson* (1841) it was reported that thirteen Scottish licences and fifty-eight English licences had been granted.[70] Together, these licences earned the owners of the patent £30,000 in royalties in 1840 alone.[71]

Despite the modest terms on which the licence was offered, Neilson and his partners became embroiled in legal actions against a number of infringers, the largest of whom were the ironmasters Baird, who had been flouting the patent since 1833. Although they enjoyed success in bringing other infringers to heel, it was not until May 1843 that the action against Baird could be heard. The trial in Edinburgh lasted ten days, a record at the time, and in total 102 witnesses were called.[72] Neilson and his partners were successful, winning £11,867 16s. in damages.[73] This, however, was only the beginning, and Neilson and co prepared another case against the Bairds covering the final two years of the patent term. They sought to reclaim the astonishing sum of £160,000 which, after other parties settled out of court, the Bairds were forced to pay.[74]

Neilson's hot blast proved to be immensely lucrative. It was, however, possible to profit from far more modest developments. In 1829, for example, Thomas Morgan patented a method of preparing iron plates for tinning. Although the saving from employing this method was only about 1s. on a box of plates worth 20s. Morgan sold the patent to a larger firm for £200 and retained free use of the invention for

66 Alan Smith, 'Steam and the city: The committee of proprietors of the invention for raising water by fire, 1715-1735', *Transactions of the Newcomen Society*, 49, (1978) p.5
67 Alessandro Nuvolari, Bart Verspagen, and Nick von Tunzelmann, 'The early diffusion of the steam engine in Britain, 1700-1800: A reappraisal', *Cliometrica*, 5, (2011), p.298
68 Patent no.5701. Bennet Woodcroft, *Alphabetical Index of patentees of invention, 1617-1852*, (2nd edn. London, 1969), p.399
69 Francis Espinasse (2009), 'Neilson, James Beaumont (1792-1865)', Oxford Dictionary of National Biography (online edn.), http://oxforddnb.com/view/article/19866, accessed 18th March 2012
70 Chancery. Hayward, *Patent cases*, Vol.4, p.376
71 Espinasse, 'Neilson, James Beaumont (1792-1865)'
72 Ibid
73 Scottish Court of Session, Hayward, *Patent cases*, Vol.4, p.516
74 Espinasse, 'Neilson, James Beaumont (1792-1865)'

himself.[75] In retrospect, this turned out to be a poor deal, as the new owners of the patent saved themselves approximately £750 a year with the invention and were able to license other users for around £300 a year.[76]

It is finally worth mentioning how these transactions were arranged. For inventors already involved in a particular industry, it would have been possible to rely on their own contacts. James Watt, for example, knew his first business partner, John Roebuck, from his time as an engine erector in Scotland. When, however, an invention originated from outside an industry the inventor was often obliged to take the initiative, offering to sell or license their patents directly to manufacturers as, for example, Lemuel Wright did. It was also common for some of the magazines described in the previous chapter to run adverts from inventors offering to sell their patents. For example, in October 1839 the *Inventors' Advocate* ran an advert for a 'valuable patent right to be disposed of, for the sum of £1,200. The Patentee of an article in extensive demand, wishes to sell a share of his patent, on terms that will secure to the purchaser a profit of £200 or £300 per annum at least…full particulars may be ascertained by applying to Delianson, Clark and Co'.[77]

An important role was also played by patent agents. As was mentioned in section 2.3.3 patent agents maintained contacts amongst manufacturers and capitalists who helped inventors obtain the funds needed to patent their inventions. Similarly, they assisted inventors in arranging licences and assignments, and the notebook of Moses Poole shows that he was often engaged by patentees to advise on these matters. For example, in 1817 one patentee enquired whether it was 'improper' to charge twenty guineas a year, or 100 guineas for seven years, for a machine he claimed would yield savings of £36 per annum (the nature of the invention is not recorded).[78] A more detailed example survives in the letters of Henry Fox Talbot. On 7th March 1842 his agent, William Carpmael (partner to Moses Poole), wrote 'I have seen Mr Beard [a businessman already involved with photography] and I suggested the following proposition…that Mr Beard should undertake to push your patent and find licences and generally manage that business relating thereto he receiving 15 percent on the returns for sales of licences'.[79] The negotiations ended when Beard demanded his 15 percent on licences Talbot sold himself as 'it may possibly…happen that for such sale you may be indebted directly or indirectly to the efforts made by me'.[80]

Similarly, Poole and other agents provided advice to purchasers. In Poole's notebook, for example, is a query from a Mr Wilkins who had agreed to purchase a large share in a patent for raising the nap of cloth by application of water. Wilkins, however, was anxious to discover whether the specification was good in law as it was 'well worth their while by every means to endeavour to protect the rights they have hoped are secured to them by the patent'.[81] Poole forwarded Wilkins's query to counsel, who, with one minor

75 Judicial Committee of the Privy Council, Hayward, *Patent cases*, Vol.4, p.709
76 Ibid
77 *Inventors' Advocate*, 12th October 1839, p.142
78 Notebook of James and Moses Poole, London, British Library, BJ00 54889, p.59
79 Larry Schaaf, (2003), William Carpmael to Henry Fox Talbot, 7th March 1842, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012.
80 Larry Schaaf, (2003), Richard Beard to Henry Fox Talbot, 29th March 1842, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012.
81 Notebook of James and Moses Poole, London, British Library, BJ00 54889, p.82

reservation, considered the patent to be valid.[82]

The third chapter discussed how patent rights were reasonably secure and section 5.2 has demonstrated how this facilitated their exchange. This section sought to specify how often these exchanges actually occurred. The qualitative evidence indicates that licensing and assignments were common and this was confirmed (certainly for assignments) by the quantitative exercise. This is especially so when one considers that the method adopted will underestimate the extent to which these transactions were made. The evidence for before 1770 is sparser, but there is no indication from the material available, that assignments or licences were in any way exceptional.

That there was a large market in patent rights, certainly after 1770, is entirely consistent with the arguments presented in the rest of the Ph.D – there was no judicial bias, there was a developed corpus of patent law, there were patent agents to assist inventors and secret working within the patent system was impracticable. As was discussed at the beginning of this chapter, a large and well-functioning market in patent rights would have been significant for four main reasons, briefly:

i) It allowed inventors to appropriate a return from their inventions without the risk and trouble of going into business themselves.
ii) It provided a means by which inventors could secure financing for the development and commercialisation of their inventions.
iii) Licensing provided manufacturers and other parties with access to new technology
iv) Licensing allowed new improvements that would otherwise infringe upon a pre-existing patent, to be implemented.

The discussion so far has provided some detail on each of these four points. On the matter of the returns available to patentees, the case of Neilson demonstrates that they could be considerable indeed. It was reckoned by contemporaries that Neilson's patent had earned its proprietors nearly half a million pounds in Scotland alone.[83] The example of Morgan indicates that it was possible for inventors to make returns from assigning and licensing more modest developments. Neilson's partnership with MacIntosh and Wilson also demonstrates the role of patents in securing finance for the development of technology. On the third point, Dutton has shown that while Wright failed to sell his invention as a secret, once it was patented he was able to assign it to a manufacturer. Finally, on the fourth point, although an inventor who developed an improvement to an already patented product or process was legally obliged to acquire a licence, these were often granted. Licensing made it less likely that patents would frustrate the process of sequential

82 Poole's notes on this matter date from 1824, and the reply was from 'Tindal', most likely the future Chief Justice of the Common Pleas (a post he held between 1829-46). His reservation was that the patentee had not explicitly stated that the water used in the process should have been close to boiling rather than just 'hot'. He stated 'I am afraid of the objection that it is the duty of the inventor to give the utmost benefit of his invention to the public, clearly and explicitly, and not to leave it as a matter of experiment…at the same time I cannot say that the objection above pointed out would be entitled to much weight or be deemed sufficient to destroy the patent'. This comment also indicates that an increasingly nuanced understanding of the specification requirement was beginning to develop around 1825. Ibid, p.84
83 *Committee on the Signet and Privy Seal Offices*, (Parl. Papers, 1849), p.42

technological development.

The next two sections will examine two examples of where patented technology was licensed and assigned. The first will look at Henry Fox Talbot and his 'Calotype', an early form of photography. The second will look at one of the most famous inventions of the industrial revolution, James Watt's separate condenser.

Section 5.4
Henry Fox Talbot and the 'Calotype'

Henry Fox Talbot was born in 1800 and experienced a traditional education at Harrow College, followed by Trinity College, Cambridge. At Trinity he developed an interest in science and mathematics and began experimenting with light-sensitive chemicals around 1833. By 1835 he had established the basic chemical processes for what came to be known as the 'Calotype'. The Calotype was achieved by soaking a sheet of paper in a weak solution of salt, which was then dried and brushed with a solution of silver nitrate. The salt and the silver nitrate reacted to produce light sensitive silver chloride which was embedded into the fibres of the paper. The process was a delicate one, every sheet of sensitized paper had to be made by hand, and many had to be rejected as deficient.[84] Once prepared the sensitized paper was placed in a *camera obscura*. The *camera* was a box where light from an outside scene could pass through an opening to meet a surface inside, where an image was produced. The sensitized paper could be placed on the surface to capture the image.[85] Initially, the paper had to be exposed to light for at least fifteen minutes but this was later reduced as Talbot and others experimented with the different components of this chemistry.[86]

However, having developed this rudimentary form of photography, Talbot neglected it, preferring to pursue other research instead. It was only with the announcement in January 1839 that a Monsieur Daguerre had also managed to fix permanent images, that Talbot was roused from his complacency. His friends immediately advised Talbot to obtain a patent, one writing 'you ought to keep it perfectly secret till you find you cannot advance farther in the matter, and then it would be advisable to secure your right by a patent. Although you do not require to deal with the matter commercially, yet a patent would give a more fixed character to your priority as an inventor…a patent would have the effect of stimulating yourself…to bring the Art to perfection'.[87] Talbot followed this advice, and when ready he obtained a patent in February 1841 for 'obtaining pictures or representations of objects'.

At first, it appears that the primary concern of Talbot was to establish his own scientific reputation vis-à-vis Daguerre and other early pioneers. Consequently, Talbot allowed free use of his process for scientific purposes and submitted a paper on the process to the *Philosophical Transactions of the Royal Society*. He was, however, quite intent on profiting from his new development as well. With an invention

84 Larry Schaaf, *Out of the shadows: Herschel, Talbot and the invention of photography*, (New Haven, 1992), p.39
85 Ibid, p.23
86 Ibid, p.40
87 Larry Schaaf, (2010), Henry Fox Talbot to David Brewster, 4th February 1839, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012.

such as the Calotype, there were probably two viable business strategies available to Talbot, besides selling the patent outright. Firstly, he could have attempted to manufacture and sell the sensitized paper and other materials for the process himself. Initially, Talbot does not appear to have contemplated this option, preferring instead to license the Calotype to artists and other professionals. To this end he entered negotiations with Richard Beard. Beard had been a pioneer in introducing Daguerre's process to the United Kingdom, and had many contacts in the nascent photography business. As was mentioned in the previous section, however, these negotiations failed and Talbot decided to manage the concern himself.

An 1842 letter from another early pioneer of photography, Antoine Claudet, reveals the terms Talbot sought to put in his licences. Firstly, Talbot only wanted to allow Claudet, and those Claudet sub-licensed, to take views of objects, withholding the right to take portraits as well. As Claudet point out, it is hard to envisage how this distinction could have been enforced: 'it would be difficult to prevent such parties to apply their apparatus to portrait taking and they could do it without being easily detected'.[88] Secondly, Talbot sought to claim a third of the total revenue as his royalty, which Claudet claimed was extortionate. Thirdly, Talbot sought to impose restrictions on the location of Claudet's establishment, although Claudet assented to this, 'I agree as my only object is to prevent opposition too near my establishment and ten miles are enough for that purpose'.

After fourteen months of negotiations, an agreement was finally reached between Claudet and Talbot. Claudet, however, did not enjoy much success. He was also using Daguerre's method which, as he wrote to Talbot, 'produces more delicate, better finished and more perfect images' than the Calotype.[89] Although copies could not be made of Daguerre's images (whereas one could with the Calotype), Talbot's process suffered from the competition. In the fifth quarter of his licence, Claudet's revenue on the Calotype was only £25 1s. 6d. and he complained 'so far…[the Talbotype]…has brought me nothing but losses, the entire takings do not even cover an assistant's salary'.[90]

In 1843 Talbot's standard royalty was 30 percent of revenue and Claudet was not the only licensee to find this objectionable.[91] Another noted that as he incurred all the commercial risk, Talbot's fees effectively accounted for half his revenues, 'relative to the 30 percent clear it appears to me to be really half, ⅓ for patent, ⅓ rent, personal attendance, and ⅓ to myself. Divide ⅓ for attendance equally, ½ will be placed to patent'.[92] Over time Talbot was forced to revise his licences, and by 1847 he was only demanding 10 percent of revenue as his fee.[93] Talbot was also forced to reduce the prices he expected licensees to charge the public

88 Larry Schaaf, (2010), Antoine Claudet to Henry Fox Talbot, 3rd December 1842, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012
89 Larry Schaaf, (2012), Antoine Claudet to Henry Fox Talbot, 24th August 1844, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 16th February 2012
90 Larry Schaaf, (2010), Antoine Claudet to Henry Fox Talbot, 15th July 1845, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 16th February 2012
91 Larry Schaaf, (2006), Henry Fox Talbot to Amélina Petit de Billier, 8th February 1843, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012
92 Larry Schaaf, (2011), West Awdry to Henry Fox Talbot, 8th February 1843, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012
93 Larry Schaaf, (2010), Henry Fox Talbot to Benjamin Thomas Cowderoy, 19th January 1847, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012

for Calotype portraits. In 1843 he had suggested to Claudet that portraits be charged at 10s. 6d. whereas by 1847 they were to be charged at 3s. 6d.[94] This means that in 1843 Talbot could expect to receive 2s. 7½d. for every Calotype portrait sold, whereas by 1847 this figure had fallen to 3½d.

Part of the problem faced by Claudet, and other users of the Calotype, was the difficulty they faced in producing serviceable images with such a delicate procedure. Even experienced practitioners struggled to produce images that satisfied customers. In 1851 Talbot tried to convince the Committee of the Great Exhibition to pay commercial rates for their use of the Calotype. Henry Cole, one of the committee members, complained to Talbot that 'at no price whatever would it be worthwhile having Mr Henneman's printing, they are too dark, not at all artistic and already show serious defects'.[95] Having taught the process to amateurs for some years, Henneman was by no means inexperienced. Cole added, 'I have hitherto understood from Mr Henneman that the actual charge of £3 3s. for each negative and the proposed charge of 2s. 6d. for each impression were fixed at that high price chiefly on account of the royalty which had to be paid to you'.[96]

The irony is that Talbot had been patronising the establishment of Henneman, his former assistant, since 1843 to improve the materials and training available to licensees. Initially, the enterprise was unsuccessful, and by 1844 Henneman was proposing to lay off assistants for lack of work.[97] Talbot, however, offered considerable assistance, for example, making it a condition of some licences that they 'covenant to purchase the iodized paper from [Henneman's] establishment'.[98] In 1848, Henneman and his partner, Mr Malone, opened an establishment on Regents Street with help from a £1,000 loan from Talbot, and a licence on 'easy terms'.[99] After this it appears, finally, that the Calotype was commercially successful. Later in the year Malone was able to report that 'the last few days have been busy ones as we have had four sets of apparatus ordered and all wanted immediately'.[100] Matters were still improving in 1850, 'I wish to tell you that the result of my examination of our books proves that the five months of this year have given an increase, considerable, compared with the five corresponding months of last year'.[101]

His efforts to profit from his invention abroad are also revealing of Talbot's commercial mindset. In France, Talbot intended to sell his patent outright as 'I could not pursue the counterfeiters here, the effort would be too great, I would therefore like to sell the patent for the invention in its entirety or the right to use it in Paris'.[102] In this his French correspondent agreed replying, 'those who speak of exploiting and of giving

94 Larry Schaaf, (2010), Antoine Claudet to Henry Fox Talbot, 27th October 1843, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012
95 Larry Schaaf, (2010), Henry Cole to Henry Fox Talbot, 14th November 1851, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012
96 Ibid
97 Larry Schaaf, (2011), Nicolas Henneman to Henry Fox Talbot, 31st May 1844, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 16th February 2012
98 Larry Schaaf, (2010), Henry Fox Talbot to Benjamin Thomas Cowderoy, 19th January 1847, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012
99 Larry Schaaf, (2010), Henry Fox Talbot to Thomas Malone, 15th February 1848, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 16th February 2012
100 Larry Schaaf, (2010), Thomas Malone to Henry Fox Talbot, 9th August 1849, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 16th February 2012
101 Larry Schaaf, (2010), Thomas Malone to Henry Fox Talbot, 12th June 1850, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 16th February 2012
102 Larry Schaaf, (2010), Henry Fox Talbot to Améline Petit de Billier, 6th September 1842, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012

you a share in the profits are not to be trusted and there is no doubt that you as an absent foreigner would be considered easy prey'.[103] As in England, though, Talbot grossly overestimated the pecuniary value of his invention. In 1842 he was quoted three different prices for the French patent – 10,000 to 12,000F, 20,000 to 25,000F and 50,000F.[104] With £1 approximately equal to 25F, these offers ranged from £400 to £2000. Talbot replied tersely to these quotations, 'the sum you indicate for the sale of the patent seems far too low to me'.[105]

Instead, Talbot entered an agreement with a Marquis de Bassano to found a Compagnie Calotype in 1843. The Compagnie was envisaged as a manufactory as well as a photography studio, similar to Henneman's establishment. Talbot suggested that there were would be three sources of profit. Firstly, there was the sale of prepared paper on which Talbot proposed a mark-up of 900 percent (!), and that he should be entitled to a third of the revenue.[106] Secondly, he proposed they profit from the sale of finished Calotype pictures, sold at a mark-up of 100 percent, and on which he would receive 25 percent of the revenue. Thirdly, they could sell chemical liquids and other paraphernalia, of which 15-20 percent of the sale price could be profit, and on which Talbot demanded nothing. Talbot, however, failed to secure returns like this in England, and in France, where the Daguerreotype was an entrenched competitor; it is unlikely Talbot even recovered the costs of his French patent. Within a year the Compagnie had collapsed and his partner de Bassano was trying to usurp Talbot's rights by patenting a near identical process in his own name.[107] Talbot failed utterly in his subsequent attempts to exploit his French patent and the February Revolution in 1848 put an end to his French endeavours.[108]

Talbot enjoyed a little more success with his American patent, although initially it seemed he would fail there as well. The first party to be interested in buying the patent was Edward Anthony, a New York photographer. Although details of Talbot's initial offer do not survive, Anthony baulked, 'it would be the height of folly for me to invest so much money in the purchase of a patent'.[109] For a while the negotiations continued on the premise that Anthony would purchase the patent outright, until Talbot began demanding a

103 Larry Schaaf, (2010), Améline Petit de Billier to Henry Fox Talbot, 5th November 1842, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012
104 Ibid
105 Larry Schaaf, (2010), Henry Fox Talbot to Améline Petit de Billier, 13th December 1842, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012
106 Larry Schaaf, (2010), Henry Fox Talbot to Améline Petit de Billier, 15th March 1843, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012
107 Larry Schaaf, (2010), Améline Petit de Billier to Henry Fox Talbot, 8th December 1843, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012
108 Some of the blame for the failure of Talbot's French ventures must be attached to Talbot himself – especially his failure to accept any outright offers for the patent from parties who would have been better placed to implement and enforce the patent. He was, however, unfortunate in having to deal with some duplicitous characters. We have already met the Count De Bassano. Another such character was Monsieur Arago, who at one stage had promised Talbot that if he sought an extension to his French patent he would 'speak up in order to pay Homage to the genuine and incontestable merit of you invention'. Larry Schaaf, (2010), Alfred Francois Bouard to Henry Fox Talbot, 6th April 1847, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012. Talbot was later informed that Arago had instead 'declared frankly that he would fiercely oppose the extension of your patent'. Larry Schaaf, (2003), Alfred Francois Bouard to Henry Fox Talbot, 9th June 1848, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012
109 Larry Schaaf, (2010), Edward Anthony to Henry Fox Talbot, 15th December 1845, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012

proportion of the revenue, calculated as a third of the profits. Anthony replied that 'it would be impracticable to tell what proportion the expenses would bear to the receipts, and if a percentage in the latter even adopted it might swallow up all and even more than the profits…our only object in purchasing the patent would be to be perfectly unfettered'.[110] A month later Anthony complained 'I have received nothing from your solicitor but new propositions', and returned to the United States without any agreement.[111] Later in 1849 Talbot was approached by Wilhelm and Friedrich Langenheim. After prolonged negotiations, Talbot managed to dispose of his American patent, accepting an offer of £1,000 from the Langenheims.[112]

There is finally a curious affair where Talbot surrendered a portion of his patent. In 1852 a letter from Lord Rosse was published in *The Times*, addressing itself directly to Talbot. It stated that photography could 'materially enlarge the boundaries of human knowledge…[but]…at present this cooperation is much hindered by the existence of patent rights and the uncertainty as to the use which may be made by unlicensed persons of those patents'. The letter continued by asking Talbot to surrender his patent rights in the public interest.[113] In a published reply Talbot assented to the request, reserving only the right for 'the application of the invention to taking photographic portraits for sale to the public'.[114]

This was not, however, Talbot surrendering his patent for the public good, but rather a calculated gamble. At this stage of the patent term, Talbot and his licensees were finally producing a reasonable income. The most profitable working of the patent was in portraiture. In 1850 for example, Malone wrote to Talbot 'it is important that we should have more portraits to do as they are profitable and do not demand a large outlay of capital'.[115] By reserving the right to use the Calotype to take portraits, Talbot was surrendering little of commercial value. But in surrendering his rights for other uses of the Calotype, Talbot believed he was improving his chances of obtaining an extension to the remainder of his patent from the Privy Council.[116] Talbot effectively dictated the letter published by Lord Rosse. In a letter sent to Lord Rosse and the painter Charles Eastlake, Talbot suggested 'that you should address to me a letter of the following kind, in which you will observe I have carefully avoided anything like a direct request to abandon the patent…the only

110 Larry Schaaf, (2010), Edward Anthony to Henry Fox Talbot, 29th January 1847, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012
111 Larry Schaaf, (2010), Edward Anthony to Henry Fox Talbot, 25th February 1847, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012
112 Larry Schaaf, (2010), John Henry Bolton to Henry Fox Talbot, 7th May 1849, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012
113 Larry Schaaf, (2011), William Parsons to Henry Fox Talbot, written July 1852, published 13th August 1852, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012
114 Larry Schaaf, (2011), Henry Fox Talbot to William Parsons, 30th July 1852, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012
115 Larry Schaaf, (2003), Thomas Malone to Henry Fox Talbot, 27th April 1850, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 16th February 2012
116 The connection between the two matters is clear in a letter written to Talbot from his sister-in-law, Caroline Edgcumbe. Edgcumbe was Lady of the Bedchamber to Queen Victoria and at the time of writing Talbot was contemplating an approach to Prince Albert to request he sign the public letter as well, which explains why he was conversing with her on the matter. Edgcumbe subsequently advised Talbot against seeking Albert's signature for fear that the letter would appear as a command to Talbot to surrender his rights. Larry Schaaf, (2010), Caroline Augusta Edgcumbe to Henry Fox Talbot, 1st June 1852, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012

signatures I consider necessary to this letter would be your own and Lord Rosse's'.[117]

Later in 1854, Talbot began instructing his lawyers to prepare his petition for the Judicial Committee. His plans were scotched, however, by his failure to enforce the patent. As described above, Talbot's process used silver nitrate as the light-sensitive chemical that was embedded into the paper. In *Talbot* v *La Roche* (1854) Talbot sought to enforce his patent against a new method of photography that he thought was an infringement of his patent. It was established that the defendant used a process analogous to Talbot's, termed the 'Collodion', but used pyrogallic acid to prepare the silver nitrate, which resulted in a reduced exposure time.[118] Talbot claimed that this infringed his process, but his prosecution clearly antagonised many contemporaries. One wrote to Talbot 'we must abandon for the present any attempt to form a society into which any considerations of your patent rights shall enter…everyone says you are pushing your claims too far'.[119] Talbot, failed to prove that the use of pyrogallic acid in the Collodion process constituted an infringement of his patent, and lost the case.[120] As he complained to his uncle, there was little point in extending a patent for a process that was already obsolete as 'other means and processes have been introduced, which a late decision of the Court of Common Pleas has pronounced to be not included in my patent right, it appears to me therefore to be useless to petition for an extension of the term'.[121]

In the 1840s photography was an extraordinary technology, perceived by contemporaries with amazement - or in the words of one historian as 'magic'.[122] Talbot pioneered the first method of photography with which it was possible to make limitless copies; he should probably have profited enormously from his developments. Although complete records or accounts do not survive, Talbot's letters indicate that his income from the Calotype was far short of what he could have achieved. This was in large part because of the heavy fees and prices Talbot sought to impose on the market. Even as the progenitor of this technology it was extortionate to ask for 30 percent of revenue from practitioners who were exposed to all the commercial risk. As late as 1850 (after Talbot had already reduced the fees substantially) Malone reported a conversation where he had been enjoined to advise that 'if Mr Talbot asked only £50 for a licence he would get £1,000 where he now gets £100'.[123] These problems were exacerbated in the early part of the patent term by the difficulty of achieving satisfactory results from Talbot's delicate chemical process.

The experience of Talbot highlights the difficulties faced by patentees in pricing their patent rights. Talbot consistently overestimated the potential pecuniary value of his invention both to himself and his licensees although this appears to be a problem common with independent inventors. Using data from the 'Canadian Innovation Centre' from 1977 to 1993, Thomas Åstebro characterises independent inventors as

117 Larry Schaaf, (2009), Henry Fox Talbot to Charles Eastlake, 10th June 1852, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012
118 Common Pleas. Hayward, *Patent cases*, Vol.7, pp.109-110
119 Larry Schaaf, (2010), Thomas Malone to Henry Fox Talbot, 12th June 1850, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012
120 Ibid
121 Larry Schaaf, (2011), Henry Fox Talbot to Henry Petty Fitzmaurice, 5th January 1855, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 16th March 2012
122 Schaaf, *Out of the shadows*, p.39
123 Larry Schaaf, (2010), Thomas Malone to Henry Fox Talbot, 15th February 1850, http://foxtalbot.dmu.ac.uk/letters/letters.html, accessed 4th February 2012

'extreme optimists'. For example, nearly half of inventors who had their inventions graded 'E' by the Centre and were strongly recommended to stop further development, persisted regardless.[124]

His international travails demonstrate that his relative failure was not attributable to some failing or quirk of the English patent system, but his optimism at the returns that could be achieved - how Talbot must have wished he had accepted the outright offer of 50,000F for his French patent in 1843. Talbot should also have appreciated that his Calotype was competing with another method which, although it could not be copied, produced images that were far superior to his own. The difficulties in producing the accurate images with the Calotype persisted for years, viz. the débâcle with the Committee of the Great Exhibition.

Section 5.5
James Watt and the separate condenser

The second case study looks at the working history of James Watt's patent for the separate condenser one of the best known inventions of the industrial revolution. By radically improving the fuel efficiency of steam engines, it ensured that they could be adopted in coal-poor areas of the country, especially in the Cornish tin and copper mines. Associated advances, such as the sun and planet gearing that provided rotary motion, allowed the application of steam power to a vast range of industrial processes. Although some econometric work has suggested that previous analyses of the steam engine have overstated its importance, the steam engine remains the archetypal technology of the industrial revolution.[125]

This section is essentially a business history of the Watt patent, focussing on his efforts to develop the separate condenser, and the business arrangements he entered to profit from it. An extraordinary range of sources survive from the firm Matthew Boulton and James Watt founded. Of particular importance are the Boulton and Watt papers held in the Birmingham Central Library. Conveniently, much of the early material has been microfilmed and this material has formed the basis of much of the research in this section. However, because the research was carried out on the microfilmed documents, rather than on the archived originals, the footnotes refer to where the documents may be found in the microfilm. This section also uses original research undertaken on the Chancery records. Not only do these provide useful information on the legal travails of Boulton and Watt, but also on the business practices adopted by the partnership to counter competition. These sources have been supplemented with two edited volumes of correspondence.[126]

The precursor of the Watt steam engine was developed by Thomas Newcomen around 1712. The Newcomen engine produced its power stroke by introducing steam into a cylinder, positioned directly

124 Thomas Åstebro, 'The return to independent invention: Evidence of unrealistic optimism, risk seeking or skewness loving?', *The Economic Journal*, 113, (2003), p.229

125 Von Tunzelmann estimated that the social savings of using steam power compared to all other power sources in 1800 was equal to 0.2 percent of National Income. Nicholas von Tunzelmann, *Steam Power and British Industrialization to 1860,* (London, 1978), chapter 6. This work, however, has been subsequently challenged. For example Nathan Rosenberg and Manuel Trajtenberg, 'A general purpose technology at work: The Corliss steam engine in the late-nineteenth-century United States', *Journal of Economic History*, 64, (2004), pp.61-99

126 In particular Jennifer Tann, (ed.), *The selected papers of Boulton and Watt, 1775-1825*, (London, 1981) and Eric Robinson and Douglas McKie, (eds.), *Partners in Science, letters of James Watt and Joseph Black*, (London, 1970)

underneath the piston. The steam was condensed by a jet of cold water. The condensation of the steam produced a vacuum under the piston which, driven down by the pressure of the atmosphere, raised the pump.[127] Watt's insight was that alternately cooling and heating the cylinder in each operating cycle was inefficient. Watt's solution was to create a second container where the steam condensation could occur separately from the cylinder (hence 'separate condenser'). This avoided unnecessary heat loss, and helped to conserve fuel. Herein lay the major advantage of the first Watt engines, their superior fuel efficiency. The large majority of Watt's engines also used the creation of a vacuum underneath the piston as the source of its power, although in a few engines erected towards the end of the patent term, Watt used steam 'expansively', using the power of steam to actively push the piston.[128]

During the initial development of the condenser, Watt relied upon the financial assistance of John Roebuck. By 1768 Watt had spent around £1,200 trying to perfect the condenser, whereupon 'Doctor Roebuck agreed to take my debts upon him and to lay out whatever more money was necessary either for experiments or securing the invention, for which cause I made over to him two-thirds of the invention'.[129] In developing the separate condenser Watt was clear on his motives, 'I was four years ago when I…[began to develop]…the fire engine and foresaw even before I made a model every circumstance that has since occurred. I was at that time spurred on by the alluring hope of placing myself above want without being obliged to have much dealing with mankind'.[130] Watt's correspondence also makes clear how important the prospect of patent protection was to the endeavour. One correspondent, John Robison, pressed him to move faster in obtaining protection, 'you see my dear Sir how many reasons in a manner force you to bestir yourself in getting your property secured. I have fulfilled my promise to Mr Boulton and Dr Small by pressing the thing upon you in the strongest manner'.[131] Because of the importance of patent protection Watt took great pains in preparing the specification. In 1769 he wrote to Dr Small, 'as I have been informed that some patents have been defeated because the specification was not clear enough to enable other people to execute the scheme I have added descriptions of the machines with drawings'.[132]

Roebuck, however, did not have the resources available to fund the development of the condenser, and in 1768, a year before the patent was obtained, Watt complained that Roebuck's other interests prevented him from paying much 'attention to the executive part' of the management of the invention, and Watt sought

127 For a full description of the Newcomen and Watt engines see Alessandro Nuvolari, 'The making of steam power technology: A study of technical change during the Industrial Revolution', (unpublished Ph.D thesis, Eindhoven University of Technology, 2004), pp.17-24

128 George Selgin and John Turner, 'Strong steam, weak patent, or, the myth of Watt's innovation-blocking monopoly, exploded', (mimeo, 2010), p.7

129 James Watt to Matthew Boulton, 20th October 1768, in Jennifer Tann, (ed.), *The selected papers of Boulton and Watt, 1775-1825*, (London, 1981), p.32

130 Boulton and Watt Papers (on microfilm), James Watt to William Small, 28th July 1769, Cambridge, University Library, Part 1, Reel 1, Item 8

131 John Robison to James Watt, 8th July 1768, in Eric Robinson and Douglas McKie, (eds.), *Partners in Science, letters of James Watt and Joseph Black*, (London, 1970), p.14

132 Boulton and Watt Papers (on microfilm), James Watt to William Small, 28th January 1769, Cambridge, University Library, Part 1, Reel 1, Item 4. This comment is also significant for two other reasons. Firstly, it confirms the argument in chapter 3 that the specification requirement was enforced at law prior to *Liardet* v *Johnson* (1778). Secondly, it indicates how the enforcement of this requirement obliged inventors to enter full and accurate specifications (although in this case Watt ended up omitting the drawings on the advice of his friend Dr Small).

Boulton's involvement.[133] Watt seized his opportunity in 1772, convincing Boulton to purchase Roebuck's share of the patent when a Scottish financial crash compromised Roebuck's financial position.[134] An agreement was eventually finalised in 1775. Boulton purchased Roebuck's two-thirds share of the patent for £2,200. In return for not pursuing Roebuck for money he was owed, Watt took possession of the shop goods and the experimental engine at Kinneil, which was rapidly packed up and shipped to Birmingham.[135]

Thus was born the partnership of Boulton and Watt. Although, Boulton originally intended to manufacture the engine parts in Birmingham, lacking a proper foundry, his manufactory was ill-suited to many of the necessary tasks.[136] The accounts of Boulton and Watt reveal that they manufactured very little during their early years. Between October 1778 and September 1784 the partnership produced goods valuing £3,992, or around £665 a year.[137] In approximately the same period, from 1779 to 1784, the partnership erected 51 engines.[138] Accordingly, Boulton and Watt were forced to rely on subcontractors to manufacture most of the engine parts. This posed its own set of problems. For example, ensuring that all the necessary parts arrived on time was an enormous logistical challenge in the eighteenth-century, and was one at which Boulton and Watt enjoyed mixed success. In an order for an engine in 1793 one customer complained, 'as Mr Wilkinson [John Wilkinson the iron founder] gave us much trouble about Wheal Maid great engine by retarding the work…I should not wish to be so served again'.[139] In response to these problems, the partnership strove to increase the proportion of engine parts it manufactured. The value of the manufacturing output of the company increased during the 1780s, and from October 1790 to September 1791 the value of goods manufactured at Soho was £10,488.[140] For comparison, in 1790 Boulton and Watt erected 21 engines.[141] With the completion of the foundry the annual statement of goods manufactured increased again from around £10,000 per annum to £15,000 in the late 1790s.[142]

However, the manufacturing of engines was never the main source of profit to the partnership. Between 1795 and 1800, Boulton and Watt made a profit of £5,716 from their manufactory - but made £42,731 from royalties.[143] When erecting their first engines Boulton and Watt charged a licence fee that was calculated as a third of the value of the coal saved by adopting their engine over a Newcomen design. As a

133 James Watt to Matthew Boulton, 20th October 1768, in Tann, (ed.), *Papers of Boulton and Watt*, p.32
134 Richard Hills, *James Watt*, (3 Vols, King's Lynn, 2006), Vol.1, p.444
135 Ibid, p.446
136 It ought to be mentioned that in 1775, James Watt was able to secure a twenty-five year extension to his patent term from Parliament.
137 Boulton and Watt Papers (on microfilm), Accounts and Balance sheets 1783 to 1797, Cambridge, University Library, Part 6, Reel 75, Item 1
138 Tann, *Papers of Boulton and Watt*, p.6
139 Richard Daniells to James Watt, 18th May 1793, in Tann, (ed.), *Papers of Boulton and Watt*, p.181
140 Boulton and Watt Papers (on microfilm), Accounts and Balance sheets 1783 to 1797, Cambridge, University Library, Part 6, Reel 75, Item 1. That the partnership was manufacturing £10,000 worth of goods, ten years before the patent expired, negates the claim of Boldrin and Levine that 'it is only after their patents expired that Boulton and Watt really started to manufacture steam engines'. Michele Boldrin and David Levine, *Against intellectual monopoly*, (Cambridge, 2008), p.2
141 Tann, *Papers of Boulton and Watt*, p.6
142 Boulton and Watt Papers (on microfilm), Accounts and Balance sheets 1783 to 1797, Cambridge, University Library, Part 6, Reel 75, Item 1
143 Boulton and Watt Papers (on microfilm), Summary of accounts 1795 to 1801, Cambridge, University Library, Part 4, Reel 43, Item 49

letter from Boulton to Watt reveals, they were obliged to adopt this royalty structure to establish the superiority of their engine over that of Newcomen, 'I don't see how you can make lump bargains in Cornwall until all parties are decided as to the rate of goodness of ours. Example Wheal Union is of such magnitude that I am confident an old engine of that power would consume in Cornwall £2,000pa in coals more than ours and I don't see how you will convince them but by comparison'.[144]

Calculating these savings was a complicated process. It was simplest where the Boulton and Watt engine was intended to replace a pre-existing Newcomen engine, in which case it was a matter of comparing the fuel consumption of the old engine with that of the new one. It was necessary, however, to take account of the time of year in which the fuel consumption was measured. Mines tended to suffer from flooding more in winter and so the engines had to be worked for more time than in other seasons. Further, the efficiency of the engines varied according to the skill of the men maintaining and working them. It was even more complicated to calculate the royalties where there was not a Newcomen engine to be replaced, or where the new engine was to perform different work. Because of these complications, many mineowners took the opportunity to dispute their premiums. At Hawkesbury Colliery the owners offered Boulton and Watt a paltry £30 annual licence on their engine, until arbitration set it at £217.[145]

Because of the challenges involved with calculating the theoretical or actual fuel savings for every new engine, the partnership introduced standardised premiums based on the comparative performance of a Newcomen engine and one of their own at the Poldice mine in Cornwall.[146] Although the tables simplified matters, the accuracy of their calculations remained a matter of contention and was raised in the many legal actions initiated by Boulton and Watt. One defendant complained that 'the statement of the complainants tables is erroneous and that they have received much larger sums and payments than they are equitably and fairly entitled to'.[147] However, although the method of calculation was open to dispute, outside of Cornwall the principle on which the premium was calculated was generally accepted. One customer sought 'leave to recommend you to settle the premium per savings [of coal] it appearing to me the most equitable'.[148]

Calculating the licence fee in this manner, had two important consequences for how the business was run. Firstly, because the profits that accrued to Boulton and Watt relied upon coal prices, they were anxious to secure orders from areas where the price of coal was high. In the early days of the partnership this meant Cornwall where high coal prices coupled with the high value of output from tin and copper mines ensured demand for fuel efficient engines. As Boulton wrote to Watt, 'remember there is but one county of Cornwall and don't let us give that away'.[149] The initial success they enjoyed in Cornwall, did much to bankroll the firm (and Boulton's other enterprises). Between 1778-85 the partnership received a total of £36,346 in royalties from Cornwall.[150]

144 Matthew Boulton to James Watt, 6th September 1777, in Tann, (ed.), *Papers of Boulton and Watt*, p.173
145 Hills, *James Watt*, Vol.2, p.115
146 Ibid
147 *Boulton* v *Vivian,* (1794), London, National Archives, C12/1730/16, fol.5
148 Robert Wild to Boulton and Watt, 28th November 1789, in Tann, (ed.), *Papers of Boulton and Watt*, p.294
149 Matthew Boulton to James Watt, 6th September 1777, in Ibid, p.173
150 Hills, *James Watt*, Vol.2, p.167

Secondly, it tied the financial fortunes of the partnership directly to the performance of their engines. A poorly erected or maintained engine would consume more coal, reducing the fuel differential between Boulton and Watt's engine and a Newcomen. This was how they derived their royalties and consequently Watt insisted on using the best subcontractors. This, however, placed the partnership in a vulnerable position. The most important subcontractor was John Wilkinson, the only ironmaster capable of boring engine cylinders with sufficient accuracy for their engines. Wilkinson abused this position to become a massive infringer of the patent. A letter written by Watt to his lawyer in 1795 reveals the extent of Wilkinson's treachery. In total, Watt claimed Wilkinson had erected 35 engines without licence, which the partnership had been supposedly unaware of.[151] It is impossible, however, that Boulton and Watt could have been unaware of an infringement on this scale, and in a letter to his friend Joseph Black, (five years before he informed his lawyer) Watt wrote 'we are going well enough in our business, but are attacked on many hands, and among the rest of our invaders are our good friends John Wilkinson and William Reynolds. The former acts avowedly for his own interest'.[152] Watt probably omitted to inform his lawyer that he had been aware of the infringement because toleration of the infringement for so long would have made it very difficult to obtain an injunction.[153]

Boulton and Watt would also have been aware of Wilkinson's failure to pay licence fees on the engines he had built with their permission.[154] They were forced to tolerate this infringement for two reasons. Firstly, until their own foundry was finished in 1796 (at a reported cost of £9,000), Wilkinson was the only available source for accurate castings of their cylinder. Watt rejoiced at the completion of the foundry 'our connection with the Iron King at Bradley is dissolved and by our new works we are independent of all such iron tyrants'.[155] Secondly, most of the engines Wilkinson erected were for his own use.[156] It would probably have been impossible for Boulton and Watt to tolerate these infringements if Wilkinson had been selling engines on their design on a large scale. The affair ended to the satisfaction of Boulton and Watt as Wilkinson eventually paid fees on the engines he had erected.[157]

In time, the partnership began to adopt different pricing policies. In some cases the fuel saving royalty was waived in preference of a fixed monthly fee. When in 1779 a group of mine adventurers owning the 'United Mines' in Gwennap, Cornwall, ordered two engines the fee was arranged on the basis of fuel savings. Later, in 1782 these royalties were commuted in return for a fixed monthly charge of £83 6s 8d. which was later increased in 1786 to £137 10s. with the addition of a third and fourth engine.[158] When Boulton and Watt began to erect rotative engines, the licence was calculated on the basis of horsepower used

151 James Watt to Ambrose Weston, 10th September 1795, in Tann, (ed.), *Papers of Boulton and Watt*, p.131-136
152 James Watt to Joseph Black, 5th December 1790, in Robinson and McKie, *Letters of James Watt*, p.184
153 Which they were clearly considering. Enclosed with the letter was a note from Watt junior enquiring whether 'you think we have grounds sufficient to recover the premiums at common law, or whether the better way will not be to stop his engines by injunction'. James Watt to Ambrose Weston 10th September 1795, in Tann, (ed.), *Papers of Boulton and Watt*, p.136
154 James Watt to Ambrose Weston, 10th September 1795, in Ibid, p.128
155 Matthew Boulton junior to Z. Walker, 14th April 1797, in Ibid, p.236
156 James Watt to Ambrose Weston, 10th September 1795, in Ibid, p.131-136
157 James Watt junior to James Watt, 2nd December 1795, in Ibid, p.121
158 *Boulton* v *Andrews,* (1795), London, National Archives, C12/461/8, fol.1

per annum. Watt was obliged to calculate a standardised definition of horsepower applicable to steam engines and the fee was fixed at £5 per horsepower or 6 guineas in London.[159] By the 1790s, as the patent term began to dwindle, and as the superior fuel efficiency of the Boulton and Watt engine became recognised, Boulton and Watt began to charge fixed prices for their engines with the licence fee paid in its entirety upon purchase of the engine. A price list from 1798 gives the price of a 4 horsepower engine as £350, £88 of which was levied as the premium.[160]

Boulton and Watt invested considerable effort in their pricing strategy and setting their royalties at a level that would maximise their income. In this they were successful; from 1795 to 1800 they received £42,731 in patent licence fees.[161] However, the yoke of licence fee payments was keenly felt in Cornwall, where Boulton and Watt were able to obtain particularly lucrative royalties. Initially, however, the pair were reluctant to pursue legal action against infringements. This may have been because of the cost of legal action, uncertainty over the validity of their patent, an unwillingness to jeopardise any on-going negotiations concerning royalties or, most likely, a combination of the three.

The mental calculus involved with deciding whether to pursue legal action against infringers is revealed in a note by James Watt junior, entitled 'considerations upon the measure most proper to be adopted in the present state of affairs with Maberley'.[162] Stephen Maberley (and his partner Jabez Hornblower) was an engineer who claimed to be working under the auspices of a 1791 patent he had purchased.[163] When the note was written (5th October 1796), Boulton and Watt had already succeeded in defeating one opponent at law, Edward Bull. Nonetheless, the cause remained a source of anxiety. The first option considered by Watt junior was whether to accept Maberley's offer to pay royalties on any future engines he erected, but not on the ones that he had already erected. Watt junior enumerated six reasons for acceding to this proposal, first of which was that 'B and W will avoid a trial for the present with all its attendant anxiety and expenses'.[164] Watt junior, however, noted against this, 'it will excite discontent from our customers and from pirates with whom we have compromised. It will establish a precedent for future invaders and will flatter them with the hope of impunity'.[165] Clearly more was at stake than just the royalties to be fore-gone in striking this deal with Maberley; the fear was that reaching such an unfavourable compromise with a 'pirate' would encourage existing customers to stop paying licence fees, and encourage others to erect pirate engines.

Boulton and Watt had already experienced this scenario earlier in the 1790s. Then they had had to deal with pirate engines erected by Edward Bull and others. Because Boulton and Watt neglected to enforce their patent with sufficient alacrity, many of their licensees began to renege on their royalties. In November

159 Hills, *James Watt*, Vol.3, p.70
160 Boulton and Watt Papers (on microfilm), James Watt junior to Matthew Boulton junior 11th September 1798, Cambridge, University Library, Part 1, Reel 6, Item 61
161 Boulton and Watt Papers (on microfilm), Summary of accounts 1795 to 1801, Cambridge, University Library, Part 4, Reel 43, Item 49
162 James Watt junior, 'Considerations upon the measure most proper to be adopted in the present state of affairs with Maberley', 10th September 1795, in Tann, (ed.), *Papers of Boulton and Watt*, p.136
163 *Boulton* v *Hornblower,* (1796), London, National Archives, C12/213/11, fol.3
164 James Watt junior, 'Considerations upon the measure most proper to be adopted in the present state of affairs with Maberley', 10th September 1795, in Tann, (ed.), *Papers of Boulton and Watt*, p.137
165 Ibid

1793, for example, 'Captain Trevithick has refused to pay any more premium for Wheal Treasury till the business is settled betwixt you and Bull after the example of Crenver [another mine that was withholding royalties]'.[166] Watt junior was clearly anxious to avoid this scenario occurring again. Elsewhere in the note he wrote that failure to pursue action against Maberley would 'confirm the Cornish people in their obstinacy and in their idea of the badness of the Patent and of B and W's timidity. They will say that if we give up the premiums in one case from fear, we shall do so in another'.[167]

Consequently, Watt junior argued against accepting Maberley's offer. The second option he considered was whether to pursue action in Chancery and obtain an injunction. In going to Chancery, the hope was that Maberley (and other infringers) would relent immediately, relieving themselves of the injunction, and resume payment of licence fees. Boulton and Watt would be in receipt of licence fees owed and would avoid the hazards of a trial at law. It might also be hoped that it would frustrate 'Bramah and all the petty London invaders, and take from them all hopes of bringing us to trial at another's expense'.[168] Despite the advantages of this second course of action Watt junior opted for a third, more aggressive, strategy, to pursue Maberley to a trial at common law, definitively establish the legality of the patent, and extract damages. This strategy was chosen because Watt junior was so bullish about their legal prospects, especially after their success against Bull. The note indicates the type of factors that would force a patentee to go to law. In particular, it emphasises how important it was for patentees who licensed their inventions to take prompt legal action against infringers.

The note also indicates how formidable a legal instrument an enforceable patent could be. Boulton and Watt's patent has been the matter of some controversy. Michele Boldrin and David Levine have argued that they were extremely aggressive in the enforcement of their patent, arresting the diffusion of steam engines, stymieing the technological development of steam engineering, and ultimately delaying the industrial revolution 'by a decade or two'.[169] However, any discussion on the affect of Watt's patent on the diffusion and development of steam engineering is necessarily tentative, as it involves speculating on what would have happened without the patent. In light of Watt's correspondence cited above, it is unlikely he would have gone to the trouble of developing the separate condenser without the prospect of patent protection.

Concerning whether Watt's patent posed a serious impediment to the adoption of steam engines, Boldrin and Levine proceed on the premise that Watt wielded a virtual monopoly over the construction of steam engines, writing 'few steam engines were built during the period of Watt's legal monopoly'.[170] The quantitative work of John Kanefsky and John Robey demonstrates that Boulton and Watt were, by some distance, the largest steam engineering firm in the eighteenth-century. However, it is an exaggeration to claim they held a monopoly. From 1771 to 1800, 1,603 engines were erected in the United Kingdom, of

166 Quoted in Hills, *James Watt*, Vol.3, p.187
167 James Watt junior, 'Considerations upon the measure most proper to be adopted in the present state of affairs with Maberley', 10th September 1795, in Tann, (ed.), *Papers of Boulton and Watt*, p.138
168 Ibid, p.140
169 Boldrin and Levine, *Against intellectual monopoly*, p.3
170 Ibid

which 478 were erected by Boulton and Watt, less than 30 percent.[171] Consequently, there was no change in the growth trend of steam engine installation during Watt's patent term. When plotted on semi-logarithmic axes, the growth trend in the number of steam engines erected during the eighteenth-century is smooth, until an acceleration in the 1790s when Watt's patent was still in force.[172]

Boldrin and Levine also argue that Watt's patent frustrated the subsequent development of steam engineering technology. This is partly because Watt succeeded in upholding a 'broad' interpretation of his patent in court. In particular, Watt was supposed to have used his patent against those (in particular, Jonathan Hornblower junior), who were beginning to use steam to actively 'push' the piston, rather than simply use atmospheric pressure to 'pull' the piston down.[173] It was to be the 'expansive' use of steam at high pressures that permitted significant fuel economies in the first half of the nineteenth-century and paved the way for the application of the steam engine to a new raft of industrial purposes.[174] It is unlikely that Watt envisaged this variation of steam technology when he prepared his specification in 1769, or later in 1775 when he re-specified for his extension, although he did later use the 'expansive' force of steam at lower pressures in some of his later designs.[175]

Jonathan Hornblower began developing his compound engine in 1781, although it only became commercially viable a decade late.[176] By the early 1790s, however Hornblower was beginning to receive orders for his engines in Cornwall, and thereafter Boldrin and Levine assert that it was legal action that halted the continued development of Hornblower's engine.[177] However, Boulton and Watt never obtained an injunction against Hornblower junior, or on the mineowners who erected his compound engines.[178] This did not pass unnoticed by contemporaries. In his answer to Boulton and Watt's bill of complaint, Edward Bull claimed he:

> conceived that the said invention did not infringe on that of the said complainants as it was of a very different construction and not in his opinion more similar to the said complainants than the engine some time since constructed by Messrs Hornblower and Winwood and which the said complainants have never attempted to interrupt the working of except by threats only.[179]

171 The figure of 1,603 engines being erected should be seen as a lower bound estimate, while John Kanefsky and John Robey also suggest that Tann's figure of 451 Watt engines is probably more accurate than their one cited here. John Kanefsky and John Robey, 'Steam engines in eighteenth-century Britain: A quantitative assessment', *Technology and Culture*, 21, (1980), p169 and p.175
172 Ibid, p.167.
173 On the subject of Hornblower, Boldrin and Levine claim that 'Boulton and Watt were able to block him in court and effectively put an end to steam engine development'. Boldrin and Levine, *Against intellectual monopoly*, p.3
174 Alessandro Nuvolari and Bart Verspagen, 'Technical choice, innovation and British steam engineering, 1800-50', *Economic History Review*, 62, (2009), p.686
175 George Selgin and John Turner, 'Strong steam, weak patent, or, the myth of Watt's innovation-blocking monopoly, exploded', (mimeo, 2010), p.7
176 The first Hornblower engine was erected at a coal mine at Radstock in 1781 but performed poorly. Richards Hills (2004), 'Hornblower, Jonathan (1753–1815)', Oxford Dictionary of National Biography (online edn.), http://www.oxforddnb.com/view/article/13784, accessed 10th May 2011.
177 Boldrin and Levine, *Against intellectual monopoly*, p.4
178 Richard Hills writes that a writ was served on Jonathan Hornblower junior, right at the end of the patent term on 21st November 1799, although no evidence of the writ survives in the National Archives. Hills, *James Watt*, Vol.3, p.215
179 *Boulton* v *Bull,* (1795), Answer of Edward Bull, London, National Archives, C12/204/15, fol.1. In a similar vein, the answer of the defendants in *Boulton* v *Andrews* (1795) claimed, 'many persons in the said county of Cornwall have preferred the engines of one Hornblower to the engine of the said complainants and that the said complainants

If Boulton and Watt did frustrate the efforts of Hornblower, it must have been by less direct means. Although they did not hold a monopoly, as the market leader, Boulton and Watt did enjoy a degree of market power, of which they were willing to avail themselves. In 1797, for example Watt junior advised Boulton junior:

> let it be our business to neglect none of the advantages with which our experience and capital furnish us and bear without repining that others pick up the crumbs which fall from our table. This applies also to the Reverend Cartwright…I expect it will hardly become worth our while to take any legal notice of him during the continuance of our patent.[180]

Also, from 1793 to 1800, Boulton and Watt obtained at least fifteen injunctions. Some of these were against out and out pirates, but others were against those who had made marginal improvements, such as Edward Bull who had invented a simplified version of the Watt engine.[181] This probably made the *threat* of legal action against those who used Hornblower's engines credible. Using this threat, Boulton and Watt were able to extract royalties from mineowners who had erected Hornblower's engines and this explains why they never obtained injunctions on those who adopted the Hornblower engine: they had no cause to.[182] That they were able to obtain premiums from users of the Hornblower engines dissuaded other mineowners from adopting them as well. The Hornblower engine was not yet so refined and obviously superior that it was worth the mineowners paying fees to Hornblower (who had patented his engine also) *and* Boulton and Watt. Consequently, further commercialisation and development of Hornblower's early designs had to wait for the expiration of Watt's patent (disheartened, Hornblower abandoned his work on reciprocating engines).[183]

The business history of Watt's patent offers qualified support for the efficacy of the market in patent rights. Watt's correspondence suggests that the prospect of patent protection, and the income it was expected to provide, was a crucial reason for his choosing to develop the separate condensor. The partnership Watt later formed with Boulton provided him with access to manufacturing plant, and the capital needed to finish the development of the separate condenser. The protection offered by the patent was a key reason for Matthew Boulton assenting to this connection.

The arguments that Watt and Boulton stifled the diffusion and development of steam engineering have probably been overstated, although there is necessarily an element of speculation in this debate. Concerning the diffusion of steam engines, the growth trend in the numbers installed did not change during

by their agents have by way of inducement to persons to use their engines in the stead of Hornblower's engine offered to reduce the sum of money which they first demanded for the use of the same'. This also indicates the partnership's proclivity for exploiting their position as the market leader. *Boulton* v *Andrews,* (1795), London, National Archives, C12/461/8, fol.4

180 Before continuing Boulton and Watt Papers (on microfilm), James Watt junior to Matthew Boulton junior, 15th November 1797, Cambridge, University Library, Part 1, Reel 6, Item 59

181 These were (with their National Archive shelfmark) *Boulton* v *Hawkins* C12/1552/24, *Boulton* v *Pasmore* C12/463/32, *Boulton* v *Reed* C12/1546/8, *Boulton* v *Bull* C12/1730/17, *Boulton* v *Vivian* C12/1730/16, *Boulton* v *Rosewarme* C12/1986/15, *Boulton* v *Oxnam* C12/213/16, *Boulton* v *Daniell* C12/213/31, *Boulton* v *Hornblower* C12/213/11, *Boulton* v *Paley* C12/956/13, *Boulton* v *Daniell* C12/463/21, *Boulton* v *Reed* C12/233/11, *Boulton* v *Fenner* C12/966/3, *Boulton* v *Thackeray* C12/1552/25, *Boulton* v *Carpenter* C12/232/27. Boulton and Watt Injunctions, London, National Archives, C12.

182 For example, in 1801 Wheal Margaret paid £537 in royalties on its Hornblower engine. Hills, *James Watt*, Vol.3, p.215

183 Hills (2004), 'Hornblower, Jonathan (1753–1815)'

Boulton and Watt's patent term. Indeed, if anything it increased in the 1790s. This suggests that their patent did not frustrate the diffusion of steam engines. On the development of steam engineering there needs to be greater specificity on how Boulton and Watt may have frustrated technological progress. Certainly, Hornblower was not frustrated by legal action itself. It was, however, the *threat* of legal action, combined with the market power the partnership could wield, which dissuaded potential customers from adopting Hornblower's engines. This disincentivised the development of high pressure steam engines and it was in this way that the Boulton and Watt patent frustrated the development of steam technology.

Section 5.6
Capital, patents and the joint-stock company

In the eighteenth-century most licences and partnerships were probably struck through personal contacts, as shown by the experience of James Watt. By the first half of the nineteenth-century (and possibly before), patent agents were also able to assist inventors transferring their patent rights. Consequently, it would be expected that patentees had sufficient access to capital for investment in their invention. As noted in section 2.3.2 the consensus in the Select Committees was that capital was generally available, one witness claiming 'capitalists are constantly looking after patent property. I do not think it often happens that there is a useful invention that you do not find some capitalist to take up'.[184] Even the patent abolitionist Lieutenant-Colonel Reid agreed that patents helped inventors obtain the capital they needed.[185]

Further, patents were considered to be essential for attracting capital into developing technology. The lawyer Thomas Webster claimed

> if any person who may be disposed to think that patents should be done away with, comes to examine the way in which particular manufactures have been built up by reason of the large amount of capital which has been thrown into them, in reliance upon the return to be obtained by means of the protection to be given for a short time, he will be very much surprised.[186]

Another lawyer observed, 'patents operate as a bounty to capitalists to divert their capital…the effect of granting patents, either for inventions made in England, or for imported inventions, has necessarily that effect'.[187] The availability of capital to inventors and entrepreneurs also has implications for the returns that could be realised from working new inventions. Without sufficient capital, it would be much more difficult for an inventor to turn an invention to profit.

There was one legal obstacle for patentees seeking capital, which was mentioned in section 5.2. Until 1832, all patents were passed containing a proviso that if a financial interest in the patent was held by more than five people, the patent would be annulled. In *Duvergier* v *Fellows* (1829), Chief Justice Best found the

184 *Committee on the Signet and Privy Seal Offices*, (Parl. Papers, 1849), p.47

185 On being asked whether 'it be the case that in this country the great majority of inventions are known to proceed from persons who are without the means of bringing them into use, should not you say that the acquisition of a patent right would give to such persons the means of obtaining better terms from men of capital?', Reid replied, 'It may, no doubt, in some instances, do so; perhaps in many instances'. *Select Committee of the House of Lords*, (Parl. Papers, 1851), p.307

186 *Select Committee of the House of Lords*, (Parl. Papers, 1851), p.13

187 Ibid, p.354

patent worked by The Patent Distilling Company, invalid 'the moment the company was formed…for they would be destroyed by any assignment to more than five persons'.[188] The proviso existed because there was a concern that joint-stock companies founded to work patents were often speculative spectres, established to defraud the unwary. In *Duvergier* v *Fellows* Chief Justice Best had asserted 'the patents that the scheme in which the parties to this action were engaged was one of those bubbles by which, to the disgrace of the modern age, a few projectors have obtained the money of a great number of ignorant and incredulous persons'.[189]

The proviso could have proved restrictive for those who sought to work a patent in a large partnership, but was easily avoided. The manufacturer John Taylor testified to the 1829 Select Committee that the rule could have been inconvenient because 'with only five persons, an inventor may not be able to raise a capital sufficient to carry his intention into effect, which might be done if a greater number of partners could be introduced', but that the proviso could be circumvented 'by putting in names under licensees or as trustees for others'.[190] Although the proviso was relaxed in 1832 by increasing the limit to twelve investors, it probably only ever represented an inconvenience.[191]

The proviso was also ineffective in withholding patent rights from joint-stock companies, its intended purpose. In an 1844 Select Committee investigating joint-stock companies the solicitor to the Eastern Counties Railway Company observed, 'the obstruction has no soundness or sense…an exclusive licence to work a patent, which is practically almost equal to an assignment, may be held by any number of persons'.[192] In registration documents submitted to the registrar of joint-stock companies, firms openly stated that their intended business was to work the exclusive licence of a patent.[193]

In the absence of any serious legal impediments the question remains, what was the availability of capital for the working of new inventions? To answer this question in a systematic way, the rest of the chapter will examine the efforts of patentees and their co-promoters in securing capital to work patents by forming joint-stock companies between 1845-52. Although Dutton has shown that there were some joint-stock companies founded to work patents before 1844 (fourteen between 1837-44), 1845 has been chosen as the starting point, as this was when the Joint-stock Companies Act came into force.[194] The Act instituted a two phase registration procedure for the incorporation of firms. The first phase was when the firm entered provisional registration with the registrar of joint-stock companies. This was a straightforward affair; all that was needed was a statement of the company's intended business, the names of its promoters, its place of

188 Common Pleas. Hayward, *Patent cases*, Vol.1, p.950
189 Ibid, p.951
190 *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.12
191 Carpmael, *The law of patents*, p.41
192 *First report of the Select Committee on Joint-stock Companies; together with the minutes of evidence (taken in 1841 and 1843), appendix and index*, (Parl. Papers, 1844, VII), p.177
193 For example, the prospectus of the Patent Tidal Wheel Company announced that 'the directors have made an advantageous arrangement with the owner of the patent for its exclusive use and the right of granting licences'. Files of the Patent Tidal Wheel Company, London, National Archives, BT 41/546/3006. Also the legality of exclusive licences granted to joint-stock companies was specifically endorsed in *Protheroe* v *May* (1839). Exchequer. Hayward, *Patent cases*, Vol.3, p.503
194 Dutton, *The patent system*, p.164

business and its nominal capital (the capital that it proposed to raise). Provisionally registered, a company could begin accepting share subscriptions from the public. Full registration was only possible when there had been enough share subscriptions, and after the subscribers had signed the Deed of Settlement (which stated the purpose of the company, its capital structure and its directors).[195] Upon full registration a company was incorporated, assuming a legal personality separate from its shareholders and providing for the free transferability of shares.[196] The company, however, did not obtain the privilege of limited liability, which until 1856 could only be acquired by Act of Parliament.[197]

Many of these registration documents survive in the Board of Trade (BT) files in the National Archives. The files provide important details such as the business of the company (important for verifying whether the company actually intended to work a patent), the proposed capital and the number of shareholders and their holdings. Companies were also supposed to submit audited balance sheets every year. Unfortunately, no provision was made for how the accounts were to be presented and what they should contain. Some directors took the opportunity to reveal nothing of substance and so the quality of the accounts that do survive, varies.[198]

In his work on joint-stock companies, Dutton found seven that were established to work patents between 1845-52. This, however, is an undercount. In the BT files there are twenty-eight companies that completed full registration, and where their stated business was to introduce or work a patent. Table 5.4 provides the names of these companies, the year in which they were founded (dated from provisional registration), the nominal capital of the company upon provisional registration, and the actual capital of the company five years after foundation (or as near that date as is possible). Appendix 5.1, at the end of the chapter provides the BT file number for every provisionally and fully registered company, along with their name, year of provisional registration, and (where available) their proposed nominal capital.

195 Ron Harris, *Industrialising English law: Entrepreneurship and business organisation, 1720-1844*, (Cambridge, 2000), p.283
196 Ibid
197 Ibid, p.288
198 Paul Johnson, *Making the market, Victorian origins of corporate capitalism*, (Cambridge, 2010), p.202

Table 5.3 Joint-stock companies fully registered to work patents, 1845-1852

Company Name	Founded	Nominal Capital	Capital after 5 years
British and Foreign Gas Light and Meter Company	1845	£25,000	£6,396 (1848)
Compressed Air Engine Company	1845	£400,000	Dissolved
Patent Cork-Cutting Company	1845	£40,000	Dissolved
Patent Fuel Company	1845	£200,000	£109,397 (1848)
Patent Galvanized Iron Company, (Malins & Rawlinsons)	1845	£500,000	£102,253 (1847)
Universal Gas Light Company	1845	£100,000	£12,470 (1846)
West of England Patent Refining Sugar Company	1845	£300,000	Dissolved
British Patent Naptha Company	1846	£10,000	Dissolved
Cambridge and Huntingdon Patent Ramoneur Company	1846	£8,000	Dissolved
Patent Tidal Wheel Company	1846	£65,000	Dissolved
Bristol District Patent Ramoneur Company	1847	£10,000	Dissolved
Lows' Patent Copper Company	1847	£100,000	£41,251 (1851)
Patent Alkali Company	1847	£110,000	£65,726 (1851)
Patent Metal-Cored Railway Sleeper Company	1847	£100,000	Dissolved
Prices Patent Candle Company	1847	£375,000	£125,000 (1848)
Westminster and Marylebone Patent Ramoneur Company	1847	£50,000	£17,500 (1856)
Coggeshall Patent Plush Manufacturing Company	1848	£5,000	Dissolved
British Electric Telegraph Company	1849	£300,000	£578,715 (1858)
United Kingdom Electric Telegraph Company	1850	£150,000	No available figure
Claussens' Patent Flax Company	1851	£250,000	£240,020 (1858)
English and Irish Magnetic Telegraph Company	1851	£300,000	£578,715 (1858)
London Cooperage Company	1851	£50,000	Dissolved
Patent Cooperage Company	1851	£100,000	Dissolved
Patent Solid Sewage Manure Company	1851	£100,000	£25,256 (1856)
Electrical Telegraph Company of Ireland	1852	£100,000	£19,155 (1853)
National Patent Steam Fuel Company	1852	£50,000	£19,370 (1856)
Patent Apyro-Type Company	1852	£30,000	Dissolved
Patent Silicious Stone Company	1852	£20,000	£22,955 (1856)

Although the table shows that there were twenty-eight companies founded to work patents during this eight year period, an additional forty-five such companies filed provisional registration between 1845-52, (for details see appendix 5.1). However, an unknown number of these provisionally registered companies became fully registered, but for which the relevant documents do not survive. For example, the deed of settlement and other documents for the Electric Telegraph Company (ETC) do not survive.[199] There cannot, however, be any doubt that the ETC was fully registered, from 1852 its share price was listed in the *Course of the Exchange*.[200] It can also be seen in table 5.3 that its Irish 'partner' firm entered provisional registration in 1852 and completed full registration.

Table 5.3 also shows that considerable amounts of capital were subscribed to these companies, sixteen of the twenty-eight had subscribed capital of £100,000 or more, six had at least £300,000 subscribed. Unfortunately, there are no overall figures for capital subscriptions to joint-stock companies in this period to

199 Provisional registration was entered in 1846. Files of the Electric Telegraph Company, London, National Archives, BT 41/218/1236

200 The *Course of the Exchange* was the unofficial price listing of stocks and shares on the London Stock Exchange. Charles Hickson, John Turner, and Ye Qing, 'The rate of return across industrial sectors on the British stock market', *Economic History Review*, 64, (2011), p.1229

compare these figures with. Later, however, between 1856-68 only 15.6 percent of registered companies had a nominal capital in excess of £100,000.[201] Also companies that proposed to work patents had a better chance of advancing to full registration. Here, 38 percent of companies that were provisionally registered completed full registration (twenty-eight out of seventy-three), whereas between 1845-52, only 20 percent of all provisionally registered companies completed full registration.[202] There were a variety of reasons why a provisionally registered company might not proceed to full registration. Possibly, the promoters decided their interests were better served by organising their enterprise as a straightforward partnership. It was also possible that the enterprise had not attracted a sufficient number of share subscriptions to finish full registration. That a higher proportion of provisionally registered 'patent' companies secured full registration, suggests that it was *relatively* easier for a company working patents to obtain sufficient capital subscriptions to become fully registered. This is particularly the case as their requirements for capital subscriptions appear to be higher than the average.

Of course the amount of capital subscribed to a company at registration could be very different from the sum of capital that was eventually paid up. The last column in table 5.3 provides the amount of capital paid up five years after the company had been founded (or as near as is possible), or whether the company had been dissolved. After five years, paid-up capital was normally short of nominal capital. This was, however, common with many joint-stock companies.[203] Capital was not called up immediately, but as and when the company required it. This often took more than five years; the ETC, which will be discussed in the next section, expanded at break-neck speed but still took eight years to call in its £600,000 of nominal capital. What the column does indicate, however, is that *successful* companies working patents could secure substantial amounts of capital. For example, following the merger of the English and Irish Magnetic Telegraph Company and the British Electric Telegraph Company in 1857, the merged company was working a capital of £578,715. Calculated as a multiple of average earnings, this is about £370 million in 2010 prices.[204] There are other more prosaic examples in the table, the Westminster and Marylebone Patent Ramoneur Company (a company using a new chimney sweeping device in London), raised £17,500 over the course of ten years. The Patent Silicious Stone Company (founded to manufacture artificial stone) was able to raise £22,955 in five years. For joint-stock companies working patents after 1844, when compared to other joint-stock enterprises, securing capital was not difficult. Firstly, the proportion of provisionally registered 'patent' companies proceeding to full registration was around double the average. Secondly, it appears that the nominal capital they sought tended to be higher than the rest of the market. Thirdly, substantial amounts

201 Johnson, *Making the market*, p.126. In this later period, however, companies registering also received limited liability. This presumably reduced the 'threshold' at which it became worthwhile for a company to incorporate itself.

202 James Taylor, *Joint-stock enterprise in British politics and culture, 1800-1870*, (Woodbridge, 2006), p.146. It should also be borne in mind that the figure presented here of 38 percent is probably an underestimate as it excludes provisionally registered companies without full registration documents surviving. Taylor's figures are derived from Reports of the Registrar of the Joint-Stock Companies in the parliamentary papers rather than the Board of Trade.

203 Johnson, *Making the market*, p.125

204 Lawrence Officer and Samuel Williamson (2011), 'Purchasing Power of British Pounds from 1245 to Present', MeasuringWorth, www.measuringworth.com/ppoweruk/, accessed 28th May 2012

of capital were paid up to successful companies working patents.

Although systematic work on the financial performance of these companies would have been useful, the Joint-stock Act made no provision for how companies were supposed to deposit their accounts, and so those that survive are of variable quality. Some companies though, were short lived and clearly unsuccessful. The Metal-cored Railway Sleeper Company, for example, had a proposed capital of £100,000, but was wound up after having made sales of £19 in seven months.[205] Others were seeking to work technology that was utterly impracticable or ahead of its time. The Compressed Air Engine Company sought to introduce an early example of pneumatic engine, technology that was only successfully commercialised thirty years later. Others, however, were much more successful. Perhaps the most successful enterprise was the Electric Telegraph Company. In 1851, its fifth full year of operation, the company made £19,123 profit and paid out a 7 percent dividend. Smaller operations were also turned to profit, sometimes very quickly. The British and Foreign Gas Light and Meter Company made £797 profit on £3,051 worth of sales in its first fifteen months, and paid a 1 percent dividend.[206]

Table 5.3 also shows that twelve of the twenty-eight companies had been dissolved within five years of their provisional registration.[207] This was a failure rate broadly in line with that reported by Shannon for industrial joint-stock companies in the 1860s. Of around 575 companies classified by Shannon as 'industrial' in 1865, 330 were trading six years later in 1871 (approximately 57 percent).[208] The mortality rate of 'patent' companies is more impressive when it is considered that they were engaged in the risky business of working new technology whereas the majority of industrial joint-stock companies in Shannon's exercise were engaged in more pedestrian activities. Perhaps most surprising is that that five of these companies (or rather their successors) are still in trade. Firstly, Price's still manufacture candles in the United Kingdom. Secondly, the four telegraph companies, after a series of mergers, nationalisation and subsequent privatisation, form the earliest predecessors of British Telecom.

Although these joint-stock companies succeeded in obtaining capital, inferring the availability of capital to work patents for other forms of business organisation, and at other periods of time, is problematic. In theory, larger partnerships of more than twelve people were debarred from holding patents, although this was easily circumvented. Even so, most of these companies were not obtaining capital subscriptions that were beyond the means of large partnerships. The Patent Silicious Stone Company was founded with a Board of Directors composed of seven members. Upon full registration in 1852, the Board had subscribed to 1370 of the 1438 shares.[209] Even some of the larger companies did not require subscriptions from many more

205 Files of the Patent Metal-Cored Railway Sleeper Company, London, National Archives, BT 41/544/2989
206 Unfortunately, no balance sheets survive after 1848. Files of the British and Foreign Gas Light and Meter Company, London, National Archives, BT 41/93/519
207 For the United Kingdom Telegraph Company there is no data provided relating to capital raised five years after provisional registration had been entered because it only began trading in 1860 – ten years after provisional registration had been entered. Files of the United Kingdom Electric Telegraph Company, London, British Telecom Archives, TGH/2/1/1
208 H Shannon, 'The first five thousand limited companies and their duration', *Economic History* (supplement to the *Economic Journal*), 2, (1930-1933), p.405
209 Files of the Patent Silicious Stone Company, London, National Archives, BT 41/545/3000

than twelve individuals. The Patent Fuel Company was founded with a nominal capital of £200,000 subscribed to by ten shareholders.[210]

Of course, attracting capital subscriptions and then calling that capital up are two different things, and it is possible that the actual capital requirements of these enterprises were beyond the means of larger partnerships. However, an analysis of the Electric Telegraph Company (ETC), a considerable enterprise, suggests this was not the case. The ETC was founded in 1846 with eight investors who subscribed to a nominal capital of £600,000. On 1st July 1846 these eight investors paid up £112,000 for their holdings.[211] The three main shareholders were George Parker Biddin who held 1,540 of the 4,480 issued shares, John Lewis Ricardo with 728 shares (whose family held another 728 shares) and William Fothergill Cooke with 1,160 shares. Four and a half years later these three men still dominated the shareholdings of the company, holding 3,830 of the 6,000 issued shares, on which they had paid up £191,500.[212] A similar pattern arises in the shareholdings of the Patent Silicious Stone Company. As mentioned above, on foundation the Board subscribed to 1,370 of the 1,348 shares and seven years later six of the original Board still retained shares in the company, holding 2,001 of the 2,343 issued shares (on which they had paid up £20,000).[213]

An analysis of shareholdings demonstrates that ownership was often concentrated in the hands of a few members who accounted for most of the paid-up capital. This pattern is not distinctive to joint-stock companies working patents; Paul Johnson has also argued that the capital they raised and worked was normally within the capacity of the average partnership.[214] This naturally raises the question of why ventures organised themselves as joint-stock companies and not as partnerships which, even with the 1844 reforms, was a much simpler process. Johnson argues that it was not because of the liquidity of ownership they provided on the grounds that in 1913 only 500 of 60,000 registered companies were traded on the London Stock Exchange.[215] The same applies with the companies listed in table 5.3 - only the British and Irish Magnetic Telegraph Company (the product of the merger between the English and Irish Magnetic Telegraph and the British Telegraph Company), and the ETC were listed in the *Course of the Exchange* in 1852.[216]

However, although joint-stock companies were not listed on the Stock Exchange, they did provide greater liquidity of ownership than partnerships, especially large partnerships where an investor required the permission of all partners to divest their shares. The shareholder registers of the larger joint-stock companies show regular transactions of shares. For example, in the ETC, although ownership remained concentrated amongst the same three investors until 1852, they were regularly transferring small amounts of shares both amongst themselves and with other investors. In the case of Bidden the cumulative effect of these dealings

210 Files of the Patent Fuel Company, London, National Archives, BT 41/541/2972
211 Electric Telegraph Company shareholders book, London, British Telecom Archives, TGA/1/6, p.1
212 This does not mean that the three men handed over £191,500 in cash to the ETC. They held the patent that was assigned to the company, and this assignation would have accounted for much of the capital they paid up. However, Bidden and Ricardo, had already spent £115,000 to acquire their stakes in the patent. Electric Telegraph Company shareholders book, London, British Telecom Archives, TGA/1/6, pp.12-13
213 Files of the Patent Silicious Stone Company, London, National Archives, BT 41/545/3000
214 Johnson, *Making the market*, p.125
215 Ibid
216 Hickson, Turner, and Qing, 'The rate of return', p.1229

was to reduce his share fell from 34.4 percent in 1846 to, 9.8 percent in 1851.[217]

The qualitative evidence outlined at the beginning of this section supported the contention that capital was available to inventors, at least from the second quarter of the nineteenth-century. This has important implications for any analysis of the market in patent rights. As capital was available, it suggests that the market in patent rights fulfilled at least one important function. Further, the availability of capital would have made it much easier for inventors and manufacturers to turn their patents to profit, supporting the incentive to engage in inventive activities. However, examining the subject in any systematic way is challenging, especially as many inventions probably did not deserve investment. This section has presented quantitative evidence on joint-stock companies, although this evidence is limited to the very end of the period. Another disadvantage with analysing joint-stock companies is that they enjoyed advantages in attracting capital over partnerships. In particular, the relative ease of transferring shares of ownership made it easier for them to attract capital in the first place. This makes it difficult to infer from the experience of joint-stock companies the more general availability of capital for working patents.

This problem, however, is alleviated by two factors. Firstly, it is possible to compare the availability of capital for the commercialisation of new technology with other economic activities. It appears that, compared to the average of joint-stock companies, 'patent' companies experienced greater success in obtaining a sufficient number of subscriptions to become fully registered. This shows that patents did not experience any more difficulty than other projects in attracting capital (especially as they tended to seek more capital than the average enterprise).

Secondly, the evidence from the joint-stock companies probably constitute the largest available dataset for financial information relating to investment in patents. In an eight year period at least twenty-eight joint-stock companies were founded to work patents. The true number is certainly higher. Shareholder registers indicate that they were not working quantities of capital that lay beyond the means of a partnership. Normally, the bulk of paid up capital originated from a small number of investors and Johnson has also documented how this was the case with other joint-stock companies during the period. Despite the limitations of the data then, it appears that capital was readily available for patents. The final section of this chapter will examine one of the joint-stock companies founded to work patented technology in more detail, the Electric Telegraph Company.

Section 5.7
The Electric Telegraph Company

The Electric Telegraph Company has been chosen as a case study for two reasons. Firstly, a reasonable amount of documentation survives relating to the development of the telegraph, the foundation of the company and its subsequent development, (especially at the British Telecom Archives, and the Institution of Engineering and Technology). Secondly, it is difficult to overstate the importance of the electric telegraph.

217 Electric Telegraph Company shareholders book, London, British Telecom Archives, TGA/1/6, p.1 & 16

With its development, for the first time in the history of man, prices, news and other information could be relayed almost instantaneously. Yet despite its importance the telegraph has attracted little attention, the 2003 *Cambridge History of Science* reports 'there is no satisfactory history of early telegraph technology'.[218] The last social and economic history of the British telegraph was published in 1973.[219] This section, by focussing on the foundation and first ten years of the Electric Telegraph Company, can only remedy this neglect in part. The section is particularly concerned with how the company commercialised its technology and, in light of the previous section, its capital and financial performance.

The signalling potential of electricity was recognised early in the eighteenth-century, and the first electric telegraph was described in 1753.[220] However, it was only with the invention of the battery in 1800, that it was possible to exert sufficient control over an electric current to produce the consistent charge needed.[221] The earliest telegraphs were based on the needle system. Magnetic needles, placed at the end of the wire, were deflected by current running through the circuit to indicate the letters of the alphabet.[222] Inspired by a public demonstration, William Fothergill Cooke began to develop his own needle apparatus using a four mile circuit belonging to Professor Wheatstone. Wheatstone was also developing his own telegraph and they were soon collaborating, initially without success. In March 1837 Cooke complained, 'an idea suggesting itself to Mr.W which I prepared to experiment upon but again failed to produce any effect'.[223] Despite these failures, in May 1837 Cooke proposed a partnership, even though they were yet to develop a fully functioning system of telegraphic communication. Wheatstone assented, impressed by Cooke's determination to 'make money'.[224]

The pair soon realised that railways would be critical to the commercialisation of the telegraph. Firstly, without a system of communication with which they could monitor and control the positioning of trains, to avert head-on collisions, railway companies had to lay double track along the entirety of busy routes. With the telegraph, however, it was possible to communicate the position and timing of trains with all the stations along a particular line. This meant that it was not always necessary to lay double track, resulting in significant savings. Serving the railways also had the advantage of ensuring a guaranteed volume of traffic in the form of railway signals. Secondly, the railway companies owned long strips of land connecting towns and cities, making it much easier to establish a public network of telegraphs. Rather than having to negotiate with every individual landowner between two settlements (or obtain an Act of Parliament), a telegraph company had only to reach an agreement with the railway company. Indeed, it is quite possible that early telegraphs were not commercialised because of the difficulties that would have been encountered in creating

218 Bruce Hunt, 'Electrical theory and practice in the nineteenth-century', in Mary Jo Nye and Bruce Hunt (eds.), *Cambridge History of Science, Volume 5, The modern physical and mathematical sciences*, (Cambridge, 2003), p.312
219 Jeffrey Kieve, *The electric telegraph: A Social and Economic History*, (Newton Abbot, 1973)
220 However, it required twenty-six different wires, one for each letter of the alphabet. Brian Bowers, *Sir Charles Wheatstone FRS, 1802-1875*, (London, 2001), p.117
221 Kieve, *The electric telegraph*, p.14
222 Ibid, p.17
223 Papers of William Forthergill Cooke, London, Institution of Engineering and Technology, UK.0108.SC.MSS.007/I, Vol.1, 14th March 1837
224 Kieve, *The electric telegraph*, p.22

any network without the assistance of railways. The early and rapid growth of the railways in Britain may explain why its telegraph network was unique in being constructed without state assistance.[225] Elsewhere in Europe the telegraph was regarded as a state concern. In France, for example, the telegraph network was administered by the Ministry of the Interior until 1878.[226]

Consequently, the first large-scale experiments that produced working telegraphs were performed on railway lines. The first system Cooke and Wheatstone operationalised used a five needle apparatus requiring five separate wires to be laid down between two stations, one to turn each needle. However, it soon became clear that the costs of laying five separate wires for each operational line was prohibitive. In 1837 Cooke proposed to the London and Birmingham that he construct a telegraphic network for their railway at a cost 'not to exceed £200 per mile'.[227] Unimpressed, the directors of the railway ordered Cooke to remove his equipment from their lines. When, however, in the following year, the partnership began to develop two and one needle mechanisms, with economies of scale, it became commercially feasible to lay telegraph lines with a sufficient messaging capacity. When, at the end of June 1851, the ETC had erected 1965 miles of wire, it was at an average cost of £84 per mile.[228] This network had an average of five wires per mile. This would have been enough for one apparatus on the five wire system, but with a two wire system allowed for an average of two and half apparatuses. Assuming that only the two wire system was used on the network, this means that the cost per mile, per apparatus, had fallen from £200 in 1837 to less than £34 by 1851.[229]

With this new system, there was a rapid growth in the telegraph business. Between 1836-44 Cooke (the venture's 'commercial' partner) spent £31,279 erecting telegraphs - whereas in 1845 he spent £71,719.[230] At the end of 1845 total receipts had been £96,974. Although this implies a loss of £6,308, Cooke noted that he was still owed large sums for 'the works then in hand'.[231] Astonishingly, until 1844, Cooke continued to manage the venture's accounts in his private ledger.[232] That Cooke was able to manage the development of England's nascent telegraph system almost single-handedly, represents a considerable business achievement. The strain must have been enormous and he had been seeking to sell a moiety of the patent since 1843, 'the

225 Government work though, was an important source of revenue in the early days of the Electric Telegraph Company. For example, telegraphs for the Admiralty earned the company £5,652 in its first four years. Board of the Electric Telegraph Company meeting book 1846-50, London, British Telecom Archives, TGA/1/3, Meeting on the 8th May 1849

226 In 1847 the Minister of the Interior, Le Comte Duchâtel, declared 'la télégraphie doit être un instrument politique, et non un instrument commerciale', or rather 'the telegraph must be a political instrument, not a commercial instrument'. Kieve, *The electric telegraph*, p.46

227 Papers of William Forthergill Cooke, London, Institution of Engineering and Technology, UK.0108.SC.MSS.007/II, Vol. 2, 20th September 1837

228 Half yearly reports of the Electric Telegraph Company, the International Telegraph Company and the Electric and International Telegraph Company, 1851-72, London, British Telecom Archives, TGA/2/1. The figure for expenditure is from the half yearly report of the Electric Telegraph Company for the first half of 1851, page 1. The mileage of the network is from the prospectus of the International Telegraph Company, page 3. The prospectus is held with half-yearly reports in TGA/2/1

229 The one and two wire apparatuses developed by Cooke and Wheatstone remained the preferred system for telegraphs until c.1860. Brian Bowers, *Sir Charles Wheatstone*, p.151

230 Papers of William Forthergill Cooke, London, Institution of Engineering and Technology, UK.0108.SC.MSS.007/VII, Vol.7, 1875

231 Ibid

232 Ibid

ultimate object' of which was 'the formation of a company'.[233] It was only with his successes in 1845, however, that Cooke was able to sell shares in the patent.[234] His first partner was John Lewis Ricardo, a Member of Parliament, who paid £60,000 for a 12/32nds share in Cooke's telegraph business. In Ricardo's schedule of payments the most valuable asset was the share in five English patents, valued at £54,000.[235] For his share in three Scottish patents Ricardo only paid £1875 and the same again for three Irish patents.[236] The remaining £2250 was paid for a share in an exclusive licence for the printing telegraph and for telegraphs 'already erected'. The second partner, the engineer George Parker Bidder, paid £55,000 for an 11/32nds share in the business.

The sale was contracted with the intention of forming a joint-stock company, which was established as the Electric Telegraph Company (ETC) on the 1st July 1846. Unfortunately, many of the records from the earliest days of the ETC no longer survive. For example, there are no records in the board agenda books for 1847 or 1848.[237] The records that do survive indicate that in its early years, the ETC was reliant on income from the railways. Between 1847-51 its railway revenue was £170,333.[238] Considering that total revenue in its fourth and fifth years was £93,389 (total revenue does not survive for 1847, 1848 or 1849), unless annual revenue was significantly higher in the first, second and third years (which is unlikely for such a rapidly expanding business), almost all of the ETC's early income came from the railways.

The surviving board agenda books also record large orders from railway companies. In one Board meeting in July 1846, orders were reported from the Midland Railway and the Eastern Counties.[239] The contract between the ETC and the Midland Railway stipulated that the ETC was to construct telegraphs on their main line and all branch lines including the Derby to Birmingham and Nottingham to Lincoln. The payment agreement was arranged by the mile, and by the number of wires which were needed on that stretch of line. So for every mile of two wires the railway was contracted to pay £122, every mile of three wires £156 and so on, to £252 for seven wires.[240] The Board Agenda Book records an initial payment of £15,000 from the Midland Railway Company a month later.[241]

The contract, however, contained a number of clauses that were incidental to the construction of the telegraph lines. Specifically, the contract contained a 'no challenge' clause, that 'the novelty and utility of the

233 Papers of William Forthergill Cooke, London, Institution of Engineering and Technology, UK.0108.SC.MSS.007/III, Vol.3, 9th May 1843

234 In 1843, all English, Scottish and Irish patents were assigned solely to Cooke, in return for a royalty to Wheatstone. Papers of William Forthergill Cooke, London, Institution of Engineering and Technology, UK.0108.SC.MSS.007/III, Vol.1, 16th January 1843

235 Papers of William Forthergill Cooke, London, Institution of Engineering and Technology, UK.0108.SC.MSS.007/II, Vol.2, 27th November 1845

236 Ibid

237 Board of the Electric Telegraph Company meeting book 1846-50, London, British Telecom Archives, TGA/1/3

238 In its prospectus the UKETC misleadingly referred to the £170,333 as profit, although it is clear that the figure referred to revenue. Prospectus of the United Kingdom Electric Telegraph Company 1851, London, British Telecom Archives, TGH/2/1/1

239 Board of the Electric Telegraph Company meeting book 1846-50, London, British Telecom Archives, TGA/1/3, Meeting on the 16th July 1846

240 Contract between the Electric Telegraph Company and the Midland Railway Company, 5th July 1846, London, National Archives, RAIL793/7

241 Board of the Electric Telegraph Company meeting book 1846-50, London, British Telecom Archives, TGA/1/3, Meeting on the 5th August 1846

said inventions…shall not be denied, put in issue, or questioned in any manner whatsoever' by the railway company nor would they 'in any manner howsoever…counterfeit, imitate or resemble…the patent privileges'.[242] The contract also made detailed provisions for the resolution of disputes between the ETC and the railway company. If a dispute occurred, the two companies were both to appoint an arbitrator to act on their behalf. These two arbitrators were in turn supposed to agree upon a third arbitrator to act as an 'umpire'. This arbitration team was to investigate the matters of the dispute and to examine witnesses on oath. The rules for the proceedings were adapted from those used in Queen's Bench. Clearly arbitration was designed as a cheap alternative to the law courts and these clauses covering arbitration and 'no challenge' were included in all of the ETC's contracts with railway companies.[243]

The ETC also contracted for wayleave rights (now termed 'easement') from the railway companies. Wayleave constitutes the right to use another party's property for a specific purpose, most commonly a right of way.[244] The wayleave granted to the ETC was for the right to erect telegraph poles for its own 'commercial' use on the railway lines. 'Commercial' use for the ETC denoted the service that they provided to the public. In return for a payment calculated according to the length of the message, and the distance over which it was to travel, the ETC allowed the public to send messages to wherever they had a station. By contracting for wayleave, the ETC were able to secure the rights they needed to erect their own commercial network.

In other contracts the ETC were allowed to use the railway telegraph lines for commercial use as well, albeit on terms that were more generous to the railway company. In 1852, the ETC reached an agreement with the Great Northern Railway (GNR) to construct and maintain, at their own cost, a network of telegraphs on the railway, totalling 408 miles in length.[245] In return GNR would pay an annual rental charge of £2,040.[246] The contract also allowed for wayleave rights to the ETC if they needed to supplement the railway telegraphs with more wires to carry the commercial traffic.[247]

The ETC also made it a condition of contracts that the railway company could not grant wayleave rights to another competitor - even when they had failed to secure these rights for themselves.[248] The first competitor to the ETC was the British Electric Telegraph Company (BETC) founded in 1849, to work the patents of Henry and Edward Highton. The second was the English and Irish Magnetic Telegraph Company

242 Contract between the Electric Telegraph Company and the Midland Railway Company, 5th July 1846, London, National Archives, RAIL793/7

243 For example, in a contract with the Chester and Holyhead company, 'the said railway company shall not during the said term dispute the validity of any of the patents now belonging to the said telegraph company but shall at all times and do hereby recognise and admit the validity thereof'. Contract between the Electric Telegraph Company and The Chester & Holyhead Railway Company, 16th October 1846, London, National Archives, RAIL 113/32

244 Shae Irving, *Nolo's plain-English law dictionary*, (Berkeley, 2009), p.146

245 Railway Agreements (Telegraphs), Great Northern Railway Company, 1852-1909, London, British Telecom Archives, TCB 491/1

246 Ibid

247 The wayleave clause was in the standard form stipulating that 'the Electric Telegraph Company shall have full liberty at all times hereafter during the said term of twenty-one years…to construct extend repair maintain work and use for their own purposes…Electric Telegraphs…upon and throughout the lines of the railway'. Ibid

248 For example, in its contract with the London, Brighton and South Coast Railway Company, although the ETC had failed to obtain wayleave rights on the London to Brighton line, the contract forbade the sale of wayleave rights to any other telegraph company. Railway Agreements (Telegraphs), London, Brighton and South Coast Railway Company, 1850-1905, London, British Telecom Archives, TCB 491/3

(EIMTC) founded in 1850, to work the patents of William Thomas Henley and David George Foster. Because the ETC had secured exclusive rights to erect operational telegraph lines on many of the railways, these newcomers were often forced to reach agreements with canals and roads to erect their own commercial lines.[249] However, roads and canals were not forms of transport that required telegraphic communication to operate, and so did not provide a volume of traffic in the way the railways did. Consequently, these new companies were strongest where the ETC was least well established. BETC was most successful in Scotland and EIMTC came to dominate Ireland.[250]

Despite their advantages, the ETC Board was concerned about this competition. This was probably because the commercial telegraph was proving to be an increasingly lucrative market. Table 5.4 shows the growth of the ETC's network between 1850-53.[251]

Table 5.4 The growth of the Electric Telegraph Company's network, 1850-1853

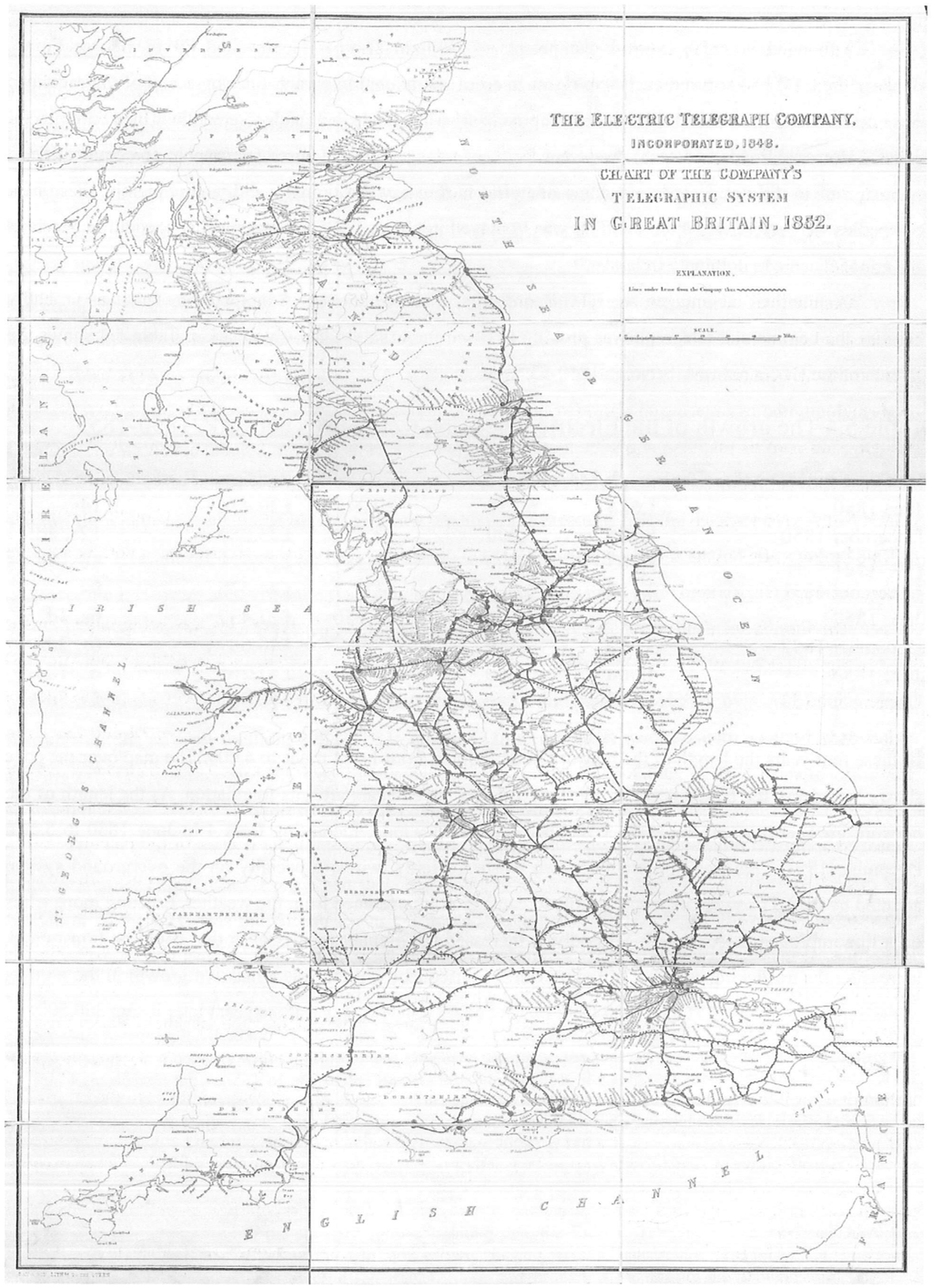
Half year ending	Miles of telegraph	Miles of wire	No. of messages	Receipts	Revenue per message
June 1850	1,684	6,730	29,245	£20,436	14s.
December 1850	1,786	7,200	37,389	£23,087	12s. 4d.
June 1851	1,965	7,900	47,259	£25,529	10s. 9d.
December 1851	2,122	10,650	53,957	£24,336	9s.
June 1852	2,502	12,500	87,150	£27,437	6s. 4d.
December 1852	3,709	19,560	127,987	£40,087	6s. 3d.
June 1853	4,008	20,800	138,060	£47,265	6s. 10d.
December 1853	4,409	24,340	212,440	£56,919	5s. 5d.

In these four years the length of the network nearly tripled from 1,684 miles to 4,409. The map over the page shows how dense the ETC's network was by 1852, just seven years after its foundation. As the length of the network grew, so too did the average number of wires per mile, increasing from 4 in June 1850 to 5.5 in December 1853. This was important for two reasons. Firstly, wires, especially on the overground system adopted by the ETC, were often susceptible to damage or interference from the weather. Erecting more wires on a line improved its reliability. Secondly, it increased the number of messages that could be transmitted, increasing the trafficking capacity of the network. Consequently, there was a massive growth in the number of messages sent by the ETC. In 1850 the ETC sent 66,634 messages, yet three years later it sent 350,500.

249 Kieve, *The electric telegraph*, p.49

250 Ibid, p.51

251 Prospectus of the International Telegraph Company, London, British Telecom Archives, TGA/2/1, p.3



Although the telegraph traffic from the railways would have been expanding with the network, much of the increase can be attributed to the opening up of the telegraph as a public service. The final column provides the revenue per message (simply the number of messages divided by receipts). The decline in the price of messages ensured that the telegraph became affordable for an increasing proportion of the population. This contributed enormously to the growth of receipts. Although the financial performance of the company will be discussed later, it is noteworthy that while the revenue per message declined, the revenue of the company tripled in these four years.

Commercial messages then were an increasingly important source of revenue for the ETC, and it tried to head-off competition from the BETC and EIMTC. Initially, the company resorted to legal measures to frustrate their competitors. For example, the ETC challenged the passing of an Act allowing the BETC to own patents without violating the proviso limiting the number of people who could hold a patent.[252] The challenge was unsuccessful, and where competition appeared the ETC was obliged to lower its charges. In 1852 the EIMTC reported on its new Liverpool to Manchester line that 'the results of competition in the working of the Manchester line clearly prove that the reduction in price, made by the ETC on the opening of the line by this company has accordingly developed the business, and that the 1/6 price pays both companies better than the 3/6 price the ETC when they were solely in the field'.[253]

The ETC were also assertive in protecting and extending their patent rights, investing large sums in legal action. For one lawsuit in 1850, the ETC paid £990 in counsel fees (including £400 to the Attorney-General John Jervis).[254] At one board meeting early in the year, it was reported that 'considerable expenses had already been incurred for models and printing and witnesses fees', and a cheque for £1,400 had to be drawn up to meet their immediate legal costs.[255] In the subsequent court case (*The Electric Telegraph Company* v *Brett and Little* (1850)) it was decided that the defendants were entitled to their patent for an improved apparatus but that 'they may not be entitled to use it, unless by the licence of the patentees of the less perfect invention, on which their own is grounded'.[256] The advance made by Brett and Little was an important one, allowing intermediate stations to send as well as receive communications. It is likely that the ETC could have secured access to this technology without legal action. Unless they had intended to establish their own network, Brett and Little probably intended to license or sell their patent. That the ETC chose to pursue legal action instead, indicates an aggressive stance towards the patent rights of others. Failure though, forced them to purchase the patent. Unfortunately, the Board Agenda book does not record the price, although overall the company spent immense sums securing patent rights.[257] The capital account for the first

252 It was possible for a company to own a patent, but to do so they had to obtain an Act from Parliament. It is not clear whether there was any particular advantage for a company to own the patent itself, rather than owning an exclusive licence, that would justify the trouble in obtaining the Act.

253 English and Irish Magnetic Telegraph Company memoranda for general meeting, 1852, London, British Telecom Archives, TGN/1/1/1

254 Board of the Electric Telegraph Company meeting book 1846-50, London, British Telecom Archives, TGA/1/3, Meeting on the 30th January 1850

255 Ibid

256 Common Pleas. Hayward, *Patent cases*, Vol.6, p.317

257 Board of the Electric Telegraph Company meeting book 1850-53, London, British Telecom Archives, TGA/1/3, Meeting on the 10th May 1851

half of 1851 shows that £28,826 had been spent buying and licensing patents in addition to those originally acquired from Wheatstone and Cooke.[258]

By 1852 the ETC had secured an immensely powerful position, which allowed it to dominate the telegraph market in England (less so in Scotland and Ireland). Its initial strength had been derived from its patent rights which covered the first commercially viable system of telegraphic communication. Consequently, the company went to great lengths to consolidate its position through large investments in its patent portfolio (nearly £30,000 in its first six years). Despite these efforts, rival networks based on competing technology, appeared within a few years. However, because of the contracts and wayleave rights it had obtained from the railway companies, the ETC was able to retain its commanding position.

It is important, however, to consider the financial performance of the company. Table 5.5 provides the key financial data for the company between 1847-54. The first row shows the amount of paid-up capital the company was working at the start of that year. The second row shows the total revenue for the year, the third expenditure, the fourth profits and the fifth the annualised dividend. The data for the table is drawn from a variety of sources. For 1851 to 1854 all financial data is derived from an ETC report.[259] Capital data for 1847 to 1850 is derived from the company's shareholder book.[260] For 1848 and 1849 capital is estimated from the shares that had been issued (6,000 in both cases) and the calls for capital that had already been made. Finally, the revenue, expenditure, profits and dividends information for 1849 and 1850 are from the board agenda books.[261] Unfortunately, this data is not available for 1847 or 1848.

Table 5.5 Financial performance of the Electric Telegraph Company, 1847-1854

Year	1847	1848	1849	1850	1851	1852	1853	1854
Capital	£140,500	≈ £200,000	≈ £250,000	£290,265	£330,000	£394,000	£557,700	£702,720
Revenue				£43,523	£49,866	£67,525	£104,185	£123,321
Expenditure				£31,399	£30,742	£43,492	£72,512	£92,678
Profits			£7,483 (half year)	£12,124	£19,123	£24,032	£31,672	£30,553
Dividend			2%	4%	7%	6¼%	6¾%	6½%

The first row of the table shows that the ETC was able to secure large quantities of capital very quickly. Within five years it had secured paid up capital of £290,265 and within nine (due partly to a merger with the International Telegraph Company) £702,720. Of course the task of securing capital was made much easier because the ETC proved to be an immensely profitable venture. Jeffrey Kieve, the last economic historian to study the ETC, suggested that the company struggled to produce a profit in its first few years. For a company that was expanding very rapidly, and had such a large demand for capital, this is a sensible suggestion. However, the earliest available data indicates that the ETC was turned to profit very quickly. In the last six months of 1849, three years after the company had been founded, it made a profit of £7,483, and

258 Half yearly reports of the Electric Telegraph Company, 30th June 1851, London, British Telecom Archives, TGA/2/1, p.1
259 Half yearly reports of the Electric Telegraph Company, 31st December 1856, London, British Telecom Archives, TGA/2/1, p.4
260 Electric Telegraph Company shareholders book, London, British Telecom Archives, TGA/1/6
261 Board of the Electric Telegraph Company meeting book 1846-50, London, British Telecom Archives, TGA/1/3

paid an annualised dividend of 2 percent in both the first and second halves of the year. Once the company became fully established it began to pay much larger dividends, averaging 6½ percent between 1851-54. These dividends were payable because the ETC was very profitable, in 1854 for example, the company made a profit of £30,553 on revenue of £123,321.

This section has not presented an exhaustive history of the early telegraph. It has, however, established the availability of capital to successful ventures working patents. Within ten years, the ETC had managed to raise over £800,000 in capital. The section has also demonstrated the importance of patent rights in encouraging and financing the development of technology, at least later during the pre-reform patent system. It was Cooke's early determination to 'make money', that took the telegraph off the laboratory bench and on to the railways and highways of Britain. It is difficult to envisage the required investment (and risk) of time and resources being made by Cooke without patent protection. Also if Cooke had not held patents in the telegraph, it is difficult to envisage Bidder and Ricardo investing so much to acquire an interest in the technology, and commercialising it under the auspices of the ETC

Conclusion

The introduction to this chapter discussed some of the reasons why an active market in patent rights would encourage the development and diffusion of technology:

i) That it provided a means for inventors to appropriate returns from their inventive activities
ii) That it enabled inventors to obtain capital and/or access to manufacturing plant
iii) That licensing and assignments facilitated the diffusion of technology
iv) That licensing enabled the subsequent development of technology

The chapter began by discussing how the law of assigning and licensing patents facilitated these exchanges. A case law specifically relating to the transfer of patent rights began to develop from the 1780s, although it was largely derived from a much larger and older body of law relating to contracts and deeds. It showed that this law was permissive, providing patentees and other parties freedom of manoeuvre in transacting patent rights. Even the apparent restriction that the patent could only be held by a limited number of people was easily circumvented via exclusive licences. The only significant obstacle to the transaction of patent rights was the length of time it occasionally took to conclude legal action. This argument builds on chapter 3, which demonstrated that the patent was a secure property right from c.1730. If the patent system had not provided inventors with a clear and secure title in their technology, it would have been a lot more difficult to sustain this market in technology rights. Consequently, the qualitative and quantitative evidence indicates that the transferral of patent rights was common, even for patents that were of a lower value.

Many inventors then chose to sell and license their patents enabling the physical dissemination of technology to other users. Further, when an inventor is obliged to adopt secret working they must be entirely self-reliant or run the risk of having their secret discovered. However, with the security of their patent, in all

three of the case studies, it was possible to sub-contract some of the manufacturing to other businesses (although in the case of Boulton and Watt one of the subcontractors, John Wilkinson, proved to be particularly troublesome).

It was also argued that patents and licensing facilitated the subsequent development of technology. On this point the evidence is more mixed. Watt certainly stifled Jonathan Hornblower's engine business, and was able to extract licence fee payments from those who used his engines. Neither, did he ever license other engine manufacturers who requested them. Watt, however, was exceptional. Firstly, he was fortunate to secure such a long extension to his patent term from Parliament. Secondly, certainly in the first half of the nineteenth-century, it was unusual for an inventor to deny a licence request. Thirdly, unlike Watt who was able to establish a legally enforceable 'broad' interpretation of his patent, both the ETC and Talbot failed to demonstrate that subsequent developments came within the purview of their patents. In the case of the ETC they were obliged to purchase the patent of Brett and Little, and for Talbot it forced him to abandon his petition for a patent extension.

It has also been argued that some inventors were able to appropriate very substantial returns from selling and licensing their patents. The case studies of Boulton and Watt and the ETC demonstrate the very large returns that could be made from successfully commercialising new technology. Between 1849-53 Cooke personally earned £25,000 in dividend payments from the ETC, exclusive of his income from share sales.[262] Much more modest endeavours, such as Morgan's patent for tinning iron plates, were also able to secure returns from selling and licensing the patent rights. However, to argue that these returns incentivised the development of technology, it needs to be shown that inventors responded to these commercial opportunities, the subject of the following chapter.

The example of Talbot, however, demonstrates some of the problems involved with these transactions. If a patentee was too ambitious (or greedy) in the terms they sought from licences and assignments, then their aggregate returns would be much less than if they offered more modest terms. It was difficult, however, for inventors to set an appropriate price for their patent rights. Adopting a royalty based on the fuel savings affected by their steam engine produced much trouble for Boulton and Watt.

The profitable working of a patent also depended on the availability of capital. In a study of joint-stock companies it was argued that many of these ventures were able to secure substantial amounts of paid-up capital to commercialise patented technology. Because of the legal advantages of organising a venture as a joint-stock enterprise it is hard to extrapolate these results to other forms of business enterprise, although a study of their shareholder books verifies that these companies were not working quantities of capital beyond the means of most partnerships. Also, comparatively speaking, 'patent' companies were more successful in attracting sufficient capital subscriptions than other joint-stock ventures.

262 Electric Telegraph Company shareholders book, London, British Telecom Archives, TGA/1/6. Even when his share of the company had fallen to 12.1 percent in the half year to 31st December 1853, Cooke was still paid a dividend of £1,732.

Appendix 5.1
Provisional and fully registered joint-stock companies, 1845-1852

Company Name	Founded	Fully registered	Nominal capital	BT 41 file
Atmospheric-pressure Pile driving Company	1845		£100,000	BT 41/31/166
British and Foreign Gas Light and Meter Company	1845	1847	£25,000	BT 41/93/519
Compressed Air Engine Company	1845	1846	£400,000	BT 41/161/914
Derbyshire and Leicestershire Patent Ramoneur Association	1845		£20,000	BT 41/190/1076
Norfolk and Suffolk Patent Ramoneur Association	1845		£16,000	BT 41/506/2777
Nottinghamshire and Lincolnshire Patent Ramoneur Association	1845		£20,000	BT 41/521/2858
Patent Concentrated Tea Company	1845		£150,000	BT 41/540/2961
Patent Cork-Cutting Company,	1845	1845	£40,000	BT 41/540/2963
Patent Fibre Manufacturing Company	1845			BT 41/541/2968
Patent Fuel Company	1845	1845	£200,000	BT 41/541/2972
Patent India Paper Manufacturing Company	1845			BT 41/543/2982
Patent Timber Company	1845		£50,000	BT 41/546/3007
Prossers Patent Wooden Railway Guide-Wheel Company	1845			BT 41/578/3150
Universal Gas Light Company	1845	1846	£100,000	BT 41/718/3871
West of England Patent Refining Sugar Company	1845	1847	£300,000	BT 41/744/4018
British National Brewing Company	1846	1847	£10,000	BT 41/99/562
British Patent Naptha Company	1846	1847	£10,000	BT 41/100/567
British and Foreign Patent Nail Company	1846		£150,000	BT 41/93/523
Cambridge and Huntingdon Patent Ramoneur Company	1846	1847	£8,000	BT 41/119/695
Continental Patent Metallized Wood Company	1846		£100,000	BT 41/165/930
County of Surrey Patent Ramoneur Association	1846		£20,000	BT 41/170/969
Cumberland Patent Ramoneur Association	1846			BT 41/180/1023
Electrical Telegraph Company	1846	1846	£600,000	BT 41/218/1236
Patent Galvanized Iron Company, (Malins and Rawlinsons)	1845	1846	£500,000	BT 41/542/2973
Patent Tidal Wheel Company	1846	1847	£65,000	BT 41/546/3006
Stirlings Patent Steam Fuel Company	1846		£50,000	BT 41/658/3594
Westminster and Middlesex Patent Ramoneur Association	1847		£25,000	BT 41/751/4056
Bristol District Patent Ramoneur Company	1847	1847	£10,000	BT 41/83/460
Lows' Patent Copper Company	1847	1848	£100,000	BT 41/410/2340
Manchester and Salford Patent Ramoneur Company	1847			BT 41/424/2402
Patent Alkali Company	1847	1847	£110,000	BT 41/538/2949
Patent Metal-Cored Railway Sleeper Company	1847	1847	£100,000	BT 41/544/2989
Patent Meter Cab Company,	1847		£35,000	BT 41/544/2990
Patent Mile Index Carriage Company,	1847			BT 41/544/2992
Patent Railway Break, Axle and Guide-Rail Company,	1847		£100,000	BT 41/545/2998
Surrey and Kent Patent Ramoneur Association	1847		£10,000	BT 41/668/3647
Westminster and Marylebone Patent Ramoneur Company	1847	1848	£50,000	BT 41/751/4055
Prices Patent Candle Company	1847	1847	£375,000	BT 41/575/3144
Caldwalls Patent Windlass Capstan and Riding-Bits Company	1848			BT 41/115/668
Coggeshall Patent Plush Manufacturing Company	1848	1849	£5,000	BT 41/155/883
Kirrages' Patent Sewer Drain and Building Block Company	1848			BT 41/338/1944
Omnibus Passenger Patent Register Company,	1848			BT 41/529/2889
Patent Electric Light Company,	1848		£250,000	BT 41/541/2966
Snyders Patent Leather Company	1848		£60,000	BT 41/635/3474
British Electric Telegraph Company	1849	1850	£300,000	BT 41/88/501
Bishopps Improved Patent Disc Engine Company	1849		£50,000	BT 41/66/362
Patent Steel and Iron Tube and Hollow Axle Company	1849			BT 41/546/3003

Company Name	Founded	Fully registered	Nominal capital	BT 41 File
Gordons' Patent Propeller Company	1850			BT 41/260/1493
London and Metropolitan Counties Patent Tobacco Company	1850			BT 41/394/2236
Patent Fire Lighting Fuel Company	1850		£30,000	BT 41/541/2971
Patent Gate, Door, Window and Shutter Company	1850			BT 41/542/2975
Patent Marble Company	1850			BT 41/543/2986
Patent Tobacco Pipe Company	1850		£35,000	BT 41/546/3008
United Kingdom Electric Telegraph Company	1850	1860	£150,000	BT 41/708/3838
Wallace Patent Enamelled Marble Company	1850			BT 41/729/3930
Claussens' Patent Flax Company	1851	1852	£250,000	BT 41/154/867
English and Irish Magnetic Telegraph Company	1851	1852	£300,000	BT 41/225/1269
Franklinski's Patent Omnibus and Cabriolet Company Ltd	1851		£25,000	BT 41/245/1396
London Cooperage Company	1851	1854	£50,000	BT 41/381/2166
London Patent Chronometer Watch and Clock Company	1851		£50,000	BT 41/396/2253
Patent Cooperage Company,	1851	1852	£100,000	BT 41/540/2962
Patent Economic Candles Company	1851			BT 41/540/2965
Patent Solid Sewage Manure Company,	1851	1852	£100,000	BT 41/546/3001
Continental Timber Preserving Company (Banners Patent)	1852		£100,000	BT 41/165/932
Electrical Telegraph co of Ireland	1852	1853	£100,000	BT 41/218/1237
Hobbs' Patent American Lock Company	1852			BT 41/298/1733
National Patent Steam Fuel Company	1852	1852	£50,000	BT 41/480/2668
Patent Apyro-Type Company. Patent Wire Type Company	1852	1852	£30,000	BT 41/539/2951
Patent Chronometer Watch and Clock Company	1852		£50,000	BT 41/539/2958
Patent Hollow Ware Company	1852			BT 41/543/2980
Patent Paddle Wheel Company,	1852		£60,000	BT 41/545/2994
Patent Silicious Stone Company,	1852	1853	£20,000	BT 41/545/3000
Steam and Atmospheric Patent Propulsion Company	1852		£40,000	BT 41/655/3579

Chapter 6

Patenting in Scotland and Ireland

Before the Patent Law Amendment Act in 1852 England, Scotland, and Ireland, maintained autonomous patent systems.[1] Although there has been substantial research on the English patent system, its Scottish and Irish counterparts have been almost entirely neglected.[2] This chapter will provide the first systematic examination of the Scottish and Irish patent systems during the industrial revolution. It will begin by outlining the law and administration of patents in Scotland and Ireland, with reference to the English system. Section 6.2 describes the compilation of the Scottish and Irish patent catalogues (normally referred to as the patent 'index').

The fifth chapter demonstrated that, even with modest developments, it was possible for inventors to appropriate returns from inventive activity by working and trading their patent rights. However, to argue that these returns induced parties to engage in inventive activities, it needs to be demonstrated that inventors were responsive to such economic stimuli. Although economic theory would suggest this to be the case, empirical evidence is necessary. Section 6.3 will provide a statistical overview of the English, Scottish and Irish patent indices. It will argue that during the first half of the nineteenth-century the growth trend of the Scottish and Irish patent indices mirror their respective trajectories of industrial development. This indicates that patentees and inventors were responsive to the economic opportunities of invention during the industrial revolution. The commercial behaviour of patentees is further examined in section 6.4 by using an established quality indicator in conjunction with the patent indices of Scotland, Ireland and England.

Section 6.1
The administration and law of patents in Scotland and Ireland

Chapter 2 discussed how, prior to reform, patenting in England was not the responsibility of a single centralised 'Patent office', but of a plethora of offices and departments. To recap briefly, the patent petition in England involved the following stages:

1st stage. The inventor submitted his petition and affidavit to the Home Office.

2nd stage. Once the petition was signed by the Secretary of State, it was referred to the law officers for their report.

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1 I would like to thank Alessandro Nuvolari for his help in preparing this chapter, and for arranging an institutional visit at the Scuola Superiore Sant' Anna in Pisa, when the first draft of this chapter was prepared.

2 There is a complete absence of any work relating to patents for inventions in Ireland during this period. There is one essay that includes a discussion of Scottish patent law. Hector MacQueen, 'Intellectual Property and the common law in Scotland c.1700-c.1850' in Lionel Bently, Catherine Ng, and Giuseppina D'Agostino, (eds.) *The common law of Intellectual Property, essays in honour of Professor David Vaver*, (Oxford, 2010)

3rd stage. The report was returned to the Home Office to receive the King's Warrant. The warrant was signed by the monarch and countersigned by the Secretary of State.

4th stage. The warrant was taken to the Patent Bill Office where the Bill for the patent was prepared.

5th stage. The Bill was taken to the Secretary of State for the Home Office. Here it received the royal signature and the sign manual. With the sign manual affixed the bill was now entitled the 'The King's Bill'.

6th stage. The King's Bill was taken to the Signet Office, where the Signet Bill was prepared

7th stage. The Signet Bill was taken to the Privy Seal Office to obtain the Privy Seal Bill.

8th stage. The Privy Seal Bill was taken to the Letters Patent Office where the patent document itself was prepared, sealed and enrolled.

9th stage. The patent was taken to the Lord Chancellor to receive the Great Seal.

10th stage. The patentee submitted their specification at the Court of Chancery.

This petition process had been set down by the Clerks Act of 1536, and the granting of patents for inventions was confirmed by the Statute of Monopolies in 1624. However, there does not appear to have been any statutory basis for Scottish and Irish patents of inventions. Certainly, there was no legislation specifically relating to either system after the two Acts of Union.[3] The Scottish and Irish petition procedures, however were markedly similar to that of England. To secure a patent in Scotland the petition had to pass through six distinct stages:

1st stage. The petition and affidavit of the inventor were submitted to the Home Office in London.

2nd stage. The petition was referred to the Lord Advocate of Scotland (the Scottish equivalent to the English Attorney-General). Caveat opposition could be lodged at this stage of the petition.

3rd stage. The report was taken to the Home Office where the King's Warrant was prepared, directing preparation of the patent.

4th stage. The patent was prepared in the office of the Director of (Scottish) Chancery.

5th stage. The patent was taken to the Keeper of the Great Seal, to have the Great Seal of Scotland affixed.

6th stage. The Specification was entered at Scottish Chancery. As in England (and Ireland), two months were awarded for entering the specification if a patent was only obtained in Scotland, four months if a patent was sought in another country, and six months if patents were sought in all three countries.[4]

3 In 1794 James Poole, acting on behalf of a 'gentleman', sought counsel opinion on what the legal basis of Irish patents was. One lawyer, Colles, replied 'although there is no statute in Ireland impowering his majesty to grant letters patent for securing the exclusive right of new inventions for 14 years, yet by the common law I am of opinion all men have an exclusive property in rights of their own genius'. Notebook of James and Moses Poole, London, British Library, BJ00 54889, p.3

4 *Report of the Committee (appointed by the Lords of the Treasury) on the Signet and Privy Seal Offices*, (Parl. Papers, 1849, XXII), p.xii

The petition in Ireland involved nine stages.

1st stage. The petition and affidavit were submitted to the Lord-Lieutenant of Ireland, the monarch's personal representative in Ireland.

2nd stage. The petition was referred to the Attorney or Solicitor-General for Ireland (the Irish law officers) for their report. Caveat opposition could be lodged at this stage of the petition.

3rd stage. On receipt of the report, a draft of the King's letter was prepared and forwarded to the Home Office in London.

4th stage. The King's letter, consisting of the authority to grant the patent, was signed by the monarch and countersigned by the Secretary of State to the Home Office

5th stage. The King's Letter was entered at the Signet Office, sealed with the Signet, and returned to the Lord-Lieutenant.

6th stage. On receipt of the King's letter, a warrant was directed to the Attorney or Solicitor-General for Ireland authorising him to draw up a fiant (a warrant) containing a grant from the King.

7th stage. The fiant was sent to the Lord-Lieutenant for his signature, and to have the Privy Seal affixed.

8th stage. The fiant was forwarded to the Clerk of the Crown, who prepared the necessary document and was responsible for sealing the patent with the Great Seal of Ireland

9th stage The specification was entered at the Irish Court of Chancery.[5]

Although there are some minor differences between the three petition procedures, the essential steps were the same. Firstly, in England, Scotland, and Ireland, the substantive examination of the petition was (in theory) undertaken by the law officer(s). Significantly, the law officers of the three countries often corresponded with each other on matters relating to patents.[6] Secondly, every petition had to pass through the Home Office in London. Thirdly, every petition at some stage required the monarch's signature. In addition, although the petition in Ireland and Scotland was as bureaucratic as that in England, some patent agencies maintained Dublin and Edinburgh offices and it is likely that the majority of inventors employed their services when obtaining a Scottish or Irish patent.[7]

Consequently, English administrative developments were adopted in Scotland and Ireland as well. Undoubtedly, the most significant change in the English petition process was the introduction of the specification which became standard practice in the 1730s.[8] Although very few Scottish and Irish patents were awarded in the first half of the eighteenth-century, specifications were soon adopted in both countries (where, as in England, they had to be entered at the Court of Chancery). The last Scottish patent without a specification was awarded in 1736.[9] Similarly, from 1728 all Irish patents were awarded on the condition that

5 Ibid

6 *Number of letters patent for inventions, sealed in each of the ten years, ending 31 December 1847, together with the fees paid*, (Parl. Papers, 1849, XLV), p.7-8

7 *Committee on the Signet and Privy Seal Offices*, (Parl. Papers, 1849), p.58

8 Bennet Woodcroft, *Patents for invention: Reference Index, 1617-1853*, (London, 1855)

9 Chapters 2 and 3 argued that the specification was introduced as a legally binding declaration of the patented invention and not as an administrative arbiter to differentiate between ostensibly similar patents and petitions. This

a specification was entered.[10]

The costs involved with acquiring a patent in Scotland and Ireland was also similar to that in England. In 1846 the minimum amount payable in official fees for an English patent was £95. By comparison, in 1849 the official fees on an Irish patent cost slightly more at £115, and less in Scotland at £63. As in England, official fees were stable over time in both countries, in 1829 for instance, the official fees on a Scottish patent were £66.[11] However, as discussed in chapter 2, patentees had to pay a great deal more than just the official fees. Firstly, they had to pay fees for patent agents. Agency fees were charged at 10 guineas for every individual English, Scottish or Irish patent. Secondly, a patentee had to pay fees to enter their specification. Although the fees charged varied according to the length of the specification, the fees charged in England, Scotland and Ireland were similar. For example, the stamp duty payable on entering the specification was £5 in each of the three countries.[12]

One expense that patentees in Scotland and Ireland would have been spared were the charges for legal and technical assistance for the preparation of the specification. As was discussed in chapter 2 these were substantial, and the average cost in 1829 was around £20.[13] However, as will be discussed later, Scottish and Irish patents almost always had an English equivalent, which was normally sealed first. Because the same description could be entered for the different national patents, the professional fees in preparing the specification only had to be incurred on entering the first (English) specification.

Overall then the minimum cost of obtaining a patent in England, Scotland, and Ireland, was broadly similar. For an English patent, with official fees of £95, agency fees of £10, specification fees of £20 and technical consultancy fees of another £20, the total cost of an enforceable patent was around £145. In Ireland, at a minimum, a patent would have cost another £145 (£115 for fees, £10 agency fees, £20 specification fees). In Scotland a patent would have cost a minimum of £90 (£65 for fees, £10 agency fees and £20 to enter the specification). This brings the total (minimum) cost for a patent covering the United Kingdom to £380. Calculated as a multiple of the average contemporary wage, an 1846 'British' patent would cost around £260,000 in 2010 prices.[14]

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argument is supported here as there were so few patents awarded in Scotland and Ireland in the first half of the eighteenth-century (two and six respectively) that there cannot have been any need to distinguish between patents in the manner suggested by Edward Hulme. Rather the specification must have been adopted for the same reasons as in England. Scottish patents and specifications, 1712-1812, Edinburgh, National Archives of Scotland, CE3, fol.1

10 State Papers, London, National Archives (N.A.), SP36/5 fol.259

11 The full cost reported by Poole for a Scottish patent was £79 10s. 5d, but this figure included other costs such as patent agency fees. To make the figure reported in the text comparable with the quote from the 1849 Committee these costs were excluded. *Report from the Select Committee on state of law and practice relative to patents for inventions*, (Parl. Papers, 1829, III), p.87.

12 Thomas Turner, *The law and practice of patents and registration of invention and design in manufacture*, (London, 1851), p.164. As of 1826 (when specifications tended to be shorter and so cheaper to enter) the most expensive specification entered in Scotland had cost £38, whereas the cheapest had cost £6 7s. *Expenses incurred in taking out a patent in Scotland*, (Parl. Papers, 1826, XXIII)

13 *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.17

14 The estimate produced here is supported by the average cost of £500 to £600 for a 'British' patent reported by the inventor Richard Roberts before an 1851 Select Committee. *Report and minutes of evidence taken before the Select Committee of the House of Lords appointed to consider of the Bills for the amendment of the law touching letters patent for inventions with appendix and index*, (Parl. Papers, 1851, XVIII), p.193. Lawrence Officer and Samuel Williamson (2011), 'Purchasing Power of British Pounds from 1245 to Present', MeasuringWorth,

That the petition procedure, and its attendant costs, were so similar in the three countries, presents an opportunity. It means that it is possible to regard individual English, Scottish and Irish patents as equivalent statistical units and that meaningful comparisons can be made between their respective patent indices. Before seeking to establish comparisons between the three countries, however, it is also important to consider possible differences in law. There are two halves to this problem. Firstly, it is important that legal issues of authorship, novelty and patentability were adjudicated in the same manner in the English, Scottish and Irish legal systems. If, for example, novelty requirements were less rigorously enforced in Ireland than in Scotland, there would probably be more patents in Ireland than if Scottish standards of novelty were maintained. The second half relates to the problem of the legal status of a patent or invention in another part of the United Kingdom. Was it, for example, possible for a party to circumvent a patent in one part of the Union by importing and selling the protected article from another, where no patent was in force?

Evidence regarding the first problem appears straightforward: both Scotland and Ireland adhered to English patent law, presumably because there were far more court cases there. With regard to Scotland, Hector MacQueen notes that decisions in Scottish courts, 'make clear the continuing sense that…the law was essentially a unity north and south of the border'.[15] He cites the example of manufactory inspections being allowed within the terms of an interdict (the Scottish equivalent of an injunction) in accordance with English practice.[16] MacQueen's argument is supported by evidence from Parliamentary Select Committees. In 1849 the patent agent Campin declared 'Scotch judges are invariably guided by English decisions in cases of patents'.[17] Concerning Ireland, although the records for patent cases are sparse, no material difference between Irish and English patent law appears.[18]

Evidence regarding the legal status of a patent or invention in another part of the United Kingdom is more problematic. Within certain time restrictions it was possible to obtain a patent for an invention in any combination of the three countries. As discussed in section 2.1, if only an English patent was sought, then two months were awarded to prepare the specification, four months if a patent was intended for one other country, and six months for all three. The additional time was granted because specification of the invention in England constituted an act of publication throughout the United Kingdom. Consequently, if the English patent was specified before the Scottish or Irish patent had been sealed, the latter would be technically invalid.

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www.measuringworth.com/ppoweruk/, accessed 18th June 2012

15 MacQueen, 'Intellectual Property and the common law in Scotland', p.25

16 Ibid, p.28

17 *Select Committee of the House of Lords,* (Parl. Papers, 1851), p.109

18 This, however, is based on the only two court cases to be published in Irish court records. The two cases are *Baxter* v *Combe* (1850), and *Carmichael* v *Combe* (1851) in Michael Roberts and Edward Shirley, *Irish Chancery Reports*, (17 vols, Dublin, 1852-1867), Vol.1, p.285 and Vol.3 p.247. For a full list of Irish court records consulted please see the bibliography. This figure of two cases can be contrasted to the eighteen published reports relating to Scottish patent law. As was established in chapter 5, because of the costs of pursuing legal action, in general, only the more valuable patents were disputed in court. That there were many more cases in Scotland than in Ireland, indicates that patent rights were generally more valuable in Scotland than in Ireland. This tallies with the conclusion in section 6.3, that economic development in Scotland made protecting inventions more valuable there than in Ireland. For Scottish law reports see Robert Henderson, *The Scots digest of appeals in the House of Lords from 1707 and of the cases decided in the Supreme Courts of Scotland, 1800-1873*, (4 vols, Edinburgh, 1911)

This was established at common law in *Roebuck* v *Stirling* (1774). Here the plaintiff claimed that as his patent bore only the seal of Scotland, only prior use in Scotland could annul it. This was refuted by the defendants who argued successfully 'the whole United Kingdom [is] subject to the same rules, regulations, and restrictions in matters of trade'.[19] Consequently, prior use anywhere in the United Kingdom would invalidate a Scottish patent, and the decision was upheld on appeal to the House of Lords.[20] This was established law for sixty years until *Haworth* v *Hardcastle* (1834), where the legality of the patent was confirmed on the grounds that 'the use of the machinery in Scotland before the patent, could not invalidate the English patent'.[21] There was no precedent for this decision, and the matter soon re-appeared in the courts. In 1842, *Brown* v *Annandale* came on appeal from the Scottish courts to the House of Lords. Here Lord Campbell stated 'the law was quite correctly laid down by this house in the year 1774', and re-affirmed the precedent set in *Roebuck* v *Stirling*.[22]

A related question was whether a party could circumvent a patent by manufacturing the protected product in one part of the United Kingdom, where no patent was in force, and legally export and sell it in another where a patent was in force. It was the ambiguous wording of the patent that raised this spectre of 'legal' infringement. While the part of the patent reciting the actual grant conferred the right to 'vend' the invention, the prohibitory part of the patent (that part which detailed the exclusion operating on other parties) made no mention of vending. This could be interpreted as permitting the manufacture or use of an invention in one part of the United Kingdom where a patent was not in force, and then selling (vending) it in another part where the patent was in force. It was, however, expressly decided in *Universities of Oxford and Cambridge* v *Richardson* (1803), that where a (copyright) patent was in force in England but not Ireland, 'if any of the King's subjects buy an article in Ireland, he cannot bring it here, where there is a patent for it, for the purpose of trading'.[23] This decision was assimilated into the law of patents for inventions and was quoted in contemporary patent treatises.[24] For process inventions, however, where the end product was generic, the law was different. For example, in sugar-refining it was possible for an Irish refiner to freely adopt improvements as long as they had not been patented in Ireland. Further, they could then sell their refined sugar at a cost advantage in England where refiners did have to pay the licence fees.[25] This will be discussed further in section 6.3.

This section has established the close similarities between the English, Scottish and Irish patent systems. Although theoretically autonomous, there was considerable uniformity in the petition procedure across the three countries. This uniformity extended to patent law as well, although there were some

19 House of Lords. William Carpmael, *Law reports of patent cases,* (3 vols, London, 1843), Vol.1, p.48
20 Hayward, *Patent cases*, Vol.1, p.177
21 Court of Common Pleas. Ibid, Vol.2, p.384
22 House of Lords. Ibid, Vol.4, p.24. Nonetheless the issue could still prove contentious. In *Brown* v *Kidston & Waters* (1852) the Lord Ordinary's initial decision to award an interdict to restrain an alleged infringement had to be overturned at the Second Division, even though the Scottish patent had been obtained four months after the English specification had been entered (and so was technically invalid). MacQueen, 'Intellectual Property and the common law in Scotland', p.26
23 Court of Chancery. Edward Holroyd, *The law and practice for inventions*, (London, 1830), p.177
24 Ibid
25 *Select Committee of the House of Lords,* (Parl. Papers, 1851), p.149

inconsistencies in the adjudication of patents from another country in the Union. The next section will describe the construction of the English, Scottish and Irish patent series.

Section 6.2
Constructing the Scottish and Irish patent indices

Before the passing of the Patent Law Amendment Act in 1852 there was no official catalogue of patents in England, Scotland, or Ireland. To remedy this situation, in 1852 the newly established Patent Office commissioned Bennet Woodcroft to produce an index of pre-reform English patents from 1617.[26] This eventually resulted in four series of English patents, described in section 4.2. Together, these four series provide information on patent date, subject matter, patentee name, residency and references to the patent in contemporary technical literature. Since their publication the Woodcroft series have become the standard reference for pre-reform patents.

There is no equivalent to the Woodcroft series for Scotland and Ireland. For both, however, there are hand-written lists surviving in the British Library. These provide some information also found in the Woodcroft series, listing patentee name, date of grant and subject matter. Although it is possible that these lists were produced as part of the same cataloguing effort that produced the four Woodcroft series, it remains unclear why they were prepared or who the authors were. Neither do they appear on the British Library (BL) Integrated Catalogue.[27] It was therefore important to check the reliability of these lists. In the case of Scotland the BL list was checked with transcripts of the King's Warrant authorising the grant of the Scottish patent (obtained at the third stage of the Scottish petition).[28] After 1792 the vast majority of these warrants can be matched to a subsequent patent recorded in the BL list. This suggests that from 1792 the BL list is accurate and what small discrepancy there is can probably be attributed to petitioners' failing to pursue the petition to the Seal.[29] Before that date, however, there are 113 warrants for inventions surviving although the BL index lists only thirty-seven patents. Because the warrant could only be obtained with the favourable report of the Scottish law officer it is not credible that so many applicants would have failed to secure the patent afterwards and so before 1793 the BL Index is supplemented by patent warrants. Reassuringly, all thirty-seven pre-1793 patents listed in the BL index are recorded in the Warrant Books.

The BL patent index for Ireland is also incomplete. Firstly, it only lists patents for which specifications were entered. This leads to an underestimate of the total number of patents granted in Ireland vis-à-vis Scotland and England, where all patents to have received the Seal are counted. Secondly, as with Scotland, it appears to undercount the number of patents awarded during the eighteenth-century, listing only seven. Fortunately, there is a contemporary Home Office document (derived from the original patent rolls)

26 Alessandro Nuvolari, and Valentina Tartari, 'Bennet Woodcroft and the value of English patents, 1617-1841', *Explorations in Economic History*, 48, (2011), p.109
27 The two series are obtainable by asking at the Intellectual Property desk in the British Library. Their titles are *Irish Index to specifications, 1788-1855* and *Scottish Index to patents, 1767-1853*
28 Scottish Warrant Books, London, National Archives (N.A.), HO106/1 to HO106/11. Pre-1774 Warrants are in SP54
29 Between 1793 and 1808, only 18 out of 184 warrants do not appear in the BL Index, less than 10 percent of the total. Scottish Warrant Books, London, National Archives (N.A.), HO106/2 to HO106/3

listing Irish patents for invention from before 1827. This lists fifty-eight Irish patents for the eighteenth-century.[30] Because it includes all patents (unspecified as well as specified), it has been used as the main source for pre-1827 Irish patents for inventions. After 1826 only the specification index has been used. Again the seven patents listed in the BL Index all appear in the Home Office paper.

It is possible to estimate how many patents are excluded from this specification index after 1826 by comparing it with the Home Office paper. Of 350 patents listed between 1800-26 in the Home Office paper, 322 appear in the specification index. This means twenty-eight patents were awarded for which no specification was later entered, approximately 8.7 percent of the specification total. If we assume this proportion of unspecified to specified patents was the same between 1827-51, then a total number of specified patents of 1,175 implies there were around 1,275 patents awarded in total.[31] Although this only represents a small underestimate, it would have been preferable to use the original Irish patent rolls. These, however, were destroyed in 1921.

After collecting the data, Irish and Scottish patents were matched with their English equivalents. Generally Scottish and/or Irish patents were obtained under the same name, similar patent title and (due to the specification requirement) within six months of the English patent. This made the large majority of matches straightforward.[32] For instance, the English patent granted to Thomas Dunn for a 'Turntable to be used on railways', on the 13th March 1845, (English patent no. 10556) was matched with the Scottish patent granted to Thomas Dunn for 'Certain improvements in or applicable to turn tables to be used on or in connection with Railway', on the 4th April 1845 and with the Irish specification entered by Thomas Dunn for 'turntables for railways' on the 19th November 1845.[33]

There were a minority of cases where there was some ambiguity in the match. For example, the Irish patent granted to Benjamin Batley for a 'New method of curing and preserving herrings' on the 15th November 1800 could have been matched with either the English patent granted to Benjamin Batley on the 11th September 1800 (no.2441) for 'Curing and preserving herrings and sprats', or with the patent awarded to him on the 25th January 1801 (no.2465) for 'Curing and preserving herrings, sprats, and other fish'. In this instance and in other cases of ambiguity, the match was normally made with the English patent with a date preceding the Scottish or Irish grant. This was because inventors tended to obtain English patents before an

30 Return to Parliament from the Rolls Office of the titles and dates of patents granted in Ireland for manufactures and inventions, London, National Archives (N.A.), HO42/218

31 The proportion of unspecified Irish patents was probably smaller than this in the second quarter of the nineteenth-century, largely because so few English patents were unspecified (5.4 per cent) before 1852 and they were normally obtained before their Irish counterparts. Christine MacLeod, Jennifer Tann, James Andrew and Jeremy Stein, 'Evaluating inventive activity: The cost of nineteenth-century UK patents and the fallibility of renewal data', *Economic History Review*, 56, (2003), p.556

32 For post-1826 Irish patents, the time limit for matches between English and Irish patents was increased to twelve months, because only the date of the Irish specification was recorded. The Irish specification could be entered twelve months after the English patent was dated because six months were allowed to enter the English specification (by which time the Irish patent had to be sealed) after which another six months were allowed to enter the Irish specification.

33 Note that this is the date the Irish specification was submitted, not when the Seal was attached to the patent. Assuming Dunn used the full six months available to him, the Irish patent would have been dated 19th May 1846.

Irish or Scottish one, irrespective of residence.[34]

There were also cases where there was not an exact match in the information between the English patent and a Scottish or Irish patent, but where it was reasonable to suppose a match could be made. For example, an English patent awarded to James Mayer for a 'machine for cutting splints for matches' on the 4th December 1839 (no.8297) was matched with an Irish specification entered by Antonio J Mayer for 'cutting splints for matches' on the 24th September 1840.

There were also a small number of patents (three in Ireland, twenty-three in Scotland) where no precise match could be made although it was likely that there was an English equivalent. This occurred where an individual, normally a patent agent, was responsible for a number of patents with similar subjects in a short period of time. After matching there remained a few Scottish and Irish patents without a matching English patent, presumably because one was never obtained.

Section 6.3
Interpreting the Scottish and Irish patent indices

Section 6.1 discussed the close similarities in the law and administration of patents in England, Scotland and Ireland, prior to reform. Because the costs and requirements of obtaining and enforcing patents were broadly the same, patents within the three jurisdictions may be legitimately regarded as statistically comparable i.e. that a patent in Scotland can be regarded as an equivalent statistical unit to an English or Irish patent. Section 6.2 outlined the compilation of the English, Scottish and Irish patent indices between which there are two discrepancies. Firstly, after 1826 the Irish index only lists patents with which a specification was later submitted. Secondly, before 1793, the Scottish index includes King's Warrants for inventions but for which patents were not subsequently obtained. Nonetheless, these discrepancies are minor and do not preclude a comparative analysis of the three patent series.

The first historian to analyse the English patent series of the period was Richard Sullivan. He argued that the contemporary patent count could be regarded as an indicator of the resources committed to (patentable) inventive activity.[35] Accordingly, he interprets the acceleration in the growth trend in English patent numbers during the late 1750s as registering an acceleration in the growth of resources committed to inventive activity.[36] This in turn is interpreted as marking the beginning of the industrial revolution. Sullivan's argument, however, assumes that the propensity to patent inventions was both high, and invariant over time, implying an implausibly low level of inventive activity before 1750. The untenability of Sullivan's assumptions is confirmed in light of Petra Moser's quantitative work on the exhibits of the 1851 Great Exhibition, discussed in chapter 1. Moser established that a substantial proportion of exhibits were not

34 For example, one prominent patent agent before the 1849 Parliamentary Select Committee, claimed that Scottish or Irish inventors 'almost invariably come or write to London first'. *Committee on the Signet and Privy Seal Offices,* (Parl. Papers, 1849), p.30

35 Richard Sullivan, 'The revolution of ideas: Widespread patenting and invention during the English Industrial Revolution', *The Journal of Economic History*, 50, (1990), p.351

36 Richard Sullivan, 'England's "Age of Invention": The acceleration of patents and patentable invention during the Industrial Revolution', *Explorations in Economic History,* 26 (1989), p.425

patented and that the propensity to patent varied considerably across industries.[37]

The work of Moser demonstrates that patent numbers cannot be interpreted as a straightforward measure of inventiveness. This is not to suggest that the growth in English patent numbers is entirely divorced from changes in the extent of inventive activity, but that inventive activity is not the only factor to influence changes in patent numbers. Rather, there are other factors that influence the *propensity* to patent. Christine MacLeod attributes the increase in patenting activity during the 1750s to economic factors.[38] She argues that growing investment in capital equipment led to the development of a specialist capital goods sector. As the output of the sector grew so too did their return from acquiring patent protection.[39] Similarly, increasing disposable incomes led to more 'consumer' patents. MacLeod argues that these developments led to a 'first-strike' mentality, where it was necessary to patent improvements defensively, to pre-empt another party from patenting them. Although MacLeod presents something of a hotchpotch of possible factors, there is one underlying argument: that changes in the economy made it more valuable to secure patent protection for one's invention.

Patent numbers then are a 'messy' indicator, responsive to changes in overall levels of inventiveness, economic developments and (as was shown in section 2.3.2) institutional changes. In analysing the Scottish and Irish patent series, however, underlying levels of inventive activity can be factored out. This is because the large majority of inventions patented in Scotland and Ireland were not developed there. In Ireland between 1800-51, 84 percent of first named patentees were resident in England, whereas only 6 percent were from Ireland. The remainder were either from Scotland (7 percent) or from abroad (3 percent). In Scotland, 88 percent of first named patentees came from England and only 10 percent from Scotland. Similarly, almost all inventions for which patents were obtained in Scotland and Ireland were also patented in England. From 1750 to 1851 there were only 151 Scottish patents that did not have an English counterpart, about 4 percent of the total number awarded. The comparable figure for Ireland was sixty-six, again ≈4 percent of the total.[40] Although in theory the three populations might have been relatively independent, in practice it is more useful to think of Irish and Scottish patents as extensions to an original English patent.

There were, however, institutional improvements to the English patent system, detailed in the second and third chapters. These improvements in the institutional framework, would have increased the propensity to patent. There is, however, no reason to suppose that it should have affected the *relative* propensity to patent between the three countries. This is because these improvements also occurred in Ireland and Scotland. For example, the ready adoption of English patent law in Scotland and Ireland, means that there

37 Petra Moser, 'Why don't inventors patent?', Working Paper No.13294, NBER, 2007, p.37

38 MacLeod attributes the increase in the propensity to patent to other factors as well citing, for example, improved transport links and increasing availability of information relating to the patent system. It is unclear whether either factor was important in increasing the propensity to patent in Scotland and Ireland. Concerning transport links, as mentioned in the section 6.1, there was no need to travel to Edinburgh or Dublin to secure a Scottish or Irish patent. It is also unlikely that increasing knowledge of the potential of the patent system was important, as the rapid growth of English patents and commercial publication of specifications pre-dated rapid growth in the Scottish and Irish patent systems. MacLeod, *Inventing the Industrial Revolution*, p.145

39 Ibid, p.149

40 There were 14 patents that were obtained in both Scotland and Ireland, but not England

was not a significant divergence in the patent law of the three countries. Similarly, it appears that patent agents had begun to assist inventors obtain Scottish and Irish patents before 1800, although the evidence is exiguous. In 1794, for example, James Poole was fielding enquiries relating to obtaining Irish patents.[41]

By the process of elimination, this means that relative changes in the number of patents in Scotland and Ireland can be attributed to changes in the economic opportunity of protecting industrial technology. This inference is supported by modern data. Nicolas van Zeebroeck and Bruno van Pottelsberghe established a strong correlation between the number of patents filed in the European Patent Office for a particular country and the size of that country's GDP.[42]

There are three factors that would have influenced a party's decision to extend a patent to Scotland or Ireland (besides affordability). The first of these was the perceived 'quality' of the invention. Generally speaking, the more valuable the invention, the more extensive the protection the inventor would invest in. Secondly, the decision to extend a patent would be influenced by the size and the value of the market for the invention in that particular country. Economic growth would augment the expected market for inventions and so would be expected to lead to an increase in patenting. The third factor that would influence an individual's decision to extend a patent would be the extent of their personal and business connections in that country. This third factor probably increased in importance with improving communications and market integration between the three countries although these developments were themselves bound up with changes in the economy.

There is, potentially, a fourth factor as was mentioned at the end of section 6.1. It may have been that patentees with process inventions obtained Scottish and Irish patents to secure their English patent against imports made using their invention from these countries. However, it is unlikely that this was an important factor. Firstly, there is no direct evidence that this was ever a consideration for an inventor extending their patent to Scotland or Ireland. Secondly, it would only be worthwhile going to the expense of say, patenting an improvement in sugar refining in Ireland, if there was an Irish sugar-refining industry that was able to compete with the English one. If there was then it was probably worth getting the patent anyway for the more straightforward reason of assigning or licensing it. Consequently, it is likely that Scottish and Irish patents do denote the opportunity of patenting technology in those countries.

The reasoning behind these first three factors is used in 'family size analysis' to appraise the value of patented inventions. Van Zeebroeck summarises the rationale for this analysis as, 'given the costs required to file and enforce patents in multiple countries, only those with sufficient expected value to their owners will be extended abroad', that in effect patent value can be inferred from the number of jurisdictions in which patent protection is obtained.[43] In a test of various methods of estimating patent value against a dataset where value assessments had come directly from a survey of the patent holders, Harhoff, Scherer and Vopel found

41 Notebook of James and Moses Poole, London, British Library, BJ00 54889, p.3

42 Bruno Van Pottelsberghe de la Potterie and Nicolas Van Zeebroeck, 'A brief history of space and time: The scope-year index as a patent value indicator based on families and renewals', *Scientometrics*, 75, (2008), p.324

43 Nicolas Van Zeebroeck, 'The puzzle of patent value indicators', *Economics of Innovation and new technology*, 20, (2011), p.36

that 'family size, the number of jurisdictions for which patent protection was granted carries the expected positive sign and is highly significant' in relation to the patent's empirical value.[44]

Van Zeebroeck also notes that family size analysis can also be used to 'denote an expected market for the patented technology', i.e. that an analysis of the distribution of patents between industries can isolate the relative opportunities for new technologies in different countries.[45] This facet of family size analysis will be explored in the rest of this section with reference to Scotland and Ireland. To attribute, however, differences in their respective patent series to changes in their economy, it is necessary to outline briefly a chronology of industrial development in Scotland and Ireland.

In the first half of the nineteenth-century, Ireland was probably the poorest country in Western Europe. Poverty was exacerbated by rapid population growth, in 1800 the population of Ireland was 5 million, yet just twenty years later it had grown to 6.8 million.[46] Consequently, living standards, as reported by the Poor Inquiry of 1835-6 were declining in almost every county.[47] The consensus is that Irish manufacturing was in relative decline during the first half of the nineteenth-century, although the extent of this decline, and its causes, are the matter of some debate. Peter Solar argues that with the abolition of duties on Anglo-Irish trade in the 1820s, most Irish industries struggled to compete and began to disappear.[48] Cormac Ó Gráda by contrast, attributes the decline of Irish manufacturing to high coal prices observing that by 1830 Ireland had abandoned (energy-hungry) industries such as glass-making, sugar-refining and salt production.[49] Frank Geary provides a slightly more positive assessment of Irish industrial performance noting that Irish manufactured exports to England actually grew in the first quarter of the nineteenth-century.[50] However, Geary's figures reveal that a diminishing proportion of the labour force was engaged in manufacturing or trade. In the 1821 census 41.2 percent of the Irish labour force was reported to be engaged in manufacturing and trade. By 1841, this had fallen to 33.6 percent and in the 1840s, as well as the misery inflicted by the famine, another 400,000 jobs were lost in textiles alone.[51] It is clear then that the proportion of the Irish labour-force involved in manufacturing was falling during the nineteenth-century, although with technological developments, labour productivity would have been improving. Consequently, there probably was some growth in aggregate output.[52]

The economic history of Scotland is perhaps as remarkable as that of Ireland albeit for very different reasons. By 1851, Scotland had experienced a process of industrialisation that had wrought changes every bit

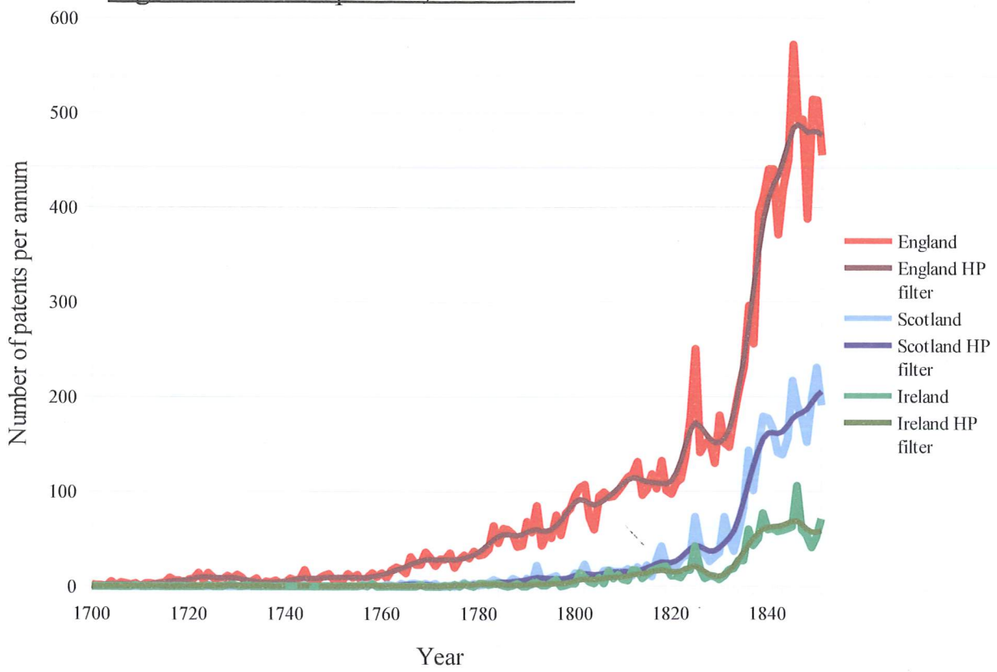
44 Dietmar Harhoff, Frederic Scherer, & Katrin Vopel, 'Citations, family size, opposition and the value of patent rights', *Research Policy*, 32, (2003), p.1358
45 Van Zeebroeck, 'Puzzle of patent value', p.36
46 Cormac Ó Gráda, *Ireland, a new Economic History, 1780-1939*, (Oxford, 1994), p.6
47 Joel Mokyr, *Why Ireland starved: A quantitative and analytical History of the Irish economy, 1800-1850*, (Oxford, 1983), p.12
48 Peter Solar, 'The Irish linen trade, 1820-1852', *Textile History*, 21 (1990), p.57
49 Ó Gráda, *Ireland, a new Economic History*, p.316
50 Frank Geary, 'The Act of Union, British-Irish trade and pre-Famine deindustrialisation', *Economic History Review*, 48 (1995), p.77
51 Frank Geary, 'Deindustrialisation in Ireland to 1851: Some evidence from the census', *Economic History Review*, 51 (1998), p.521
52 Ó Gráda, *Ireland, a new Economic History*, p.308

as transformative as anything that had happened in England.[53] In the eighteenth-century Scotland was relatively poor. Between 1765-95, the wages of carpenters in Aberdeen or Edinburgh, never reached two-thirds of the level of carpenters in Manchester or Exeter.[54] In the last quarter of the eighteenth-century though the Scottish textile industry began to grow with annual imports of cotton growing seventeen fold between 1781-86 to 1799-1804.[55] Although textiles dominated large scale manufacturing during the first quarter of the nineteenth-century, after 1830 there was an abrupt diversification of Scottish manufacturing into other 'revolutionary' sectors.[56] Especially important was Neilson's invention of the hot blast process which allowed Scottish iron output to grow from 37,500 tons in 1830 to 700,000 tons twenty years later.[57] Scottish industry now had access to the cheapest iron in the world spurring further development in railways, shipbuilding, engineering and mining. As soon as 1841, Crafts estimates that the proportion of male workers in 'revolutionised industry' was above 30 percent in three out of eight Scottish regions compared to four out of forty-three in England.[58]

Although this is only been a brief overview of the relevant Scottish and Irish economic history, it is clear that the two countries experienced contrasting fortunes. While manufacturing in Ireland stagnated through to 1851, Scotland had already industrialised. This suggests that there should be divergent patterns in their respective patent series. Because Scotland's rapid economic development made the protection of new inventions more valuable than in Ireland we would expect to see many more patents in Scotland than Ireland. Figure 6.1 shows the number of patents awarded in England, Scotland, and Ireland, for every year between 1700 and 1851. The light-coloured lines indicate the annual total of patents awarded in each of the three countries. Because there is considerable fluctuation in annual totals, the Hodrick–Prescott filter has been used to dampen short-term fluctuations and clarify the longer-term trends. These are shown by the darker lines.[59]

53 Christopher Whatley, *The Industrial Revolution in Scotland*, (Cambridge, 1997), p.7
54 Thomas Devine, 'Scotland', in Roderick Floud, and Paul Johnson, *The Cambridge Economic History of Britain, Volume I, Industrialisation, 1700-1860*, (Cambridge, 2004) p.395
55 Whatley, *Industrial Revolution in Scotland,* p.25
56 Devine, 'Scotland', p.399
57 Ibid, p.400
58 Nicholas Crafts, *British economic growth during the Industrial Revolution*, (Oxford, 1985), p.4-5
59 Nuvolari and Tartari, 'Value of English patents', p.103

Figure 6.1 British patents, 1700-1851



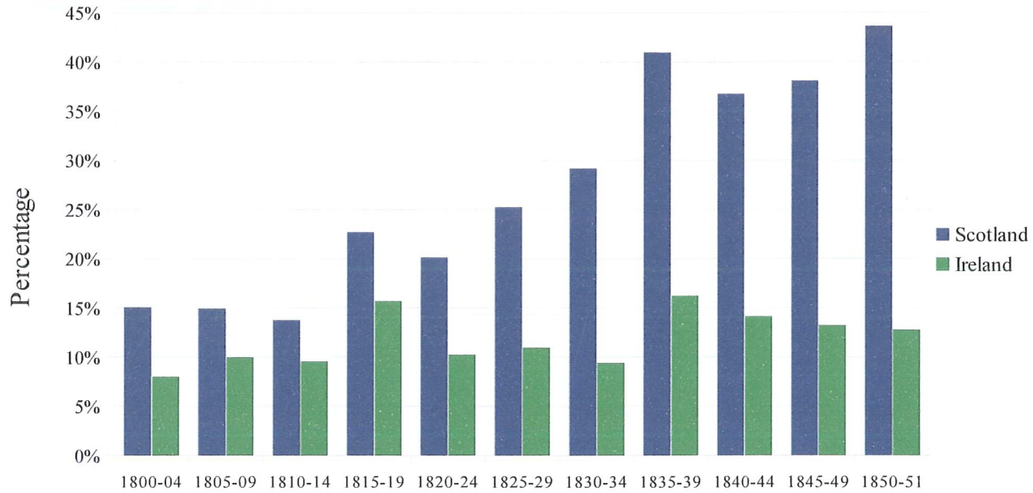
The overall growth pattern in patenting is striking. Before 1760 there were very few patents awarded anywhere in the United Kingdom. After 1760, however, annual English patent numbers begin to take-off. In 1750 only seven English patents were awarded; yet in 1799, eighty-two. This steady growth continued until a second 'boom' beginning in the 1830s.[60] This pattern is similar in Scotland and Ireland, albeit with a different chronology. Annual patent totals in both countries remained close to zero until 1790 after which there was steady growth. Then in the 1830's, as in England, there was a marked acceleration. One difference between Scotland and Ireland is that after this burst of growth Scottish patents numbers continued to grow while in Ireland numbers stagnate. There were also many more patents awarded in Scotland than in Ireland. Between 1820-51 there were almost three times as many Scottish patents (3,375) than Irish (1,239).

As discussed above, however, the majority of Scottish and Irish patents may be regarded as extensions of an English equivalent. It is important then to consider the extent to which growth in Scottish and Irish patenting was driven by growth in the 'base' English series. If the propensity to extend patent

60 Although Sullivan located what he considered to be a 'break-point' in the growth trend of patent numbers in the second half of the 1750s, no attention has been paid to what appears to be a new, higher, regime of trend growth in patenting after 1830. This acceleration in patenting may be attributable to the contemporaneous development of railways. If established, this would be analogous to the relationship between canal construction and growth in patenting in the United States posited by Kenneth Sokoloff. Sokoloff argues that canals, by increasing access individuals and firms had to markets, increased the return to invention (and patenting) by increasing the number of marketable units, to which the advance could be applied. In the English case, without further research, this can only be a speculation. Kenneth Sokoloff, 'Inventive activity in early industrial America: Evidence from patent records, 1790-1846', *The Journal of Economic History*, 48, (1988), 813-850

protection to Scotland remained constant, this would imply there was no Scottish industrial 'catch-up'. Figure 6.2 shows the total of Scottish and Irish patents awarded in five year periods as a percentage of the total awarded in England during the same period, (1850-1851 is also included).

Figure 6.2 Scottish and Irish patents as a proportion of English patents, 1800-1851



This series shows Scottish patent totals catching up with those of England, increasing from a low of 13.6 percent in 1810-14, to an average of 39 percent between 1835-51. This establishes that the propensity to extend patent protection to Scotland almost triples in about thirty years. By contrast, there is no significant change in the percentage of English patents extended to Ireland.

The difference between Scotland and Ireland becomes starker, when looking at per capita patenting. Table 6.1 presents the number of patents awarded per million population in each census year from 1801.[61] Because the annual patent totals fluctuate, a 'patent average' for each year is calculated. The patent average is simply the average number of patents awarded each year for a nine year period, with the census year as the middle year. For example, the patent average for 1801 is calculated by dividing the total number of patents granted between 1797 and 1805 by nine. The patent average was then divided by population to produce a figure for the number of patents per million population.

61 The population totals are derived from census data, except for Ireland 1801 and 1811 which are estimates from the Public Record Office of Northern Ireland. http://www.proni.gov.uk/index/exhibitions_talks_and_events/19th_century_emigration_to_the_north_america_online/statistics.htm. Accessed 10th May 2011

Table 6.1 Scottish and Irish Patents by population, 1801-1851

Ireland

Year	Population	Patent Average	Patents per million population
1801	≈ 5.40	5.00	0.93
1811	≈ 6.00	10.11	1.69
1821	6.80	17.89	2.63
1831	7.77	19.44	2.50
1841	8.18	59.11	7.23
1851	6.55	54.67	8.34

Scotland

Year	Population	Patent Average	Patents per million population
1801	1.61	9.89	6.14
1811	1.81	14.67	8.12
1821	2.09	32.00	15.30
1831	2.36	47.33	20.02
1841	2.62	157.89	60.26
1851	2.89	207.00	71.65

It can be seen that Scotland had significantly more patents by population, than Ireland. Even before the famine decimated the Irish population, in 1841 there were only seven patents awarded per million population. The equivalent figure for Scotland was sixty, over eight times that for Ireland.

These results were anticipated by the discussion of patent family analysis and the comparative industrial performance of Scotland and Ireland. With the onset of widespread industrialisation in Scotland during the 1830s, there was a tripling in patents per million population. By this measure there was similar growth in Ireland, but from a much lower starting point. To be robust, however, this pattern also needs to be demonstrated at the sectoral level. In particular, Crafts' work on the share of Scottish and English adult male labour in 'revolutionary' industrial sectors suggests that patenting in Scotland should have been heavily concentrated in those sectors compared with England and Ireland.[62]

There is one potential problem with this analysis. Alessandro Nuvolari has established that higher-quality inventions tended to be concentrated in particular sectors, especially chemicals, construction, glass, metals and paper.[63] As there is a higher propensity to extend patent protection on more valuable inventions (a proposition that is explored further in the final section), there is a danger that the results of a sectoral analysis will be skewed towards those sectors with a higher proportion of high-quality inventions. Because of this pattern, the sectoral distribution of patents awarded in all three countries, 'Britain' (and theoretically the population with the highest average quality of patents) is also shown in table 6.2 for comparison.[64]

62 Although the work of Moser, discussed above, emphasises the difficulties in using patent statistics to analyse the sectoral distribution of inventive activity the concern here is the *relative* sectoral distribution of patents between the three countries.

63 These five sectors all had average WRI* scores in excess of 1.1. Higher quality is defined here by reference to this WRI* measure. Nuvolari and Tartari, 'Value of English patents', p.109

64 That 'British' patents do have a higher average quality, as measured by WRI*, is established in table 6.3.

The patents were classified by sector using Nuvolari's classifications from his 2011 article.[65] In the article he categorised all English patents into twenty-one industrial sectors. The exercise excludes patents sealed after 1841, because Nuvolari's classifications are unavailable, as well as those inventions that were only patented in Scotland and/or Ireland. Table 6.2 presents sectoral concentration statistics for the four patent populations (England, Scotland, Ireland and 'Britain'). The first row for each population gives the total number of patents awarded in each sector between 1800-41. The second row gives the percentage of all patents accounted for by that sector. The third row gives the concentration statistic for each sector, the fraction of patents in that sector squared. At the bottom of the third row is the sum of the concentration statistics, the Herfindahl Index. Finally, below this, is a figure showing 1 divided by the Herfindahl Index. This equates to the number of sectors there would need to be for there to be an equal distribution between them, as denoted by the Herfindahl Index. So if there were an equal distribution between the twenty-one sectors, the Herfindahl Index would be 0.0476 (1/21). This figure represents a measure of how sectorally concentrated the patent population was, with a higher value denoting a more equal distribution.

65 Nuvolari and Tartari, 'Value of English patents', p.112

Table 6.2 Sectoral Concentration of British patents, 1750-1841

	England	%.of English patents	Concentration	Ireland	%.of Irish patents	Concentration	Britain	%.British patents	Concentration	Scotland	%.of Scottish patents	Concentration
Agriculture	264	3.09%	0.00095	15	1.70%	0.00029	13	1.72%	0.00029	30	1.55%	0.00024
Carriages	481	5.62%	0.00316	31	3.51%	0.00124	21	2.77%	0.00077	70	3.62%	0.00131
Chemicals	705	8.24%	0.00679	136	15.42%	0.02378	117	15.46%	0.02389	243	12.57%	0.01580
Clothing	181	2.12%	0.00045	13	1.47%	0.00022	11	1.45%	0.00021	31	1.60%	0.00026
Construction	376	4.40%	0.00193	31	3.51%	0.00124	22	2.91%	0.00084	47	2.43%	0.00059
Engines	1095	12.80%	0.01639	104	11.79%	0.01390	88	11.62%	0.01351	288	14.90%	0.02220
Food	455	5.32%	0.00283	75	8.50%	0.00723	66	8.72%	0.00760	122	6.31%	0.00398
Furniture	460	5.38%	0.00289	21	2.38%	0.00057	18	2.38%	0.00057	38	1.97%	0.00039
Glass	72	0.84%	0.00007	9	1.02%	0.00010	8	1.06%	0.00011	18	0.93%	0.00009
Hardware	602	7.04%	0.00495	37	4.20%	0.00176	28	3.70%	0.00137	73	3.78%	0.00143
Instruments	391	4.57%	0.00209	21	2.38%	0.00057	17	2.25%	0.00050	37	1.91%	0.00037
Leather	151	1.77%	0.00031	18	2.04%	0.00042	16	2.11%	0.00045	35	1.81%	0.00033
Manufacturing	433	5.06%	0.00256	48	5.44%	0.00296	39	5.15%	0.00265	94	4.86%	0.00236
Medicines	221	2.58%	0.00067	6	0.68%	0.00005	5	0.66%	0.00004	12	0.62%	0.00004
Metallurgy	410	4.79%	0.00230	46	5.22%	0.00272	42	5.55%	0.00308	119	6.16%	0.00379
Military	205	2.40%	0.00057	9	1.02%	0.00010	8	1.06%	0.00011	21	1.09%	0.00012
Mining	49	0.57%	0.00003	4	0.45%	0.00002	1	0.13%	0.00000	7	0.36%	0.00001
Paper	322	3.76%	0.00142	38	4.31%	0.00186	36	4.76%	0.00226	102	5.28%	0.00278
Pottery	145	1.70%	0.00029	8	0.91%	0.00008	7	0.92%	0.00009	23	1.19%	0.00014
Ships	432	5.05%	0.00255	51	5.78%	0.00334	44	5.81%	0.00338	116	6.00%	0.00360
Textiles	1104	12.91%	0.01666	161	18.25%	0.03332	150	19.82%	0.03926	407	21.06%	0.04433
	8554	100%	0.06987	882	100%	0.09576	757	100%	0.10100	1933	100%	0.10416
Herfindahl Index			14.313			10.443			9.9010			9.600

These results indicate that sectors with higher average quality inventions were more likely to have patent protection extended to Scotland and/or Ireland. Of Nuvolari's five high quality sectors, highlighted with a yellow background, four had higher concentrations in the British population than in England (the exception being construction). Despite this trend towards greater concentration in the high value sectors, the population of Scottish patents have a higher Herfindhal index score (0.104 or 9.6 sector equivalent) than the more restricted, higher quality, population of 'British patents' (0.101 or 9.9). This means that even when accounting for the tendency of smaller (higher quality) populations to have a higher sectoral concentration, Scotland has a higher concentration than either England or Ireland.

In which sectors were Scottish patents concentrated? The fore-going discussion has suggested that Scottish patents would be predominately found in heavy 'revolutionised' industry. For comparison Crafts' definition of revolutionised industry, referred to earlier, is adopted. Crafts' figures for employment in 'revolutionised industry' in 1841, used Clive Lee's employment categories, of chemicals, metal manufacture, engineering, vehicles, textiles and transport.[66] Although the sectoral classification used by Lee (and Crafts) differs from that used to classify these patents, here the revolutionised industries are taken as chemicals, metallurgy, engines, textiles and ships. These sectors are highlighted with a blue border. It can be seen that in Scotland four of these five sectors (engines, metallurgy, ships and textiles), accounted for a higher proportion of patents than in the three other populations. Similarly, the fifth sector (chemicals) accounted for a higher share of patents in Scotland than in England. The combined share of these 'revolutionary' patents was 43.8 percent in England, compared to 60.7 percent in Scotland (and 56.5 percent in Ireland).

This section began by outlining some of the problems and ambiguities involved with interpreting patent numbers. It was argued, however, that because the large majority of patented inventions in Scotland and Ireland originated from England, their patent series could be plausibly interpreted as denoting the market for new inventions. An analysis of the Irish and Scottish patent indices, at the aggregate and sectoral level, was shown to tally with their respective industrial performances, implying that inventors were responsive to economic and commercial opportunities. This contention will be explored in the final section.

Section 6.4
Patents and the incentive to invent

The results in the previous section indicate that inventors made informed decisions on the commercial value of extending patent protection to Scotland and/or Ireland. More generally this would indicate that inventors were responsive to market signals in their activities. Tom Nicholas, using patent renewal and historical citations data, makes a similar case regarding British invention between 1880 and 1930, arguing that inventors 'were responding to expected profits' in their inventive activity.[67] Although the British economy (and patent system) was more developed at this later point it did share some important characteristics with

66 Crafts, *British economic growth*, p.5
67 Tom Nicholas, 'Independent invention during the rise of the corporate economy in Britain and Japan', *Economic History Review*, 64, (2011), p.1015

the period under consideration here. In particular, invention was dominated by independent inventors and there was a developed market in assigning and licensing patent rights.

It was established in section 6.1 that the costs of patent protection increased with the number of countries in which it was acquired. The cost of a patent for England was £145, for England and Scotland, £235 and all three countries, £380. In addition, because there may be more infringements to police and possibly prosecute the costs of enforcing a patent also increase with geographical scope. Because of these additional costs, if patentees were responsive to market forces, it would be expected that those inventions of a lower prospective value would not be extended to Scotland and/or Ireland.

We can test for this using Alessandro Nuvolari's WRI* (Woodcroft Reference Index) indicator of patent quality, which was also adapted in section 5.2. Briefly, Nuvolari used the number of references listed in Woodcroft's *Reference Index* as an indicator of the technical quality of the patent. Because the average number of references received by patents varied over time, Nuvolari adjusted for the period in which the patent was granted, producing a time-adjusted WRI* indicator. Nuvolari tested the reliability of the WRI* indicator by comparing the quality of four populations of 'important patents', as defined elsewhere in the historiography, with the full population of patents. This was done by employing the Fligner-Policello test, a non-parametric test of stochastic equality.[68] The test reveals the probability that a random patent selected from the population of 'important patents' will have a higher quality, as denoted by WRI*, than a random patent selected from the rest of the sample. Nuvolari found that in all cases relating to the four populations of important patents, the hypothesis of stochastic equality could be rejected at the significance level of 1 percent.[69] This means that the WRI* indicator may be regarded as a robust indicator of the technical quality of an invention.

It should be stressed that WRI* should be regarded as an indicator of technical quality, not commercial value. The two are not synonymous. There is no denying the technical ingenuity of Babbage's (unfinished) mechanical computing machines but it is unlikely they would have proved commercially viable. On the basis, however, of Nuvolari's own testing of the reliability of the WRI* measure (and the higher propensity for patents with high WRI (law) scores to be litigated, shown in section 5.3) it is reasonable to suppose that technical quality (as measured by WRI*) and commercial value were closely linked.

Nuvolari allotted all English patents awarded between 1700 and 1841 a WRI* score. Because Scottish and Irish matches had already been established with English patents, it was possible to measure and compare the WRI* score of three different populations. The first was the population of patents where protection was only obtained in England ('popE'). The second was the population of English patents where protection was extended to Scotland ('popES') and the third where protection was extended to Scotland and Ireland ('popESI'). As in Nuvolari's paper, the Fligner-Policello test was employed to test the hypothesis of stochastic parity in the quality of patents between the three populations. Three comparisons were made. Firstly, between popE and popES, secondly, between popE and popESI and finally between popES and

68 Nuvolari and Tartari, 'Value of English patents', p.105
69 Ibid

popESI. To check for the robustness of the results the Mann-Whitney statistic, a similar test for assessing the medians between two samples, was also calculated.

Table 6.3 British patent quality, 1750-1841

	Number	Median WRI*	Mean WRI*
England (popE)	6496	0.7978	0.9403
England & Scotland (popES)	1933	1.0912	1.1694
England, Scotland & Ireland (popESI)	757	1.0912	1.2809
Fligner Policello statistic		**Significance**	
popE v popES	7.600	***	
popE v popESI	6.611	***	
popES v popESI	1.271	0.1019	
Mann-Whitney Statistic			
popE v popES	-7.411	***	
popE v popESI	-6.494	***	
popES v popESI	-1.921	0.0548	

The first part of the table states the basic statistics for the three populations. As expected English patents have a lower mean and median WRI* than both popES and popESI. Similarly, popESI has a higher mean WRI* than popES, although it has the same median WRI*. The second part of the table shows the Fligner-Policello statistic for the three comparisons This indicates that the hypothesis of parity of quality between popE and popES can be rejected at a significance level of 1 percent - i.e. that there is a significant probability that a patent randomly chosen from popES will have a higher WRI* score than a patent from popE. Similarly, the hypothesis of parity of quality between popE and popESI can also be rejected at a significance level of 1 percent. In the comparison between popES and popESI, although it appears that there is a greater chance a patent randomly chosen from popESI will have a larger WRI* score than a patent from popES, the result is not significant. The robustness of these results is confirmed by the Mann-Whitney test in the third part of the table.

Section 6.3 analysed the patent indices of Scotland and Ireland. It argued that inventors were responding to economic and commercial opportunities. This section tested this proposition by comparing the quality of patents that were extended to Scotland and Ireland with those that were not. Because inventors appraised the commercial and economic value of their activities it was found that patents extended in this manner tended to be of a higher quality than those that were not.

The previous chapter discussed the returns that could be made from patenting inventions, specifically from licensing and assignment. It was argued, however, that for these returns to act as an inducement to invention, then inventors would have to be responsive to such economic stimuli. The mental calculus involved with setting out on an invention 'project', and subsequently extending patent protection on that invention, are not identical, but they are analogous. The latter probably involved a more explicit reckoning of the costs of protection compared with the potential returns. Such a calculation though was based on both the

'quality' of the invention and the projected demand for it. These were also important considerations in the decisions involved with invention and patenting. Qualitative evidence confirms the view that not only were inventors often 'economic' men but that the inducement offered by patent protection was an important one. In 1774 William Kenrick wrote, 'the most plausible and politic method of bestowing that encouragement is…by vesting a legal right or property in the inventor or by the grant of letters patent from the crown'.[70] Later in 1829, the engineer John Farey told the Select Committee, 'that many great inventions would never have been brought to bear as they have been, but for the encouragement offered by a patent'.[71] Farey might be accused of self-interest in these comments, but even if this were so, it still demonstrates how an inventor perceived the maintenance of the patent system as serving his interests. Perhaps however, it is more interesting to see how patent abolitionists perceived things. Robert MacFie, a sugar refiner, bemoaned, 'the patent laws are injurious in this respect, that they substitute a desire for money in the place of the more legitimate desire for doing good and earning a laudable distinction; they make every discovery a matter of money-value'.[72]

Conclusion

This is the first analysis of patenting in Scotland and Ireland during the industrial revolution. Section 6.1 outlined the administrative and legal characteristics of the two patent administrations. It established that there were close similarities in the administration of patents in England, Scotland and Ireland. Although patents were expensive to obtain for an inventor who hired an agent to act on his behalf (as the majority did) the petition would have been a relatively simple process. Section 6.1 also established that there were close similarities in the law of patents.

Because the law and administration of patents were similar in the three countries, statistical comparisons between the three patent series was possible. The direct comparability of individual patents between the three countries was confirmed by the matching process in section 6.2 that found 96 percent of Scottish and Irish patents had a direct English equivalent. There are two reasons why the Scottish and Irish patent series offer a relatively 'clean' source for studying the relationship between technology, economic development and the market. Firstly, because the majority of patents obtained in these countries were not the result of domestic inventive activities, but were originally from England, we can be reasonably sure that changes in patenting in these countries were (largely) the result of changes in the economic opportunity for new technology. Secondly, because there was little institutional disparity, relative changes in the Scottish and Irish patent series could be attributed to changes in the commercial opportunity for new inventions.

Section 6.3 analysed the growth and sectoral breakdown of patents in the three countries. It showed that there was rapid growth in Scottish patent numbers and that they were heavily concentrated in industrial sectors. In comparison, Irish patent numbers remained low, especially relative to the size of the population. These results indicate a close relationship between economic opportunity, patenting and technology.

70 William Kenrick, *An address to the artists and manufacturers of Great Britain*, (London, 1774), p.20
71 *Select Committee on law relative to patents*, (Parl. Papers, 1829), p.140
72 *Select Committee of the House of Lords,* (Parl. Papers, 1851), p.154

The work of Nicholas had demonstrated the importance of this relationship for a later period, albeit one with a similar economic pattern of invention. The final section examined this relationship further by comparing the quality of patents in three different populations, patents obtained in England alone, patents obtained in England & Scotland, and patents obtained in England, Scotland & Ireland. The exercise established that inventions where patent protection was extended to Scotland and/or Ireland tended to be of a higher quality than those where protected was only secured in England. This demonstrated the sensitivity of inventors to economic opportunities, supporting Bob Allen's supposition that inventors and inventive activity were responsive to these economic stimuli.

Conclusion

The thesis has examined the British patent system as a potential contributory factor in technological and economic development during the industrial revolution. The introduction discussed how the role of patenting during this period has been variously interpreted. In general, economic historians who have favoured 'demand side' explanations for the development of technology, (notably Bob Allen and Stephen Broadberry), have argued that patents, by protecting the intellectual property of inventors, increased the rate of return to inventive activities. This same argument was espoused with greater emphasis by Douglass North. Consequently, there was greater investment of time and money in inventive activities than would have been the case without a patent system. Economic historians who have favoured 'supply side' explanations have preferred instead to emphasise the circulation and assimilation of new ideas and ways of thinking as the progenitor of industrialisation. In the case of Deirdre McCloskey this is to the exclusion of conventional, incentive based, causes although Joel Mokyr has adopted a more balanced interpretation. Accordingly, they have concentrated more on the institutional failings of the patent system and have allotted it a more marginal (or non-existent) causative role in the British industrial revolution.

It is the latter group for whom empirical research on the patent system has offered greater succour. Both Harold Dutton and Christine MacLeod argue that throughout the period, patents were, for many inventors, prohibitively difficult and expensive to obtain. For those who did acquire a patent, the protection it offered was often illusory. Without a relevant corpus of law, and in the face of endemic hostility, patents were rarely enforceable until judicial attitudes began to meliorate after 1830. Curiously, they differ on the implications of these institutional defects. Dutton argues that as long as they offered a degree of protection in excess of the next best alternative (normally secret working), patents continued to encourage the development of technology. Indeed, by providing for diffusion through the back-door of piracy and infringement, these defects may have abetted the diffusion of technology.

MacLeod dismisses Dutton's arguments as 'panglossian'.[1] Rather, she argues that secret working was widely practised both as an alternative to patenting and in conjunction with it. Before 1830, this even occurred in sectors where it was difficult or costly to keep commercialised technology secret. After 1830, when judicial hostility declined and patent law began to develop, matters did improve. But the insecurity of patents was not entirely resolved until reform in 1852 and even then, for many, the habits of secrecy had become 'ingrained'.[2] That secret working was widely preferred implies that patents did little to incentivise the development of technology. Neither did patents facilitate the diffusion of technology. Although inventors were obliged to enter detailed descriptions of their patented inventions from the 1730s, they were not always reliable. Further, because specifications were rarely published, or available for consultation in Chancery,

1 Christine MacLeod, 'The paradoxes of patenting: Invention and its diffusion in eighteenth and nineteenth-century Britain, France and North America', *Technology and Culture*, 32, (1991), p.906

2 Christine MacLeod, 'Strategies for innovation: The diffusion of new technology in nineteenth-century British industry', *Economic History Review*, 45, (1992), p.304

MacLeod argues that secret working within the patent system was practicable, frustrating technological diffusion further.

The first two research chapters of the thesis reassessed the institutional aspects of patenting. Together they argued for a more balanced and positive appraisal of the patent system. The second chapter discussed the administration of patents and the petition procedure for obtaining a patent. It found that prior to c.1770 patents were often difficult to obtain. The expenses, the uncertainties, and the personal attendance required for the petition would have proved insuperable for many inventors, and served to keep patent numbers low. However, with the appearance of agents, and an associated milieu of technical advisers from the 1770s, inventors no longer had to conduct the petition personally. Relieved of these travails, especially the inconvenience of an extended stay in London, the patent became much easier to obtain. The significance of this development has been hitherto understated, and mis-dated to the beginning of the nineteenth-century.

There was also a (limited) logic to the petition, with its convoluted procedure and attendant costs. While inventors were reluctant to submit their petitions to a board of examination, there was a general preference, at least until 1829, for caveats and fees to be maintained as a guard against fraudulent and illegal patents. The role of caveats in particular has been understated. The petition has been characterised as one purely of registration, when in fact caveat opposition introduced an element of examination, consolidating the legal cachet of the eventual grant.

The third chapter detailed the development of patent law, which the historiography structures into three periods. The first, between 1700-53, was when the Privy Council retained primary jurisdiction of patent disputes. The Council did not follow precedent, and so there was no opportunity for a corpus of patent law to accumulate beyond the strictures of the Statute of Monopolies,. The second period began when the jurisdiction of patent disputes passed to the common and equity law courts in 1753, and lasted until 1830. In this second period the development of patent law was obstructed by a hostile judiciary. Only when this hostility began to disappear after 1830, was there a formation of patent law sufficient for patentees to enjoy a reasonable degree of legal security.

The chapter revised the first two components of this chronology. Firstly, it found that the jurisdiction of the Privy Council had been declining before the end of the seventeenth-century. After 1670, there is not a single instance of a patentee enforcing their rights in the Council. Instead patentees sought injunctive relief in the equitable jurisdiction of Chancery. By compelling competitors to refrain from infringing their patent (or be found in contempt of court), injunctions provided patentees an effective means of maintaining their rights. This was not only the case in the first half of the eighteenth-century, but throughout the period. Secondly, the patent was not perceived with hostility by the judiciary. Rather, the patent was settled on secure legal foundations; conceived as a contract between the inventor and the public. Although this contractual conceptualisation of the patent was only fully elucidated at the bench in the 1780s, its jurisprudential antecedents stretched back to when the specification had become a mandatory requirement in the 1730s. Most importantly, the accuracy of the specification was an important consideration in law as soon as it was introduced (viz. *Hamblin's Case*, 1731). Accordingly, considerations of the 'public good' and 'utility' in the

granting and litigation of patents had disappeared by the 1750s. This in turn meant that there was a more thorough elucidation of patent law before 1830 than previously thought.

There were, however, facets of the legal system that did undermine the rights of patentees. In particular, the lack of statutory law did, despite the efforts of the judiciary, occasionally preclude the equitable decision. Similarly, the strictness with which the specification was assessed before the second quarter of the nineteenth-century, often proved troublesome for inventors seeking to enforce their patent. This, however, was consistent with the contractual logic of the patent grant, and cannot be attributed to any judicial bias. On balance, the ready access to injunctive relief, the sequential development of legal precedent, and ultimately the certain jurisprudential foundations of the patent grant, all served to consolidate its security and enforceability.

Although there were no major statutory reforms to the patent system prior to 1852, these chapters demonstrated that there were important improvements to the accessibility and efficacy of patent protection. In 1700, it was difficult for an inventor to navigate the protracted, expensive and politicised petition procedure. Further, once obtained, the patent could still be challenged in the Privy Council where cases hinged upon fluid considerations of the public interest and utility. Consequently, few inventors bothered to acquire patents, and it is unlikely that the existence of the patent system did much to encourage inventive activity at the turn of the eighteenth-century.

With the introduction of the specification in the 1710s, and especially from when it became a mandatory requirement in the 1730s, matters began to improve. Firstly, the specification displaced the 'public good' as the consideration on which the patent was awarded, depoliticising the petition, and removing it as grounds on which to vitiate a patent. The papers of Charles Yorke show that this had happened by the mid-1750s. Secondly, by providing a definitive legal statement of what had been patented, the specification helped patentees enforce their rights in Chancery. Thirdly, it ensured that patents came to be established on a stable and 'modern' legal footing; adjudicated by a more consistent (albeit strict) set of criteria. However, the practicalities of obtaining patent protection remained onerous until the 1770s when specialised patent agents began practising. By making the patent significantly easier to obtain, agents contributed to the increase in patenting.

With the growth in patenting, especially from the third quarter of the eighteenth-century, the system continued to evolve. In particular, with an increase in patent cases there was a continued elaboration and elucidation of patent law. Critically, this began long before 1830. Similarly, it became commercially viable for agents to offer a wider range of services for clients. For example by maintaining contacts with manufacturers and capitalists, they helped inventors obtain funding and partners to commercialise their inventions. Consequently, the growth in patenting was partly self-sustaining.

The improvements to the patent system isolated by MacLeod and Dutton occurred largely after 1830. This falls at the very end of the 'classical' industrial revolution. Consequently, MacLeod and Dutton provide little empirical support for those, such as North and Allen, who have argued that the patent system encouraged inventive activity *during* the industrial revolution. The argument here is very different. Before

1760, the beginning of the industrial revolution, the specification had yielded important improvements to the patent system. Soon after, the appearance of patent agents made patent protection much easier to obtain. The system's continued development, in particular the accumulation of patent law, provided patentees greater surety in the efficacy of their patent protection. The patent system was by no means perfect, high fees in particular limited access to its provisions. However, this analysis resurrects the possibility that the patent system, by providing access to effective protection, did encourage the development and diffusion of technology during the industrial revolution. The last three chapters explored this possibility in detail.

The fourth chapter examined the role of patents and the specification in the diffusion of technology. Concerning the preparation of specifications, the chapter confirmed the analysis of MacLeod for the period before the 1760s. When it was in their interests, patentees did enter intentionally obfuscatory specifications. However, although the specification was strictly interpreted before c.1825, chapter 3 showed that patentees had a much better chance of success in court than previously supposed. Accordingly, for an inventor seeking an enforceable patent there was no reason to enter a misleading description. Rather, the specification requirement acted as it was intended, obliging inventors to enter an accurate and diligently prepared specification.

The chapter also established that the provisions for consulting specifications in Chancery were much better than has been previously argued. Indeed, by the 1790s many were concerned that specifications were *too* readily available, especially for foreigners. It was only later in the Victorian period that the provisions in these offices were regarded as insufficient. As well as being available via Chancery, the chapter also found that with the publication of the *Repertory of Arts* beginning in 1794, specifications were often published and widely distributed. From 1820, virtually all specifications were printed in one form or another. Although the quality of these reproductions varied, some publications (notably the *Repertory*), often printed specifications in full. The one factor that did impede the diffusion of technology by patents were the high fees charged to obtain them. This dissuaded inventors from acquiring patent protection, and so from depositing specifications of their inventions. Although the quality and technological significance of these 'additional' patents after 1852 (when the fees were reduced) was generally modest, in technological sectors where the propensity to patent was low prior to reform, such as chemicals, it is likely that some high quality inventions were not patented and so specified.

The availability of specifications had two important consequences. Firstly, if an inventor sought an enforceable patent, it was impossible to supplement it with secret working after the specification requirement was enforced from the 1730s. If the inventor entered a misleading specification they would be exposed and contemporaries were confident this was rarely attempted. Secondly, with the publication of the *Repertory* in 1794, patent specifications came to constitute a unique corpus of widely diffused, reliable, and up to date technical information. The importance of patent specifications as a source of instruction is evident from the wide variety of books, journals and magazines that printed them, the circulation of this literature, and their distribution in libraries and reading rooms. The patent system then did much to facilitate the codification and diffusion of the latest technology during the industrial revolution.

The fifth chapter examined the market in patent rights. An analysis of this market provides an entrée into the returns that inventors could appropriate, the availability of capital to work new inventions, and the ways in which new technology was physically disseminated and developed. Also, because it was often difficult to transfer secrets (although this depended on the technological sector to which they related), by analysing the market in patent rights it is possible to differentiate between the advantages of patenting vis-à-vis secret working.

The chapter argued that the assignment and licensing of patent rights was relatively straightforward. There were no significant legal restrictions imposed on these transfers, and this allowed inventors and other parties to tailor their agreements in accordance with the nature of the technology and their business requirements. Consequently, for when the available material allows (from 1770 onwards), assignments, and to a lesser extent licensing, were shown to be common. Before that date quantitative work is not possible, but there is no indication that the assignment or licensing of patent rights was exceptional.

The regular assignment and licensing of patents facilitated the physical dissemination of technology. In theory, it should also facilitate the sequential development of technology. When patented technology is improved upon, subsequent improvements cannot be implemented without the licence of the patent holder of the original invention. Whenever licences are unlikely to be acquired, the incentive for other parties to improve on patented technology will be diminished for the duration of the original patent. Some of the empirical evidence, however, suggests that patents were used to stifle the development of technology. For instance, James Watt obstructed the development of steam engineering during the last ten years of his patent term. He achieved this through a judicious mix of legal action, *threatened* legal action, and market power. Consequently, he was able to extract royalties from those who used more sophisticated, fuel efficient engines, such as Hornblower junior's. Also Watt never licensed other engine manufacturers. However, some of the circumstances concerning Watt's patent were exceptional. Later, in the first half of the nineteenth-century, it was reportedly unusual for an inventor to refuse a licence to anyone who requested one. Also, Watt may have been fortunate in successfully enforcing a 'broad' definition of his patent – both the Electric Telegraph Company and Henry Fox Talbot failed to do so in the mid-nineteenth century, by which time the law had begun to privilege the rights of patentees vis-à-vis the public.

It was also argued that some inventors were able to appropriate substantial returns from selling and licensing their patents. Large scale enterprises such as Boulton and Watt and the Electric Telegraph Company became very profitable enterprises from their astute management of patent property. However, more modest endeavours, such as Morgan's patent for tinning iron plates, were also able to secure returns from selling and licensing patent rights. It is difficult to envisage how these returns could have been achieved with secret working. The profitable working of a patent also depended on the availability of capital. In a study of joint-stock companies working patents it was argued that many of these ventures were able to secure substantial amounts of paid-up capital to commercialise patented technology. Because joint-stock offered important advantages in raising capital, specifically the provision of free transferability of shares, it is difficult to extrapolate these results to other business forms (and to earlier periods of the industrial revolution).

However, a study of their shareholder books indicate that these companies were not working quantities of capital that would have beyond the means of larger partnerships. Also, when compared with other joint-stock enterprises, companies working patents were much more successful in attracting capital subscriptions.

The final chapter examined the Irish and Scottish patent systems and their patent indices. This is the first analysis of patenting during the industrial revolution in either country. An analysis of the indices established a pattern of rapid growth in Scottish patents, and relative stagnation in Ireland. This suggested that in Scotland and Ireland there was a close relationship between the level of industrial development, changes in the commercial opportunity of intellectual property and resultant growth in patent numbers. This hypothesis, however, assumes that patentees were responding to the market opportunity of new technology. Section 6.4 tested this assumption by comparing the relative quality of inventions for which protection was only obtained in England with those that had had protection extended to Scotland and/or Ireland. The test demonstrated that the more valuable the invention, the more likely the patent was to be extended, supporting the assumption that inventors were responsive to the relative market opportunity of different inventions. Contemporary comments also make clear that not only were inventors often 'economic' men but that the inducement offered by patent protection was an important one.

The first two research chapters argued that from c.1770, adequate patent protection was available to inventors in England. This makes it plausible to propose that the patent system actively encouraged inventive activity during the industrial revolution. This possibility was explored in the final three chapters. The fourth chapter outlined the role of patenting in promoting the diffusion of technology. It demonstrated the important role of patents in encouraging the circulation of new techniques and useful knowledge after 1794. Joel Mokyr has emphasised the importance of the circulation of useful knowledge in sustaining technological change during the industrial revolution, coining the phrase 'Industrial Enlightenment'.[3] With their wide distribution, and the quality of technical information they provided (in the form of specifications), these publications formed an important component in the circulation of technical knowledge in the first half of the nineteenth-century. More research, however, is required on the publication of specifications during the eighteenth-century, a period that Mokyr emphasises as particularly important for the Industrial Enlightenment. It is unlikely that patent specifications made a contribution during the first half of the century, there simply were not that many, and most were of a poor quality. It is possible, however, that patent specifications began to contribute to the circulation of technical information in the second half of the eighteenth-century, as the numbers entered increased, and their quality improved.

Both Broadberry and Allen emphasise how the development of technology was shaped by the structure of the English economy.[4] In particular, both argue that high wages led to the adoption of more capital-intensive methods of production. The assumption that inventors and manufacturers were responding to these market signals was supported with empirical evidence in the last chapter. Within their analyses of the

3 Joel Mokyr, *The enlightened economy: An Economic History of Britain, 1700-1850*, (London, 2009), p. 40

4 Robert Allen, *The British Industrial Revolution in global perspective*, (Oxford, 2009). Stephen Broadberry and Bishnupriya Gupta, 'Lancashire, India, and shifting competitive advantage in cotton textiles, 1700-1850: The neglected role of factor prices', *Economic History Review*, 62, (2009)

development of industrial technology, Broadberry and Allen also suggest that patenting formed an important component in the incentives to invent. Previously, there was not the empirical evidence to support this. Patent protection was supposedly difficult to obtain, and the security it provided illusory. Now, at least from c.1770, there is. Patent agents improved the accessibility of patent protection enormously, while the law courts had adopted a universally accepted rationale for the patent grant. The fifth chapter showed how the transferability of patent rights allowed inventors to commercialise their inventions in more efficient and profitable ways than if they had been obliged to work their inventions alone. The empirical evidence in the final chapter demonstrates the supposition that the profits to be accrued from patenting inventions encouraged the development of technology during the industrial revolution.

How significant was this encouragement? The positive argument should be hedged with three important caveats. Firstly, there are clear limits to the role of patenting. The provision of effective patent protection would not alter whether an invention was *socially* efficient to develop i.e. it does not influence the 'background' institutional and economic conditions that determine whether an invention would ever have been commercially feasible. Rather, it reduces the threshold at which it becomes *privately* efficient to develop. Secondly, the economic and technological impact of patenting was not universally beneficial. Despite widespread licensing, there is evidence to suggest that the exclusionary nature of the patent did obstruct sequential technological development.

Thirdly, patenting was not the means of protection available, it was also possible to work technology in secret. There are, however, two major limitations with secret working. Firstly, it was often difficult to exchange technology that was protected by secrecy in the way that patented technology could be. Secondly, it imposes severe constraints on production. The larger the scale of production, the more likely it is that the technology will be exposed. Consequently, secret working appears to have been preferred in technological sectors where commercially viable production runs could be small, such as chemicals and medicines. Conversely, the work of Moser shows that patenting was widely used in sectors where the commercial working of technology was incompatible with secrecy, such as steam engineering and manufacturing machinery – sectors that coincidentally where central to the industrial revolution. In these sectors, where protection could not be achieved with secret working, the provision of patent rights was essential for ensuring that it was privately efficient to develop technology.

More research is needed on the alternative strategies available for the appropriation of returns from inventive activity before the positive case proposed here can be fully tested. In particular, more research is required on the commercial and technological factors that meant some inventions were worked in secret, while others were patented. In particular, a case study on an industrial sector where patenting and trade secrecy were both commonly employed could isolate the distinguishing characteristics of technology that was subject to either regime of protection. Nevertheless, the patent system made a signal contribution to technological development during the industrial revolution. The protection it provided, and the profits this proffered, was integral to encouraging inventive activities, especially in technological sectors without alternative means of protecting commercialised technology.

Glossary

Affidavit	A written statement, verified by oath or affirmation, submitted as evidence for judicial proceedings. If the statements in an affidavit are found to be false, the author could be prosecuted for perjury.
Assignment	An assignment was when the patentee sold the patent, either in its entirety, or a portion of it. When the patent was assigned in its entirety, the original patentee surrendered all legal interest. Partial assignments were normally made as part of an agreement to work the patent in partnership.
Caveat	A form that could be submitted at various offices concerned with the administration of patents in England, Scotland and Ireland, although caveats were normally entered with the law officers. The form was essentially a declaration of interest in a particular technological sector. If a petition for a patent relating to that sector passed through the office, the caveat holder was informed about the petition. Upon notice being received, the holder could then decide to oppose the petition if they felt it conflicted with one of their own inventions.
Court of Chancery	The Court of Chancery was primarily responsible for the administration of the law of equity. The chief judge was the Lord Chancellor who until 1813 heard all cases in the court. In 1813 he was joined by a Vice-Chancellor and another two in 1841. There was also a Scottish and Irish Court of Chancery (where specifications to Scottish and Irish patents were deposited).
Court of Common Pleas	One of the three senior courts adjudicating English common law, the other two being the Court of Exchequer and the Court of King's Bench. The three courts had rough parity of jurisdiction and all heard patent cases. The chief judge was the Chief Justice of the Common Pleas, who was joined by three puisne Justices of the Common Pleas. There was also an Irish Court of Common Pleas.
Enrolment Office	One of the three offices in (English) Chancery where a specification could be deposited.
Estoppel	The legal principle whereby in an agreement made by deed both sides verified the pertinent facts on which the deed was founded. In so doing neither side can subsequently deny the veracity of these facts.
Court of Exchequer	One of the three senior courts adjudicating English common law, the other two being the Court of Common Pleas and the Court of King's Bench. The three courts had rough parity of jurisdiction and all heard patent cases. The chief judge was the Chief Baron of the Exchequer, who was joined by three puisne Barons of the Exchequer. There was also an Irish Court of Exchequer.
Injunction	A court order, obtainable on application from the Court of Chancery, compelling a party to refrain from a particular act. They were often obtained by patentees to stop the infringement of their patent.
Joint-stock company	A company where shares of ownership were freely transferable. Before 1856, however, investors in these companies still carried unlimited liability for the financial obligations of the company.
Court of King's Bench	One of the three senior courts adjudicating English common law, the other two being the Court of Exchequer and the Court of Common Pleas. The three courts had rough parity of jurisdiction and all heard patent cases. The chief judge was the Chief Justice of the King's Bench, who was joined by three puisne Justices of the King's Bench. There was also an Irish Court of King's Bench.
Law Officers	The chief legal advisers to the government. They were supposed to examine every patent petition and decide whether the patent should be awarded, although by the mid-

	eighteenth century this only happened in the event of caveat opposition. In England there were two officers, the senior Attorney-General and the junior Solicitor-General. In Ireland there was also an Attorney-General and Solicitor-General. In Scotland there was one law officer, the Lord Advocate.
Licence	A licence constituted an agreement by the patentee to waive the right of exclusivity to the invention in return for a royalty or some other form of consideration.
Patent Bill Office	The office in Chancery where the Patent Bill was drawn up. This document contained the exact wording of the sealed patent.
Petty Bag Office	One of the three offices in (English) Chancery where a specification could be deposited.
Privy Council	Once the primary executive body in English government, by the eighteenth-century the Privy Council acted primarily as an advisory body to the monarch. In the first half of the eighteenth-century it retained a limited jurisdiction over patent law. Later in 1835 its Judicial Committee was given responsibility for patent extension and patent confirmation cases
Privy Seal Office	The office was primarily concerned with the passing of patents of all kinds (for example, patents of appointment to a government position) as well as patents for inventions. By the nineteenth-century, however, it served almost no practical purpose.
Rolls Chapel Office	One of the three offices in (English) Chancery where a specification could be deposited.
Scire facias	A writ applied for by a private party to one of the law officers for a case to be pursued, by the Crown, to annul a patent.
Stare decisis	The legal principle whereby judges adopt the precedent and reasoning established by decisions in superior courts. The direct English translation of the Latin is "let the decision stand".
Court of Session	The supreme common law court of Scotland. It was divided into the Outer House and the appellatory Inner House, which was itself divided into two divisions of equal authority.
Signet Office	The office was primarily concerned with the passing of patents of all kinds (for example, patents of appointment to a government position) as well as patents for inventions. By the nineteenth-century, however, it served almost no practical purpose and an 1849 parliamentary report recommended its abolishment.
Specification	The detailed description of the patented invention which, from the 1730s, had to be deposited at the court of Chancery after the patent had been sealed. The time limit varied, although it was normally a few months.

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