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Patents, industry control, and the rise of the giant American corporation

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Abstract

We examine how some early U.S. corporations used patents to control competition, thus creating monopoly or cartel positions, with super-normal profits. We thus highlight one economic rationale for the rise of the giant corporation, expanding the Chandlerian paradigm. Based on evidence from the House of Representatives' 1912 "Oldfield hearings" and three industry case studies, we demonstrate how patent pools and restrictive licensing of fundamental patents led to the stifling of innovation and to negative competition and welfare effects. Focusing on pooling and licensing agreements is particularly important, as these, unlike patents themselves, are not normally open to public scrutiny.

Key words: Intellectual Property Rights; patent pools; restrictive licensing; industry control; USA corporations; business history.

JEL: O31; O34; L41; L42; D22; D43.

Introduction

The importance of 'fundamental' patents is emphasized in the literatures on patent law and competition policy, which note the substantial market power, and potential monopoly implications, of such patents in the context of current new technologies, such as biotech, semiconductors and 3D printing (Barton, 1997; Kuotsan and Hanting, 2014). Patents are often regarded as "intellectual property". However, as Bessen and Meurer (2008, 4; 125-6) note, patent rights are, at best, a very imperfect form of property. Patents provide a right to exclude others from marketing an invention, without granting the holder an affirmative right to market it (given the possibility of infringing other patents). Moreover, patent litigation is uncertain, as the boundaries of patents are often not well-defined, due to problems such as questionable validity and fuzzy or unpredictable boundaries. Combined with the notoriously high cost of U.S. patent litigation, the patent law system can act as a disincentive to innovation and often redistributes patent property rights to the party with the deepest pockets, rather than the best legal case (Bessen and Meurer, 5-14).

This lack of clear, transparent, patents rights (in contrast to, for example, real property) provides scope for firms with problematic patent rights but substantial capital to win patent battles, by exhausting the financial resources of their opponents through actual, or threatened, litigation. As this paper shows, these problems were already plainly visible in the closing decades of the nineteenth century, enabling well-financed firms to assert fundamental patent rights that enabled them to dominate both their own industries and their downstream value chains.

The breadth or focus of patents, and the consequences for industry control, have attracted less scholarly attention than the length of patent rights. In Kitch's (1977) approach to patents as prospect system, the advantage for a firm holding a dominant patent is the coordinated development of an industry, as opposed to rivalrous uncoordinated development, which causes duplication and inefficient use of resources. However, Merges and Nelson (1990) dispute that

coordinated development is preferable to rivalrous development. They admit that the latter can cause 'waste', but also stress the lack of incentives for a single right-holder to develop an invention to its full potential. Most importantly, control of the technology by one inventor will preclude possible significant improvements by other inventors, thus leading to social costs. This argument is supported by historical cases that show how fundamental patents, and patent litigation, were used to gain dominant positions in the 'new' industries of the second industrial revolution (1860 to 1914) in the UK and the USA (Scott and Spadavecchia, 2019).

A further under-investigated facet of the control, if not monopoly, granted by patent rights is the practice of patent pooling, whereby a group of firms combine their patents. Examples can be found in contemporary industries, particularly those based on complex technologies (Kingston, 2001). Bessen and Meurer (2008, p.80) identify the 1850s as the decade that saw the first major efforts to control markets by patent pools and similar devices. Following extensive litigation in the sewing machine sector, the Sewing Machine Combination created the first U.S. patent pool, in 1856. At around the same time the Drapers Company embarked on a concerted strategy of amassing large numbers of patents to extend their monopoly for loom temples, a technique they later used for spinning spindles in the 1870s and automatic looms in the 1890s.

Patent pools can prevent and resolve patent wars, for example in the U.S. aircraft industry during World War I. However, the very same industry provides evidence that patent pooling hampered competition in R&D, providing grounds for the US Department of Justice to dissolve the pool in 1975 (Moser, 2013). Moreover, Contreras et al. (2018) have shown that voluntary pooling of patents achieved little co-ordination and synergies in green technologies.

This paper examines the importance of control over "broad" or "fundamental" patents, and patent pools, to the creation of monopoly power and the rise of giant corporations in a range of

mainly machinery-based sectors in late nineteenth and early twentieth century America. While the imperative for economies of scale and scope rapidly transformed many capital-thirsty industries into concentrated oligopolies, other sectors had lower minimum efficient scales and sought to control competition in their sectors via cartels. Chandler (1990, 72-5) notes the widespread use of trade associations to control prices and competition prior to the Sherman Antitrust Act – often followed by a holding company structure thereafter - which implies that scale economies were insufficient, on their own, to bring about rapid concentration. These included large numbers of firms making machinery (for factories, offices, and households), where technological change from manual to semi-manual and finally automatic, machinery was underpinned by patentable inventions. Our analysis thus expands on the Chandlerian framework and sheds light on one set of factors underpinning the rise of giant corporations, even in the absence of huge capital requirements or high minimum efficient scale – the factors typically used to explain America's first merger wave (Chandler, 1990; Tedlow, 1991; Cassis, 2007).

Such examples may explain why many contemporary or near contemporary academics and policy-makers were often much more equivocal regarding the *general* need for giant corporations to achieve minimum efficient scale in many sectors and doubted that the potential efficiency advantages of monopoly, or oligopoly, could outweigh their negative welfare impacts (Vaughan, 1930; Stevens, 1912). As late as 1965, Joe Bain argued, based on empirical analysis and previous studies, that plant-level scale economies were real, but were typically insufficient to justify high industry concentration (Bain 1965, p.60; Stigler, 1950). Moreover, in contrast to the well-known story of Ford and General Motors creating a mass, oligopolistic, market by price reductions, competing on price was not the typical strategy for U.S. product market leaders in machinery. In a range of sectors, including combined harvesters (International Harvester); sewing machines

(Singer); refrigerators (Frigidaire); radios (RCA) and vacuums (Hoover) the leading firm set prices somewhat higher than its competitors. Indeed, achieving patent control was often instrumental in price hikes, as, for example, in rubber tires (Vaughan, 1930).

Both academics and some industry insiders (such as T.K Quinn, a former Vice-President of General Electric) noted that barriers to entry, such as monopolising technology through patents or control of raw materials, were often integral to strategies of market control, enabling dominant firms to persistently earn abnormal profits (Bain, 1965; Quinn, 1973). Such barriers might increase competitors' unit costs at all points along the cost curve – through high royalty charges or excessive prices for controlled production inputs. Alternatively, they might deny competitors access to most of the cost curve, through maximum market share clauses in patent licenses, or removing price competition by setting minimum retail prices for licensees' outputs.

Such mechanisms were largely "invisible" to outsiders, as patent licenses, unlike the patents themselves, were not open to public scrutiny. This paper examines the importance of control over "broad" or "fundamental" patents, or patent pools, to the creation of monopoly power and the growth of giant corporations. Such control can restrict or block access to technologies that are essential to operation in the sector. We examine this using evidence from the House of Representatives' "Oldfield hearings" before the Committee on Patents (1912), together with three specific case-studies.

The next section provides a general analysis of the role of fundamental or broad patents as strategic assets, enabling the patent holder to achieve market domination by excluding, or controlling, competitors. This is followed by a review of the importance of patents in gaining market control in various sectors, based on evidence from the Oldfield Committee hearings. Three more detailed case-studies are then presented, to show how patent licensing could be used to

control such fundamental factors in market competition as price, market share, and even the licensee's ability to engage in product innovation for goods with a patented component. The final section draws conclusions regarding the importance of patent control to the rise of the corporation and the typical impacts of patent control on competition, innovation, and consumer welfare. We also make some tentative proposals regarding how the negative social welfare impacts of the patent system might be mitigated.

Patents as strategic assets

Patent pools/monopolies constituted one of several methods for excluding competitors, including war-like "unfair competition" tactics - such as "fighting brands," sabotage and other intimidation - as practiced by National Cash Register; Standard Oil; United States Steel - or control over a vital raw material (Stevens, 1912). A number of contemporary economists identified patents as important instruments for blocking competition and creating monopoly positions, especially after the 1890 Sherman Act outlawed other methods for achieving these goals. Patents blocked or highly restricted competition in a range of sectors, including motion pictures (Motion Picture Patents Company); tires (Rubber Tire Wheel Company); electric lighting and power (General Electric); enamel ware (Standard Sanitary Manufacturing Co.), washing machines; glass containers; and shoe machinery – among others (Vaughan, 1930).

The resource-based view argues that firms can only reap super-normal profits if they have superior resources which are isolated and protected from competitors (Knott et al., 2003). Patents are sometimes modelled as probabilistic "exclusion rights" – providing a legally (and, in some cases, technically) challengeable monopoly position (Scott Morton and Shapiro, 2014). Legal protection against diffusion, via patent protection, provides a relatively robust safeguard against

such dissipation in strong patent law regimes, such as the USA. Moreover, even relatively weak patent claims can still exclude competitors if the patent-holding firm has greater financial muscle, given the exorbitant costs of taking patent cases through a series of appeals. Patents thus constitute important strategic assets - resources and capabilities that are: difficult to trade and imitate; scarce; appropriable; and specialized (Amit and Shoemaker, 1993). These characteristics are especially strong for fundamental or `broad' patents, which are, by definition, inimitable. Moreover, where patents are cumulative, building on previous technology, through improvements, their strategic role can become dynamic – as holders of earlier patents can block improvement patents that build on their innovation and are thus in a stronger position to develop, or purchase, those improvement patents.

Such exclusion rights in turn reduce the risk, and increase the returns, on investments in complementary assets such as marketing capabilities; larger, more efficient, plants; regulatory knowledge; and investments in non-patentable process and/or product innovation. This would therefore encourage upstream and downstream integration into such complementary assets – as evidenced in the formative period of the U.S. corporation. Such assets become further sources of competitive advantage largely because of their original complementarities with the exclusion rights – which justifies higher investments in them compared to competitors (Stiglitz and Heine, 2007).

While economics and business journals were relatively silent regarding the use of patent licenses to restrict competition and its anti-trust implications during the formative era of the modern corporation, these issues were widely-discussed in academic law journals and by policy-makers (Feuer, 1938). Patents constituted legal monopolies, which gave their owners rights to take actions and make agreements that would otherwise fall foul of anti-trust, or other, legislation.

American patent law gave patent-holders a statutory right not to grant patent licenses, together with a relatively free hand in whatever conditions they wished to insert into licensing contracts (Frost, 1973). These powers were widely used to create near-monopoly positions for the patent-holding firms (Feuer, 1938).

Patent case-law upheld the patent owner's right to restrict licensees' output in accordance with a schedule set out by the owner, or to sell manufactured products embodying the patent at a specified price (Feuer 1938, p.1155). In addition to creating monopoly positions, this facilitated the creation of cartels via "sham" patent licensing arrangements. This was highlighted by *United States v. United States Gypsum Co.* (333 U.S. 364 (1948)). During the late 1920s the gypsum board industry had been organized as a price-fixing license system, using patents owned by United States Gypsum. Several licensees had actively assisted in creating this arrangement, which led to a rise in the price of patented board from $14 to $20. The cartel discouraged members from producing unpatented board (which was not greatly different from patented board) and licensees eventually ceased producing it altogether. United States Gypsum also agreed to enforce uniform terms of sale – which meant that the prices of unpatented goods, such as plaster, were also fixed when sold jointly with gypsum board. While these arrangements were eventually found to be illegal, the system and the abnormal profits it created had then been in operation for some 20 years (Gibbons 1965, pp.280-2).

The "Bath Tub Pool" provides a further example of the use of patent pools as a subterfuge to give legal protection to what was, essentially, a cartel, managed by a trade association. In late 1909 - early 1910 the Standard Sanitary Manufacturing Co. and fifteen other firms in the enameled sanitary iron ware sector (bath tubs, sinks, lavatories, etc.), set up a cartel, the Sanitary Enameled Ware Association, controlling around 85 percent of national production, for an industry with an

annual output of $10-14 million (Stevens 1912, 617-618). These included the owners of three competing patents for enameling, which collectively were valuable (but not essential) for sanitary enameled goods. Their patent license prohibited discounts over standard trade prices (without the permission of the licensor, i.e. the trade association) and sought to extend control to the jobbing sector of the industry, by compelling jobbers to accept a schedule of prices and discounts, with a prohibition on using sanitaryware of firms outside the cartel, on pain of being blacklisted (Stevens 1912, pp. 621-5). The Supreme Court found this arrangement to be in violation of the Sherman Act, as industry control arose primarily from combination, rather than patents (Vaughan 1930, p. 43).

G.R. Gibbons (1965) identified four types of horizontal restraints on competition: minimum sale price regulation; controls over the quantity of production; division of markets territorially; and division of markets by field of production of articles or their use. This study adds an additional one – control over product innovation in non-patented products associated with the patented product/production method. This was often achieved via "tying". For example, tied leasing was used by the Motion Picture Patents Co. to enforce stringent restrictions on motion picture leases. No two distributors could supply films to the same exhibitor, while the distribution sector was compelled to use only projection machines and films controlled by the Company. Like shoe machinery (discussed below), the Motion Picture Co. set uniform terms and conditions for each strata of the industry (manufacturers, distributors, and exhibitors), while also blocking vertical integration of these activities (Vaughan 1930, p.43).

Such methods were generally regarded as illegal under anti-trust legislation, but enjoyed a degree of immunity if incorporated into patent licenses. Licensing arrangements often created cartel-like structures. W.J. Baumol (1992) argued that cartels have positive impacts on efficiency,

especially by accelerating the diffusion of new technologies, which typically outweigh their ambiguous impacts on new R&D (though he acknowledged negative price effects). However, Baumol assumed that cartels are composed of voluntary participants, at liberty to break ranks if it does not meet their requirements. This assumption is invalid for fundamental patents/pools, that can block any firm's activity by withdrawing its license. The patent holder is thus able to reap a disproportionate share of the abnormal profits generated by the cartel, not only by licensing fees, but by a range of other methods. As the following cases show, the much greater power enjoyed by the patent-holder in a patent-licensing cartel, compared to the type of cartel Baumol discussed (based on willing participation), increases the welfare costs of cartelization and greatly raises the probability of innovation being stifled.

Patents as a market control device: evidence from the Oldfield hearings

The House of Representatives' 1912 "Oldfield hearings" represented the most comprehensive official investigation into the anti-competitive use of fundamental patents and patent pools in this era. The Committee on Patents, (known as the Oldfield Committee after the name of its chairman), was tasked with recommending revisions to US patent law. The committee held hearings during Spring 1912 to gather evidence and opinions (Montague, 1913).

Fixing prices on patented goods was discussed at great length by the Committee. Section 32 of the 1870 Patent Act granted the owner of a patent the right to fix the retail price and conditions under which patented articles may be sold and used, any person violating such conditions or restrictions being liable for prosecution for contributory infringement. The Committee wanted to revise section 32, to abolish the rights to fix prices or to compel the purchaser or lessee of patented machines to only purchase supplies for that machinery from the patent holder.

These were widespread practices. A witness estimated that 65 percent of patented articles were marketed with resale clauses (House of Representatives 1912, p.236). The Committee regarded these restrictions as depriving consumers of the benefits of competition. Frank Dyer, a patent lawyer and President of Thomas Edison Inc., pointed out that firms in various sectors had grown large leveraging this right, including Button Fastner Co., Viktor Talking Machine Co., American Graphophone Co. and its selling agent, Columbia Phonograph Co; Gillette Razors Co.; Western Clock Co. and United Shoe Machinery Co. (House of Representatives 1912, pp.50-65).

Retail price fixing was also dominant in the typewriter sector. The Committee chairman had received a number of offers at an identical price, $100, despite there being several major firms in the sector. This price was well above manufacturing cost, estimated at $18 by George Frederick**,** Vice President of the Business Bourse, business journalist, and former president of Printer's Ink (House of Representatives 1912, p.275). Retail price fixing was a form of trade restraint legally allowed only in the case of patents, as evidenced by the Supreme Court decision on Dr Miles Medical Co. v. John D. Parker & Sons Co (House of Representatives 1912, p.296 and pp.326-327).

Representatives of various industries supported price fixing. Fletcher Gibbs, chairman of the National Catalogue Commission of the National Association of Stationers and Manufacturers, saw it as instrumental to protect retailers from the power of large combines or trusts. Gibbs estimated that there were 300 trusts in the USA, which were forcing retailers to lower their prices. Those trusts and large concerns were buying goods in greater quantities, "upon the closest possible margins and frequently going over the heads of the trade to the manufacturers" (Ibid. p.24). Retail prices fixed by manufacturers thus kept smaller and less efficient retailers in business, thereby maximizing the numbers of points of sale, but restraining competition in the retail sector and

raising prices to the consumer. Further examples of corporations controlling retail prices via price fixing on their patented articles included Rubber Tire Wheel Co., Bement and Sons Co. - manufacturers of "float spring tooth harrows", and Gem Cutlery Co. - safety razor blades (House of Representatives 1912, pp. 324, 328 and 335).

Mr Shanahan, secretary and general manager of Bissell Carpet Sweepers, was probed by the Committee about an additional strategy to stifle competition, the so called “locking up” of patents. This involved patenting improvements of existing articles when the broad or parent patent was about to expire, thus making the parent patent continuous. Shanahan opposed the Committee’s proposition that improvement patents should expire with the parent or fundamental patents. He acknowledged his corporation’s product monopoly (with only two competitors, whose combined output did not equal that of Bissell), yet claimed that their dominance was achieved through the superiority of their products (House of Representatives 1912. 137-153 and 149). Mr Naulty, general manager of Fairfax United States Mail-chute System, confirmed that improvement patents were used to extend the life of original patents and monopolize the ‘entire art’ rather than the specific invention, citing several examples (House of Representatives 1912, pp. 209-214).

A further important threat to competition discussed at the Hearings was patent pooling through cross-licensing agreements. This strategy was discussed during the hearing of businessman and inventor H. Ward Leonard. Leonard was previously employed by Thomas Edison and was one of the four engineers who first established the incandescent lighting system, later becoming Edison’s general manager for the United States and Canada. Since 1886, he had his own independent manufacturing business (House of Representatives 1912, p.78). Leonard warned the committee of the great threat posed by corporations pooling patents through mutual licensing agreements. He had direct experience of the electrical industry, where General Electric and

Westinghouse made an agreement, `the Board of Patent Control,' in 1896 (for ten years, renewed for the following five years and ended in 1911 because the United States Attorney General threatened to institute legal proceedings if it was further extended) (House of Representatives 1912, p.95). This stipulated that neither company would acquire any patent license, except by giving a six months option to the other one, on the same terms. Thus, Leonard had been obliged to grant Westinghouse the same license that he granted to General Electric (House of Representatives 1912, p.83).

The Board of Patent Control had over 7,000 patents, in addition to protective positions on over 20,000 more. Furthermore, the two corporations could not compete with each other on the basis of innovation, as the agreement prevented them from using patent rights against one another. Leonard estimated that, through the patent-pool, these two corporations controlled 80 percent of electric-power machines, removing any market for patents in this important sector (House of Representatives 1912, p.93).

Controlling industries or products through purchasing patents for inventions doing similar tasks, and thereby blocking alternative routes to production, was a major concern of the Committee, implying widespread use of this practice (Ibid. p.162). Leonard argued that the Sherman Act should be applied to such pooling agreements, given their restraining nature (Ibid. p.102). Firms highlighted as using this practice to block competition included the Harvester Co., United Shoe Machinery Co., General Electric, the Tobacco Co., and Standard Oil, all of which bought up competing patents to create a 'monopoly of monopolies'. In addition to monopolizing competing patents, they declined to purchase new patented inventions that could not be used without licenses for patents they controlled, thus blocking their development (House of Representatives 1912, pp. 552, 554, 557 and 917).

A further widely-used tactic employed by patent-holders, exploiting Section 32, concerned contracting purchasers or lessees of patented machines to use specific ancillary or complementary products, generally manufactured by the patent-holder. This meant that a manufacturer who had a patent for a product or component could impose restrictions on unpatented goods used in association with it, thereby extending its monopoly to unpatented articles and possibly on the 'whole art', by crowding out competitors (Ibid. pp. 277-278). This right had been upheld by the Supreme Court (Henry vs A.B. Dick Co. in 1912), a case considered of great importance and extensively discussed in the press (Gladney 1916; Vaughan 1930, p.48). This concerned a widely used piece of office equipment, the patented Rotary Mimeograph machine. The machine was sold with the "license restriction that it may be used only with the stencil paper, ink and other supplies made by the A. B. Dick Company, Chicago, U.S.A." A Mrs Sku in New York City used it with a suitable ink supplied by Sidney Henry, who was aware of the license agreement and was successfully sued for contributory infringement. The Court held that: "The rights in patented articles are such that the owner of the patent may completely sever ownership of the article from the right to use it. The article may pass to a purchaser with no right of use or with only a right to use in a specified way; the use not permitted is necessarily reserved to the patentee. If that reserved control of use be violated, the patent is thereby invaded." (Gladney 1916, pp. 204-5).

A similar case involved Heston-Peninsular Button Fastener Co., which had a patent on a machine for fastening buttons on shoes. The machine was sold to dealers, allegedly at production cost, under the license restriction that they should buy the patented fasteners from the manufacturer. The court found, "that the fasteners were in effect counters of the royalties - counters of the profit which the patentee should take" (House of Representatives 1912, p. 290 and 326).

Another means of controlling an industry or product was filing patents but not working the inventions, until other inventors applied for improvement patents. In the case of 'broad patents' this strategy meant that individuals who produced additional inventions or developments during the pendency of the application had to pay royalties to applicants who had only been waiting for such developments (House of Representatives 1912, p.14). Furthermore, patents could be kept pending indefinitely, which made it possible for wealthy concerns to maintain a patent monopoly of a single invention for 20, 30, or even 40 years. The Oldfield Committee was particularly keen on revising this aspect of patent law, (Section 17), by making the patent term begin with the date of application and granting a patent life of 19 years, rather than the current 17 years (House of Representatives 1912, p.316).

Amendments proposed by the Committee to Section 17 of the 1870 Act included the so called "working clause," according to which, "if a patent is not acted upon within four years from issuing, the patent should be either revoked or the owner should be required to grant license to manufacturers who want to use the patent" (House of Representatives 1912, p.14). However, various witnesses argued against the four year working clause on the grounds that it would damage smaller corporations and independent inventors. For example, a Mr Delaney had tried for several years to get Western Union and Postal Telegraph Co. to adopt his system of automatic telegraphy. The two corporations did not want to adopt it because they thought the new system would lead to a reduction of dividends. A four year working clause would mean that an inventor like Delaney would lose his rights on the invention because incumbents prevented its application (House of Representatives 1912, pp.173-4). A similar opinion was expressed by Thomas Pelham, sales manager of Gillette Razors Co., who warned the Committee that under the compulsory license clause, large corporations, with abundant capital, would be able to take patent rights from small

manufacturers and inventors. “The big people would gobble up the small ones under your provision” (House of Representatives 1912, p.203).

In addition to corporations using patent rights to control industries or products, they also capitalized on their financial muscle, by infringing patents owned by independent inventors and small businesses. Mr Baekeland, president of the American Institute of Chemical Engineers, recommended that if inventors did not have financial resources to defend their patents from infringements, they had better not patent their inventions at all and resort to secrecy instead. Baekeland was previously Associate Professor of Chemistry at the University of Ghent before moving to the USA. His first successful invention was a photographic process called Vellox paper. Lacking the financial resources to defend a patent, he practiced secretly, and after he made the business a success, sold out to a large corporation on his terms (House of Representatives 1912, p.116-7). Joseph O’Brien, editor of *Inventors’ Outlook*, patent attorney, and inventor, warned the Committee that owing to large corporations’ piracy towards independent inventors, the United States was now benefitting to a lesser extent from inventions (House of Representatives 1912, p.170).

To examine the substance of these claims, we focus on three specific patent cases, based on different strategies for market control: the semi-automatic washing machine; automatic glass container machinery; and shoe machinery.

The semi-automatic washing machine

The washing machine industry provides a good example of the use of litigation *threats* as an instrument of industry control. In 1950 the *Columbia Law Review* noted that, “a patent, which, were it judicially tested, would be found to be invalid, may be of great value to a patentee merely

as a basis for threatening others with infringement suits" (Anon. 1950, p. 1121). The "others" included not only manufacturers, but down-stream suppliers or users. This gave the patent-owner considerable coercive power, mainly exerted outside the court system as, "by the very assertion of his claim for infringement, regardless of merit, [he could] impair the salability of the accused good. Thus, he can achieve for himself or his licensees a competitive advantage even though his patent may ultimately be declared to be invalid" (Ladd 1959, p. 353). This was a widely used tactic; for example, independent radio equipment manufacturers, using E.H. Armstrong's patents, complained to the Federal Trade Commission about nuisance suits brought against them by Radio Corporation of America (RCA), "not instigated in good faith with the expectation of prevailing therein, but…for the purpose of driving them out of business through costly litigation and to frighten their distributors into refusing to handle their products through fear of being liable for contributory infringement" (US Federal Trade Commission 1924, p.88).

Hand-washing clothes was a particularly laborious and unpleasant task, usually taking a full day for the housewife. Various hand-powered devices were developed to lighten this work, with the "funnel on a stick" machine being superseded by the "milk stool dolly", from around 1900, using the agitation principle, i.e. oscillating back and forth (Blackburn 1940, p.8). Electric-powered machines were introduced in around 1908 and by the late 1910s washers were beginning to incorporate both washing and spin dry functions in a single tub (US Federal Trade Commission, 1925, p.25; Maxwell 2003, p.16).

The industry rapidly became tightly controlled through patent licensing. The Iowa Washing Machine Co. was established in 1907 to license the Stocking-Mendenall patent for the speed gear of hand-operated washing machines. This allowed it to both levy a 35c per machine royalty on competitors and to enforce minimum prices. Following the expiration of their basic patent in June

1921 this company effectively ceased to operate, though a broadly similar strategy was then pursued by another company, Maytag (US Federal Trade Commission 1925, pp. xxi & 26-29).

Maytag – the industry leader for most of the inter-war era - was a former agricultural machinery firm that had diversified into domestic washing machines to reduce seasonal demand variations (Hagley Museum Library & Archives, 1926-1927). The fundamental patents for the powered washing machine were those covering the swinging wringer and drive gear mechanisms. Maytag and its associates gained control of patents that enabled them to assert an exclusive right to machines with reversible swinging wringers, forming the "Maytag syndicate" in 1917, jointly with three other companies, to pool eight patents (plus one pending). The trust agreement gave each company the right to manufacture under its pooled royalties, while charging other firms royalties, with Maytag taking the largest (32 per cent) share. Shortly after, 25 manufacturers established the rival National Household Devices Co. patent pool, as a defensive measure against the syndicate's patent infringement threats. Litigation between the two patent pools, from 1921, was settled by an agreement whereby they formed a joint pool, with the Maytag syndicate retaining authority to grant licenses and receiving 60 per cent of royalties. By October 1923 some 64 manufacturers were paying them royalties of 50c per machine, while seven more enjoyed royalty-free access under the agreement (US Federal Trade Commission 1925, pp. xxi & 30-32).

Following unification of the patent pools the proportion of powered washing machines produced by licensed manufacturers rose sharply, from 25 per cent in 1920 to 85 per cent in 1922. Many took out licenses following threats of infringement suits, either against the firm in question, or its larger retail customers (Ibid. p. xxi). One of the few firms to hold out against Maytag was Syracuse Washing Machine Co., which ignored repeated threats of litigation over 1919-1922. No litigation ensued however, possibly due to Maytag being aware of potential weaknesses in their

position - they did not hold certain earlier patents on key features of the reversible swinging wringer (Maxwell 2003, p. 47; Hoover and Hoover 1993, p. 118). Instead, from 1922, they started threatening Syracuse's retailers with litigation. Syracuse reacted by indemnifying its retailers against any damages (US Federal Trade Commission 1925, p. xxii). This tactic has again become widespread, with patent holders targeting down-stream value chain participants, such as retailers or customers, with threatened, or actual, litigation. Down-stream concerns are typically in a weaker financial and patent-knowledge position to challenge infringement claims, and therefore more likely to settle, a strategy often countered by producers indemnifying their downstream value chain members (Meurer, 2018). However, such indemnification is, and was, expensive, making it problematic for smaller manufacturers.

Maytag's *assertion* of patent infringement strategy helped it to achieve and retain industry dominance, with a 33 per cent share of all washers sold during 1928 - four times that of its nearest competitor and six times its second nearest (Jasper County Historical Museum 1950, p.312). Maytag also used its patent control over the gear-driven wringer to block product innovation by rival manufacturers, as demonstrated in *Vulcan Manufacturing vs Maytag Company* ((C.C.A. 8th 1934) 73 F. (2d) 136). Maytag's license contained a clause allowing manufacturers only to make and sell "swinging wringers and gear mechanisms… for use… in …power-operated washing machines of the general type and design shown in the circular attached… Second party further agrees not to sell any of the said patented licenses separately or as a part of any other mechanism than on the washing machines… of the general type shown in the attached circular…" (Harvard Law School, 1934).

A Maytag licensee, Vulcan, commenced production of what it claimed to be a better type of machine. Maytag then sued, on the grounds that the use of its patent on this new machine was not permitted by the license. The defense pointed out that Maytag was trying to control washing

machine design and was thus imposing an illegal condition upon the privilege of using the wringer patent. However, the court ruled that Maytag was permitted to limit Vulcan to using the patent on one type of machine only (Waite 1942, pp. 422-423). Thus the restriction proved enforceable, even though its effect was to hamper Vulcan's ability to compete with Maytag in the market for an unpatented end product – washing machines (Gibbons 1965, p. 465).

It took until 1939, when the "gyrator" patent litigation reached the Supreme Court, for Maytag's patent claim to be finally declared invalid (Maxwell 2003, p.47; Hoover and Hoover 1993, p.118). Meanwhile Maytag's tight control over technological development had blocked product innovation and contributed to the very slow diffusion of washing machines compared to other consumer durables such as vacuums and refrigerators. Maytag's focus on technology protection and patent enforcement activities appears to have been regarded as an alternative to continued product innovation. After launching the very successful Model 80 washing machine series in 1922, Maytag continued to produce essentially similar machines for the rest of the inter-war era (see Figure 1), in contrast to leading firms in other durables sectors—such as Frigidaire, Radio Corporation of America, and Hoover, who invested intensively in systematic R&D to sustain their competitive advantage (Maxwell 2003, pp. 41-46). It also successfully prevented technological innovation by its licensees. A 1934 trade article noted "the almost complete uniformity of present washer design" in terms of both mechanisms and features, in contrast with much stronger product differentiation in the mid-1920s (Anon. 1934, p.31). The strength of Maytag control over product development is evidenced by the fact that when, in 1935, two young inventors developed the first fully-automatic washing machine, they had to seek backing from a firm outside the sector—Bendix Aviation Co (Blackburn 1940, p.9). Indeed an "ultraconservative

and lawyer laden" Maytag only launched its own fully automatic washer range in 1949 (Maxwell 2003, pp. 19 and 47).

Maytag model 80 series (1922-27)

Maytag model 32-33 (1937-41)

Figure 1. The very limited technological development of the Maytag washer from 1922 to 1941. Source: photographs reproduced courtesy of Lee Maxwell.

Automatic glass container machinery

The glass-container machinery sector demonstrates how patents can be used to extend control not only to the industry in which the firm operates, but also the downstream value chain (in this case, firms producing glass containers, or food and drink products sold in them). Glass container output was rapidly expanding at the turn of the twentieth century, with a 50 percent increase in output from 1899-1904 (Miller and Sullivan 1984, p.83). Semi-automatic machines

had been developed from the 1880s, but the major breakthrough occurred in 1905, when glassmaker Michael Owens invented a suction machine that slashed the costs of glass production compared to manual methods. The Owens Bottle Machine Corporation, capitalized at $3,000,000, dominated both the glass-making machinery and glass container sectors until a competitive machine emerged a decade later (Petro, 1944; Miller and Sullivan 1984, p.85).

Karl Peiler, an engineer from MIT, developed the plunger-feed method of making glass, which transformed semi-automatic machines into fully automatic ones. His patents were acquired by the Hartford-Fairmont Company in 1915. This machine was much less complex and cheaper to build and operate, than Owen's suction process, making it more suitable for shorter production runs (Miller and Sullivan 1984, p.86). Owens reacted by trying to block their invention, by purchasing patents and patent applications involving this method, with some success (Morrow 1945, p.432; Corning Museum of Glass website, 2020).

In 1924 the two companies agreed to exchange licenses on their feeder patents and to share the expenses of further patents and infringement suits, while Owens was to receive a portion of Hartford's patent income (Anon. 1940, pp.1173-4). Section 22 of the agreement also gave Owens a veto over the extension of licenses for Hartford's machines – effectively granting the strongest glassware producer a veto over its competitors' use of patented machinery vital to volume production in the sector (Petro 1944, p.83). Owens had thus gained control over the two fundamental processes for mechanised glass containers, which he used to protect and extend his market dominance over glassware (Anon. 1940, pp. 1173-6).

In 1927 it was estimated that average output per man-hour for automatic machines was between 642 and 4,010 per cent higher than for hand manufacture (according to type of product) and 242 - 2,664 percent higher than semi-automatic machines, while labour costs per gross were

reduced by 89.7-97.3 and 78.5- 95.6 percent compared to manual and semi-automatic production respectively (Stern 1927, p.8). This created huge profits for the industry's dominant players, but kept prices high for consumers (compared to a competitive market structure).

Owens' largest competitor, Hazel-Atlas Glass Co., was persuaded to make a cross-licensing agreement with Hartford in 1932, following eight years of litigation that cost Hartford $900,000 ($17,100,000 in 2020 prices) and a roughly similar amount for Hazel-Atlas (Petro 1944, p.85). This undermined the position of smaller independent firms who had hoped that Hazel-Atlas would challenge the validity of the combine's patent control. The Lynch Corporation was also forced by litigation costs to enter a licensing arrangement with Hartford in 1933. Gaining control over Lynch's patents – which were related to the Owens/Hartford patents, but not directly competitive with them - further strengthened the combine by allowing it to refuse access to a wider range of patents if its terms were not met. It was also alleged that, in the milk bottle trade, the patent combine operated an understanding that new licenses would only be issued if they did not disturb existing distribution channels (Anon. 1940, pp. 1174-1179). Hartford's licensing monopoly was then virtually absolute (Owens did not license-out the suction process) and its return on operating profits rocketed from 4 percent in 1932 to 10 percent in 1933; 23 percent in 1935; and 68 percent in 1937 (Petro 1944, p.88).

Hartford licenses included restrictions on the type, and often the quantity, of containers that licensees could manufacture. Some also included territorial restrictions, or restrictions on which customers they could supply. Hartford's licensing restrictions tended to favor strong firms at the expense of weak ones, to avoid conflicts with firms that could afford protracted litigation. For example, Hartford threatened to sue America's largest fruit jar manufacturer, Ball Brothers. However, it also offered them an exclusive license (as far as it was able to). Ball Brothers accepted,

subject to a reduction in output by Hazel-Atlas, which cut its annual fruit jar production to 300,000 gross. This deal restricted the market for fruit jars to three companies. Similarly, the milk bottle market was reduced to ten firms by Hartford's restrictive licensing agreements (Morrow 1945, pp. 432-433).

By 1938 Hartford and Owens owned or licensed some 96 percent of America's glass container production (Anon. 1940, p. 1175). Hartford was open about its policy of controlling prices and output; its President, Mr Smith, declared that no licenses would be granted to "price-cutters" (Morrow 1945, p.434). This policy substantially raised prices for products sold in glass bottles and jars – including a substantial proportion of foodstuffs purchased by lower income families.

The glass container patent pool succeeded in reducing the number of independent glassware companies from 155 in 1904 (prior to the patents under discussion) to 100 in 1923 and 40 in 1937 (37 of which were Hartford licensees and thereby subject to its market restrictions). It had also removed all competition in the glass container machinery sector, by both litigating against independent machinery firms and harassing their customers with threats and suits for infringement (Anon. 1940, p. 1174). Owens was in the unique position of having to pay no patent fees or accept any restrictive licensing (though Hazel Atlas had also negotiated a very favorable arrangement) and maintained control over the industry, together with the high profits that came with it. Control was exercised via the industry's trade association, which set production quotas, fixed prices (indirectly) and discouraged new entrants (Petro 1944, pp.88-89). The patent system had thus allowed manufacturing processes that had the potential to substantially reduce prices for important food items to instead become monopolized by a few strong, collusive, firms, while competitors were either marginalized or pushed into liquidation.

Shoe Machinery

The shoe machinery patent monopoly provides another example of how patent control over machinery can be used to control the sector using that machinery, though in this case control was used to prevent the emergence of large shoe firms, that otherwise might contest control. During the second half of the nineteenth century shoe manufacture was transformed from a skilled handicraft to a highly mechanized industry. Mechanization drastically reduced the costs of shoe-making, as shown in Table 1. Shoe manufacture was a complicated process, involving four main classes of machinery: lathing machines, welt sewing and out-sole stitching machines, heeling machines, and metallic-fastening machines.

Table 1: Man-hours required to manufacture 100 pairs of shoes, by type, in 1863 and 1895

Type of shoe	Man-hours required		
	1863 (hand)	1895 (machine)	% reduction
Men's cheap grade, kip, pegged boots, etc.	1,437	154	89.3
Men's fine grade, calf, welt, etc.	2,225	297	86.7
Men's medium grade, calf, welt, etc.	1,832	235	87.2
Men's grade, pegged, brogan,etc.	283	62	78.1
Women's find grade, kid, welt, etc.	1,997	173	91.3
Women's cheap grade, kid, turned, etc.	1,025	80	92.2
Women's cheap grade, grain, pegged, etc.	538	83	84.6

Source: Stern, B., 1939. Labour Productivity in the Boot and Shoe Industry. Works Progress Administration Report B-6, Philadelphia, PA, p. 3.

Despite supplying a fragmented shoe manufacturing industry, by 1911 shoe machinery production had become almost entirely concentrated in a single firm - United Shoe Machinery

Company (hereafter USM) - described by a contemporary as America's "foremost example of a patent monopoly" (Stevens 1912, p.608). This was achieved via the 1899 merger of the four main machinery companies: Goodyear Shoe Machinery Co. (producing around 10 percent of lasting machines and 80 percent of sewing and outsole-stitching machines); Consolidated and McKay Lasting Machine Co. (60 percent of lasting machines); Mckay Shoe Machinery Co. (around 70 percent of heeling machines and 80 percent of metallic fastening machines); and Eppler Welt Machine Co. USM, originally capitalized at $25 million (Stevens 1912, pp. 609-610), had a 70 percent market share on its formation (Braeman 2010, p. 288). By 1911, when it was first indicted, USM and its subsidiaries were said to control 98 percent of national shoe machinery output (see Table 2).

Table 2: USM's 1911 market share, by class of machine

Machine	Number of machines		% USM
	USM	Other firms	
Clicking	3,655	0	100.0
Eyeletting	4,472	150	96.8
Pulling-over	1,632	0	100.0
Lasting	7,496	7	99.9
Standard screw	409	0	100.0
Pegging	141	0	100.0
Tacking	3,488	6	99.8
McKay sewing	808	8	99.0
Welt-sewing	2,527	142	94.7
Outsole stitching	2,676	758	77.9
Loose-nailing	1,835	24	98.7
Heeling	2,019	17	99.2
Slugging	1,876	23	98.8

Braeman, J., 2010. The people's lawyer" revisited: Louis D. Brandeis versus the United Shoe Machinery Company. American Journal of Legal History 50 (3), 290.

From its foundation to 1910, the assets of USM grew at an average annual rate of almost 10 percent, to $40.8 million (Kaysen 1956, p.7). USM's principal means of deterring competition was a virtual monopoly of patents vital for machinery covering key stages of production, such as stitching and welting. When these basic patents expired, it relied on improvement patents to perpetuate its control. Moreover, it used rigorously-enforced tying leases to lock-out competitors. USM provided machinery to shoe manufacturers on 17 year leases, with tying clauses preventing lessees using any non-USM machinery. This practice extended USM control to a wide range of "auxiliary" shoe machines, which were generally not patented. A comprehensive "right to terminate all leases" clause enabled USM to withdraw all USM machinery from any manufacturer breaking the terms of lease for any machine – effectively putting them out of business (Braeman 2008-2010, p.289).

USM used its monopoly power to acquire 37 shoe machinery companies over 1899-1911 at bargain prices, mainly to gain ownership of their patents and secure covenants with their principals that if they subsequently invented, patented, or improved, shoe machinery they should assign these to USM. According to W.S. Stevens, this strategy reflected the fact that many USM patents were potentially challengeable by new inventions (Stevens 1912, pp. 611-2). One inventor, Thomas G. Plant, developed a complete range of machinery for all stages of shoe manufacture, which he introduced into his Boston factory in May 1910 in place of his existing USM leased machines. He had thus overcome USM's key strength – its stipulation that if a firm used any non-USM machines, it could not use any USM ones. USM allegedly dealt with this by pressing the Boston and New York banks to refuse him any extension of credit, forcing Plant to sell out to USM for $6,000,000, in a deal that also included any patents that he might own or control over the following 15 years (Stevens 1912, pp. 612-3; Braeman 2008-2010, p. 293).

USM pursued a policy of offering equal terms to all manufacturers, regardless of their size or location. This, together with the standardization of machinery across the industry, eliminated machinery (and, to a large extent scale) as a differentiator of labor productivity across firms (Stern 1939, pp.3-5). Larger shoe manufacturers argued that USM's tying strategy allowed USM to impose "exorbitant" charges, suppress competition, and reduce the pace of technical change, to protect the value of its existing leased machines (Braeman 2008-2010, p. 293). Reducing scale economies in shoe manufacturing blocked the emergence of larger and financially stronger shoe firms, that might challenge USM's control over the shoe value chain.

In 1911 a group of shoe manufacturers formed the Shoe Manufacturers Alliance, to campaign for a modification of USM leases, to remove the tying clauses (Roe 2013, p. 946). A 1911 civil suit claimed that USM was a combination in restraint of trade, in violation of Sections 1 and 2 of the Sherman Act. USM won, but faced another suit in 1915 under the new Clayton Act. This time the government won and USM was forced to modify its leases. Following negotiations with the shoe manufacturers' representatives, USM introduced shorter leases from November 1922, removed the exclusive use and restrictive use lease clauses, and dropped the practices of tying principal machines with auxiliary machines; and machines with supplies (Kaysen 1956, pp. 3-16). However, USM continued to use its financial muscle to attack competitors, by infringing competitors' patents and bringing "bad faith" patent infringement cases that small firms could not afford to fight, together with practices such as price discrimination - charging lower mark-ups on machines facing competition, in order to drive that competition out of business (Kaysen 1956, pp. 74 and 110).

Conclusions

This study has investigated the impact of legal monopolies established by corporations through 'broad' or 'fundamental' patents. Our evidence is consistent with the approach of Merger and Nelson (1990) and the findings by Lampe and Moser (2010) concerning the sewing machine patent pool, that fundamental patents and their pooling stifled innovation. This remains a major criticism of U.S patent law; for example Bessen and Meurer (2009, 144-6) concluded that the U.S. patent system acts as a brake on innovation, rather than a facilitator.

We show that fundamental patents (combined with sufficient financial muscle), enabled their holders to defeat alleged infringers, even if the evidence for infringement was relatively weak. Moreover, this paper enhances our understanding of the impacts of patent cartels. As mentioned above, Baumol (1992) argued that cartels might have positive impacts on efficiency and, especially, on the dissemination of innovation. Our evidence shows that cartel membership was not voluntary for most licensees, and that licensing agreements hindered innovation, with negative consequences for new R&D, output growth, and prices. The consolidation of patents in the hands of few corporations or cartels also had detrimental impacts on competition, consistent with contemporary dynamics in the software industry (Kwon and Marco, 2021).

This study highlights dynamics and motives behind the emergence of modern corporations in a range of industries, that typically had relatively low minimum efficient scale and, therefore, might have otherwise been able to reap the private and social advantages of competitive markets, for both the manufacturing sector and its downstream value chain. Our washing machine case shows that patent control over specific components could be used to extend control to any good embodying those components. The strategic use of fundamental patents and licensing agreements is further supported by the glass-container case, where "patent wars" led to control over the two alternative automatic glass-making processes by a single combine. In addition to control over

glass-making machinery, Owen Bottle Machine Corporation also gained control over the glass container industry. USM achieved similar control over the shoe industry, via its patent monopoly of footwear machinery, but – in contrast to the glass container sector - adopted a strategy of restricting scale economies for shoe manufacturers, to maintain its value chain dominance. In all three cases, the firm that emerged as industry leader was interested primarily in manufacturing an item not directly subject to patent control (washing machines, glass containers, and shoes respectively).

While the main focus of this work concerns the use of patents to gain technological, industrial, and market control, we shed new light on a specific form of competition restraint - control over product innovation in non-patented products that embody patented technologies. Such practices were generally regarded as illegal under American anti-trust regulation, but enjoyed a degree of immunity if incorporated into patent licenses (Gibbons 1965, p. 423).

In most cases a less restrictive patent system could have provided more than adequate rewards for invention, without the negative competition and price aspects associated with the 1870 Act. Even its impacts on innovation are at best ambiguous, given that financial muscle and legal expertise often counted more than inventive ability in determining who reaped the rewards from technological advances. Indeed, in many cases, especially those relying on improvement or fundamental patents, America's strict patent laws may have slowed down technological advancement.

Our industry cases point to the core issue of designing a system of property rights capable of balancing private and public gains from innovation, in particular by enabling innovators to appropriate the returns from their R&D, while at the same time allowing competition. (May and Sell, 2006). Achieving this ideal system entails a number of facets. First, following the argument

of Bessen and Meurer (2009), patent law should be modified to make patent property rights less imperfect as `property'. Patents should have clear boundaries, to avoid cases where patents that have narrow definitions when filed are later interpreted as covering a much wider field. Moreover, where the boundaries of the patent are unclear, the default position should be a presumption that the patent is interpreted narrowly. Patents should also be written in clear language and, when not clear, the presumption should again be that the narrow interpretation holds. Clear patent boundaries would also ameliorate the problem of patent 'thickets', i.e. overlapping patent rights belonging to different firms, which occur frequently in complex and modular technologies. These have a detrimental effect on subsequent innovations, as innovators need to seek licensing agreements from multiple patent owners (May and Sell, 2006; Hall, Graevenitz and Helmers, 2021). On the contrary, patent clarity defines the limits around which innovators are free to operate (Ashtor, 2022).

Another negative feature of patents' imperfect property characteristics is the enormous cost of patent litigation, which was already strongly evident in the late nineteenth century and is still a major impediment to an efficient patent system. A presumption of narrow interpretation would mitigate predatory actions - by corporations with weak patent rights but deep pockets – such as harassing companies to pay up rather than face potentially exorbitant legal fees. However, these reforms would not significantly impact one of the key negative impacts of patents – their monopoly rights, which produce potentially severe negative social welfare consequences, ranging from higher prices to the consumer to avoidable deaths in cases where life-saving drugs are developed, but are prohibitively-priced. This is less of a problem for other types of property, given that property rights in, for example, real estate, constitute local monopolies, but rarely involve wider – potentially global – ones. Reforms might include a shorter life-time for patents and legislation to

prevent patents being extended by improvement patents. In extreme cases, such as life-saving drugs with no close substitutes, governments might also consider legislation to remove some of the monopoly pricing element, such as price controls and/or compulsory licensing.

Lowering the cost of litigation and clear definitions of patent boundaries are areas of paramount importance in order to preserve a plurality of sources of innovation. Division of labor in innovation is well established in knowledge-intensive industries such as biotechnology and electronics, where new knowledge can be generated by independent specialists and upstream firms and embodied into new products by dominant firms and lead users (Arora, Cohen and Walsh, 2016; Arora and Gambardella, 2010). As mentioned above, defined boundaries and affordable litigation costs would enable independent specialists and smaller innovative firms to protect their property rights vis-à-vis large corporations (Kingston, 2001), allowing society to benefit from the ingenuity of a greater number of individuals and organizations.

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