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Determinants of creativity and innovation: Evidence from economic history

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loan programs that offer similar terms to borrowers of different ex ante risk levels may be undercut by private creditors, leaving government programs with only the riskier borrowers.¹⁶

¹ L. Lochner and A. Monge-Naranjo, “The Nature of Credit Constraints and Human Capital,” NBER Working Paper No. 13912, April 2008, and American Economic Review, 101(6), 2011, pp. 2487–529; L. Lochner and A. Monge-Naranjo “Credit Constraints in Education,” NBER Working Paper No. 17435, September 2011, and Annual Review of Economics, Vol. 4, 2012, pp. 225–56; and L. Lochner and A. Monge-Naranjo, “Student Loans and Repayment: Theory, Evidence and Policy,” NBER Working Paper No. 20849, January 2015.

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² College Board, *Trends in Student Aid, 2001 and 2011*.

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³ Z. Bleemer, M. Brown, D. Lee, and W. van der Klaauw, “Debt, Jobs, or Housing: What’s Keeping Millennials at Home?” Federal Reserve Bank of New York Staff Report No. 700, November 2014.

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⁴ Students leaving school with lesser (or no) degrees acquire much less debt as shown by P. Steele and S. Baum, “How Much are College Students Borrowing?” New York, NY: College Board Publications, 2009.

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⁸ L. Berkner, *Trends in Undergraduate Borrowing: Federal Student Loans in 1989–90, 1992–93, and 1995–96*, Washington, D.C.: U.S. Department of Education, National Center for Education Statistics, NCES 2000-151, 2000; C.C. Wei and L. Berkner, *Trends in Undergraduate Borrowing II: Federal Student Loans in 1995–96, 1999–2000, and 2003–04*, Washington, D.C.: U.S. Department of Education, National Center for Education Statistics, 2008.

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¹⁵ L. Lochner and A. Monge-Naranjo, “The Nature of Credit Constraints and Human Capital,” *American Economic Review*, 101(6), 2011, pp. 2487–529.

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Determinants of Creativity and Innovation — Evidence from Economic History

Petra Moser

Innovation and creativity are the primary source of improvements in human welfare. Yet, due to two major empirical challenges, it is difficult to determine the factors that encourage creativity and innovation. First, modern settings often lack clean experimental variation, because policies designed to encourage innovation adapt in response to lobbying, which makes it difficult to identify causal effects. Second, innovation and creativity are exceedingly hard to measure. For example, patent counts are the standard measure of innovation, but they fail to capture important innovations that occur outside of the patent system, for example in countries without patent laws. Excluding such developments may distort economists’ views on the determinants of innovation.

My research addresses these identification and measurement challenges by exploiting a wealth of historical events that changed intellectual property laws and other policies independently of changes in innovation. In practice, this research approach combines in-depth analyses of historical records with statistical tests of large data sets. For example, I exploit a large amount of credibly exogenous variation in national patent laws in the 19th century — before interest groups had begun to lobby for changes in patent policy — to analyze data on innovations with and without patents that were exhibited at world fairs.¹ Complementary research uses the Nazi’s decision to dismiss all Jewish scientists to examine the effects of high-skilled immigrant scientists on U.S. innovation.² Another proj-

ect exploits variation in the timing of Napoleon’s military victories to examine the effects of copyrights on Italian opera.³

Does Existence of a Patent System Encourage Innovation?

My research addresses a central question in economic history: Has the creation of property rights in ideas encouraged innovation and economic growth? A strong tradition argues that secure property rights built the foundation for the industrial revolution in Britain and the United States.⁴ Innovation is, however, a cumulative process and strong property rights for early generations of inventors reduce payoffs for those in later generations.⁵ These costs are particularly severe if patents are broad and their boundaries uncertain, so that later generations are continuously at risk of infringing on existing patents. Recent patent wars over smart phones and tablet computers have moved these issues to the forefront of policy debates, but the underlying tensions are more general. My research exploits historical variation in 19th century patent laws — when countries such as Switzerland and the Netherlands had not yet adopted patent laws or had abolished them for political reasons — to investigate the effects of patent laws on innovation.

To measure effects on innovation, I construct historical data sets to capture innovations that occur within and outside of the patent system. Patent data fail to capture all such innovations, which compromises their use in empirical analyses of the effects of patent laws. To address this



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Moser combines empirical methods from economic history and applied microeconomics to examine the determinants of technological innovation and artistic creativity. She has used historical variation in patent laws to examine the how patent policies can influence the rate and direction of technical change, as well as the geography of innovation. Her research also examines the role of human capital — in the form of high-skilled immigrant scientists — on innovation. New projects investigate the effects of copyrights on creativity in literature and music, and explore the link between mental disorders and innovation.

Moser received her Ph.D. in economics from the University of California, Berkeley, and an M.A. in international relations from Yale University. As an undergraduate, she studied economics, with minors in politics and European languages, at the University of Tübingen in Germany and as a Fulbright student at the University of Missouri.

Moser grew up in a tiny medieval town in Germany, close to the Moselle Valley, and still enjoys running the local hills. This summer, she and her family have moved to Brooklyn, and are excited to explore their new neighborhood, hot dog stands and all.

major data constraint, I have used exhibition catalogues for the 1851 world technology fair in London [Figure 1] and the 1876 U.S. Centennial Exhibition in Philadelphia to collect detailed historical information on nearly 20,000 innovations with and without patents, including their industries, locations, and whether they won a prize for being particularly innovative.

These data indicate that the existence of a national patent system may not be necessary to encourage innovation. In 1851, for example, Switzerland contributed twice as many exhibits per capita as the other European countries, and won a disproportionate number of prizes for being especially innovative, even though it had no patent system. Exhibition data show that only a small share of innovations were patented,⁶ calling into question the role of patents in encouraging the Industrial Revolution. In 1851, just 11 percent of British exhibits and 15 percent of U.S. exhibits were patented.

The exhibition data also indicate that the share of innovations covered by patents varied significantly across industries. Fewer than 5 percent of Britain's chemical exhibits in 1851 and 10 percent of scientific instruments were patented, compared with 20 percent of manufacturing machinery. Remarkably, U.S. inventors relied on and avoided patents in the same industries as British inventors despite vast differences in national patent laws.

Rather than increasing the number and the quality of innovations, patents appear to influence the direction of technical change. Exhibition data reveal that innovations in countries without patent laws were concentrated in a narrow set of industries, such as scientific instruments, food processing, and chemicals, where innovations were difficult to reverse engineer, so that secrecy offered an effective

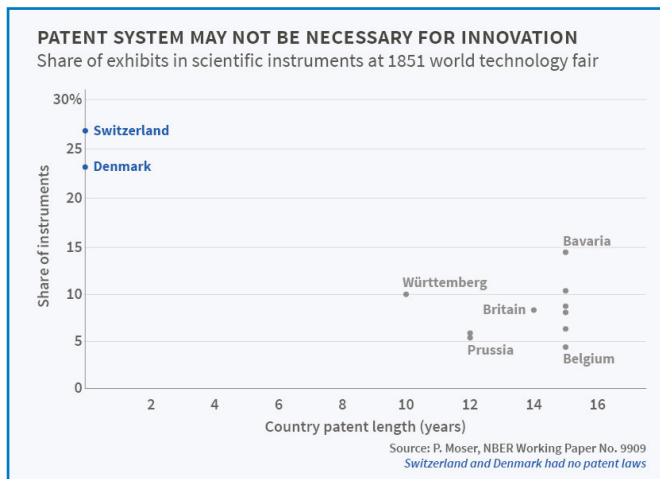


Figure 1

mechanism to protect intellectual property.⁷

Scientific breakthroughs, such as the development of the periodic table, which reduced the effectiveness of secrecy, created an exogenous shift towards patenting in chemicals without affecting other industries. I exploit this shift to examine historical data on the geographic location of innovations and workers. This analysis indicates that shifts toward patenting can encourage the *diffusion*, if not the level, of inventive activity.⁸

Complementary research on incentive prizes, which links exhibits with patents and the records of the *Scientific American*, the premiere science journal of the time, shows that prizes can be an effective alternative to patents, if they publicize promising research ideas.⁹ Extensions of this research examine the

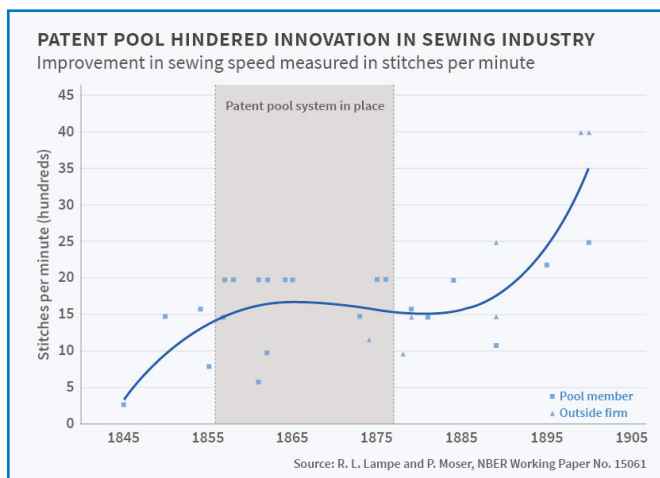


Figure 2

role of intellectual property rights in encouraging biological innovation,¹⁰ and use field trial data to measure variation in the size of patented inventions.¹¹

Patent Pools and Compulsory Licensing

If patent laws fail to encourage innovation, can they be modified to become more effective? One potential mechanism to reduce litigation risks is the creation of a patent pool, in which firms combine patents for complementary parts of the same technology; pool members can then license all patents as a package to outside firms. In recent years, pools have formed across many technologies, ranging from tablet computers to diagnostic kits for breast cancer. Yet their effects on innovation are poorly understood. My research with Ryan Lampe uses the example of the first patent pool in U.S. history, the Sewing Machine Combination (1856–77) to examine the effects of a pool on the creation of new technologies. An analysis of patents, firm entry, and quantitative measures for improvements in sewing speed suggest that innovation declined with the formation of the pool.¹² [Figure 2] We also find that the creation of a pool can divert R&D towards inferior technologies that allow non-members to avoid direct competition with the pool. These effects are particularly severe if pools increase litigation risks for non-members or if they create a system of differential license fees that put members at a disadvantage.¹³ Both of these traits are common features in modern pools. These findings are confirmed in a large-scale analysis of 20 pools that formed under the New Deal.¹⁴

Another prominent policy mechanism is compulsory licensing, which allows governments to license for-

role of intellectual property rights in encouraging biological innovation,¹⁰ and use field trial data to measure variation in the size of patented inventions.¹¹

Another prominent policy mechanism is compulsory licensing, which allows governments to license for-

eign-owned patents to domestic firms without the consent of foreign patent owners. Emerging economies, such as India, Brazil, and Thailand have used this policy to improve access to HIV medications and other essential innovations covered by foreign-owned patents. Because of its potentially significant implications for consumer welfare, compulsory licensing is one of the most controversial topics in intellectual property policy today. Yet, there is almost no systematic, empirical evidence on the effects of compulsory licensing. My research with Alessandra Voena provides such evidence by exploiting an exogenous episode of compulsory licensing in 1918, when the United States decided to subject all enemy-owned patents to compulsory licensing. [Figure 3] In the United States, compulsory licensing led to a 20 percent increase in patenting by domestic inventors, who were allowed to produce and improve German-owned technologies.¹⁵ Notably, compulsory licensing also encouraged invention in Germany, possibly by increasing the threat of entry in research fields that had been dominated by a small number of firms.¹⁶

Émigré Scientists and U.S. Innovation

Along with intellectual property rights, science and immigration policies are critical levers that help determine innovation. Biographical evidence suggests that German Jewish scientists who fled Nazi Germany revolutionized American science. In physics, émigrés such as Edward Teller and Hans Bethe formed the core of the Manhattan Project, but due to the strategic nature of their work, it is impossible to quantify their contributions. In chemistry, patents are an effective mechanism to protect intellectual property, and patent counts create a useful proxy for changes in innovation.

An analysis of historical patents suggests that U.S. invention increased by 31 percent in fields in which émigrés were active inventors.¹⁷ New inventor-level data indicate that émigrés encouraged U.S. invention by training younger scientists and by attracting U.S. scientists to research in émigrés' fields.

Can Copyrights Encourage Creativity?

Another alternative policy mechanism is the copyright, which creates much narrower property rights than a patent and may thereby avoid many problems with the current patent sys-

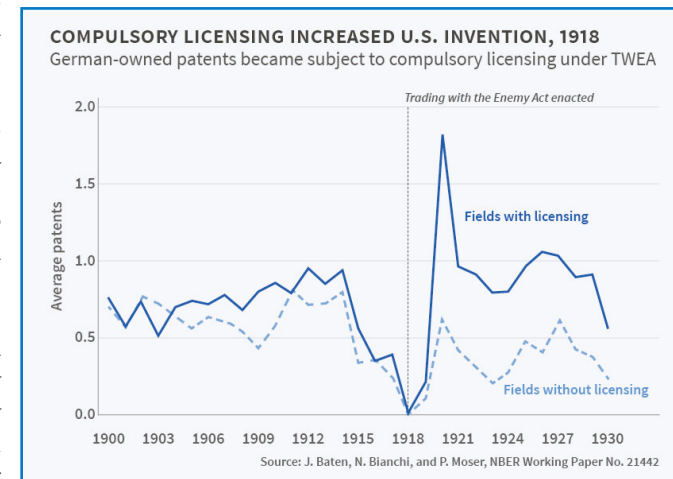


Figure 3

tem. However, systematic empirical evidence on copyrights is scarce due to a lack of experimental variation and to severe selection problems. At copyright lengths of 95 years for corporate owners, modern copyrights are extremely long-lived, which implies that commercially viable works that are *off* copyright today are an extremely selected sample of durable works. Nicknames for modern laws, such as the 1998 “Mickey Mouse Protection Act” bear witness to intense lobbying, which makes it difficult to disentangle the causal effects of copyright policies and other forces that may affect innovation.

My research with Xing Li and Megan MacGarvie addresses these issues by exploiting historical variation in copyrights. Our analysis of copy-

rights in literature exploits an unintended differential increase in the length of U.K. copyrights in 1814 — in favor of dead authors — to examine the effects of longer copyrights on book prices in Romantic Period England.¹⁸ We show that extensions in the length of copyright protection led to a significant increase in the price of books by dead authors. Archival data on contract negotiations show that payments to authors also increased after 1814, suggesting that copyright protection can benefit authors.¹⁹

To examine the effects of copyright on creativity, Michela Giorcelli and I exploit variation in the timing of Napoleon's military victories to examine the effects of copyright protection on the production of Italian operas.²⁰ Italian states that came under French influence by 1801 adopted French copyright laws, while states that came under French influence after 1804, when France's parliament adopted its *code civil*, did not adopt copyright laws. Giorcelli and I find that composers produced substantially more operas after the adoption of copyright laws. Composers also began to produce higher-quality operas, as measured through both historical popularity and longevity. Interestingly, the data yield no evidence that copyright *extensions* encourage creativity.

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NBER News

38th Annual NBER Summer Institute

The NBER hosted its 38th annual Summer Institute during a three-week period in July 2015. There were more than 2,600 registered participants, and 512 research presentations. More than 20 percent of those who attended the meetings were first-time Summer Institute participants; roughly one third were NBER affiliates.

Alan Krueger of Princeton University, the past chair of the President’s Council of Economic Advisers and a current research associate, delivered the 2015 Martin Feldstein Lecture, addressing the question “How Tight is the Labor Market?” He explored the challenge of measuring the number of long-term unemployed

workers and estimating the extent to which the behavior of these individuals is affected by public policies and labor market conditions. An [edited text](#) of his lecture appears earlier in this issue of the *NBER Reporter*.

A [panel discussion](#) during the International Finance and Macroeconomics Program provided a timely opportunity for researchers to assess developments in the Greek financial crisis. Research associates Susan Athey and Guido Imbens of Stanford University delivered the 2015 Methods Lectures on “Economic Applications of Machine Learning.” These lectures focused both on the econometric issues that arise in esti-

mating machine learning models and on the applications of these models in fields such as industrial organization and health economics. All three of these presentations have been videotaped and posted on the NBER website under the “NBER Videos” Tab.

Summer Institute participants represented 440 institutions, an increase of nearly one third from just a few years ago. The Summer Institute is highly decentralized, with 55 distinct meeting sessions organized by 119 different researchers. A complete list of sessions from the 2015 Summer Institute may be found at: <http://nber.org/confer/2015/SI2015/SI2015.html>

Conferences

International Seminar on Macroeconomics

The NBER’s 38th International Seminar on Macroeconomics took place in Zürich, Switzerland on June 26–27. The seminar was organized by research associates Jeffrey Frankel of Harvard University, Francesco Giavazzi of Bocconi University, Hélène Rey of London Business School, and Kenneth West of University of Wisconsin–Madison. These papers were discussed:

- **Tarek A. Hassan**, University of Chicago and NBER; **Thomas Mertens**, New York University; and **Tony Zhang**, University of Chicago, “Not so Disconnected: Exchange Rates and the Capital Stock” (NBER Working Paper No. 21445)
- **Lorenzo Bretschger** and **Christian Julliard**, London School of Economics, and **Carlo Rosa**, Federal Reserve Bank of New York, “Human Capital and International Portfolio Diversification: A Reappraisal”
- **Harris Dellas** and **Dirk Niepelt**, University of Bern, “Sovereign Debt with Heterogeneous Creditors”