Can Public Policy Influence Private Innovation?

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Abstract

Private innovation appears to have played a major if not dominant role in the growth of output per capita since the Industrial Revolution. Yet economic theory indicates that the level of investment in private innovation will generally be less than is socially optimal unless public policies such as patents encourage additional investment. Therefore, public innovation policy would seem to be critical to economic growth. Surprisingly, a large body of research fails to find unambiguously positive effects of patents on innovation and economic growth, even though patents have been used for hundreds of years. While some industries in some nations clearly benefit from patents, many other industries do not and patents might actually discourage innovation in some industries. Economic theory has provided valuable insights, yet real-world policy apparently needs to reflect a richer set of behavior and a more complex legal environment. New research is developing a more nuanced understanding including research on alternative means of providing rewards to innovators, research on the costs of litigation and disputes arising from the failure of patents to provide clear boundaries, research on cumulative innovation and strategic uses of large blocks of patents, and research on the extension of patent coverage to new technologies and to developing nations. In addition, major new sources of data permit much more extensive empirical research.

INTRODUCTION

In 1529, one Anton Müller of Danzig (Gdansk) invented a loom that wove multiple ribbons simultaneously. The Danzig city council, however, worried about the effect this invention would have on the employment of weavers, secretly had Müller drowned. This policy succeeded in suppressing the invention for nearly a century until it reemerged in Flanders nearly a century later. This invention eventually developed into a more automated form known as the *Dutch Loom*, the first automated loom and a predecessor of one of the key technologies of the Industrial Revolution.

Clearly, policy can have an effect on innovation, but not always the effect that is best for society. The question is whether policies can and do have net

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positive social effects on innovation. Indeed, there appear to be large differences in the abilities of nations to develop and employ new technologies. Is this because of differences in innovation policies? Alternatively, is it due to other differences in general economic institutions, culture, or even geography? In particular, can social science tell us how well past policies have worked and provide helpful guidance to policymakers for the future?

Perhaps surprisingly, the positive evidence for major past innovation policies, such as patents, is mixed at best. Patents seem to work well in some circumstances but not in others. It appears that past economic theory has been a bit too simple, not recognizing some of the costs that patents can impose on innovators as well as the contingent nature of the benefits. Perhaps not surprisingly, economists and other social scientists have only had limited success providing guidance to policymakers that is implemented. However, change is visible on both fronts. Richer economic theory, empirical analysis of newly developed datasets and detailed policy analysis have begun to provide a better understanding of what works, where the problems lie and how better policy can be crafted.

FOUNDATION

Almost all of the social science research relevant to public policy for innovation has been in economics, so I will begin with a brief overview of the relevant economic theory. Modern economic analysis of innovation begins with Kenneth Arrow's 1962 essay where he argued that inventions would be underpriced in competitive markets without patents and where he considered the incentives for innovation in both monopolies and competitive markets. Arrow formalized a long held intuition that free-riding externalities would undermine the returns to innovation without patents. In Arrow's analysis, inventions are a form of information, an "idea" that can be replicated at a negligible marginal cost. Without a patent, a competitive market would price the idea at this marginal cost, so inventors would have difficulty recouping their initial investments without patents. Patents, by creating a temporary monopoly, allow the patent holder to charge a higher price and thereby provide a greater return on the inventor's investment in innovation.

In 1969, William Nordhaus developed a model of the tradeoff between the social losses associated with the high price under this temporary monopoly and invention incentives. In his model, the tradeoff was determined by a policy variable, namely the patent term. Subsequent models added additional policy variables such as patent "breadth" and "scope." These were followed by models of patent races, where inventors would race to get a patent, depending on the strength of the incentives, and models of sequential

innovation, where the tradeoffs between pioneer inventors and improvers were affected by policy variables.

Yet these foundations had significant limitations in regard to guiding policy. First, many of the putative policy variables such as patent "breadth" did not correspond to any real-world policy levers. Although patent lawyers talk about the breadth of a patent, this is based on specific analysis of particular patents, it is often highly uncertain and is not something that could be measured by economists or easily regulated by the Patent Office or courts.

Second, the basic economic models presented a highly idealized version of patent rights, not reflecting, for example, costs that the patent system imposes on innovators. Indeed, all property rights rely on a system of "public notice": a way to determine the boundaries and owners of the rights. Much policy is focused on providing efficient public notice. When a property rights system works well, economic agents can conduct clearance searches at little cost and can obtain the necessary licenses to conduct their business. However, when public notice functions do not work well, clearance search can become too costly to perform and the boundaries of property rights can be unpredictable. In this case, economic agents become prone to inadvertent infringement, giving rise to unwanted disputes and litigation. Bessen (the author) and Meurer (2008) have explored the role of public notice for patents. The expected costs of possible disputes and litigation over unclear boundaries of patents impose disincentives on prospective innovators, tending to counter the positive incentives provided by patent rents.

Third, despite the seeming consensus on the centrality of patents to innovation, many economists remained deeply skeptical about the benefits provided by real-world patent systems. The empirical support for patents was not strong. Survey research showed that patents did not provide strong incentives in most industries. There were other ways of protecting innovations and other incentives, including prizes and government contracting. Moreover, in some cases innovators freely shared their knowledge, seemingly contradicting the canonical models. In addition, some researchers had difficulty finding the relevance of patent race models to real-world innovative competition. Some economists, such as Boldrin and Levine (2008), questioned whether patent monopolies fundamentally slowed innovation when each new innovation cumulatively builds on previous innovations.

While the simplified models do provide valuable insights, they can prove of limited value for guiding policy where the law is complex and where innovators act under a richer set of conditions than envisioned in these models.

THE STATE OF RESEARCH: HAVE INNOVATION POLICIES PROMOTED INNOVATION?

By far, most of the empirical research in this area has focused on patents, which is not surprising because patents have been used for centuries. Douglass North argued that secure property rights facilitated the British Industrial Revolution, including patent rights on inventions. However, economic historians studying patents have been more doubtful. The reason for their skepticism is that few of the major inventions of the Industrial Revolution had patents that brought substantial rewards to their inventors. Many inventions were not patented. Indeed, it appears that only 11% of British inventions shown at the 1851 World's Fair were patented. Other major inventions were patented but did not make money, sometimes only becoming commercially feasible after the patent expired. Some inventors obtained patents and then were ruined by costly litigation. Some, such as Arkwright, had their patents invalidated; Arkwright made a fortune nevertheless. In addition, a few, such as James Watt, had profitable patents. If most inventors did not benefit from patents, it is hard to argue that patents provided them a strong incentive to innovate.

Other sorts of evidence also show what is at best—a mixed picture of the ability of patents to spur innovation. A number of cross-country studies have run panel regressions on national rates of gross domestic product (GDP) growth using a variety of right-hand-side controls, including the strength of the nation's patent rights. While the strength of general property rights is generally correlated with economic growth, the strength of patent rights or intellectual property rights is not. Patent rights do seem to be correlated with national rates of R&D spending, but some evidence suggests that the causality might run in the reverse direction. That is, in one study changes in the law to strengthen patent rights follow national R&D spending. This might happen if firms invest in R&D and then lobby for legal changes once they have achieved some success.

A number of other studies look at natural economic experiments where patent law was changed, often in response to obligations associated with trade treaties. In general, pro-patentee changes in a nation's patent laws tend to increase patenting by foreign firms. This makes sense because their products now can be sold with a greater degree of exclusivity if protected with a patent. However, such changes in patent law do not, in general, lead to more domestic patenting or more domestic R&D spending. A possible exception exists for highly developed nations.

Another sort of evidence comes from studies of patent value. The rents that a patent generates are a partial measure of the incentive that patents provide. A discounted stream of rents provides a measure of patent value. Two sorts

of econometric methods have been used to measure the value of patents to their owners. One method uses data on the payment or nonpayment of the renewal fees that must be paid to keep a patent in force. Economists infer that if a patent holder is unwilling to pay a fee to keep a patent in force for, say, an additional year, then the rents that the patent generates must be less than the fee. Under some simple assumptions, the mean value of rents can be estimated for a group of patents and these can be compared to R&D expenditures. This literature finds that patent rents tend to run about 10–15% of R&D—suggesting that patents provide a rather modest but positive incentive for R&D spending and that most R&D spending might take place without patents. However, renewal estimates typically do not observe the rents on the most valuable patents because all of these patents are renewed to the full term of the patent. In effect, the renewal method estimates the values of these patents by extrapolation and therefore it is possible that these estimates are understated.

A second method produces estimates that are overstated. This method estimates the value of patents held by public firms by regressing a measure of the market value of the firm against measures of its assets, including a stock of patents. The coefficient on the patent stock provides a measure of patent value. The corresponding rents turn out to be about 18% of R&D spending, slightly above the estimates found using renewal data. In addition, this estimate will be overstated to the extent that firms obtain additional patents in response to success in the market place (a reverse causality).

Despite the small size of patent rents relative to R&D, the rents are positive and significant. Nevertheless this does not necessarily imply that patents spur innovation. The problem is that patents also impose costs—disincentives—on innovators, as noted above. The costs of patent litigation, including both the costs of lawyers and the effect of the lawsuit on business, are one of those costs when patent boundaries are unpredictable or too costly to conduct clearance search. Researchers have estimated these costs for public firms using stock market event studies around the filing of patent lawsuits. These estimates suggest that: (i) the costs have grown rapidly since the mid-1990s, (ii) in technologies such as pharmaceuticals and chemicals—where patent boundaries are well-defined—the costs imposed by litigation are small compared to patent rents, but, (iii) in other technologies, especially information technologies, litigation costs are now far greater than patent rents. In these industries, patents appear to provide a net disincentive to innovation.

Much recent research has focused on specific aspects of patents and innovation, thus helping to fill out a more detailed picture of the innovation landscape. In addition to estimating the burden of litigation on innovators, research on patent litigation has also identified factors that affect a firm's

hazard of being sued or of having to go to court to enforce its patents. Other research, both theoretical and empirical, has sought to better understand the nature and timing of dispute settlement.

One important area in litigation research has been on patent "nonpracticing entities" (NPEs), known popularly as *patent trolls*. These are organizations that do not develop a technology to be implemented, but, instead, acquire patents to assert against others in order to collect royalties. The number of lawsuits involving NPEs has soared in recent years; over 5000 defenses were mounted in 2011 in lawsuits filed by NPEs according to one source. This new development has been controversial. The patent system has long had a variety of nonpracticing agents who have facilitated markets for technology. Indeed, one of the recent advances in research has been recognition that patents can serve to facilitate markets for technology and these have been historically important. They allow small inventors who might not have the resources and skills to bring a product to market to sell or license the technology to a party who can produce and distribute it. However, the recent spate of NPEs tend to be much more interested in litigating against firms that have already developed technologies than in licensing a technology to firms that need it. That is, much of the NPE activity is about licensing freedom from the threat of a lawsuit rather than licensing an actual technology, with training, know-how, and so on. Some research shows that NPE litigation appears to do far more damage to the defendants, who tend to be firms that invest heavily in technology, than any benefit it provides to the small inventors who create the patents used in NPE lawsuits.

Another area of study has been on those subject matter areas where the courts have extended patent coverage during recent years. Before 1994, for example, software algorithms were seen as unpatentable by themselves. Court decisions since the mid-1990s have extended patent coverage not only to software, but also to methods of doing business and mental processes. Over a quarter of a million patents have now been issued in these new areas, making for something of a natural economic experiment. Research has shown that patents in these new areas are *much* more likely to be involved in litigation. Indeed, NPE lawsuits are heavily concentrated in software and business methods. It appears that the high rate of litigation is not so much because these fields are new to the patent system, but rather that these subjects of major problems with patent notice. In particular, the interpretation by the courts of patent boundaries in these fields has been highly unpredictable, giving rise to opportunistic litigation. Research on software patents has been influential in legislative proceedings in Europe and in court decisions in the United States.

Software patents have also featured in another area of research, namely, patent thickets. Because firms acquired tens of thousands of software patents

(being conceptual, they often require very little R&D), economists became aware that they were using them strategically as a block. A number of theoretical papers have studied the nature of this strategic interaction and a number of empirical papers have sought to identify the effects of patent thickets on innovation. The findings appear to be double-edged: patent thickets do deter entry of innovators into new markets, but prospective entrants are more likely to enter if they acquire patents themselves.

Economists have also studied the operation of the patent office and the patent examination process. Research on one administrative procedure—a "post-grant review" proceeding that allows third parties to challenge patents immediately after they are issued—influenced legislation in the United States such that the proceeding was included in the patent act passed into law in 2011.

This review has focused on research on patents. Research has also been done on other sorts of policies intended to foster innovation. For example, economists have attempted to estimate the effect of R&D tax credits on R&D spending.

NEW DIRECTIONS

Three sorts of factors influence those areas where future research will be fertile:

Better, more realistic understanding of how innovation works. For example, "spillovers" have long been identified as important, but this concept includes a variety of different sorts of actual behavior. Some new research has focused on the effect of laws that restrict employee mobility, one source of spillover. Other research is looking into the free exchange of knowledge among innovators, something long recognized, but little explored.

Better data. Patent offices and courts are making more data available to researchers, opening up new areas of inquiry, for example, better information on patent prosecution and on payment of renewal fees. In addition, a number of surveys have been initiated in recent years, covering all aspects of the innovation process.

New developments. Nonprofit organizations have proposed using prizes and similar measures in order to promote the development of pharmaceuticals for neglected diseases. This is promoting research on prizes. In addition, international trade treaties have resulted in dramatically changed patent systems in developing countries such as China, also opening up new avenues for research.

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James Bessen is a scholar on the economics of innovation and patents who has also been a successful innovator and CEO of a software company. In 1983, Bessen developed the first commercially successful "what-you-see-is-what-you-get" desktop publishing program, founding a company that delivered PC-based publishing systems to high end commercial publishers. Since leaving the software business, Mr. Bessen has done economics research on innovation, including theoretical and empirical studies of the economics of patents as well as studies of innovation in the nineteenth century and its effects on skills, wages, and productivity. His work on patents has influenced policymakers and courts in the United States, Europe, and Australia. He is the author of *Learning by Doing: The Real Connection between Innovation, Wages, and Wealth* (Yale 2015). With Michael J. Meurer, he wrote *Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk* (Princeton 2008). Currently, Mr. Bessen is a Lecturer in Law at the Boston University School of Law and Fellow at the Berkman Center on Internet and Society at Harvard.

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