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Patents are the Foundation of the Market for Inventions

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Abstract

The paper develops a comprehensive framework demonstrating that patents provide the foundation for the market for inventions. Patents support the establishment of the market in several key ways. Patents as a system of intellectual property (IP) rights increase transaction efficiencies and competition because they offer exclusion, transferability, disclosure, certification, standardization, and divisibility. Patents allow owners to control how inventions are made, used and sold so that the market for inventions is a market for innovative control, which provides efficient incentives for invention, innovation, and investment in complementary assets. Patents as intangible real assets promote the financing of invention and innovation. The market foundation role of patents refutes the erroneous "rewards" view of patents. The discussion considers how economic benefits of the market for inventions should guide IP policy and antitrust policy.

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Introduction

The U.S. patent system is facing a perfect storm of criticism. For many academics, the patent system is a "failure" (Bessen and Meurer, 2008), in a "crisis" (Burk and Lemley, 2009), and a "major wound" that should be abolished (Boldrin and Levin, 2013, p. 18). The press tends to agree: "[a]busive and frivolous lawsuits brought by holders of patents are costing the American economy billions of dollars."[1] Antitrust policy makers seeking "a proper balance between exclusivity and competition" argue that "[i]nvalid or overbroad patents disrupt that balance by discouraging follow-on innovation, preventing competition, and raising prices through unnecessary licensing and litigation" (Federal Trade Commission, 2011, p. 1). The Supreme Court in a series of opinions (*Bilski*, *Prometheus*, *Myriad*) has ruled claims for a wide range of subject matters as patent-ineligible.[2] Commentators have noted the "hostility to patents"

[1] Editorial Board, 2014, "Abusive and Frivolous Patent Suits," *The New York Times*, April 6, http://www.nytimes.com/2014/04/07/opinion/abusive-and-frivolous-patent-suits.html?_r=0 Accessed April 16, 2014.

[2] Lamenting this state of events, Judge Moore in *CLS v. Alice* United States Court of Appeals, Federal Circuit, Dissenting-in-part opinion filed by MOORE, Circuit Judge, in which RADER, Chief Judge, and LINN and O'MALLEY, Circuit Judges, join, states "I am concerned that the current interpretation of § 101, and in particular the abstract idea exception, is causing a free fall in the patent system. The Supreme Court has taken a number of our recent decisions and, in each instance, concluded that the claims at issue were not patent-eligible. *See Bilski, Prometheus,*

by the Executive Branch.[3] Congress is in the midst of extensive bipartisan patent reform efforts.[4] According to industry lobbyists such as the Electronic Frontier Foundation "[w]e happen to be at a special point in time when every branch of government is itching for patent reform."[5]

Myriad (under consideration). Today, several of my colleagues would take that precedent significantly further, lumping together the asserted method, media, and system claims, and holding that they are all patent-ineligible under § 101." http://www2.bloomberglaw.com/public/desktop/document/CLS_Bank_Intl_v_Alice_Corp_Pty_Ltd_717_F3d_1269_106_USPQ2d_1696_2/1, Accessed January 30, 2014.

[3] On concerns about Executive Branch opposition to patents, see Kevin Noonan, 2014. "Thoughts on the USPTO's Patent Eligibility Guidelines (and What to Do About Them)," March 18, Patent Doc: Biotech an Pharma Patent Law & News Blog, http://www.patentdocs.org/2014/03/thoughts-on-the-usptos-patent-eligibility-guidelines-and-what-to-do-about-them.html, Accessed April 16, 2014. See also Lisa L. Mueller, "The Thorny Problem of Patentable Eligible Subject Matter: An Introduction," http://www.natlawreview.com/article/thorny-problem-patentable-eligible-subject-matter-introduction, Accessed April 16, 2014.

[4] Kristal High, 2014, Patent Reform Movement Shines a Light on Economic Development Opportunities, March 28, *Huffinton Post*, http://www.huffingtonpost.com/kristal-high/patent-reform-movement-sh_b_5048578.html, Accessed April 16, 2014.

[5] Adi Kamdar, 2014, "The Patent Reform We Need to See from the Senate," Electronic Frontier Foundation, March 31, https://www.eff.org/deeplinks/2014/03/patent-reform-we-need-see-senate, Accessed April 16, 2014.

The anti-patent storm, setting aside political and business interests, reflects a basic misunderstanding of the purpose of the patent system. The standard view – that patents provide "rewards" for inventors – does not accurately describe public and private institutions, is based on incorrect economic analysis, and is highly misleading for public policy. In this paper, I argue instead that patents provide the foundation of the market for inventions. I develop a comprehensive economic framework for the study of patents that extends work I have done on market microstructure, the theory of the firm, and innovation (Spulber, 1999, 2009a, 2014). I then show that the market foundation role of patents has important implications for antitrust and public policy towards intellectual property (IP). I suggest that a better understanding of the market foundation role of patents may help calm the anti-patent storm.

Patents foster the development of the market for inventions in several important ways: by increasing transaction efficiencies and competition, by allowing owners to control how inventions are turned into innovations, and by supporting the financing of invention and innovation.[6] The market for inventions includes not only disembodied inventions but also inventions embodied in goods and services, production processes, transaction techniques, and firms.[7] Patents create economic benefits because the market for inventions generates efficient

[6] I discuss the market for inventions and examine some of the implications of transaction costs and other market frictions for invention and innovation in Spulber (2014).

[7] I develop a formal model of the market for inventions with endogenous R&D and entry of inventors and producers (Spulber, 2013a, 2013b). On empirical studies of the market for inventions see Arora et al. (2001a, 2001b).

incentives for invention and innovation. Patents thus 'promote the progress of science and useful arts' by providing the basis of the market for inventions.[8]

First, I show that key features of the patent system – exclusion, transferability, disclosure, certification, standardization, and divisibility – increase *transaction efficiencies and competition* in the market for inventions. These properties of patents reduce transaction costs associated with transferring, licensing, cross-licensing, combining, implementing, and developing inventions. Patents give owners rights to exclude others from making, using, or selling their inventions.[9] Patents help convert inventions into transferable assets so that inventors and adopters can transact more efficiently in the market for inventions. Patents promote disclosure of inventions, which reduces costs of search and bargaining in the market for inventions. Patents provide certification of technologies, which decreases information asymmetry in the market for inventions. Patents provide standardization in IP, which reduces the costs of contracting in the market for inventions. Finally, patents allow greater divisibility of technology, which promotes modularity and increases gains from trade in the market for inventions. Patents thus generate economic benefits that are based on more efficient transactions and greater competition in the market for inventions.

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[8] The US Constitution offers valuable guidance regarding the purpose patents in granting Congress the power "To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries." U.S. CONST. art 1 § 8, cl. 8.

[9] Alchian (2008) points out that the three aspects of property rights are exclusion of access, control over how the asset will be used, and transfer of the asset to others.

Second, I argue that the market for inventions is a *market for innovative control*. Patent owners not only obtain residual returns by commercializing their inventions but also choose how inventions will be made, used, or sold. Patents thus are transferable assets representing *investment projects with random outcomes*. The market for inventions helps determine the value of inventions, selects the best inventions, and allocates inventions to the highest value users. Because it is a market for innovative control, the market for inventions generates efficient incentives for invention, innovation, and investment in complementary assets. The market for inventions provides incentives for the efficient organization of firms and industries in terms of the extent of vertical integration of R&D and manufacturing. Efficiencies in the market for innovative control help explain the market returns to patent ownership.

Third, I emphasize that patents facilitate the *financial separation* of inventions from their inventors, helping inventors obtain financing.[10] By serving as *intangible real assets*, patents are useful for contracts that finance invention, as indicated by the use of licensing or transfer options for companies funding university research. Entrepreneurs report that patents can be important in securing financing for startups and establishment of firms.[11] Patents also are important for corporate finance and appear as intangible real assets in the balance sheets of corporations. Patents affect the value of corporations in two main ways.[12] Patents that are "assets in place" affect the firm's earnings either through licensing royalties or through own-use of the technology

[10] See Myers (1999, 2000) on financial separation and entrepreneurship. See Spulber (2009a, 2009b) on financial separation in the theory of the firm and Spulber (2014) on financial separation in the theory of the innovative entrepreneur.

[11] See particularly the major study by Graham et al. (2014).

[12] This follows Myers (1977) distinction between "assets in place" and "growth opportunities."

as a productive input. Patents that offer “growth opportunities” affect the firm’s expected value because they indicate the potential to invest in innovation based on the firm’s IP or to invest in invention of related technology. Financial contracts and the capital structure of firms help provide incentives for invention and innovation.

The market foundation role of patents offers insights into IP policy and antitrust. With patent protections for IP, the market for inventions determines the market value of inventions and the returns to invention, innovation, and complementary inventions. IP policy should maintain the property rights system because of its benefits for competition and transaction efficiencies. This implies maintaining the key features of the patent system: exclusion, transferability, disclosure, certification, standardization, and divisibility.

The market foundation role of patents implies that antitrust policy should support rather than weaken IP protections. When there is a market for inventions, *competitive pressures* both among inventors and among producers who apply inventions increase incentives to invent and to innovate (Spulber, 2013a, 2013b). On the supply-side of the market for inventions, competitive pressures increase incentives to invent and decrease royalties for inventions. On the demand-side of the market for inventions, competition drives incentives of adopters to purchase or license discoveries, to introduce economic innovations based on those discoveries, and to invest in complementary activities. Weakening patents reduces incentives to participate in the market for inventions, leading inventors to protect their IP through other means such as trade secrets, research and development (R&D) alliances, and vertical integration. In the absence of a market for inventions, competitive pressures tend to reduce incentives to invent and to innovate.

The market foundation role of patents stands in stark contrast to the “rewards” view. Contrary to the “rewards” view, patents neither provide rewards for inventors nor do they

determine what rewards if any an inventor receives. Also contrary to the "rewards" view, the market foundation role of patents shows that the economic arguments on the basis of "deadweight welfare loss" are incorrect.

The public policy implications of the market foundation role of patents differ markedly from the "rewards" view of patents. Chief among the flawed recommendations based on the "rewards" view is that governments should replace patents entirely by awarding "prizes" to inventors and freely distributing inventions – effectively socialized invention and innovation. Roin (2014) observes that there has been an "explosion" of research on "prizes" with most researchers arguing for replacing patents with "prizes." Based on the "rewards" view, other researchers recommend weakening patents through antitrust, compulsory licensing, government ownership, price controls, taxes, and subsidies.[13] The "prizes" or increased market regulation approaches would stifle or eliminate the economic benefits that result from markets for invention. Whether as regulators or prize givers, governments lack the vast amounts of information dispersed in the market place, as Friedrich Hayek understood.

There are a number of important prior works that are related to the market foundation role of patents discussed here. Judge Giles Rich in a series of writings emphasizes the importance of patents for innovation. Rich (1972, p. 26) observes "A time-limited exclusive right to subject matter which was neither known, nor obvious from what was known, *takes nothing from the public which it had before*. As a necessary corollary, the disclosure in a valid patent gives to the public knowledge it did not possess, actually or potentially, and thereby makes for

[13] See Roin (2014) for an overview and discussion ("over the past two decades there has been a virtual explosion of scholarship about prize systems"). See also Polanyi (1943), Wright (1983), and Shavell and van Ypersele (2001).

progress," (emphasis in original). Harold Demsetz (1969, p. 14) points that the problem of indivisibility of information is best handled by "a private property system that reduces the cost of contracting and raises the cost of free-loading while, at the same time, it provides incentives and guidance for investment in producing information."[14]

An important contribution by Edmund Kitch (1977) argues that the function of patents is to help attract resources to innovative "prospects."[15] Kitch (1977) contrasts his "prospects" view of the patent system with the "rewards" view. Patents are "prospects" because a patent generally discloses an invention *before* it is fully developed and covers *potential* innovations based on that invention. Kitch (1977) correctly points out that patents allow owners to coordinate the search for technological and market improvements, to invest in innovation based on the invention, to invest in distribution and marketing of the invention, to contract more readily with providers of complementary information, resources, and financing, to avoid duplicating investment of other patent holders, and to exercise control over the technology. The present analysis extends this discussion and offers an economic framework for understanding the market for inventions.

In F. Scott Kieff's (2001) highly insightful analysis: "the treatment of patents as property rights is necessary to facilitate investment in the complex, costly, and risky commercialization activities required to turn nascent inventions into new goods and services. Furthermore, property

[14] For a more skeptical view of the market for ideas, see Gans and Stern (2010).

[15] Kitch (1977, 266) states "the view of the patent system offered here conceives of the process of technological innovation as one in which resources are brought to bear upon an array of prospects, each with its own associated sets of probabilities of costs and returns. By a prospect I mean a particular opportunity to develop a known technological possibility." See also Barzel (1968).

treatment is equally necessary to help society decide which inventive activities are worth protecting in the first instance," (p. 703). Kieff (2001) critiques the "rewards" view of patents, pointing out that reward systems do not account for innovative activities after inventions have been made.[16] Kieff (2001, p. 710) highlights both coordination and investment in commercialization: "The patent right to exclude competitors who have not shared in bearing these initial costs provides incentives for the holder of the invention and the other players in this market to come together and incur all costs necessary to facilitate commercialization of the patented invention." The analysis of the market for inventions presented here encompasses the coordination and commercialization aspects of patents discussed by Kieff.

The paper is organized as follows. Section I examines how patents improve transaction efficiencies and competition in the market for inventions. Section II considers how the market for inventions is a market for innovative control that provides incentives for invention and innovation, promotes selection of the best inventions, allocates inventions efficiently, gains from trade, and investment in complementary assets. Section III considers how patents are useful for financing invention and innovation. Section IV discusses implications for IP policy and antitrust policy. Section V concludes the discussion.

I. Transaction Efficiencies and Competition in the Market for Inventions

Patents increase the efficiency of transactions and competition in the market for inventions. This is because the patent system offers a sophisticated property rights framework that combines exclusion with other mechanisms that facilitate exchange. The discussion in this

[16] See also Smith (2007), Spulber (2011) and Daily and Kieff (2013).

section identifies some key elements of the patent system that are fundamental for market exchange.

A. Exclusion

The United States Patent and Trademark Office (USPTO) defines a *patent* as "an intellectual property right granted by the Government of the United States of America to an inventor 'to exclude others from making, using, offering for sale, or selling the invention throughout the United States or importing the invention into the United States' for a limited time in exchange for public disclosure of the invention when the patent is granted." Although the present discussion applies to IP generally, my focus is on *utility patents* that "may be granted to anyone who invents or discovers any new and useful process, machine, article of manufacture, or composition of matter, or any new and useful improvement thereof."[17] Inventions include commercial, scientific, and technological discoveries.

The U.S. patent system involves all three branches of government. The Congress establishes the rules of the system through legislation such as the 2011 America Invents Act (AIA). The Executive branch reviews patent applications and awards patents through the USPTO, which is an agency of the Department of Commerce. Finally, the Judiciary adjudicates legal cases involving patent awards and patent infringement. Patent law encompasses a rich set of legal precedents including many Supreme Court decisions.

[17] The USPTO also grants design patents "to anyone who invents a new, original, and ornamental design for an article of manufacture" and grants plant patents "to anyone who invents or discovers and asexually reproduces any distinct and new variety of plant." See USPTO, http://www.uspto.gov/patents/index.jsp, accessed January 18, 2014.

The patent protects the inventor's investment-backed expectations. The inventor invests in invention and commercialization of the invention because exclusion of others protects these expectations. Enforcement requires the patent holder to monitor infringement and to incur legal costs: "it is up to the patent holder to enforce his or her own rights if the USPTO does grant a patent." [18] Exclusion is enforced through injunctions and patent damages for infringement. This implies that legal battles over infringement are a natural aspect of the patent system and do not in themselves indicate problems with patents. Many studies critical of the patent system tend to emphasize litigation costs without considering the economic benefits of the patent system; see for example Bessen and Meurer (2008) and Burk and Lemley (2009).

The patent grant does not in itself provide a reward for invention, such as a "prize" for winning a contest, a government subsidy, or an employer bonus. The patent grant is not a financial reward designed to induce some type of inventive behavior or level of effort. Also, the grant of a patent by the USPTO is not based on the costs of R&D or the efforts of the inventor in making the discovery (Spulber, 2011). The patent grant is based on the features of the invention, the details of the application, and is contingent on whether the invention is useful, novel, and non-obvious.

Because patents give owners the right to exclude, they provide the critical elements of property rights needed to establish a market for inventions. An inventor's returns, if any are ever obtained, are based on the inventor's commercialization efforts and the market value of the invention. Therefore, the value of the inventor's asset is determined after the fact and depends on

[18] http://www.uspto.gov/patents/resources/types/utility.jsp#heading-1, Accessed January 29, 2014.

the demand for the invention and the supply of alternatives in the market for invention. Because of exclusivity, inventors have the opportunity to obtain the market value of their patents.

Economic historians have documented extensively the importance of the patent system in the commercialization of invention and private ordering, see Khan and Sokoloff (2001) and Lamoreaux and Sokoloff (2003). Khan's (2005, p. 314) study of the U.S. patent system from 1790 to 1920 finds that "[s]ecure property rights in patented inventions helped to create tradeable assets." During this period, the U.S. patent system "stood out as conduit for creativity and achievement among otherwise disadvantaged groups" and "comprised a key institution in the progress of technology" (Khan, 2005, p. 221). Khan (2013b) examines the international market for inventions from 1790 to 1930 and shows that international trade in patented inventions responded to incentives from IP protections. Khan finds that greater protections for IP rights encouraged the formation of global markets for inventions.

The growing volume of patent applications provides some evidence that the patent system is a highly effective institution. The USPTO receives over 500,000 applications per year.[19] However, increases in the number of patents or the number of citations need not increase innovation and productivity, a phenomenon known as the "patent puzzle." Boldrin and Levine (2008) conclude based on a literature survey that "strengthening the patent regime increases patenting!" However, evaluating the market value of patents for both disembodied and embodied inventions should provide a better indication of the connection between patents and innovation.

An indication of the benefits of IP protection is that companies conducting in-house R&D choose to obtain patents for their inventions. For example, the ten leading patenters in the US in

[19] http://www.uspto.gov/patents/resources/types/utility.jsp#heading-1, Accessed January 29, 2014.

2013 were corporations conducting in-house R&D: IBM (6,809), Samsung (4,675), Canon (3,825), Sony (3,098), Microsoft (2,660), Panasonic (2,601), Toshiba (2,416), Hon Hai (2,279), Qualcomm (2,103), and LG Electronics (1,947). [20] Extensive and growing patenting by universities and public research organizations also provides evidence of the benefits offered by the patent system.[21]

B. Transferability

Transferability of patent usage and ownership contributes significantly to the establishment and operation of the market for inventions. Because they are transaction institutions, markets require legal transferability of products. John R. Commons (1931, p. 648) states "[t]ransactions are the means, under operation of law and custom, of acquiring and alienating legal control of commodities, or legal control of the labor and management that will produce and deliver or exchange the commodities and services, forward to the ultimate consumers." Technology transfers that occur through infringement, imitation, and spillovers are not market transactions. Patent owners often license patents after infringement occurs; which can convert such technology transfers into market transactions. Kieff (2001) emphasizes the importance of patents as property rights for commercialization and identifies problems with liability rules.

The market for inventions consists of transaction institutions for allocating IP. The market for inventions includes exchange between inventors and adopters of technology. The

[20] Barinka (2014).

[21] The World Intellectual Property Organization (2011) observes a significant increasing in patent applications by universities and public research organizations.

market for inventions also involves intermediated exchange through a wide variety of market makers, dealers, brokers, insurers, and other specialists. The market for inventions encompasses a wide variety of transactions for exchanging both disembodied and embodied technology.

Transactions involving disembodied technology include selling patents, licensing patents, and cross-licensing patents. Patent owners may bundle knowledge transfers with patent licensing or transfers, particularly when patent owners are inventors who have tacit knowledge. The returns to selling the bundle cover the market value of the IP and the costs to the inventor of codifying and communicating tacit knowledge (Spulber, 2012).

The market for disembodied inventions includes transfers of knowledge, discoveries, ideas, and technologies that are protected by IP other than patents, including trademarks, copyright, and trade secrets. The market for inventions also includes contractual R&D and R&D consortia.[22] R&D outsourcing contracts and R&D partnership contracts specify ownership of the inventions created by the project. Employment contracts specify who owns inventions created by employees. Contracts for education and training specify ownership of information contained in courses and instruction materials.

The market for inventions also includes goods and services that embody inventions, products manufactured using inventions, and transactions techniques that apply business method inventions. Patents often provide IP protections for inventions embodied in products, production

[22] On empirical studies of the market for inventions, see Arora et al. (2001a, 2001b), Gambardella et al. (2007), Gans et al. (2008), Arora and Gambardella (2010), Serrano (2010), and Galasso et al. (2013). See also the discussions in Kamiyama et al. (2006), Athreye and Cantwell (2007), Troy and Werle (2008), Arora and Gambardella (2010), and Gans and Stern (2010).

processes and transaction techniques. The market for inventions includes mergers and acquisitions (M&A) involving companies that own or embody inventions. M&A involves the purchase of a firm's assets including their patent portfolios.

Markets are transaction institutions that are created and managed by individuals and firms (Spulber, 1999, 2009a, 2014). Markets are endogenous to the economy and involve formal and informal rules of exchange that can be characterized as "market microstructure" (Spulber, 1999). Firms that create markets choose profit-maximizing market designs. Firms generate and operate a wide variety of physical and virtual market places such as stores, websites, intermediaries, and auctions. The market for inventions involves these types of institutions, just as do markets for other types of goods and services and financial assets.

Firms create and operate markets through intermediation, price adjustment, marketing, sales, communication and other coordination mechanisms (Spulber, 1999, 2014). Because markets are endogenous, their institutional features depend on the decisions of market-making firms, the characteristics of buyers and sellers that participate in the market, and the types of goods and services that are exchanged. Market institutions can be efficient for the task at hand without necessarily resembling financial commodity markets. Firms create and operate transaction institutions in the market for inventions.

Markets rarely conform to the neoclassical economics paradigm of homogenous goods, anonymous trading through an exogenous auctioneer, price-taking behavior, or rivalrous consumption. This combination of features is absent from practically all markets, and certainly should not be normative standards applied to markets for inventions. Many markets involve highly differentiated products, for example all properties in commercial and residential real estate differ in terms of combinations of location and building features. Even securities markets

have submarkets for the stocks of individual companies, for example the New York Stock Exchange has specialists that make the market for the stock of individual firms. Many markets involve an absence of anonymity such as labor markets or markets for outsourcing contracts. Many markets involve price-setting by sellers or price negotiation between buyers and sellers. Finally, there are many markets with non-rivalrous consumption, such as television and radio programs, news, technical information, online education, and entertainment (games, movies, music).

Some critics of the patent system apply inappropriate benchmarks based on the theoretical market model in neoclassical economics. According to Troy and Werle (2008) for example,

> "[f]undamental and strategic uncertainty related to patent trading – a specific decontextualized institutional form of knowledge property – has prevented functioning markets for patents from emerging. Apparently, patent transactions are not made in perfect, anonymous neoclassical markets. Also, if we define markets less rigidly as institutional fields constituted by sellers and buyers, intermediaries and regulators, sharing rules, standards, and norms which govern transactions, we can hardly speak of a market for patents."

This argument is based on the unrealistic definition of markets as centralized auctions, such as organized financial exchanges. The authors also rule out transactions involving intermediaries, regulators, standards and norms. This definition not only eliminates financial exchanges but also practically any market, because practically any market has a microstructure with these features (Spulber, 1999). Criteria that define almost all markets out of existence should certainly not be applied to patents and are misleading for public policy.

C. Disclosure

Disclosure often is portrayed as a quid pro quo: the patentee provides disclosure of the invention in return for the patent award. However, disclosure has value to inventors and adopters as a foundation for market transactions. Disclosure provides a description of the invention, the list of claims and other information in the patent are useful for transactions. It is not necessary for buyers and sellers to spell out all this information every time a transaction occurs. This reduces the costs of licensing and technology transfer contracts. Patents provide transaction efficiencies in a manner that is similar to other forms of ownership registration including securities, real estate, and motor vehicles.[23]

Disclosure reduces the costs to potential adopters of determining what technologies are available for licensing or transfer and what types of prior work has been done. This can reduce the costs of innovation for potential adopters. Disclosure also reduces the costs to other inventors who can learn about prior art and avoid duplicating past research. Inventors also can benefit by extending and improving on existing inventions. Disclosure is also useful for potential adopters to reduce their risk of infringement.

Disclosure also increases transaction efficiencies by reducing search costs in the market for inventions. The USPTO provides a centralized searchable data base for patents. Potential adopters can reduce their costs of obtaining technology by finding out about what patented technologies are available. Inventors also benefit from lower search costs because disclosure reduces their costs of publicizing their inventions to potential adopters.

[23] Patent ownership also is comparable to incorporation of companies, which provides information about the name, purpose and location of the company.

Disclosure to the USPTO also mitigates adverse selection in bargaining between inventors and adopters. Adverse selection in bargaining can result in the failure of a buyer and a seller to come to an agreement even though the transaction would offer gains from trade. When the quality of the seller's good is observable to the buyer but not to the seller, the seller's offer may not be sufficient to compensate the buyer. Disclosure increases the information about inventions available to potential adopters, thus reducing asymmetry of information in negotiations between inventors and adopters.

Kieff (2001, 2003) argues that inventors have incentives to disclose their inventions accurately so as to increase the likelihood that their patent will be valid if challenged in court. Kieff (2003) points out that disclosure reduces social costs by providing information about property rights, so that registration in itself generates transaction efficiencies. Kieff (2001) emphasizes that the patent system promotes commercialization through incentives for accurate disclosure.

D. Certification

The USPTO performs a variety of certification tasks that reduce transactions costs in the market for inventions. These tasks include patent review that determines whether the patent satisfies various criteria that determines whether the invention is useful, novel and non-obvious. The USPTO provides a recognized method of screening and certification that allows market participants to avoid duplicating theses costs. The certification role offered by the USPTO and the courts provide generic information that supplements the important certification contributions of specialized market intermediaries.

The USPTO's patent review alleviates adverse selection in the market for inventions by certifying the disclosure of information about the invention. This reduces the potential for the "lemons" problem where bad inventions drive out good inventions. The certification system is accompanied by *ex post* review in the courts that determines not only the validity of the patents but also implicitly provides a check on the patent system itself. The certification system also is subject to *ex post* review in the market for inventions itself. Market transactions provide indications of the performance of the certification system. Simply having a patent does not guarantee that the patent has market value, indeed many patents do not have market value. The fact that many patents have value provides an indication of the service provided by the USPTO certification system.

Thus, licensing of patented inventions, patent transfers, and the production of goods and services that embody patented inventions provide evidence of the market value of the USPTO certification system. This serves to refute the assertions of some critics that the patent system creates "bad patents." A number of critics suggest that the USPTO's examination processes have generated patents that are invalid in terms of usefulness, novelty or non-obviousness (Lemley, 2001, Thomas, 2002, Jaffee and Lerner, 2004, Lemley and Moore, 2004). Katznelson (2007) demonstrates that various studies purporting USPTO standards to be inferior to agencies abroad are based on incorrect statistical analysis. Katznelson (2007) critiques statistical methods used by Martinez and Guellec (2004) and Jensen et al. (2006). Katznelson (2007, p. 29) observes that "even accurate patent grant rate comparisons among national patent offices are of little probative value and should not be used as indicators of examination rigor or patentability standards."

Some critics of the patent system argue that particular types of inventions generate "bad patents." For example, Merges (1999) objects to patenting of software and business method

inventions because such technologies were formerly "impossible" to patent.[24] As I argue elsewhere (Spulber, 2011), business method inventions reflect commercial discoveries and should not be treated differently from traditionally defined scientific and technological discoveries. Critics of these types of inventions reflect familiar biases against entrepreneurs and market transactions. There is evidence that software and business method patents are if anything higher in quality than other types of inventions (Allison and Tiller, 2003).

Potential adopters have greater information about inventions than might otherwise be disclosed in transactions involving trade secrets. One type of efficiency loss from adverse selection known as the "lemons problem" occurs if lower-quality goods drive higher-quality inventions from the market. This can occur in principle when buyer willingness to pay depends on the expected value of a good. Suppliers of goods that are better than the expected value will exit the market and suppliers of goods that are worse than the expected value will stay in the market, possibly leading to the collapse of the market entirely. Economic analysis shows that this problem can be alleviated by intermediaries that invest in certifying the quality of goods.[25]

Certification also reduces transaction costs by determining the identity of the initial patent owner. The US patent system traditionally awarded a patent to the inventor that was the first to invent, which required an initial determination of the identity of the first inventor. Under

[24] Merges (1999) combines a discussion of the USPTO patent examination process with a presumption that software and business method inventions will lead to bad patents, although these are entirely different questions.

[25] See Biglaiser (1993), Biglaiser and Friedman (1994, 1999), and Spulber (1996, 1999).

the America Invents Act, the patent is awarded to the first to file.[26] Although there are costs and benefits associated with either system, there are benefits to determination of the initial assignment. This reduces the costs of search in the market place by specifying the assignment of property rights.

E. Standardization

Standardization is an important feature of the patent system that has not gotten sufficient attention. Although each invention is different, patents have consistent features. Patents are standardized documents with an application number, a bar code, an application date, an award date, names of inventors, names of assignees, a title, an abstract, citations to prior patents, and formal specification of claims. Patents are standardized in terms of duration, which is generally twenty years from the time the application was filed. The patent application procedure and examination process are standardized.[27] There is a complex set of rules that apply to all patent applications and patent awards.[28] In addition to these rules, there are standardized legal procedures for patent owners seeking injunctions and damages for infringement.

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[26] Keiff (2001) suggests that a rush to file under the first-to-file rule can lead to inadequate disclosure, resulting in patents being more likely to be found invalid and reducing incentives for commercialization.

[27] See the *Manual of Patent Examining Procedure* (MPEP), Ninth Edition, March 2014, USPTO, http://www.uspto.gov/web/offices/pac/mpep/index.html, Accessed April 10, 2014.

[28] The United States Code Title 35 – Patents sets for the laws governing patents, http://www.uspto.gov/web/offices/pac/mpep/consolidated_laws.pdf, Accessed April 10, 2014.

The patent system provides a set of rules governing licensing and transfer of ownership.[29] According to the USPTO, an assignment must include "all of the bundle of rights that are inherent in the right, title and interest in the patent or patent application."[30] A patent licensing agreement "transfers a bundle of rights which is less than the entire ownership interest, e.g., rights that may be limited as to time, geographical area, or field of use." The USPTO maintains public records on assignments.

The patent system offers a standard vocabulary that is common usage in market transactions. Patent numbering and public records of patents and applications offers a highly convenient system for asserting IP; it is sufficient for a company to state the patent number or application number on a product or its packaging. Under the America Invents Act, companies have the option of virtual marking by listing a website with the patent information. This lowers transaction costs by separating patent marking from product manufacturing and distribution (McCaffrey, 2011).

All of this standardization reduces transaction costs in the market for inventions. Standardization of products is an essential aspect of market efficiency. Standardization allows buyers and sellers to focus their attention on the idiosyncratic features of the transaction at hand Standardization allows for economies of scale in transactions. Also, standardization allows buyers and sellers to make comparisons with other transactions, thus facilitating competition. Standardization of vocabulary lowers the costs of communication and negotiation.

In the market for inventions, standardization in patents simplifies licensing contracts, technology transfer agreements, and other transactions. The patent document is part of the

[29] http://www.uspto.gov/web/offices/pac/mpep/s301.html, Accessed April 10, 2014.

[30] Id.

agreement and the technology does not have to be fully described each time a transaction occurs. Prices and other contract terms adjust to reflect the unique features of the technology itself and the purposes of the agreement between the buyer and seller.

Standardization in patents reduces transaction costs associated with the development and adoption of technology standards. Patents provide a means for IP owners of conveying information to standards organizations. Companies with patents that read on a standard can readily declare patents "essential" to a standard by communicating the patent numbers to the organizations. Companies that develop new technologies related to existing standards can obtain patents for those standards and report those to standards organizations. Companies seeking to adopt technology standards can determine what IP may be relevant to the standard by observing what patents declared "essential." Patents serve as standard building blocks for technology standards.

F. Divisibility

Patents are useful for the divisibility of technology into discrete units. Although there is considerable debate over whether patents should be broader or narrower, patents serve to define boundaries between inventions. This has important benefits for transactions in the market for inventions.

Patents necessarily impose boundaries on inventions as spelled out in patent claims and the specifics of the technological descriptions. There are numerous transaction advantages of the divisibility. The most important benefit of discreteness is that buyers and sellers can enter more easily into transactions that only involve a specific technology. The technology can meet the

particular purposes of the adopter without their having to purchase a host of costly technologies that they might not need.

Patents as discrete inventions are the building blocks for collections of inventions. Patents can be combined to form a patent portfolio. Firms can assemble a portfolio of patents with different technologies to meet their production needs. Buyers can license or purchase patents from different patent owners. Patent bundling offers transaction efficiencies by providing convenience to buyers and sellers. Because they represent discrete inventions, the particular needs of buyers and sellers can be satisfied by choosing the best combination of patents.

By offering divisibility, patents promote efficiency in the organization of firms and industries. A firm need not conduct R&D on all the technologies necessary to produce a product or service. Instead, firms can specialize in a particular type of R&D. Then, buyers can assemble the technologies they need through the market for inventions. In this way, patents help foster *modularity* of technologies, which allows the separation and combination of different parts of a technology platform.

Modularity of technologies generates efficiencies from specialization and division of labor. Different companies can focus on invention, innovation and manufacturing. Also, companies can focus on different types of R&D. For example, in the computer industry different firms can focus on R&D in software, microprocessors, memory, and screens. This type of specialization improves inventors' knowledge and experience in comparison with what occur if firms would need to be proficient in all technologies needed to produce a particular product.

Because patents offer divisibility, as well as exclusivity and transferability, companies can engage in specialized R&D and exchange technologies in the market for inventions. This allows a division of labor in invention, innovation, and manufacturing. Specialization allows

companies to take advantage of economies of scale and other types of efficiencies in invention, innovation, and manufacturing. Market exchange of technologies generates gains from trade by selection of the best inventions and wider usage of the best inventions (Spulber, 2008, 2010). Patents offer technological divisibility to the market for inventions that increases gains from trade.

II. Innovative Control

Patents are the basis of a market for innovative control. The returns from licensing or selling patents are only part of patent ownership. A patent owner can exercise residual rights of control because they can exclude others from making, using or selling the invention.[31] Because the market for invention is a market for innovation control, it provides incentives for efficiencies in invention, innovation, and investment in complementary assets. This is related to the way that ownership of corporate securities is the basis of a market for corporate control. Securities facilitate the separation of ownership and control and yield other transaction efficiencies (Manne, 1965, Spulber, 2009b).

A. Invention and Commercialization

Because of patent protections for IP, the market for inventions is a market for innovative control. The market for innovative control provides incentives for inventors to produce desirable inventions. Inventions are the *outputs* of R&D. This is quite different from rewards for inventive

[31] The patent owner does not grant rights of control because the patent owner is subject to whatever legal and regulatory restrictions might apply. The patent owner thus exercises residual rights of control in commercializing and developing the patented invention.

efforts, which are the *inputs* of R&D. Simply subsidizing invention or rewarding inventive efforts could produce more inventive efforts but not necessarily better inventions. Subsidies or rewards for invention in the absence of IP protections also would not provide incentives for commercialization of inventions, which is essential for diffusion of technology and innovation.

The market for innovative control provides important economic benefits. The interaction of the demand and supply of inventions determines the market value of inventions. Inventors compete to supply producers with inventions and producers compete to obtain inventions or develop their own inventions (Spulber, 2013a, 2013b). The market value of an invention reflects competition from both substitute and complementary inventions on the supply side of the market for inventions. The market value of inventions depends on the stock of inventions and anticipation of future discoveries that may enhance the demand for particular inventions or render those inventions obsolete. The market value of an invention also reflects the returns to applying inventions obtained by adopters on the demand side of the market for inventions.

As a result of competition among inventions, the market for inventions helps to determine the best inventions for particular needs of consumers and firms. Competition among potential adopters also helps the market for inventions allocate inventions to the highest value users. The market for inventions determines the relative returns to invention, commercialization, and innovation. As a result, the market for inventions provides valuable information and guidance to inventors and adopters.

The patent provides IP protections for additional development of the invention and embodiment of the invention in some innovations covered by the claims. This is consistent with Kitch (1977) who explains that patents are “prospects” analogous to mineral rights that have yet to be fully developed. To formalize these concepts, I characterize a patented invention as an

intangible real asset whose market value is random. The randomness in the value of the asset is due to randomness in the outcomes of the development process, in the costs of the development process, and in market valuations of the outcomes of R&D. The market value of the asset also can depend on the extent of the claims in the patent.[32]

The market value of the asset can be represented by a random variable *V* that is distributed according to a probability distribution *F(V)*. The random variable *V* can be viewed as an *investment project*. The probability distribution of the value of the asset *F(V)* can be generalized in various ways. The patent owner can choose among various investment projects with random outcomes, so that the distribution of the value of the patent depends on the choice of projects. The patent owner can invest in development and commercialization, so that the distribution of the market value of the patent depends on the level of investment.

With patent protections, inventors' expected returns depend on the market value of their inventions. This provides incentives to inventors to invest in R&D and commercialization of inventions that depend on the supply of and demand for different types of inventions. The expected market value of inventions provides guidance to inventors for efficient investment in R&D. Efficient levels of investment in R&D reflect the tradeoff between the expected benefits and costs of R&D. Inventors will have incentives to invest such that the expected marginal returns to R&D equal the marginal costs of R&D.

The market for inventions provides additional guidance to inventors on the choice of R&D projects. Because market values of individual inventions differ, the returns to producing

[32] Although the emphasis here is on development of the invention, the framework is sufficiently general to include randomness in the legal and regulatory process. This could include randomness in the legal patent validity as discussed in Lemley and Shapiro (2005).

inventions through R&D depend on how the resulting inventions will be valued in the market. The expected returns to different directions in R&D will depend on scientific and technical opportunities and the potential market value of successful outcomes. Efficient levels of investment in R&D will be targeted to particular areas on the basis of expected returns to different types of inventions.

The market for inventions also provides guidance on how much to invest in commercialization and how to commercialize particular inventions. Commercialization of inventions requires investment in communication, marketing, and sales efforts. Patent owners also need to identify potential adopters who might license or purchase their inventions. Patent owners need to choose among different methods of commercialization including transfers, licensing, cross-licensing, services, and contract R&D. In addition, patent owners must monitor potential infringement and if necessary invest in the legal costs of obtaining damages and injunctions. The market for inventions contains many types of transactions including embodied inventions. This implies that limited licensing does not indicate market failure, contrary to some studies (PatVal-EU Project, 2005, 2006, Giuri et al., 2007).

Patents play a significant and expanding role in the market for inventions as shown by substantial patents sales. For example, in 2011 Nortel Networks sold about 6000 patents and patent applications for $4.5 billion to a consortium of companies that included Apple, EMC, Ericsson, Microsoft, RIM, and Sony.[33] Serrano (2010) finds that the highest rates of transfers

[33] Charles Arthur, "Nortel Patents Sold for $4.5bn," *The Guardian*, July 1, 2011, http://www.theguardian.com/technology/2011/jul/01/nortel-patents-sold-apple-sony-microsoft, Accessed January 25, 2014.

occur in information and communications technology (ICT) and the pharmaceutical and medical industries.

Patents are important for commercializing inventions through licensing. Using data from the Securities Data Corporation (SDC), Anand and Khanna (2000) find significant licensing activity in the Chemicals, Computers, and Electronics industries. Arora et al. (2007) apply extensive survey data on research labs in the U.S. manufacturing sector and show that patent protection of IP supports the market for technology licensing and the provision of specialized technology services. The market for inventions includes not only domestic markets but also international transactions related to IP; royalty and licensing fees in international transactions grew faster than global GDP reaching $2.8 billion in 1970, to $27 billion in 1990, to $180 billion in 2009.[34]

B. Innovation

Because patents allow their owners to exclude others from making, using, or selling the inventions, they provide innovative control to IP owners. Patents are forward-looking because they offer IP protections for innovations based on patented inventions. Given these protections, firms have market incentives to develop innovations that use the invention in their products, production processes, and transaction techniques. The market for innovative control provides incentives for efficient levels of investment in innovation and for targeting investment toward innovations with desirable features.

The market for innovative control also promotes efficiencies in the organization of firms and industries. Weaker IP protections increases transaction costs for inventors and innovators.

[34] This is according to the World Intellectual Property Organization (WIPO) (2011, p. 9).

Inventors and innovators will have incentives to replace patent protections with other mechanisms including contracts and vertical integration.[35] With stronger IP protections, inventors and innovators can make decisions about transactions, outsourcing and vertical integration based on other business considerations. The market for innovative control also allows the entry of specialized intermediaries who can invest in commercialization, innovation and complementary assets.[36]

As with securities markets, the market for inventions allows separation of ownership and control. The patent owner can obtain returns from the patented invention while delegating control over usage to licensees who employ the technology. The patent owner does not need to undertake all the transactions needed to apply the invention, but instead can rely on others to apply the invention. Delegation of control to licensees also provides benefits from specialization and division of labor. The patent owner can obtain returns from licensing and the licensees can apply their expertise to commercializing and applying the invention.

C. Investment in Complementary Assets

The market for innovative control also provides incentives to invest efficiently in *complementary assets*. Assets that are complementary to inventions include human resources, absorption of inventions, IP, product design, capital equipment, marketing, sales, procurement, and establishment of new firms. Patent protections allow companies to make investments in those complementary assets that are specific to particular inventions rather than in generic complementary assets. Invention-specific investment can generate greater economic returns. For

[35] See Arora (1996) and Arora and Merges (2004).

[36] See Yanagisawa and Guellec (2009) and Hagiu and Yoffie (2013).

a discussion of the importance of complementary assets in innovation, see particularly Teece (1986, 2006).

Inventors at Amazon Technologies obtained patent number 8615473 B2 for a "Method and system for anticipatory package shipping:"

> "According to one embodiment, a method may include packaging one or more items as a package for eventual shipment to a delivery address, selecting a destination geographical area to which to ship the package, shipping the package to the destination geographical area without completely specifying the delivery address at time of shipment, and while the package is in transit, completely specifying the delivery address for the package."

The basic invention is the discovery that the delivery address can be specified after shipping has begun. The value of this invention to a major e-commerce company such as Amazon.com is evident because shipping is a major aspect of their service and constitutes a significant part of their costs.

The Amazon patent specifies not only the basic invention but also looks ahead to innovations that will be introduced to the market based on that invention. Among the 24 claims, the patent contemplates different embodiments of the invention, including multiple computer systems that will communicate with each other, with one computer system initiating the shipment and the second computer system determining the destination and communicating with this first computer system.

Implementing a complex shipment system as envisioned in Amazon's patent will require investment in complementary assets, including computer software and hardware and machinery in the company's warehouses. To get some idea of the extent of this investment, consider that Amazon has spent over $5 billion on its facilities in five years, operates 40 fulfillment centers,

and has plans to build more. Amazon's fulfillment center in Phoenix, Arizona covers an area greater than 28 football fields.[37]

Amazon's shipping patent provides an indication of market incentives for investment in invention, innovation and complementary assets. In this example, Amazon is applying its own invention. Amazon's incentives to develop better shipping techniques are based on the market returns to improved shipping services and the lower costs of more efficient shipping technologies. Amazon has incentives to offer products and services based on its basic invention because of the market returns to developing and implementing its invention. Amazon has incentives to invest in complementary assets such as computers, fulfillment centers and specialized equipment to realize the full returns to its invention and related innovations. Amazon's patent allows it to exclude others from making, using, or selling its business method invention.

As illustrated by the Amazon's shipping method patent, patent protections protect incentives for invention, commercialization, innovation, and investment in complementary assets. The market for innovative control provides guidance for what types of inventions to pursue and the direction of subsequent development, innovation and complementary investments.

[37] Megan Rose Dickey, 2012, "Mind-Blowing Facts About Amazon's Giant Shipping Operations," *Business Insider*, November 26, http://www.businessinsider.com/amazon-fulfillment-center-tour-2012-11?op=1 Accessed, April 14, 2014.

III. Financing Invention and Innovation

A key function of patents is helping to obtain *financing* of invention and innovation. Inventors attempt to create inventions by applying effort, knowledge, creativity, capabilities, insights, and scientific observations. If R&D is successful, the discovery may be valuable in commercial applications or as an input to further R&D. The discovery is the knowledge of the inventor, whether explicit or tacit, so it can be difficult to separate the discovery from the inventor. Patents help inventors to achieve financial separation from their inventions, which is necessary for financing. By protecting IP rights, patented inventions serve as intangible real assets for companies.

A. Patents and Financial Separation

Financial separation of the invention for the inventor is critical for investment and financing of invention and innovation. The patented invention is an intangible real asset that embodies the inventor's discovery as well as subsequent development of the invention. The separation of the invention from the inventor is analogous to the creation of a firm by an entrepreneur. Myers (1999, p. 134) observes "[t]he company starts up with human capital. As and if it succeeds, an intangible real asset is created: the technology is embodied in product design; the production process used, and in the product's reputation with customers." Myers (1999, p. 134) points out "[t]his real asset separates from the people who created it and can in due course be appropriated by financial investors. The venture could not raise outside money otherwise."[38]

[38] See also Myers (2000).

By separating invention from inventors, patents facilitate the financing of R&D. Patents support financing of R&D by independent inventors and specialized firms. As intangible real assets, patented inventions support invention and innovation by corporations. Graham et. al (2014) find that startups patent to obtain financing as well as seeking competitive advantage and deterring infringement. Arqué-Castells (2012) shows that investment by venture capitalists (VCs) funds the development of inventions and increases patenting by start-ups. Studies using aggregate industry data tend to show that VC funding tends to increase patenting (Arqué-Castells, 2012).

Innovation requires costly investments in developing and commercializing inventions. The inventor must invest in communicating the discovery to others by codifying it in the form of technical reports, diagrams, blueprints, computer code, statistical analyses, and mathematical formulas. The inventor incurs costs of developing the invention in the form of models, prototypes, equipment, materials, chemical compounds, and biological matter. The inventor can embody the invention by investing in the development of new products, new manufacturing technologies or new transaction methods.

Inventors may not be able to invest efficiently in developing or commercializing their inventions if they cannot obtain financing. Innovation can be inefficient if financially-constrained inventors cannot transfer their inventions to others. When inventors face financial constraints and limits on market transferability of their inventions, the conditions of the Fisher Separation Theorem (1906, 1907, 1930) do not hold. This has important implications for invention and innovation.

Consider an inventor who has created an invention. The invention can be developed and commercialized through additional investment in innovation. In a two-period setting, for

example, the optimal investment in innovation equates the expected marginal return to investment to the per-unit cost of investment.

To examine the implications of transferability for the inventor's decisions, suppose that the inventor is financially constrained and does not have sufficient funds to cover the costs of investing efficiently in innovation. Also, suppose that the inventor cannot obtain financing to develop and commercialize the invention. The innovator will be forced to under invest in innovation and if a minimum level of investment is needed, the innovation may be unable to develop the innovation at all. This problem is readily solved if the inventor can transfer the invention to others. Buyers that are not subject to liquidity or financing constraints will be willing to pay up to the maximum value of the innovative project. Buyers will develop the innovation efficiently either through investment of their own funds or by obtaining financing for the costs of innovation.

Consider an independent inventor who cannot transfer the invention and also is subject to liquidity and financing constraints. The inventor must invest in innovation and will face a tradeoff between consumption and investment in innovation. An inventor who cannot transfer the invention to others and is financially and liquidity constrained faces interconnected consumption and investment decisions. The inventor's investment in innovation will reflect his marginal utility of consumption, subjected discount rate and initial endowment.

Suppose instead that the inventor can transfer the invention to others who then can efficiently invest in developing the innovation. Then, because others can invest efficiently, the investment project will attain the maximum expected value. The inventor will maximize the benefits of consumption subject to a budget constraint that includes the returns from the sale of

the invention. The efficient investment level will not depend on the costs and benefits of innovative investment and not on the inventor's endowment or preferences.

This discussion demonstrates how patents generate gains from trade by facilitating the financial separation of inventions from their inventors. The inventor will be made strictly better off by transferring the invention to others than by developing the innovation himself. This follows from the standard Fisher Separation Theorem. Inventors who are financially and liquidity constrained benefit from transferring inventions to others in the market who can invest efficiently in innovation. Innovators who acquire inventions benefit by investing in developing and commercializing inventions.

B. Patents and Financing Innovation

Patents also can provide a means of financing invention and innovation. Independent inventors and specialized firms can obtain financing for the invention by offering to license or transfer the patent to a company that provides financing. Companies that fund research can obtain an option to license or purchase the inventions after they are patented. If the inventor or specialized firm has already obtained a patent, the patent can serve as collateral for financing to develop the invention and to innovate based on the invention. Nathan Myrvold recommends the creation of patent-backed securities and suggests that "the business of invention would function better if it were separated from manufacturing and developed on its own by a strong capital market that funded and monetized inventions."

Patents are intangible real assets that contribute to the market value of the firm. The patent provides IP protections for an investment project V. Suppose that the firm's assets consist of a patent with expected market value EV. Corporations obtain financing based on their patents.

In the balance sheet of a firm financed by debt and equity, the market value of debt and equity equals the expected market value of the firm's intangible real asset, *EV*.

Patents can represent "assets in place" in the sense of Myers (1977). Patents that are "assets in place" contribute to the market value of the corporation. Patented inventions affect the firm's earnings through licensing revenues or as productive inputs. Studies show that patent ownership by corporations contributes significantly to their market value.[39] The market value of patent ownership reflects the value of own-use of technology, the benefits of cross-licensing, and earnings from licensing. Companies earn significant revenues from licensing patents. For example, IBM earns about $1 billion annually from licensing revenues.[40] Robbins (2009) estimates that in 2002 US corporations reported about $67 billion in earnings from IP protected by patents and trade secrets. Adams et al. (2013) study the effect of patent ownership on the value of companies based on licensing revenues of specialized patent intermediaries.

Patents also can represent "growth opportunities" in the sense of Myers (1977). Patented inventions serve as "growth opportunities" because the company can develop the invention, innovate based on the invention, and invest in complementary assets. Also, the company can develop new technologies that extend their patented inventions. Myers (1977) points out that assets that are "growth opportunities" can function as call options because they involve investment decisions under uncertainty.

The capital structure of the firm can have incentives effects on investment in invention and innovation. Myers (1977) shows that equity financing is best for inducing firms to maximize

[39] On the financial valuation of patents see Munari and Oriani (2011) and Murphy et al. (2012). See Hall (1993) and Hall et al. (2007) on the stock market value of R&D investment.

[40] Barinka (2014).

expected value of projects. This is because debt financing could cause the firm to avoid some projects that have positive expected value. Equity financing provides incentives for efficiency in the choice of R&D projects as well.

Debt financing is useful as an incentive mechanism for inducing effort. Jensen and Meckling (1976) argue that with moral hazard, debt financing gives managers incentives for more efficient performance in comparison to equity financing. Poblete and Spulber (2012) show generally that the optimal contract with moral hazard and limited liability takes the form of debt. This is because debt-style contracts serve to concentrate payments to the agent in the best states, which induces efficient levels of effort. Poblete and Spulber (2014) extend this analysis to R&D and show that debt-style contracts are the optimal contract for inducing R&D effort.

Investment in R&D by companies provides evidence that the exclusivity provided by patents protects investment-backed expectations. Corrado et al. (2009) consider average annual capital spending during 2000-2003 and estimate that companies invested approximately $640 billion in R&D and development of computer software.

The role of patents as intangible real assets further shows that patents are not “rewards” for inventors. Inventors are no more rewarded by patents than companies are rewarded by registering securities. Indeed, patents as intangible real assets are analogous to *financial assets* in many ways. Just the market for inventions provides returns and control to patent owners and determines the value of patented inventions, so securities markets provide returns and control to owners of securities and determine the value of publicly-traded firms. Inventors seeking patents must make filings and disclosures to the USPTO including a description of the invention and information showing that the invention is useful, novel, and non-obvious. Firms selling securities must register those securities with the Securities and Exchange Commission (SEC) and make

various disclosures including a description of the security, an explanation of the company's properties and business, information about the company's management, and certified financial statements.[41] Just as each patent is different, so each corporate security is different, Procter & Gamble stock is not the same as ExxonMobil stock.

IV. Public Policy Implications

The present analysis of the market for inventions has implications for antitrust policy and public policy towards patents. Protection of IP and antitrust policy are complements because protecting IP promotes competition in the market for inventions and in markets for goods and services that embody or are manufactured with patented inventions. Conversely, antitrust policy that favors competition in market for invention and in product markets will increase incentives to innovate. This implies that both patent policy and antitrust policy should favor stronger IP rights. Patent policy and antitrust policy should avoid making exceptions to protections of IP rights. Policy makers thus should avoid restrictions of IP rights on the basis of cutting-edge technologies such as software, business methods, or biotechnology.

A. The Fallacy of "Deadweight Welfare Loss"

Public policy arguments directed against patents and IP in general often are based on the notion of "deadweight welfare loss." The argument is that because the use of inventions is non-rivalrous and because information can be distributed at zero marginal cost, the welfare-maximizing price of an invention should equal zero. According to this argument any positive price would generate a "deadweight welfare loss" so that technology should be freely available.

[41] See http://www.sec.gov/about/laws.shtml, accessed April 3, 2014.

Because patent owners may receive a positive payment for their inventions, the argument suggests that inventors should receive "prizes" from the government. The "prize" system would eliminate IP rights with inventions entering the public domain. Alternatively, the government would own the inventions and distribute them freely to potential users. The discussion in this section shows that the economic argument based on "deadweight welfare loss" is incorrect. A later section considers other problems with government "prizes."

The "deadweight welfare loss" argument is a fallacy for various reasons. First, and foremost, the argument overlooks the role of markets in allocating goods and services. As the discussion thus far emphasizes, markets provide a mechanism for allocating goods and services to the highest value users. Markets require property rights to support exclusion, control and transferability. Market prices provide signals to buyers and sellers about costs and scarcity. Market prices also provide incentives to buyers in their purchasing decisions allowing them to evaluate their purchases of goods and services in comparison to alternatives. Market prices provide incentives to sellers to offer competing and complementary goods and services. Market prices for inventions provide a guide for efficient investment in invention and innovation. With zero prices for technology, there will not be returns to investment in developing innovations and complementary assets that are specific to the new technology.

Second, the "deadweight welfare loss" argument is a revival of the flawed natural monopoly argument for government regulation. The argument goes back to the familiar public works discussion of Dupuis (1844) and Hotelling (1938). Whenever a firm operates at an output where there are economies of scale in production, marginal cost pricing will not generate sufficient revenues to cover costs. Invention, commercialization and innovation involve fixed costs so that these activities are indeed subject to economies of scale. However, practically any

other economic activity involves economies of scale. Insisting on government ownership whenever economies of scale exist would require abandonment of a market economy entirely because economies of scale are pervasive in manufacturing, services and distribution. With economies of scale, even the theoretical ideal of a marginal cost pricing equilibrium that is Pareto optimal is likely to be a vacuous concept, see Spulber (1989, ch. 8). Markets routinely allocate goods and services whose production and distribution features economies of scale. Market returns necessarily cover the average costs of production so that firms are able to break even.

Third, markets routinely address the "deadweight welfare loss" problem. In practice, firms in industries with economies of scale can approach marginal pricing when necessary with two-part tariffs and other pricing mechanisms (Spulber, 1989).[42] A two-part tariff involves a fixed fee that helps to cover fixed costs while allowing firms to lower per-unit fees. It should be emphasized that patent licensing often features two-part tariffs with an up-front lump-sum royalty and a royalty per-unit of output produced using the invention. Royalties can be based on the number of units sold or revenues from sales.[43] Markets also distribute some products such as broadcast television and Internet search using advertising revenues. Products such as cable television rely on combinations of access fees and advertising revenues. Markets for patents and other IP thus have pricing mechanisms that address efficiency without the need for government ownership or price regulation.

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[42] See also Kieff (2001) on market pricing of inventions. Roin (2014) also points out that two-part tariffs for inventions remove some of the theoretical advantages of "prizes."

[43] On the difference between per-unit royalty rates (based on the apportionment rule) and ad-valorem royalty rates (based on the entire market value rule), see Llobet and Padilla (2014)

Fourth, it should be emphasized that commercializing, distributing, and applying inventions provide economic benefits and necessarily have economic costs. These activities are among the many economic services provided by the market for innovative control. Marketing activities serve to diffuse inventions and innovations in the economy. Marketing and sales of products are not a "waste" but rather economic activities that address allocation of goods and services. These economically beneficial activities also entail transaction costs and costs of production. Market returns to commercializing, distributing, and applying inventions cover these transaction and production costs. Patent owners who commercialize their inventions expend resources searching for potential licensees and negotiating licensing agreements. Patent owners also expend resources in codifying, developing and demonstrating their inventions. Patent owners devote effort to developing industry standards by participating in standards organizations. Contrary to the "deadweight welfare loss" argument, allocation of inventions and innovations is not a free lunch.

B. Antitrust Policy

Antitrust policy towards patents should consider their role as the foundation of the market for inventions. This immediately eliminates the false conflict between patents as monopoly rewards for inventors and antitrust as rent control. The antitrust policy objectives of promoting competition and consumer welfare complement the market foundation role of patents.

Indeed, patents serve to promote competition among inventors and among adopters. Competition in the market for inventions limits inventors' rewards; most patented inventions receive no rewards. The patent system, by creating transferable assets from inventions, help translate market competition into incentives for invention and innovation. When there is a market

for inventions, competition among inventors increases incentives for invention and innovation. Additionally, when there is a market for inventions, competition among adopters increases incentives for invention and innovation (Spulber 2013a, 2013b). Without such protections, companies resort to secrecy and vertical integration, which can result in competition reducing incentives to invent and to innovate.

A common misconception among economists is that patents give their owners an economic monopoly. For example, Kenneth Arrow's (1962) classic analysis states "[w]ith suitable legal measures, information may become an appropriable commodity. Then the monopoly power can indeed be exerted."[44] Boldrin and Levine (2013) argue that patents provide "a monopoly as a reward for innovation" and that there is "little doubt that granting a monopoly for any reason has the equally ill consequences we associate with monopoly power." The patent as monopoly argument has been refuted by John Stuart Mill (1848), Kitch (1977, 2000) and Spulber (2013).[45]

The characterization of patents as economic monopolies is incorrect because a patent only gives exclusivity of ownership of a particular invention – a patent does not prevent competition from other inventions. A patented invention faces competition from inventions that are in the stock of past inventions. For example, the USPTO issued 276,788 patents in 2012. Patents filed on or after June 8, 1995 have a term of twenty years from the time of filing, so the

[44] See also Nordhaus (1969, 1972), Scherer (1972), and Gilbert and Shapiro (1990).

[45] John Stuart Mill (1848, p. 932) observes that "the condemnation of monopolies ought not to extend to patents." This is quoted in Machlup and Penrose (1950, p.).

stock exceeds two million patents. See Table 1 for the number of patents issued in the US from 1963 to 2012.

A patented invention also faces *potential* competition from future inventions. Thus, a patent does not create a barrier to entry into the market for inventions because any other patented invention can enter the market for inventions. Any invention that is novel and thus does not infringe on patented inventions can enter the market for inventions.

A patented invention faces additional competition from inventions that are not protected by IP rights including inventions that were patented but whose term has expired. For example, patented pharmaceuticals face competition from generics. A patented invention faces competition both within and across the patent categories established by the USPTO. This is because the patent categories have to do with the properties of the inventions, which need not correspond to adopters' uses for inventions. For example, a computer software invention such as an e-mail program can compete with a computer hardware invention, such as a fax machine.

Nor does a patent create barriers to entry in product markets. Any product that uses other patented inventions or that uses any technology that does not infringe on the patented invention can enter the product market. Thus, producers that offer product that applies a patented invention face competition in the product market. Competition in the product market from firms using other technologies limits the economic returns to a particular invention.

A patented invention faces competition both from inventions that are substitutes and from inventions that are complements. The economics definition of substitute (complementary) products refers to those products whose demand increases (decreases) with an increase in the price of the other products. Products are economic substitutes if some buyers must be willing to switch some of their consumption from one good to another in response to changes in the relative

prices. The concept of economic substitutes only requires products to be comparable rather than identical, which is referred to as perfect substitutes. Products are economic complements if some buyers derive benefits from joint consumption. Buyers can derive benefits from consuming a selection of complementary products, so that joint consumption of all complementary products is not necessary, in contrast to perfect complements.

Competition and entry of substitutes in the market for invention limits or eliminates the market power of inventions. When inventions are vertically differentiated, that is buyers can rank inventions consistently on the basis of quality, buyers' willingness to pay for a particular invention is limited by the incremental contribution of that invention to their profits. Inventions other than the best invention are not adopted and inventors need not recover their costs of invention. Buyers will tend to apply the best invention and royalties are less than or equal to the incremental benefits of the best invention as compared to the best alternative. This outcome corresponds to dominant designs or to technology standards based on the best technology. The best technology is subject to change as new inventions continue to enter the market.

When inventions are horizontally differentiated, multiple technologies may be adopted in the market for inventions. Chamberlin's (1933) model of monopolistic competition is useful for characterizing competition in a particular segment of the market for inventions. This model features price setting by suppliers and competitive entry. Although suppliers have pricing power, entry dissipates rents. With up-front fixed-fee royalties, the equilibrium royalty will equal the cost of invention divided by the number of licenses offered by every inventor plus licensing costs. A similar argument can be made when inventors charge a royalty based on the units of

output sold by adopters.[46] Even if inventors have pricing power, entry of substitute inventions drives inventors' economic profits to zero.

Even in the absence of substitutes, inventions compete with complementary inventions in the market for inventions. As first illustrated by Cournot's (1838) model of dual monopoly, suppliers of complements compete for economic rents. Competitive pressures form complementary inventions limit the returns to each invention. The entry of additional complementary inventions tends to diminish the returns to each invention when adopters of the inventions have a given total benefit. This is the case even when complementary inventions are necessary for adopters to produce final products. When complementary inventions are not

[46] Consider Chamberlinian competition among inventors who enter the market to supply different inventions. Suppose that an inventor incurs fixed costs K to produce a new invention, to obtain a patent, and to commercialize the invention. Suppose that an inventor incurs a distribution cost c to license the invention to each licensee, which can be positive or equal to zero. Inventors offer an up-front fixed fee royalty of R to each licensee. Let $D(R)$ be the total number of adopters per invention at a symmetric equilibrium when all inventors offer the same royalty. Let $D'(R)$ be the slope of each inventor's demand when all inventors offer the same royalty. Given the royalties charged by other inventors, each inventor chooses a royalty that maximizes profit taking as given the royalties set by other inventors. For each inventor, the marginal revenue from licensing equals the cost of licensing to an adopter, c, $D(R; n) + RD'(R) = c$. Inventors conduct R&D and continue to enter the market until each inventor earns a zero profit. The royalty per license equals the average cost of invention and licensing, $R = k/D(R) + c$. Together, these conditions determine the royalty charged by each inventor and the number of inventors that enter the market for inventions.

necessary, competition among inventions constrains the returns to a particular invention based on its incremental contributions to the final products.

C. The "Rewards" View and "Prizes" for Invention

Despite the popularity of this approach among academics, there is no empirical evidence that prizes would either reward inventors or lead to commercialization and innovation. Indeed, studies reveal that prizes have minimal effects on invention or diffusion of technology. A "prize" system would lack all of the key features of the patent system – exclusion, transferability, disclosure, certification, standardization, and divisibility. Without these fundamental elements a market for inventions would be highly constrained and less efficient. It is difficult to imagine invention and innovation without a market for inventions.

Replacing patents with "prizes" is analogous to replacing corporate securities with "prizes" for investors. Such investment "prizes" would not finance corporations because they would provide neither return of principle nor return on principle. Invention "prizes" would not stimulate invention and innovation because they would not provide economic returns for inventors, innovators or investors in complementary assets. Just as investment prizes could not replace financial markets, so invention prizes cannot replace the market for inventions.

The idea of government "prizes" is not new. Michael Polanvyi (1944, p. 65) argues that "In order that inventions may be used freely by all, we must relieve inventors of the necessity of earning their rewards commercially and must grant them instead the right to be rewarded from the Public purse."[47] Arrow (1962, p. 615) also advocates giving government "prizes" for inventions,

[47] Emphasis removed.

> "In an ideal socialist economy, the reward for invention would be completely separated from any charge to the users of the information. In a free enterprise economy, inventive activity is supported by using the invention to create property rights; precisely to the extent that it is successful, there is an underutilization of the information. The property rights may be in the information itself, through patents and similar legal devices, or in the intangible assets of the firm if the information is retained by the firm and used only to increase its profits."[48]

Kremer (1998, p. 1137) on the basis of "deadweight welfare loss" concerns argues that "competitive markets do not provide appropriate incentives for the production of ideas." Kremer recommends that the government purchase patented inventions using auctions and place them in the public domain.

Many academics favor replacing patents with prizes. Roin (2014) states "The consensus view is that if the government can set prizes that offer equivalent incentives for innovation as intellectual property, it should grant prizes instead of intellectual property because the public would receive the same benefits of innovation without the deadweight loss from higher consumer prices." However, replacing patents with government prizes generates many economic problems. Roin (2014) points out that patents allow the rewards to owners to vary over time reflecting changes in the value of inventions, giving patents an important advantage over static "prizes" with common ownership. Kieff (2001) emphasizes that common ownership of technology leads to the "tragedy of the commons," overuse that dissipates the value of the invention just as overuse dissipates other types of resources.

[48] Arrow (1962, p. 615) suggests that the Soviet Union offers an example of such a system of "prizes."

Even adopting the "rewards" view of IP *arguendo*, "prizes" fail to provide returns to inventors. Governments are likely to provide rewards to cronies of politicians, lobbyists, political donors, or ideological allies. Presumably monetary "prizes" for inventors would be financed from general taxation, which would face considerable resistance by taxpayers. The high cost of rewarding inventors and innovators would be prohibitive for government budgets. This suggests that monetary "prizes" would do little to reward inventors in comparison to market returns.

Governments can be expected to offer few "prizes" whether honorary or pecuniary with minimal compensation. Beginning in the late 1950s, the Soviet Union instituted a system of "inventors' certificates" that involved transfer of the invention to state ownership and some limited monetary and non-monetary rewards for the inventor based on usage (Blair, 1973, Maggs, 1990). Compared to patent systems in market economies, this approach was not successful in generative innovation (Maggs, 1990). In addition, the Soviet Union offered a limited honorary "prize" system. During its entire existence, the Soviet Union awarded its "Honoured Inventor of the USSR" medal only sixteen times.[49] Compare such "prizes" with the USPTO system that generates over 250,000 patents per year.[50]

[49] The medal was awarded from 1983 to 1991; "The Presidium of the Supreme Soviet of the USSR was the main conferring authority of the award based on recommendations from the State Committee for Inventions and Discoveries of the USSR and the Central Council of the All-Union Society of Inventors and Innovators,"

http://en.wikipedia.org/wiki/Honoured_Inventor_of_the_USSR, Accessed March 29, 2014).

[50] Private groups such as the X Prize Foundation also offer "prizes" for inventors. These "prizes" generate tournaments in which inventors compete to offer the best invention that satisfies the

Governments are not very good at commercializing and diffusing inventions. The failure of government diffusion of technology is illustrated by the major benefits that resulted from the Bayh-Dole Act. The Bayh-Dole Act offers a natural experiment illustrating how markets diffuse innovations and governments do not. The U.S. government provides research grants to universities, non-profit organizations, and small businesses. However, the incentives for invention provided by such grants are accompanied by markets for invention, which provide additional incentives for commercialization and innovation. This was recognized by the Bayh-Dole Act, which permits organizations that receive federal government funding to own inventions rather than transferring ownership to the government.[51] Prior to the Bayh-Dole Act, government ownership of inventions resulted in minimal commercialization or diffusion of innovations. About 5% of the 28,000 patents owned by the government were commercialized, and private ownership in contrast generated significant commercializing of inventions though patent licensing by universities.[52] In the first 25 years following the Act, university patent licensing generated 4,350 new products and 6,000 new firms (Bayh et al., 2009, p. 3). The Bayh-Dole Act resulted in high levels of entrepreneurship by scientists and spurred the rise of

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rules of the competition. Again, such contests offer relatively few awards in only a small number of topic areas in comparison with the US patent system.

[51] University and Small Business Patent Procedures Act, 1980, 35 U.S.C. § 200-212, 37 C.F.R. 401.

[52] Council On Governmental Relations, The Bayh-Dole Act: A Guide to the Law and Implementing Regulations 1–2 (1999), http://www.cogr.edu/docs/Bayh_Dole.pdf, cited by McDonough (2006, p. 199).

university technology transfer offices (TTOs) (see Aldridge and Audretsch, 2011, and the references therein).[53] According to the Association of University Technology Managers reports that there were about 40,000 active technology licenses and options in 2012 (AUTM, 2013).

Even if inventors were somehow to produce inventions under a system of government "prizes," administering such a system would be impossible. Government officials would need to determine what types of inventions should receive "prizes" *before discoveries are made*. This would require government officials to have foresight exceeding the combination of all scientists, engineers and other researchers.

Government officials also would need to determine what types of inventions were needed by consumers and firms. As Friedrich Hayek emphasizes, this would depend on the impossible requirement that government officials' knowledge of the needs of individuals would equal individual's own knowledge of their needs. The government would also need to know how much to reward inventors, again requiring knowledge of inventions before the fact, knowledge of inventors' costs and scientific opportunities, and knowledge of private benefits from inventions.

The implementation of the "prize" system generally involves replacing the market for inventions with a socialist system of invention and innovation. For example, Love and Hubbard (2007) propose a fixed "prize" fund that would be equally divided among innovators, with inventions entering the public domain. Inventors would be compelled to surrender their IP rights. Then-Congressman Bernard Sanders of Vermont, a self-described socialist, introduced a bill based on their proposal (The Medical Innovation Prize Fund Act, H.R. 417, 109th Congress., 2005).

[53] See also Siegel et al. (2007) and Grimaldi et al. (2011).

Common ownership of inventions would eliminate incentives for commercialization of inventions, as Kieff (2001) explains (see also Abramowicz, 2003). Common ownership of inventions also diminishes incentives for innovation to develop products, manufacturing processes, and transaction techniques based on those inventions. Additionally, common ownership can diminish marketing of products that embody inventions. Advocates of "prizes" and common ownership view the discouragement of marketing as an advantage of a prize system. For example, Love and Hubbard (2007, p. 1554) assert that marketing products is a "waste,"

> The elimination of marketing monopolies, the de-coupling of R&D incentives from prices, and the creation of an evidence-based reward system linked to changes in health outcomes will lead to significant reductions in expenditures to market products, the area of the largest waste in the current system.

Contrary to this assertion, marketing and sales are important coordination mechanisms in a market economy. They serve to communicate information about products and prices to buyers and to coordinate purchasing decisions.

With public ownership of inventions, government officials would need to invest in commercializing inventions or developing innovations that apply the prize-winning inventions. This would involve public expenditures for the costs of commercialization and innovation, effectively putting public agencies in the innovation business. Involving public agencies in commercialization and innovation would require public agencies to develop business expertise that is already available in the private sector.

Public commercialization and innovation would generate insurmountable problems of economic planning. Exercising command and control over economic activity has led to

significant problems in socialist economies. The collapse of socialist economies such as the Soviet Union provides sufficient evidence that even the operation of traditional technologies by governments is not feasible. The diffusion of new technologies and management of innovation generally are beyond the scope of government administration.

Most significantly, government "prizes" for inventors would fail to fulfill the functions of IP in product markets. Markets determine the value of goods and services through interaction of supply and demand, and the same applies to inventions. John Stuart Mill (1848, p. 932) explains this clearly: "the reward conferred by it depends upon the invention's being found useful, and the greater the usefulness, the greater the reward; and because it is paid by the very persons to whom the service is rendered, the consumers of the commodity."[54]

A "prize" system without property rights for inventors would eliminate the allocative and dynamic efficiencies of the market for inventions. Inventors would lose innovative control over their inventions, thus eliminating incentives to allocate inventions to the highest-value uses. Lack of innovative control would eliminate incentives to continually develop inventions, to commercialize inventions, to introduce innovations based on inventions and to invest in complementary assets.

Historical evidence casts doubt on "prizes" as sources of invention and innovation. According to Khan (2014a) "the historical record shows that administered prize systems tend to be associated with the potential for bias or corruption, unpredictable methods of allocation and outcomes, as well as other deficiencies attendant on a nonmarket orientation." Khan (2011) studies inventors in Britain and the U.S. during the transition from the First to the Second Industrial Revolutions and finds that because prizes are less systematic than patents, they offer

[54] This is quoted in Machlup and Penrose (1950).

lower expected benefits for inventors. Khan (2013a) considers a sample of exhibits and premiums at U.S. industrial fairs between 1837 and 1874 and finds that prize winners tended to belong to privileged social groups, with prizes awarded less systematically than patents and unrelated to various proxies for the productivity of the innovation.[55]

Khan (2014c) provides a critically important historical comparison of the effects of patents and "prizes" on technology diffusion. She compares patented inventions with innovations that were submitted for prizes at annual industrial fairs of the American Institute of New York in the 19th century. Khan finds that patents promote much greater spatial diffusion of innovations than prizes. Additionally, Khan's research shows that patents had large and significant effects on unpatented innovations in contiguous and adjacent counties, in contrast to limited geographic effects of prize-winning inventions.

V. Conclusion

Effective IP policy and antitrust policy require an informed debate. The patent controversy has been ill-served by the simplistic and inaccurate "rewards" view of patents. Based on the "rewards" view of patents, many advocate that the patent system should be replaced by government "prizes." This naïve idea assumes that governments can determine what inventions should be rewarded before discoveries are made, what the amount of the rewards should be, and who should receive the awards. The government "prize" idea assumes further than economic transactions in the market for invention are costless and that positive prizes indicate the presence of a "deadweight welfare loss." There is little if any empirical support for the notion that the government can replace the patent system with prizes and either common ownership or public

[55] See also Khan (2014b).

ownership and distribution of inventions. Historical research shows that prizes and public ownership of inventions do not lead to invention or diffusion of technology. Historical experience in myriad failed socialist economies confirms that "socialized innovation" is an oxymoron.

The market foundation role of patents presents a more complex but realistic analysis of invention and innovation. The economic benefits of patents derive from their major contributions to the formation of the market for inventions. The U.S. patent system fortuitously offers many important features that contribute to transaction efficiencies and competition. The patent system provides IP protections that support a market for innovative control. The patent system further supports private financing of invention and innovation. The market foundation role of the U.S. patent system has a proven record of performance, having fostered significant technological change and economic growth.

The analysis in this paper implies that public policy towards IP should be based on long experience with markets for all types of goods, services, and financial assets. Economic understanding of how market mechanisms contribute to allocative and dynamic efficiency extends readily to invention and innovation. The market for inventions, whether in the form of disembodied technology or discoveries embodied in products, services or production processes, offers efficiencies that are closely related to how markets perform in other areas of the economy. Private ordering offers institutions such as licensing, cross-licensing, transfers, and contractual R&D for addressing the specific features of invention and innovation. Antitrust policy towards IP should be based on the tradition of promoting competition and economic efficiency in other types of markets. Antitrust policy most effectively promotes innovation, competition, and transaction efficiency when it supports the market foundation role of patents.

U.S. Patent Statistics Chart
Calendar Years 1963 - 2012

Year of Application or Grant	Utility Patent Grants, All Origin Total	Design Patent Grants	Plant Patent Grants	Reissue Patent Grants	Total Patent Grants
2012	253,155	21,951	860	822	276,788
2011	224,505	21,356	823	1,029	247,713
2010	219,614	22,799	981	947	244,341
2009	167,349	23,116	1,009	453	191,927
2008	157,772	25,565	1,240	647	185,224
2007	157,282	24,062	1,047	508	182,899
2006	173,772	20,965	1,149	519	196,405
2005	143,806	12,951	716	245	157,718
2004	164,290	15,695	1,016	298	181,299
2003	169,023	16,574	994	421	187,012
2002	167,331	15,451	1,133	460	184,375
2001	166,035	16,871	584	480	183,970
2000	157,494	17,413	548	524	175,979
1999	153,485	14,732	420	448	169,085
1998	147,517	14,766	561	298	163,142
1997	111,984	11,414	394	277	124,069
1996	109,645	11,410	362	279	121,696
1995	101,419	11,712	387	316	113,834
1994	101,676	11,095	499	317	113,587
1993	98,342	10,630	442	332	109,746
1992	97,444	9,269	321	360	107,394
1991	96,511	9,569	353	263	106,696
1990	90,365	8,024	318	370	99,077

Year of Application or Grant	Utility Patent Grants, All Origin Total	Design Patent Grants	Plant Patent Grants	Reissue Patent Grants	Total Patent Grants
1989	95,537	6,092	587	317	102,533
1988	77,924	5,679	425	244	84,272
1987	82,952	5,959	229	245	89,385
1986	70,860	5,518	224	260	76,862
1985	71,661	5,066	242	276	77,245
1984	67,200	4,938	212	300	72,650
1983	56,860	4,563	197	362	61,982
1982	57,888	4,944	173	271	63,276
1981	65,771	4,745	183	365	71,064
1980	61,819	3,949	117	285	66,170
1979	48,854	3,119	131	309	52,413
1978	66,102	3,862	186	364	70,514
1977	65,269	3,929	173	410	69,781
1976	70,226	4,564	176	422	75,388
1975	72,000	4,282	150	378	76,810
1974	76,278	4,304	261	435	81,278
1973	74,143	4,033	132	314	78,622
1972	74,810	2,901	199	275	78,185
1971	78,317	3,156	71	246	81,790
1970	64,429	3,214	52	269	67,964
1969	67,559	3,335	103	233	71,230
1968	59,104	3,352	72	186	62,714
1967	65,652	3,165	85	196	69,098
1966	68,405	3,188	114	179	71,886
1965	62,857	3,424	120	246	66,647
1964	47,375	2,686	128	200	50,389

Year of Application or Grant	Utility Patent Grants, All Origin Total	Design Patent Grants	Plant Patent Grants	Reissue Patent Grants	Total Patent Grants
1963	45,679	2,965	129	198	48,971

Source of data: USPTO, http://www.uspto.gov/web/offices/ac/ido/oeip/taf/reports.htm Accessed January 18, 2014.

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