Priority Rules:
An Empirical Exploration of First-to-Invent versus First-to-File

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Abstract

Even as we stand on the cusp of the broadest set of changes to the US patent law in two generations, virtually no empirical analysis has been conducted on the impact of the primary components of the proposed reforms. Until now. In this paper we investigate the expected effects on patenting behavior of the major change in the America Invents Act of 2011*: a shift in the patent priority rules from the United States' traditional "first-to-invent" system to the dominant "first-to-file" system. This is a deeply controversial change: Opponents argue that first-to-file disadvantages small inventors and leads to lower quality patents. Those in favor emphasize administrative simplicity and the cost savings of first-to-file. While there has been some theoretical work on this topic, we use the Canadian experience with the same change the US is considering as a natural experiment to shed the first empirical light on the question.*

Our analysis uses a difference-in-difference framework to estimate the impact of the Canadian law change on small inventors. Using data on all patents granted by the Canadian Intellectual Property Office and the US Patent and Trademark Office, we find a significant drop in the fraction of patents granted to small inventors in Canada coincident with the implementation of first-to-file. We also find no measurable changes in patent quality. The results are robust to several different specification checks. While the net welfare impact that can be expected from a shift to first-to-file is unclear, our results do reveal that, contrary to the conventional wisdom, the rule change is not free — it is likely to result in reduced patenting behavior by individual inventors.

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INTRODUCTION

When President Barack Obama outlined his immediate economic agenda in the aftermath of the national debate surrounding the raising of the debt ceiling in early August 2011, he did something that no other President in recent memory has done: he personally and publicly placed patent law reform at the top of his list of priorities, lauding the *America Invents Act of 2011*[1] as an

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[††] Professor of Law, University of Pennsylvania Law School. This paper has been selected for presentation at the *Workshop on the Law and Economics of Intellectual Property and Competition Law* sponsored by the Max Planck Institute and ETH Zurich, as well as the *Conference on Empirical Legal Studies*. The authors wish to thank the Canadian Intellectual Property Office, Tim Von Dulm for research assistance, Alexander Stack of Gilbert's LLP for helpful discussion about the Canadian patent system, and Colleen Chien, John Golden, James Grimmelmann, Dietmar Harhoff, Mark Lemley, Mike Meurer, Randy Picker, Ted Sichelman, and participants at the *2011 Intellectual Property Scholars Conference* for helpful comments that have greatly improved this paper.

[1] *See* H.R. 1249, *The Leahy-Smith America Invents Act* (June 23, 2011). See also S. 23, *The America Invents Act of 2011* (March 8, 2011). H.R. 1249

opportunity to "cut the red tape" interfering with American innovation.[2] Thus the structure of the US patent system, usually the province of technocrats, academics and high-tech lawyers, leapt to the top of the national discussion. Of course, for many observers, it had already been there: The financial press this summer has been transfixed by a series of blockbuster deals involving patents.[3] Even NPR's popular *This American Life* program joined the fray, with an hour-long program in July 2011 on "patent trolls." [4]

What is shocking—and should be troubling to those concerned about innovation—is how little actual empirical analysis exists that might allow us to predict the changes that the *America Invents Act* will put into effect. Indeed, regarding perhaps the most substantial change—one that will impact the way that every inventor files for a patent—almost nothing is known. For the *Act* marks the death of what has been for some time a uniquely American tradition in patent law — the "first-to-invent" system of patent priority rules. Until now, the US has been the only country to deviate from the "first-to-file" system used elsewhere.[5]

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passed the House of Representatives on June 23 by a vote of 304-117. S. 23 passed the Senate 95-5 on March 8, 2011.

[2] *See* The White House Blog, *Putting Americans Back to Work: President Obama Speaks on the Debt Compromise*, Aug. 2, 2011, available at

http://www.whitehouse.gov/blog/2011/08/02/putting-americans-back-work-president-obama-speaks-debt-compromise

[3] *See e.g.,* Chris V. Nicholsohn, *Apple and Microsoft Beat Google for Nortel Patents*, NY TIMES DEALBOOK, July 1, 2011, at http://dealbook.nytimes.com/2011/07/01/apple-and-microsoft-beat-google-for-nortel-patents/; Quentin Hardy, *Google Buys Motorola For Patent Parts*, Forbes, August 15, 2011, at *http://www.forbes.com/sites/quentinhardy/2011/08/15/google-buys-motorola-for-patent-parts/*

[4] *See When Patents Attack!,* THIS AMERICAN LIFE (Episode 441, July 22, 2011), available at http://www.thisamericanlife.org/radio-archives/episode/441/when-patents-attack

[5] In 1998, the Philippines switched to a first-to-file system, leaving the U.S. as the last country with a first-to-invent system. *See* Gerald J. Mossinghoff & Vivian S. Kuo, *World Patent System Circa 20XX, A.D.*, 38 IDEA

The reasons for the U.S.'s outlier status are complex,[6] and — perhaps most importantly for our purposes here — not based on empirical research about the actual impact on invention of a first-to-file versus a first-to-invent rule.[7] The study we present here is intended to help fill that gap, offering some insights into what a switch to first-to-file might mean. By carefully analyzing the shifts in patenting behavior the last time a major industrialized nation — Canada — switched from first-to-invent to first-to-file,[8] we find that such a switch will likely reduce the patenting behavior of individual inventors,[9] although whether the benefits of the first-to-file system (primarily reduced administrative and decision-making costs) nonetheless outweigh the reduction in individual inventors is a question that remains unclear. What is clear, however, is that the change to first-to-file is very likely to have real consequences in how inventors (especially individual inventors) utilize the US patent system.

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529, 548 (1998). Canada's switch in 1989 is regarded as the last major industrialized nation to switch — a fact which we exploit for our study.

[6] *See* Mark A. Lemley and Colleen V. Chien, *Are the US Patent Priority Rules Really Necessary*, 54 Hastings L. J. 1299, 1301-1305 (2003) (discussing the politics of the first-to-invent versus first-to-file rules). *See also* Gerald Mossinghoff, *The First-to-Invent System Has Provided to Advantage to Small Entities*, 84 J. Pat. & Trademark Off. Soc'y 425, 426 (2002) (noting the controversy surrounding proposals to switch to first-to-file).

[7] Others have considered whether the results of interefence decisions — an aspect of the first-to-invent rule — have favored different entity types or have other systematic variations. *See* Lemley & Chien, id.; *see also* Mossinghoff, id.

[8] *See An Act to Amend the patent Act and to Provide for Certain Matters in Relation Thereto*, R.S.C. 1985 (3rd Supp.) c. 33. *See also* Gregory C. Ludlow, *Intellectual Property (1987-93), Part I — Summary of Government Activity*, 25 Ottawa L. Rev. 89, 103 (1993) (noting the change).

[9] See infra Section xx.

Patent priority rules establish who among competing inventors has the right to receive a patent on an invention. At first blush, this seems a remarkably simple question: the first inventor should receive the patent grant. But the situation becomes much more complex when there are multiple inventors independently working in the same area of technology: only one can receive the patent grant. And while it is simple to establish a basic first-in-time rule — the first inventor gets the patent rights — the question is what act triggers the establishment of the rights. This, then, is the basic difference between the US first-to-invent system (FTI system) and the first-to-file system (FTF system) used everywhere else. In the US FTI system, the first "inventor" is given the patent rights, while elsewhere the inventor who first files her application at the patent office will receive the rights. The primary arguments in favor of a first-to-invent system are (1) that it is more fair, in the sense that it is most likely to grant the rights to the truly *first* inventor, rather than the one who got to the patent office first, (2) that it enables prospective patentees to perfect their invention, application, and/or consider commercial viability prior to filing, and (3) that it prevents larger, well-resourced companies from gaining a systematic advantage in patenting by reaching the patent office first. The arguments in favor of a FTF system are (1) significant administrative simplicity[10] and (2) additional inducement for early patent applications.[11]

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[10] See, e.g., Lemley and Chien, supra note xx, at 1331 n. 99 (describing the costs of the interference system).

[11] Several theories support a preference for early patenting. First., early patent applications mean earlier disclosure of inventions to the public, as well as earlier expiration of the patent rights themselves. See, e.g., John F. Duffy, Rethinking the Prospect Theory of Patents, 71 U. Chi. L. Rev., 439 (2003). Second, early patenting can prevent rent-dissipating races to invent, by assigning the rights to inventions early in their development. See mark Grady & Jay Alexander, Patent law & Rent Dissipation, 78 Va. L. Rev. 305, 317 (1992). Third, early patenting can allocate inventions to individuals or firms who then have strong incentives to develop these prospects to maximum private and social value. See Edmund W. Kitch, The Nature and Function of the Patent System, 20 J. L. Econ 265 (1977).

As noted above, there is virtually no empirical work on the question of the impact in inventors of the FTF rule. Our strategy here is to exploit a law change in Canada in 1989 to examine the effects of the priority rules on individual inventors. More specifically, in 1989, Canada switched away from a US-style (indeed, almost identical to the US) FTI system to a FTF system, providing a natural experiment of sorts on the effect of such a change.[12] By comparing the change in share of patenting by individual inventors in Canada before and after the law change, and using the same metric in the United States as a control, we can isolate and measure the impact of the Canadian FTF switch on individual inventors.[13] In doing so, we find strong evidence that the change to FTF reduces patenting behavior by individual inventors, implying that some critics of the FTF rule may be at least partially right — though the net policy implications are unclear.[14]

The balance of the paper follows in four parts. In Part II, we detail the policy questions and legal details surrounding the FTI versus FTF systems, as well as the Canadian law change that prompts our study and prior related literature. In Part III we describe our datasets and data collection process. In Part IV we detail the empirical strategy we undertook, and present the main results. Part V explores some possible shortcomings of our analysis, and seeks to address the main objections to our results.

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[12] See supra note xx and sources cited therein. *See also* Robin Coster, *From First to Invent to First to File: The Canadian Experience*, American Intellectual Property Law Association, April 2002, Shih-tse Lo & Dhanoos Sutthiphisal, *Does It Matter Who Has The Right To Patent: First-To-Invent Or First-To-File? Lessons From Canada* (2009) NBER Working Paper 14926 http://www.nber.org/papers/w14926; Blake R. Wiggs, Canada's First-to-File Experience - Should the U.S. Make the Move?, 73 J. Pat. & Trademark Off. Soc'y 493 (1991); Philip C. Mendes da Costa, NAFTA-*The Canadian Response Or Why Does The Canadian Patent Act Keep Changing*? 22 AIPLA Q. J. 65 1994.

[13] See infra Section xx.

[14] See infra Section xx.

We end with a brief conclusion with discussion of the possible policy implications and suggestions for further research.

II
FIRST-TO-INVENT VS FIRST-TO-FILE: A PRIMER

Patent priority is a relatively straightforward concept, determining the question of whom, among contemporaneous inventors of a particular subject matter, is awarded the patent to that subject matter. In a perfect world, patent systems would not require such rules: inventors would work on distinct inventions, and receive patents on them once (or if) they had reached the substantive thresholds for patentability. Unfortunately, it is common for inventors to work on overlapping or even the same inventions, often at nearly the same time — information is simply not available to prevent such occurrences.[15] It is under these circumstances in which the priority rules step in, allocating the patent rights to single inventors (or inventive entities, in the case of joint inventorship). Note that regardless of *how* the rules allocate the patent grants, these circumstances are costly for both inventors and society.[16] Thus, the system of allocating priority matters — significantly.[17]

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[15] The term for this is patent races. See, e.g., Fudenberg, D, Tirole J, Gilbert R, Stiglitz J. 1983. Preemption, Leapfrogging, and Competition in Patent Races. European Economic Review. 22:3-31; See, e.g., Mark F. Grady and Jay Alexander, Patent Law and Rent Dissipation, 78 V.A. L. Rev. 305, 313 (1992).

[16] See Grady and Alexander, supra note __, at 313; Duffy, supra note __, at 442.

[17] Imagine being part of a research team that works for years (and spends millions of dollars) to solve a particular technological problem. Unbeknownst to the investors or researchers, a similar research team was concurrently working on the same problem (and also spending millions of dollars). Assuming near contemporaneous development of the solution, the patent priority rules would then determine the winner and loser of this race,

To date, modern patent systems have used one of two systems for allocating priority to patent rights. The first, known as a "first-to-invent" system, attempts to grant the rights to the inventor who can prove the earliest date of invention.[18] What this means is that the decision-making body, whether the Patent Office or the Courts, must weigh various kinds of evidence relating to the inventive process and it's timing. The second, and dominant approach, has been the first-to-file system, wherein the first inventor to file her application in the relevant jurisdiction is awarded the patent.[19] As compared to the first-to-invent approach, the evidentiary inquiry required for awarding priority under first-to-file is substantially reduced — indeed, almost nonexistent.

Both of these approaches are modified first-in-time systems. One might reasonably ask whether there might be a better system for allocating patent rights among competing inventors. For example, by granting the rights to the inventor best suited to commercialize the technology.[20] Professors Abramowicz and Duffy have recommended, as part of a dramatic rethinking of the patent prosecution process, that the first inventor to receive a granted patent (from among competing patent offices) be awarded priority.[21] Or perhaps the patent rights could be auctioned or shared among closely competing inventors. For our purposes,

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with the loser having not only lost the investment, but also perhaps being precluded from further closely related research.

One issue that is not well known empirically is how much the priority rules matter for the general welfare of society. Priority rules which discouraged wasteful duplication of effort would be beneficial. But it may be the case that the reward of a patent for priority of invention induces more rapid and sophisticated research and that the benefits outweigh the costs of duplicative effort.

[18] See infra Section XX.

[19] See infra Section XX.

[20] This is implicit in Kitch, supra note __, at xx.

[21] See, Michael Abramowicz & John Duffy, Ending the Patent Monopoly, 157 U. Pa. L. Rev. 1541, 1606 (2009) (suggesting first-to-grant as among options).

however, we do not consider these other approaches, and instead investigate the relative effects between the first-to-invent system (the current U.S. system) and the first-to-file approach (used elsewhere).

A. The Current US System: First-to-Invent

The U.S. patent priority system is established in 35 U.S.C. § 102(g), which reads in relevant part:

> A person shall be entitled to a patent unless - … before such person's invention thereof, the invention was made in this country by another inventor who had not abandoned, suppressed, or concealed it. In determining priority of invention under this subsection, there shall be considered not only the respective dates of conception and reduction to practice of the invention, but also the reasonable diligence of one who was first to conceive and last to reduce to practice, from a time prior to conception by the other.

This section has been interpreted by the courts to mean that the patent grant is given[22] to a prior inventor (who did not abandon, suppress, or conceal the invention), if that prior inventor can show (1) a first reduction to practice of the invention, or (2) a first conception of the invention, plus reasonable diligence from that time until a time just prior to conception by another.[23] The filing

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[22] Note that there are two possible procedural postures of priority contests. In the first — known as an "interference", — the USPTO will conduct a proceeding under 35 U.S.C. § 102(g) to determine which of those who filed applications claiming the same subject matter will receive the patent grant. In the second, during post grant litigation, a court will determine whether the provisions of §102(g) have been violated, and thus whether the patent is invalid because of a prior inventor.

[23] See, e.g., Brown v. Barbacid, 276 F.3d 1327 (Fed. Cir. 2002); Mahurkur v. C.R. Bard, Inc., 79 F.3d 1572, 1577-78 (Fed. Cir. 1996); Eaton v. Evans, 204 F.3d 1094, 1097 (Fed. Cir. 2000).

date of the application is not determinative — though the first filer has some important evidentiary advantages in these proceedings.[24]

As established in §102(g), the patent priority rules are highly complex, involving careful definitions of what terms such as "reduce to practice"[25], "conception"[26] and "reasonable diligence"[27] mean. (Not to mention abandonment, suppression, or concealment.[28]) In addition, there are substantial evidentiary complexities: proving earlier dates of invention (typically most important for the later-filer) requires each party to bear the burden of proof, and in some cases, the later filer will face a heightened ("clear and convincing evidence") standard.[29] Further, corroborating evidence is always required in these areas.[30]

B. The First-To-File Rule

By contrast to the FTI rule, the FTF system is (relatively) simple and straightforward. For example, the Canadian rule states:

> § 28.2 (1)
>
> The subject-matter defined by a claim in an application for a patent in Canada … must not have been disclosed … (c) in an application for a patent that is filed in

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[24] See 37 C.F.R. § 41.207(a)(2) (requiring that any party seeking to prove an earlier date of invention bears the burden of proof). See also Price v. Symesk, 988 F.2d 1187, 1192-94 & n.2 (Fed. Cir. 1993).

[25] See, e.g., Eaton v. Evans, 204 F.3d 1094, 1097 (Fed. Cir. 2000).

[26] See, e.g., Brown, supra note __, at 1333; Estee Lauder v. L'Oreal S.A., 129 F.3d 588 (Fed. Cir. 1997).

[27] Griffith v. Kanamaru, 816 F.2d 624 (Fed. Cir. 1987); Donald S. Chisum, Patents § 10.07[4][d] & [f] (2002).

[28] Peeler v. Miller 535 F.2d 647 (CCPA 1976).

[29] See 37 C.F.R. 41.207(a)(2).

[30] Brown, supra note __, at 1333.

> Canada by a person other than the applicant, and has a filing date that is before the claim date.[31]

There are other provisions that deal with contemporaneously filed applications claiming priority to earlier applications (or foreign applications),[32] but the basic thrust is the same: the patent right goes to the first inventor who files her application with the patent office.

The proposed US FTF rules (found in the House and Senate versions of the *America Invents Act of 2011*) are similar in basic approach: the patent grant is given to the inventor with the earliest "effective filing date"[33], but are subject to some additional exceptions — including one which allows a later-filer to win priority if she publicly disclosed (or caused to be publicly disclosed) her invention prior to the filing of the earlier application.[34]

C. The Policy Implications of Patent Priority Rules

There are important policy questions related to a shift to a first-to-file system. Chief among these is whether a first-to-file system discriminates against individual inventors, small businesses, or non-profits, rendering them less likely to obtain effective patent protection than larger organizations.[35] (A weaker version of this

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[31] Canadian Patent Law, § 28.2

[32] See id. at § 28.2(d)(i) – (iv).

[33] The effective filing date refers to either the filing date of the application in question, or the filing date of an earlier application from which the current application can claim the benefit of that earlier date. See. S.26, § 2.

[34] See id. at § 2, revising § 102(b)(2). In a sense this creates something of a "first to publish" system — first disclosure being an important defense against a first filer.

[35] See, e.g., Lemley & Chain, supra note __, at 1304-05; Donald S. Chisum, The Harmonization of International Patent Law, 26 J. MARSHALL L. REV. 437,

question is whether the current U.S. first-to-invent system in fact favors such entities.[36]) The suggestion is that a first-to-invent system — which necessarily allows a later applicant to obtain the patent rights to an invention first claimed in an earlier application by another inventor — allows those with fewer resources (e.g., individuals, small business, and non-profits) to obtain patent protection without the need to "rush" to the door of the patent office.[37] There are good reasons to believe that organizations with more resources will be, on balance, more able to file patent applications quickly. At the simplest level, the cost of patenting is likely to be less of a concern for larger organizations.[38] Further, additional resources means more patent attorneys or agents can be dedicated to drafting and filing applications. The inventors themselves may be more able to redirect the time required by the patent application process away from their other duties. Larger organizations may have routinized patenting procedures, designed to yield rapid applications. Smaller organizations and individuals, with constrained patenting resources, may wish to wait until the commercial potential of an invention is clearer prior to filing. Each of these factors, and likely several more, at minimum raises a serious question about the effect on individual inventors and small businesses of a change to the first-to-file system.

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440 (1993); Robert W. Pritchard, The Future Is Now-The Case for Patent Harmonization, 20 N.C. J. INT'L L. & COM. REG. 291, 300 (1995).

[36] See, e.g., Mossinghoff, supra note __, at 426; Gerald J. Mossinghoff, The First to Invent System Has Provided No Advantage to Small Entities, 87 J.P.T.O.S. 514, 515 (2005) (updating earlier work).

[37] See, e.g., Dana Rohrabacher & Paul Crilly, The Case for a Strong Patent System, 8 HARV. J.L. & TECH. 263 (1995).

[38] The most recent statistics available from the American Intellectual Property Law Association suggests that on average filing a patent application of low complexity costs about $7,000, and that filing a patent of relative complexity costs between $9,000 and $12,000. See AIPLA Annual Economic Report, 2009 at 25. *See also* S. J. H. Graham, R. P. Merges. P. Samuelson, and T. M. Sichelman, High Technology Entrepreneurs and the Patent System: Results of the 2008 Berkeley Patent Survey, 24 BERKELEY TECH. L.J. __ (2009) (discussing the sensitivity of startups to the costs of patenting and enforcement).

It is important to understand, however, that the rules of patent priority are far from the only set of incentives operating on a putative patentee's decision on whether to patent, and when. Indeed, while the current first-to-invent system may at first glance seem to encourage waiting to apply for a patent (or at least not penalize it substantially)[39], the rules themselves do the opposite. For example, the first applicant in a priority contest (known as the "senior party") gains a *de facto* presumption that she is the first inventor, forcing the later filer (the "junior party") to present proof of an earlier invention date.[40] Furthermore, other critical patent rules, most prominently those related to prior art, strongly encourage an early filing — simply, the earlier the filing date, the less prior art will be available.[41] Thus, while the first-to-invent rules offer an important benefit to later patent applicants, their incentive effect is likely to be muted by other, countervailing, incentives built into the patent system.

On the other hand, it is clear that the patent priority rules do matter, significantly. Several scholars have analyzed the results of priority contests under 35 U.S.C. § 102(g), and found that junior parties — later filers of applications — win over 40 percent of the time, a somewhat surprising number, given the evidentiary advantages given to the first applicants.[42] Interestingly, the size of the parties seem to have relatively little effect on the win rates in priority contests.[43]

Priority rules may have a substantial impact for another reason: the determination of what is included in "prior art." Under section

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[39] See, 35 U.S.C. § 102(g). See also

[40] See 35 U.S.C. § 102(g). As studies of interference proceedings have found, the junior party does win nearly half the time, so this advantage is plainly not dispositive.

[41] See, e.g., 35 U.S.C. § 102(a), (b).

[42] See Lemley & Chien, supra note __, at 1309 (reporting that junior parties won 43 percent of the time).

[43] See, e.g., Mossinghoff, supra note __, at 517-18; Lemley & Chien, supra note __, at 1321-22.

102 (a) of the U.S. patent act, a person may lose the right to a patent if the invention was known, used, or described in print before the claimed date *of invention*. Under a first-to-file system, the key date becomes not the date of invention, but the filing date. This expands the period of time during which there could be invalidating prior art available and thus reduces the likelihood of validity. This is another mechanism by which the change in priority system may affect the worth of a patent, but with the same impact, that the expected value on the date of invention is likely to be diminished.

This question has more than distributional import. Although it has been clear that the rate of individual patenting has been decreasing in the US over time,[44] it is widely believed that individuals and small entities have an important impact on the innovation ecosystem — perhaps an outsize impact.[45] This is for several reasons. First, there is some evidence that the inventions from smaller entities are more likely to be "disruptive" in nature, moving the pace of technological change forward.[46] Second, in some industries, such as high technology and pharmaceuticals, small companies and individuals serve as important innovation inputs into larger, established companies.[47] Finally, even if small entities are no more effective than their larger counterparts at

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[44] See USPTO, All Technologies Report: Jan 1, 1986, Dec. 31, 2010, at table A2-1.

[45] See Mark D. Janis, Patent Abolitionism, 17 BERKELEY TECH. L.J. 899, 910 (2002); Michael J. Meurer, Inventors, Entrepreneurs, and Intellectual Property Law, 45 HOUS. L. REV. 1201, 1202-03 (2008).

[46] Joseph A. Shumpeter, Capitalism, Socialism and Democracy (1942); Eric A. von Hippel, The Sources of Innovation (1988).

[47] See, e.g., A.B. Jaffee, M. Trajtenberg, and M.S. Fogarty, Knowledge Spillovers and Patent Citations: Evidence from a Survey of Inventors, 90 American Econ. Rev. 215 (2000). See Zoltan Acs and David Audrestch, Innovation and Small Firms (1990); See U.S. Small Business Administration, Small Serial Innovators: The Small Firm Contribution to Technical Change, Small Business Research Summary, No. 225. (Feb. 2003).

innovation, the distribution of patent rights — and thus marketplace power — has important consequences.

This is not to suggest that we have a firm view on the value of innovations by individuals and small firms versus large companies, nor that we take a position regarding the wisdom of the potential change in the US to a first-to-file rule. Our point here is to note that there is some evidence to suggest that if the first-to-file rules indeed disproportionally impact small entities, that could have important effects on innovation. In short, this is an important policy change that appears to have potential impact on long-run innovation.

III
RESEARCH DESIGN

As the foregoing has suggested, there is an urgent need to empirically investigate one of the major (if not the major) claims related to a potential shift from first-to-invent to first-to-file in the United States: that the change will adversely affect the patenting behavior of individuals and small entities, as compared to larger organizations. However, an obvious obstacle in conducting this investigation is the fact that the US has not changed its priority rules, so there is no way to directly compare the U.S. first-to-invent system with the proposed first-to-file system found in the *America Invents Act of 2011*.

However, although the US has not undertaken a change in priority rules, the most recent such shift in a highly-developed country occurred in Canada in 1989, offering an opportunity for empirical investigation. Canada has a patent system very similar to that of the U.S., has similar economic features to the U.S., close geographic proximity, and a fairly integrated economy with the U.S.—making it a good comparison. Also, Canada has relevant patent data available from 1978 to the present, making empirical analysis possible. Thus, our basic research strategy is to exploit the 1989 change from first-to-invent to first-to-file in Canada as a

means to get insights into what that shift in the U.S. might suggest. Specifically, we want to investigate how the law change affected the patenting behavior of individual inventors.

However, simply comparing the patenting behavior of Canadian individual inventors before and after the law change, without more, allows only limited insight into the question. For example, one would not be able to rule out that any change in activity was related to an array of other factors, most especially larger economic changes. Thus, we need to utilize a control group to help isolate the effect of the Canadian law change. For this we used data on US patenting during the same time period—again, the US did not change its priority rules, and given the similarities between the US and Canadian patent systems (not to mention economies), the US data is comparable. Thus, our research design uses a modern econometric technique known as a *difference-in-difference* analysis[48] to control for effects other than the priority rule change: by comparing the observed differences in individual patenting behavior in Canada across the 1989 change in the law to the differences in individual patenting behavior in the US during the same time period, we can isolate the effect of the law change on individual patenting behavior (in Canada).

The *difference-in-difference* technique is aimed at closely approximating the ideal scientific experiment, with treatment and control groups. In this case, Canada is the treated group, since it had the change in priority rule. Ideally, one would compare it to an identical country (the control group) that did not have such a change. In this study, we use the United States as the control group, since it is similar in many important ways to Canada, and did not have a priority rule change at the same time. By comparing the change in Canada with the change in the United States, we can cleanly detect the effect of just the law change, and not other

[48] See, e.g., Joshua D. Angrist and Jorn-Steffen Pischke, Mostly Harmless Econometrics 227-43 (2009).

spurious effects, such as those related to global changes in innovation.

A. The Canadian Law Change

In 1986, *An Act to Amend the Patent Act and to Provide for Certain Matters in Relation Thereto* was introduced in Canada.[49] The bill passed the House of Commons on May 6, 1987 and the Senate on November 19, 1987. The law changes became effective on October 1, 1989. Patent applications filed prior to October 1, 1989 were processed under the FTI rules, while applications after that date were processed under the new rules.[50]

For our purposes here, the important change was the shift from a FTI system to the current (in Canada) FTF system noted above. Prior to the enactment of the changes in 1989, Canada's patent priority system was similar to the current US system, including a procedure (called a "conflict proceeding") to sort out the priority of co-pending applications.[51]

The 1986 and 1987 patent reform acts also include other important changes to the patent law, several of which we discuss in detail below. For one, the patentability of pharmaceutical drugs was confirmed.[52] For another, the patent term was changed from 17 years from the date of issue to 20 years from the date of filing.[53] The law also introduced a deferred examination process, whereby applicants can file applications, but not request the CPO to begin

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[49] An Act to Amend the Patent Act and to Provide for Certain Matters in Relation Thereto, R.S.C. 1985 (3rd Supp), c. 33 [hereinafter 1987 Amendments]

[50] See 1987 Patent Amendments, RSC 1985 (3rd Supp.) c. 33, ss 8-10. See also id at s. 55.

[51] R.T. Hughes and J.H. Woodley, Hughes and Woodley on Patents 595 (Butterworth's 1984) (describing the Canadian first-to-invent system).

[52] See 1987 Patent Amendments, supra note __, at s. 6.

[53] See id at s. 16.

examining them until some time later, as much as seven years later.[54] And finally, maintenance fees were introduced, requiring annual payments by both applicants and grantees to maintain their applications and patents, respectively.[55]

B. Prior Literature on Priority Rules

Most prior studies investigating the effect of the first-to-file system in the US have been based on data gathered from "interference" proceedings — the complex system implementing the first-inventor priority rules found in 35 U.S.C. § 102(g). In general, these studies have documented little if any impact related to entity size in the current first-to-invent system. For example, Mossinghoff (2005) found no evidence that small entities are advantaged by the FTI system, and indeed concludes that in some ways small entities are disadvantaged by the current system.[56] Specifically, he gathers data on interference proceedings from 1983-2004, and finds that small entities took advantage of the FTI system (by winning an interference contest despite filing an application second) slightly fewer (286 times) than the number of times that such entities were disadvantaged (289 times) by the FTI system (by losing an interference contest despite filing first).[57] Breaking the results out by type of entity, he finds that individual inventors in particular gain no advantage from the FTI system, being disadvantaged about 20 percent more of the time than they

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[54] See id at s.12. The seven-year window was later reduced to five years in 1992.

[55] See id at s. 16.

[56] Specifically, he argues that interference proceedings, which are complex and lengthy, favor larger entities. See Gerald J. Mossinghof, 87 J. Pat. & Trademark Off. Soc'y 514, 520 (2005). Lemley and Chien confirmed in their study that large entities initiate interference proceedings more than small entities, and reach a similar conclusion. See Mark A. Lemley and Colleen V. Chien, 54 Hastings L. J. 1299, 1323 (2003).

[57] Mossinghoff, supra note __, at 517.

were advantaged by the system.[58] In a 2002 study, covering the time period 1983-200, Mossinghoff found similar results.[59]

In *Are the U.S. Patent Priority Rules Really Necessary*, Mark Lemley and Colleen Chien empirically analyze the results of interference proceedings and court cases involving patent priority in the US. They find that the first applicant — the senior party — is usually, but by no means always the first inventor. Indeed, they find that about 40 percent of the time, the junior party wins the priority contest, though they do identify a significant difference between litigated case outcomes and decisions by the USPTO's Board of Patent Appeals and Interferences.[60] Thus, they conclude that, contrary to some scholarly discussion, the priority rules for patent do actually matter, significantly.[61] Lemley and Chien also investigate the grounds on which the victors in the priority contests succeeded, and conclude that in a large majority of cases (about 67-71 percent, depending on the party type), the showing of a first reduction to practice is the grounds for victory.[62] This is a somewhat surprising result, given the complexity of the priority rules — only rarely do parties win on the basis of earlier conception, or the lack of diligence of the other party, or abandonment, suppression or concealment.[63] They argue, therefore, that the priority rules could be greatly streamlined, eliminating much of the complexity and cost, without changing the results in the cases very much.[64]

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[58] Id. at 519.

[59] Mossinghoff, 84 J. PAT. & TRADEMARK OFF. SOC'Y 425, 430 (2002).

[60] Mark A. Lemley and Colleen V. Chien, Are the U.S. Patent Priority Rules Really Necessary?, 54 Hastings L. J. 1299, 1309 (2003)

[61] See id. at 1308. Cf., Peter A. Jackman, *Adoption of a First-to-file Patent System: A Proposal,* 26 U. BALT. L. REV. 67, 84;

[62] Id. at 1315.

[63] Id.

[64] Id. at 1319.

While Lemley and Chien do not themselves try to determine whether the FTI system benefits or harms small entities or individual inventors, they argue that their findings are consistent with Mossinghoff's suggestion that the system does not greatly benefit these groups.[65] In particular, as noted above, they find that large entities are more likely to initiate interference proceedings, suggesting that "[i]f anything, small entities are getting bogged down in interference proceedings initiated by larger companies." They also argue that their basic findings — that first inventors are sometimes the last to file — would not much change under a first-to-file system: the extra incentives to file more quickly should apply, they say, across categories of inventors, so there is little reason to think that first inventors would themselves be more likely to file early. We are not so sure this makes intuitive sense; if a category of inventors (first inventors) are significantly able to gain benefits from a system (i.e., the FTI system), and that system is changed, then one would expect the incentives to be disproportionally felt by that category of inventors, though they are surely correct that the incentives to file early are uniform and widespread in the patent system.

Thus, the major empirical analyses related to the priority system in the U.S. are limited in their ability to answer the question of whether the system helps or hurts individual inventors and small entities. First, by relying on data related to actual priority contests these studies only tell us what happens when there is a significant claim that a first inventor was the last to file.[66] That is, they don't measure the effects that the FTI system versus the FTF system might have on the basic incentives to file for patents (not to mention to engage in innovative activity itself). Second, although Lemley and Chien do not read their study this way, some of their

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[65] Id. at 1321.

[66] Both interference proceedings and litigation (the two venues by which a priority contest can be resolved) are extremely expensive and thus involve only a very small fraction of all patents; therefore, when a priority contest does actually occur, the stakes must be substantial.

results do seem to challenge Mossinghoff's premise that the FTI system is not beneficial to small entities. First, the very fact that the FTI system matters — that the first inventorship rules of priority do indeed drive the results in a substantial minority of cases — together with the arguments that individuals and small business are somewhat more likely on the margin to file quickly, lends some weight to the suggestion that small entities are favored under the FTI system. Second, the relative simplicity of the priority contests, typically only requiring a showing of an earlier date of reduction to practice, suggests that the complexity of the FTI system should not be a disproportionate burden on small entities. Thus, we think it is safe to say that most of the research to date does not offer much information on the effect of the first-to-invent rule, especially with respect to entity size — which is perhaps the primary argument in policy circles right now.

In addition to these US studies, there is one very interesting study that takes a similar — though not identical — approach to the one we conduct here. In *Does it Matter Who Has the Right to Patent: First-to-invent or First-to-file? Lessons from Canada*, Shih-test Lo and Dhanoos Sutthiphisal investigate whether the Canadian law change in 1989 — from FTI to FTF — has had a measurable impact on innovative output in Canada.[67] By comparing industry-level inventive activity between Canada and the United States, they conclude that the change to FTF had a small negative impact.[68] Lo and Sutthiphisal focus their analysis on the years 1983 and 1994, seeking to avoid entangling their results with other possible policy changes in the US or Canada. Using patent counts, as well as measures of patent value, as a measure of inventive output (and thus their dependent variable) their model attempts to explore the differences in output per R&D inputs in 1983 (under the FTI system) and 1994 (under the FTF system). They also use

[67] Shih-tse Lo and Dhanoos Sutthiphisal, Does it Matter Who Has the Right to Patent: First-to-invent or First-to-file? Lessons from Canada, NBER Working Paper No. 14926 (April 2009), at 4-5.

[68] Id. at 5.

Americans who seek patents in Canada as a baseline comparator, arguing that Americans' inventive activity will be less impacted by the Canadian FTF reforms than will domestic inventors. Finally, they also look at Canadian patent filings abroad (in the US and Europe) to account for other changes in the 1989 reforms, most especially the inclusion of maintenance fees. In general, they find relatively little impact on patenting behavior attributed to the change to FTF in 1989. The do, however, find that Canadian small businesses and individuals patented less in the US after the law change, implying a decrease in inventive activity.[69] Thus, they tentatively conclude that the changes in the law seemed to channel patenting behavior towards larger businesses.

C. Data Used in this Study

In order to empirically investigate the impact of the first-to-file priority rule, we obtained bibliographic data on granted patents from the Canadian Intellectual Property Office (CIPO) and the United States Patent and Trademark Office (USPTO).[70] For both data sets we focus on application dates during the period from 1984 to 1993.[71] This period is chosen to allow a long enough timespan to detect changes in patenting behavior due to the law

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[69] Although Lo and Suttiphisal used Canadian patenting in the US as their measure here to, they argue, avoid any effects related to the maintenance fees, their result here seems equally explained by the rise in the costs of Canadian patenting as a result of the new fees. That is, larger entities can be expected to see a shift in patenting in their direction when the costs of patenting rise, and there is good reason to expect that Canadian inventors who file in the US will also file patents in Canada, so rises in the costs of patenting in Canada will likely have a similar effect on the costs of patenting — to Canadian companies — in the US.

[70] Canadian data is available from the Canadian Intellectual Property Office (CIPO), http://www.cipo.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/eng/wr02466.html. The US data is available at http://www.uspto.gov/products/catalog/patent_services/patdata.jsp

[71] For both data sets application date is the actual filing data of the patent application.

change, but not so long so that long-term trends and other changes are likely to introduce excess noise into the data.[72] The U.S. and Canadian datasets are similar, and both include information on application date, patent grant date, inventor, assignee, patent number, number and word count of claims, and technology classification.[73]

One significant difference between the two datasets is the size: there are 163,464 patents in the Canadian data and 890,344 in the U.S. data. While the total number of patents granted in the U.S. is over five times that of Canada, the disparity goes in the other direction when normalizing for country size or GDP. Using 1990 populations[74][75], there were 6.32 Canadian patents granted per 1000 people and 3.59 patents per 1000 Americans.[76] Additionally, through the ten year period of the data, there were 294 patents granted in Canada per billion dollars (1989 US$) of annual GDP compared with 162 patent grants in the U.S. per billion dollars of annual GDP.[77]

Because the focus of this investigation is the impact of the priority rule on what types of entities are granted patents, it is crucial to have a clear definition of an individual patentee.[78] In both the Canadian and U.S. data, inventors must be individuals, but assignees can be individuals or corporations. There can be multiple inventors and assignees in both data sets. In the Canadian data, we define a patent as having a corporate inventor — and thus not an

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[72] Some specifications use shorter time periods in order to focus even more precisely on the 1989 law change.

[73] See Appendix XX (Dataset Fields)

[74] "Estimated population of Canada, 1605 to present". Statistics Canada. 2009.

[75] U.S. Census Bureau 1990 Census available at http://www.census.gov/main/www/cen1990.html

[76] Note that these are total patents granted in each country, regardless of country of origin of patentee or inventor.

[77] GDP data available at http://www.imf.org/external/ns/cs.aspx?id=28

[78] All assignment data for both countries is as of the patent issue date.

individual patentee — if at least one of the assignees as of the grant date is not also an inventor. This is because in the Canadian dataset, individual inventors are also listed assignees, as well as any corporate assignees.[79]

The U.S. data is easier to classify, due to additional data made available by the USPTO.[80] A field is included with that data set that includes a classification of the type of assignee entity. We create a binary variable that is one if the assignee type is an individual. In order to make the coding comparable with the Canadian data we also use a second definition for the US dataset. For this variable, we define an individual inventor as one that has a missing assignee name, implying that no assignment has been made as of grant and thus the inventor is likely an individual.[81] The two definitions we use for US data disagree less than one time in 1000 observations.

With these definitions in place it is useful to compare the base rates of assignment to individuals during the time period studied. In Canada, 9.9% of patents are granted to individuals, while this rate is 16.9% in the United States. Among domestic inventors, though the pattern is reversed, with 36.4% of Canadian patents granted to Canadians going to individuals, while in the U.S. 23.2% of Americans entities receiving patents are individuals. The higher overall rate of individuals in the U.S. data may therefore reflect the greater proportion domestic patentees comprise, differences in variable definition in the two datasets, the impact in Canada of the priority rule change, or other factors. What is much more important for the purposes of our analysis is that the variables are relatively stable over time or trend in the same way. We examine this shortly.

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[79] We discuss and attempt to address potential shortcomings arising from this definition in Section V.

[80] Ideally we would compare similarly defined small entities or individuals across the two data sets. Unfortunately, the CIPO does not include such classifications with the data.

[81] This is actually the definition used in the results presented in this paper.

Another way to compare inventive activity in the U.S. and in Canada is by looking at country of inventors and assignees. In Table 1, we see that US inventors make up nearly 50 percent of Canadian patent grantees, followed by Japan with 14 percent. Canadian inventors are fourth in their country, with about 7 percent of the total. The pattern in the US is similar (Table 2), with American inventors comprising just over half of granted patentees. This is followed by Japanese inventors, which make up 21 percent. Canadian inventors account for 2 percent of the U.S. data, but were actually granted about 40% more patents in the U.S. (17,805) than in Canada (12,944). In both countries, inventors from five large European nations (Germany, France, UK, Switzerland, and Italy) together comprise much of the remaining inventors. The distribution of country of top assignees (not reported) is very similar to that for inventors.

Table 1

Top 25 Countries of Inventor Submitting Canadian Patent Applications 1984-93

Country of First Inventor	Number of Patents from 1984-1993	Fraction of Total
UNITED STATES	80,332	49.14
JAPAN	23,829	14.58
GERMANY	12,186	7.45
CANADA	12,055	7.37
FRANCE	8,598	5.26
UNITED KINGDOM	7,123	4.36
SWITZERLAND	3,154	1.93
ITALY	2,813	1.72
NETHERLANDS	2,683	1.64
SWEDEN	2,108	1.29
AUSTRALIA	1,296	0.79
FINLAND	1,163	0.71
BELGIUM	1,098	0.67
AUSTRIA	830	0.51
DENMARK	562	0.34
ISRAEL	409	0.25
NORWAY	387	0.24
UNKNOWN	364	0.22
SOUTH AFRICA	337	0.21
HUNGARY	266	0.16
SPAIN	250	0.15
SOVIET UNION	209	0.13
REPUBLIC OF KOREA	190	0.12
NEW ZEALAND	168	0.10
LUXEMBOURG	131	0.08

Calculations based on CIPO data

Table 2

Top 25 Countries of Inventor Submitting U.S. Patent Applications 1984 - 1993

Country of First Inventor	Number of Patents from 1984-1993	Fraction of Total
UNITED STATES	475,003	53.35
JAPAN	190,910	21.44
GERMANY	71,120	7.99
FRANCE	27,672	3.11
UNITED KINGDOM	25,378	2.85
CANADA	17,781	2.00
SWITZERLAND	12,206	1.37
ITALY	11,696	1.31
NETHERLANDS	8,775	0.99
SWEDEN	7,552	0.85
TAIWAN	7,474	0.84
AUSTRALIA	4,269	0.48
REPUBLIC OF KOREA	4,236	0.48
AUSTRIA	3,443	0.39
BELGIUM	3,259	0.37
ISRAEL	3,004	0.34
FINLAND	2,875	0.32
DENMARK	1,906	0.21
SPAIN	1,319	0.15
NORWAY	1,160	0.13
SOVIET UNION	1,047	0.12
SOUTH AFRICA	1,044	0.12
HUNGARY	871	0.10
UNKNOWN	733	0.08
HONG KONG	537	0.06

Calculations based on USPTO data

A list of top corporate patentees (by assignee name) includes some of the best known companies in the world, for both U.S. and Canadian patents (see Tables 3 and 4). GE, IBM, Canon, Toshiba, and Du Pont are among the firms granted the most patents in both countries. Within the top 100 non-individual patentees in the U.S. (available from the authors) there are a few entities that do not qualify as corporations: parts of the federal government or military and a university (MIT). In the Canadian data, a few erroneous top assignees result from data entry errors[82], along with the Canadian military, National Research Council of Canada, and 4 individuals (Jean-Francois Grollier[83], David T Green[84], Robert C. Berfield[85], and

[82] These include "Co", "Company", "Co KG", "Co-Conn", "Co Inc", and "Sons Inc".

[83] A chemist who has directed R&D for L'Oreal since 1994.

[84] Patents on medical technologies.

Josef Pedain[86]). Further investigation is being made to determine whether these individuals were working for a corporation at the time of the patent grants or were in fact working in independent research labs.

Table 3

Top Companies by Canadian Patent Applications 1984 - 1993

Company Name	Number of Patents from 1984-1993
GENERAL ELECTRIC COMPANY	235
AMERICAN TELEPHONE AND TELEGRAPH COMPANY	180
MINNESOTA MINING AND MANUFACTURING COMPANY	172
SONY CORPORATION	168
NV PHILIPS GLOEILAMPENFABRIEKEN	167
INTERNATIONAL BUSINESS MACHINES CORPORATION	158
WESTINGHOUSE ELECTRIC CORPORATION	150
SHELL CANADA LIMITED	149
NEC CORPORATION	142
E I DU PONT DE NEMOURS AND COMPANY	136
THE DOW CHEMICAL COMPANY	127
HOECHST AKTIENGESELLSCHAFT	118
CIBA-GEIGY AG	116
GAMBLE COMPANY	110
EASTMAN KODAK COMPANY	105
UNION CARBIDE CORPORATION	96
FOCKE HEINZ	88
THEURER JOSEF	86
EI DU PONT DE NEMOURS AND COMPANY	79
DOW CORNING CORPORATION	78
EXXON RESEARCH AND ENGINEERING COMPANY	77
RCA CORPORATION	76
GENERAL MOTORS CORPORATION	72
CO	79
COMPANY	78

Calculations based on CIPO data

[85] Vacuum cleaner related patents

[86] Chemical coatings patents.

Table 4

Top Companies by U.S. Patent Applications 1984 - 1993

Company Name	Number of Patents from 1984-1993
Canon Kabushiki Kaisha	9,189
Hitachi Ltd.	8,986
Kabushiki Kaisha Toshiba	8,342
General Electric Company	7,769
International Business Machines Corporation	7,210
Mitsubishi Denki Kabushiki Kaisha	7,104
Eastman Kodak Company	6,409
Fuji Photo Film Co. Ltd.	6,122
Motorola Inc.	5,333
Matsushita Electric Industrial Co. Ltd.	4,693
NEC Corporation	4,692
U.S. Philips Corporation	4,529
Siemens Aktiengesellschaft	4,446
Bayer Aktiengesellschaft	4,075
Sony Corporation	3,978
Xerox Corporation	3,763
E. I. Du Pont de Nemours and Company	3,662
General Motors Corporation	3,643
Fujitsu Limited	3,594
The Dow Chemical Company	3,524
Westinghouse Electric Corp.	3400
Minnesota Mining and Manufacturing Company	3341
Texas Instruments Incorporated	3312
Sharp Kabushiki Kaisha	3225
BASF Aktiengesellschaft	3156

Calculations based on USPTO data

IV
ANALYSIS AND RESULTS

As described in Section III above, we use the Canadian change to the patent priority rules as a natural experiment in order to understand its relative impact on individual inventors. In order to control for contemporaneous changes that could also affect innovative activity, we use the United States as a control group. The U.S. is chosen because of the geographic proximity, economic similarity, and close economic ties.

A. The Rate of Patenting in the US and Canada

For an experiment to be a clean one, it is helpful for there to be a sharp discontinuity in the treated group and none (or a much smaller one) in the control group. One measure of innovative activity in a country is the rate of patent applications. Figures 1 and 2 report these rates for Canada and the U.S. for the period from 1984 – 1993. There is a substantial difference in the time series of patent applications in the two countries.

Figure 1

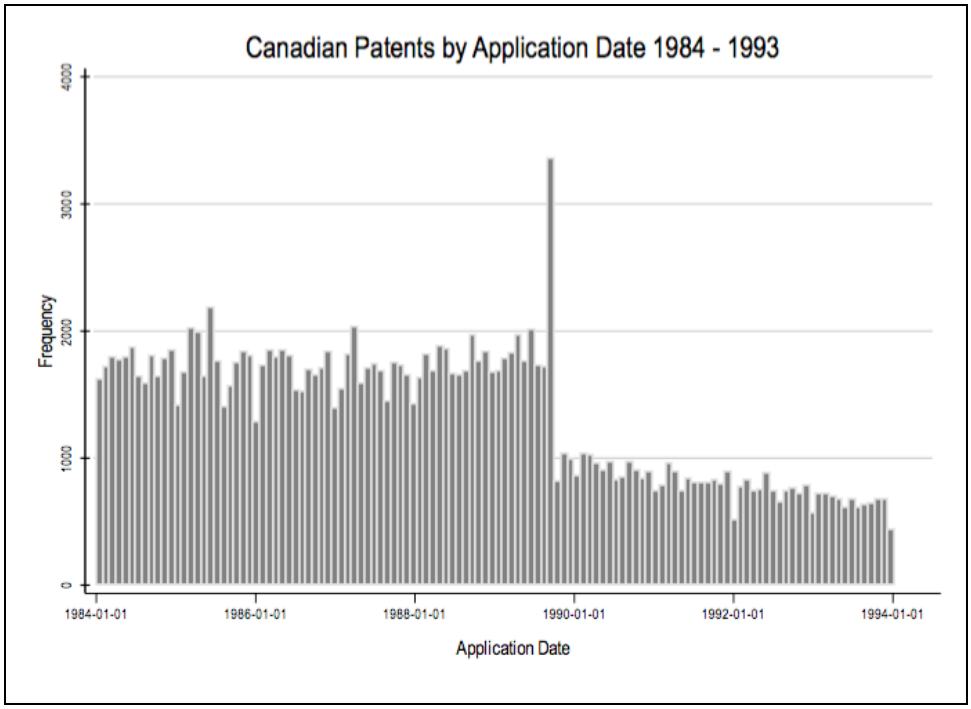
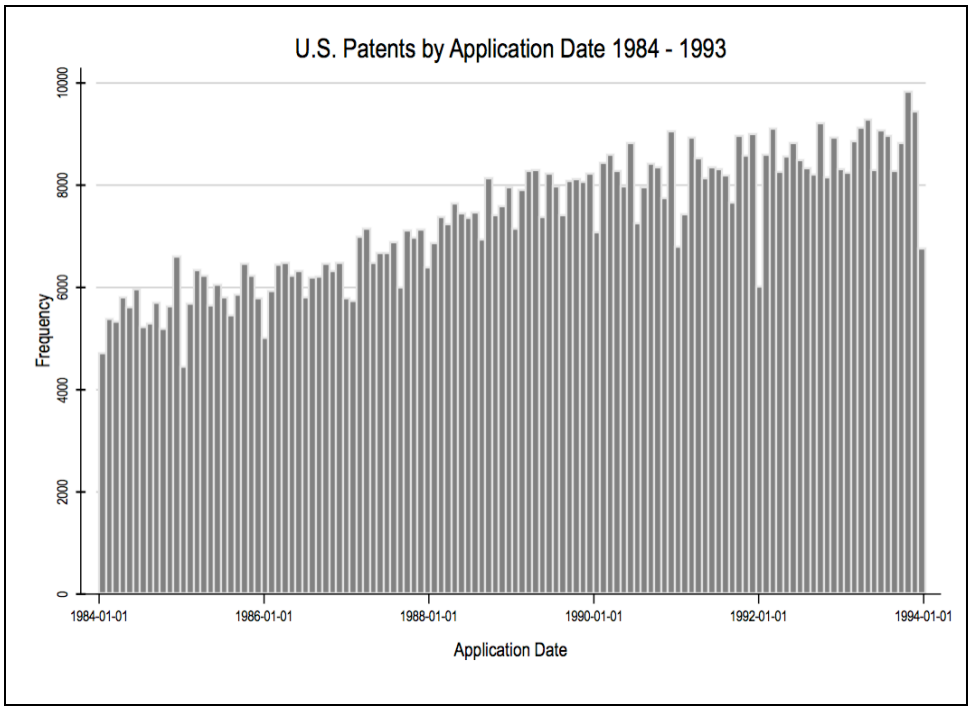


Figure 2



As shown in Figure 1, in Canada, between the beginning of 1984 and mid-1989, the number of subsequently granted applications is relatively stable at around 1700 per month. After a brief spike to 3400 patents in the month immediately before the law change on October 1, 1989, the rate drops to less than 1000 per month, which remains roughly stable (with a slight decline) through 1993. This is in sharp contrast to the pattern in U.S. patents where there is a fairly steady increase in subsequently granted applications from 6000 per month in 1984 to around 9000 in 1993. Below we discuss further the relevance of the large overall drop in applications.[87] For now, we take this as evidence of the substantial

[87] In order to test this concern, we run regressions including dummy variables for IPC class interacted with post and find that the "post" dummy is still significantly negative. If the entire reason for the drop in Canadian patents was explained by some classes being negatively impacted by the law change, and these were just the classes that had the highest individual inventor representation, then there should be no overall effect of the post

impact of the 1989 law change and examine its effect on individual versus corporate inventors.

D. The Effect of First-to-file: Individual vs. Corporate Inventors

The most compelling evidence for the impact of the first-to-file rule on small inventors is a visual difference in difference. The traditional difference–in-difference subtracts off the change in the control group from the change in the treated group. In this case, the results are so stark that it is easily seen by the visual comparison in Figure 3, which reports the representation of individual inventors in the U.S. and Canada. In Figure 3 we see a sharp decline in the fraction of individual inventors, from 10.7% prior to the end of 1989 to 7.8% afterward. During the same period in the U.S. the proportion of individual inventors dropped slightly, from 17.4% to 16.5%.

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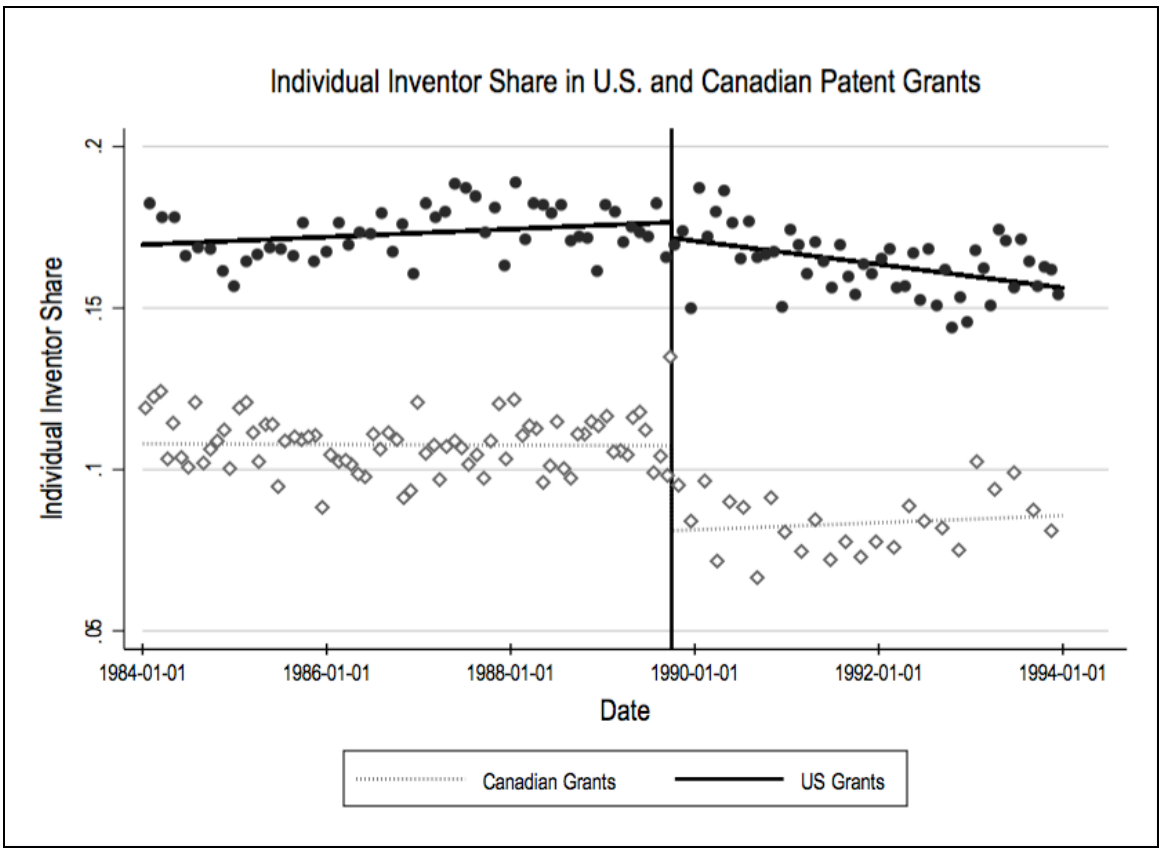
dummy. In fact, we find it to be statistically significant and a large negative value.

Figure 3



The numerical results from the difference-in-difference are reported in Table 5. We see that both the United States and Canada experienced a decline in fraction of individual inventors following the Canadian law change. This likely represents a long-term increase in the amount of innovation that occurs under corporate auspices.[88] But importantly the magnitude of the decline is about three times greater in Canada than in the U.S. This is also relative to a lower baseline share of individual inventors, so in percentage terms, the decline in Canada is almost 25%, compared to about 5% in the U.S. The net effect of the law is reported in the bottom right hand corner of Table 5. The proportion of individual inventors in Canada declined 1.5 percentage points more than the decline in the

[88] Citation.

U.S. following the Canadian law change. This result is statistically significant at well below the 1% level.[89]

Table 5

Difference in Difference: Individual Inventor Representation

	Before	After	After - Before
United States	0.1734	0.1639	-0.0095
	(.00056)**	(.00056)**	(.00079)**
Canada	0.1077	0.0832	-0.0245
	(.00088)**	(.00118)**	(.00156)**
Canada - US	-0.0657	-0.0807	-0.0150
	(.00117)**	(.00168)**	(.00205)**

Cells indicate fraction of patents granted to individuals, with standard errors in parentheses. Before is prior to October 1, 1989, the effective date of the change of Canadian priority rule from first-to-invent to first-to-file. "United States" data from the USPTO; "Canada" data from the CIPO from 1984 through 1993.
* indicates significance at $p < 0.05$ ** indicates significance at $p < 0.01$

To make these results more precise, and allow for control variables, we run a regression of the form

$$(1) \quad II_{Ct} = \alpha + \beta C + \gamma * post_t + \delta C * post_t + \epsilon_{Ct}$$

where II_{Ct} is the fraction of individual inventors in the data in Country C at time t. We code C as 1 for Canada and 0 for the U.S. and thus β is the Canadian fixed effect. $Post_t$ is 1 after the effective date and zero before and thus γ captures any overall before-after effect (in some specifications, a linear time trend is also included). The coefficient of interest is δ, which is the difference-in-difference estimate.

The results from estimating this equation by ordinary least squares regression are reported in the first column of Table 6. This result replicates what we have already seen in Table 5, a reduction of about 1.5 percentage points in the fraction of individual

[89] Ideally we would like to examine relative application rates of individuals and larger entities, in addition to grant rates, but application data is not available in Canada prior to the law change.

inventors after the effective date of the first-to-file rule. The other columns report results from additional regressions. In column 2, rather than the using the effective date to define the before and after periods, we use the date of bill passage, November 19, 1987. The figures indicate that not much occurred around this date, but this specification is included for completeness. Not surprisingly, the coefficient on the interaction term is substantially smaller, although still statistically significant.

Table 6

Effect of Priority Rule on Fraction of Individual Inventors

VARIABLES	(1) Base Specification	(2) Date of Passage	(3) Linear time trend	(4) Year dummies	(5) IPC Class Controls	(6) Probit marginal effects	(7) Counts
After	-0.00956	-0.00574	-0.0107	-0.0095	-0.00623	-0.0091	254.1
	(0.000794)**	(0.000856)**	(0.00140)**	(0.00253)**	(0.000741)**	(0.000754)**	(25.98)**
Canada	-0.0657	-0.0659	-0.0657	-0.0654	-0.0529	-0.0642	-952.7
	(0.00105)**	(0.00130)**	(0.00105)**	(0.00105)**	(0.00101)**	(0.00100)**	(21.81)**
After*Canada	-0.0149	-0.00453	-0.0149	-0.0156	-0.0213	-0.0243	-378.6
	(0.00181)**	(0.00172)**	(0.00181)**	(0.00181)**	(0.00175)**	(0.00229)**	(26.34)**
Year			0.00023				
			-0.000238				
Constant	0.173	0.173	-0.283	0.171	0.17		1,144
	(0.000561)**	(0.000709)**	-0.474	(0.00126)**	(0.000521)**		(21.44)**
Observations	1,053,808	1,053,808	1,053,808	1,053,808	1,053,808	1,053,808	240
R-squared	0.005	0.005	0.005	0.006	0.133	0.007	0.965

For columns 1-6, the dependent variable is a dummy that is one for patents granted to individual inventors and zero otherwise; data is at the patent level. Column 7 reports results from data at the month-country level where the dependent variable is the count of patents granted to individuals. Coefficients on year dummies are not reported in column 4. Except for in column 2, After indicates that the patents was applied for subsequent to October 1, 1989, the effective date of the change of Canadian priority rule from first-to-invent to first-to-file. In column 2, the critical date is November 19, 1987, the date of passage. Data is from the USPTO and CIPO from 1984 through 1993. Robust standard errors in parentheses.
* indicates significance at $p < 0.05$ ** indicates significance at $p < 0.01$

In columns 3 and 4 we include a linear time trend and year dummies, respectively. This is to account for overall changes that might affect innovative activity in both the U.S. and Canada. The coefficient on the interaction term is unchanged, indicating unsurprisingly that there is not a large amount of overall change in the rate of individual innovation during this time period.

All of the regressions to this point have used a linear probability model. Since the dependent variable is binary, probit may be more appropriate[90], so we run a regression of the form:

$$(2) \qquad p(II_{Ct}) = \Phi(\alpha + \beta C + \gamma * post_t + \delta C * post_t + \epsilon_{Ct})$$

Column 6 reports the marginal effects from this regression. The magnitude of the coefficient (-.0243) is a bit larger than in the base specification, but once again there is a statistically significant negative effect of the law change on individual inventor representation.

In column 7 we report results from a regression of the same form as (1) but where now II_{Ct} is the monthly count of patents granted to individual inventors. The result is consistent with the other specifications: there is a substantial negative impact of the law change on patents granted to individual inventors, yielding 379 fewer of them per month.

We next explore potential heterogeneity in the impact of the effect by country of inventor. If individual inventors are more likely to patent in their home country, then we would expect to see a bigger impact of the Canadian law change on Canadian inventors, relative to American or other inventors. Table 7 reports results from this analysis.

[90] Since this is a difference-in-difference specification and the independent variables of interest are binary, it is unlikely that probit will yield substantially different results.

Table 7

Variation in Effect by Country of Inventor

VARIABLES	(1) Canada	(2) U.S.	(3) All other countries
After	0.000523	-0.0131	-0.0131
	-0.00722	(0.00122)**	(0.000882)**
Canada	0.0256	-0.143	-0.0136
	(0.00736)**	(0.00147)**	(0.00132)**
After*Canada	-0.0488	-0.00852	-0.0222
	(0.0119)**	(0.00254)**	(0.00209)**
Constant	0.364	0.238	0.0912
	(0.00510)**	(0.000872)**	(0.000631)**
Observations	29,836	555,335	468,637
R-squared	0.001	0.015	0.001

Each column reports results of a separate regression by country of inventor. Dependent variable is a dummy that is one for patents granted to individual inventors and zero otherwise; data is at the patent level. After indicates that the patents was applied for subsequent to October 1, 1989, the effective date of the change of Canadian priority rule from first-to-invent to first-to-file. Data is from the USPTO and CIPO from 1984 through 1993. Robust standard errors in parentheses.
* indicates significance at $p < 0.05$ ** indicates significance at $p < 0.01$

Each column in the table is a separate regression run only on inventors from the specified country. In all cases, there is a statistically significant decline in individual inventor representation following the Canadian law change. However, as expected, the magnitude of the decline is far larger for Canadian inventors: -.0488, compared to -.0085 for Americans and -.0222 for all others. This should come as no surprise that individual inventors in Canada are most affected by the Canadian law change. The decline in the fraction of individual inventors among other nationalities indicates that Canadian law changes can still have a potential affect among those individuals considering patenting in that country.[91] Together, the empirical results indicate a statistically significant and substantial reduction in patents granted to individual inventors subsequent to the Canadian law change.

[91] There are alternative explanations as well, which we discuss further in the next section.

E. Patent Quality Changes

Besides the impact on individual inventors, the other major concern that is often raised about a first-to-file priority rule is that it will lead to lower quality patent applications. Clearly, a first-to-file system encourages inventors to submit a patent application as quickly as possible following invention. The question is whether this rush leads to lower quality patent disclosure, undermining a major social benefit of the patent system.

Given our datasets, whether patents granted under the first-to-file rule are of lower quality than under those under first-to-invent is a testable proposition. We use several proxies for patent quality to evaluate the impact of the 1989 Canadian law change, including length of the first claim, total number of claims, and complexity of the first claim. If the "rush to patent" theory is correct, we should see a substantial decline in each of these measures.

We find no significant change in patent quality due to the 1989 Canadian law change using any of these measures.[92] For illustration, note Figures 4 and 5 below, depicting the word count of claim 1 of each granted patent in Canada and the United States, respectively.

[92] We use the same difference-in-difference technique as employed above to examine the impact on individual inventor share.

Figure 4

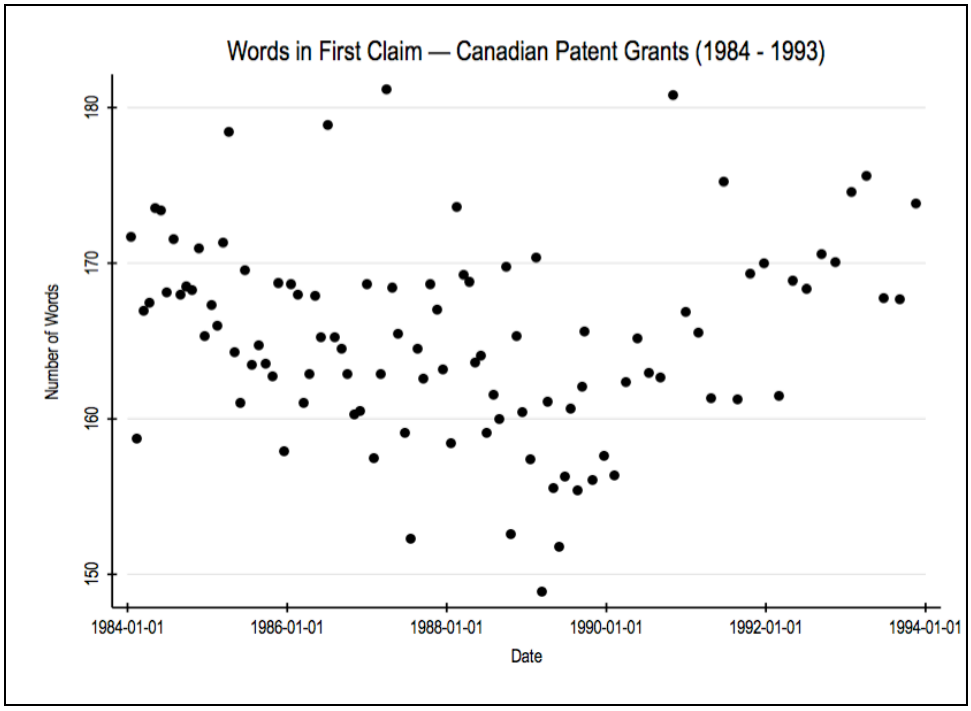
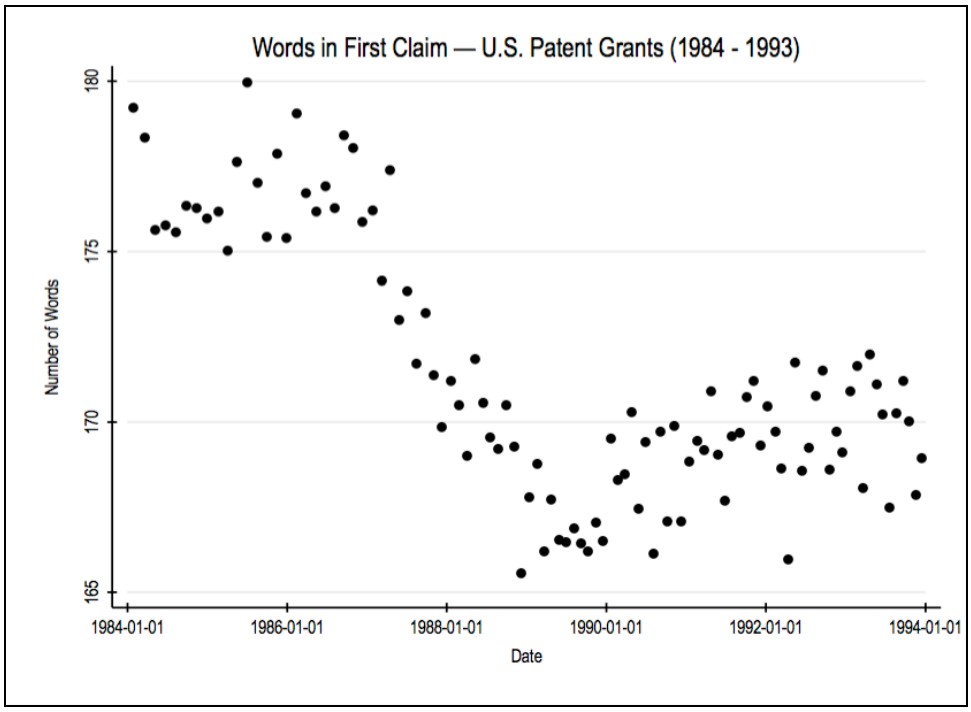


Figure 5



What we find, and can be seen in Figures 4 and 5, is a large drop in Claim 1 wordcount during the time period of our analysis in US patents. This is an interesting pattern, and one that suggests further research well beyond the scope of this project.[93] What we can determine here, however, is that the 1989 law change in Canada does not appear to affect patent quality (as measured by our metrics).

F. Addressing Potential Concerns and Robustness Tests

Although we believe we have identified — at least tentatively — a substantial effect on individual inventors as a result of the shift to a first-to-file rule, we have considered several possible confounding factors and limits to the conclusions that we can draw from our analysis. Although we don't believe that any of these undermine our basic conclusion, we address them below.

1. The Contemporaneous Patent Term Change

Along with the change to the first-to-file system, Canada changed the patent term with the law implemented in 1989.[94] The patent term had been 17 years from grant date, and became 20 years from application date.[95] This change could potentially impact the fraction of individual inventors seeking patents, and therefore explain the results we find, rather than the patent priority system.

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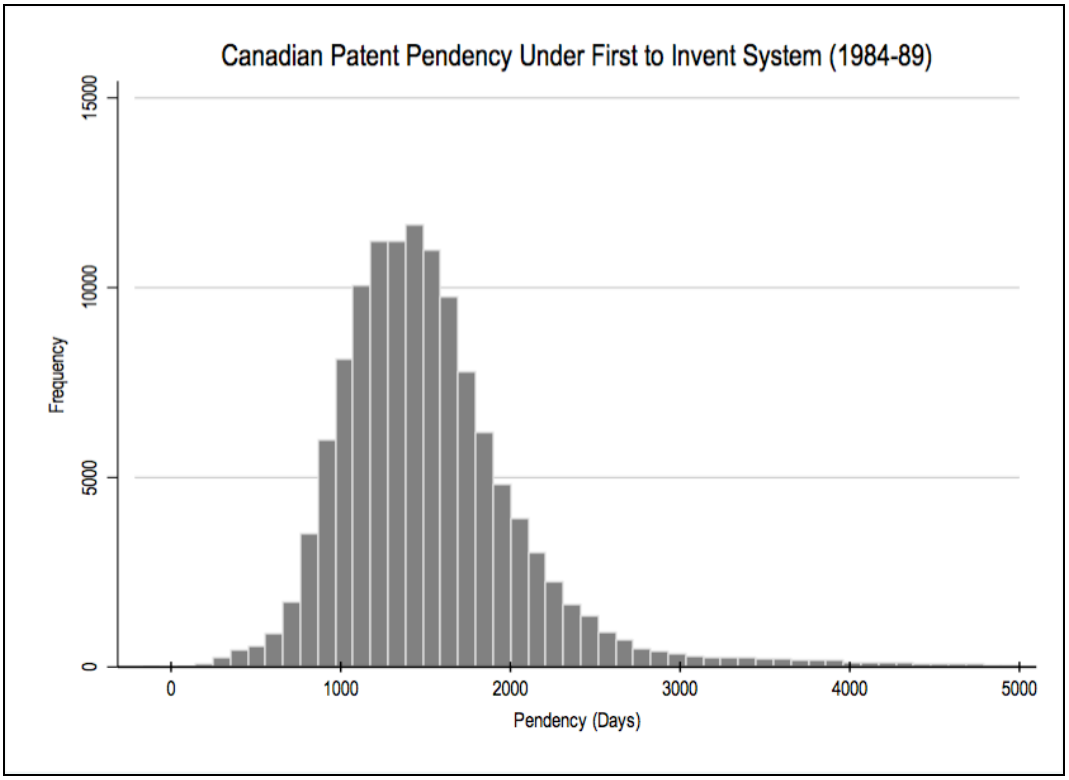
[93] We believe that this pattern in the US data may be a response by inventors to changes in US patent law wrought by the creation of the US Court of Appeals for the Federal Circuit in 1982. The consensus is that the Federal Circuit greatly increased the likelihood that patents would be upheld as valid, enabling patentees to seek broader — here, shorter — claims. As we note in the text, this is an avenue for future research.

[94] See Gregory C. Ludlow, Intellectual Property (1987-93), Part I – Summary of Government Activity, 25 Ottawa L. Rev. 89, 104 (1993); 1987 Patent Amendments, s. 16.

[95] *Id.*

When the U.S. made the same change in patent term the net effect was an increase in patenting[96], so one might think this could not account for the decline in the rate of individual patenting observed here. But as Figures 6 and 7 make clear, the processing time in Canada is substantially longer than in the U.S. Prior to the Canadian law change the processing time was about 51 months in Canada versus 22 in the U.S. Thus the net effect of the change in patent term is to decrease the effective duration of patent protection and thus decrease the incentive to patent generally. [97]

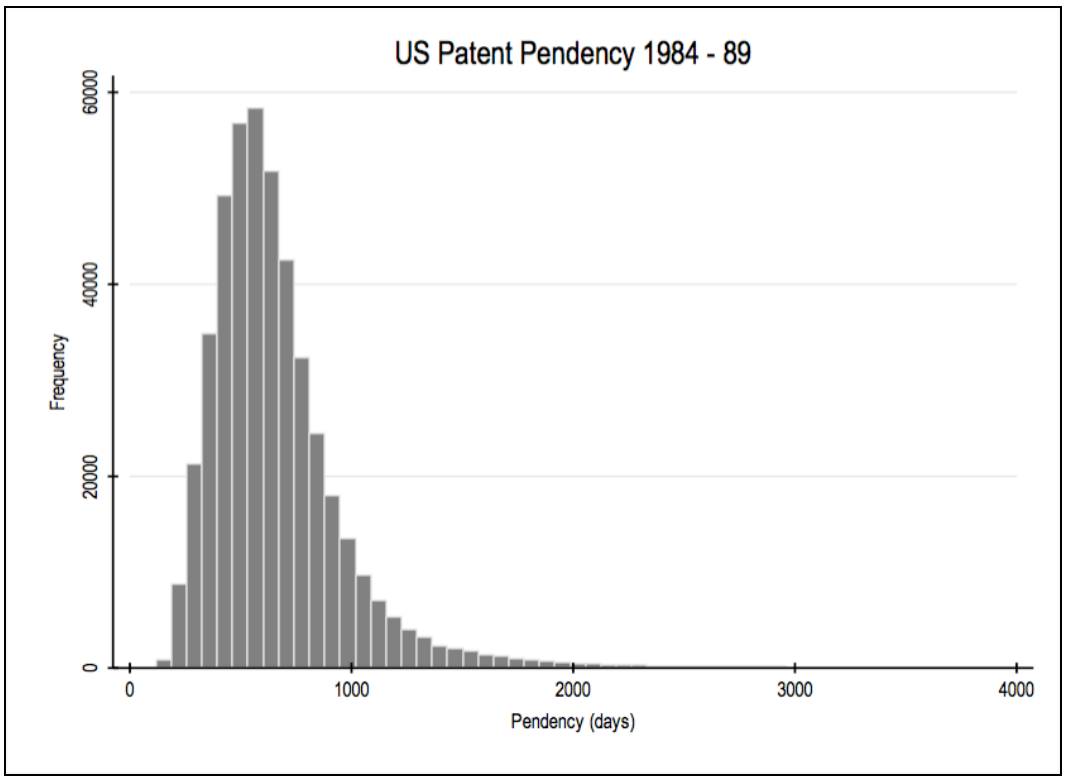
Figure 6



[96] *See* David Abrams, Did TRIPS Spur Innovation? An Analysis of Patent Duration and Incentives to Innovate, 157 U. Pa. L. Rev. 1613 (2009).

[97] *See id.* for a discussion of the incentive effects of patent term changes.

Figure 7



However this decreased incentive to patent should affect both businesses and individuals, and it is not clear why the effect would be stronger on individual inventors. If anything, individuals tend to have higher discount rates, and thus a decrease in duration should make a smaller impact on their decision to innovate relative to businesses.

Besides the direct effect on the incentive to innovate, the change in processing time could also have heterogeneous effects by patent class.[98] It could be the case that those classes that receive the greatest decrease in effective patent protection are also those with the greatest proportion of individual inventors. To test this, we analyzed the individual inventor share of patents in technology classes, and then checked to see whether that correlated with mean

[98] See Abrams supra note __, at xx for an investigation of this in the U.S. context.

class pendency — a positive correlation here (more pendency, more individual inventors) might suggest that individual inventors were disproportionately affected by the patent term change. We did not find this correlation. If anything, we find that individual inventors tend to be (slightly) overrepresented in classes with lower pendency. Figures 8 and 9 depict these results graphically, before and after the shift to first-to-file, respectively.

Figure 8

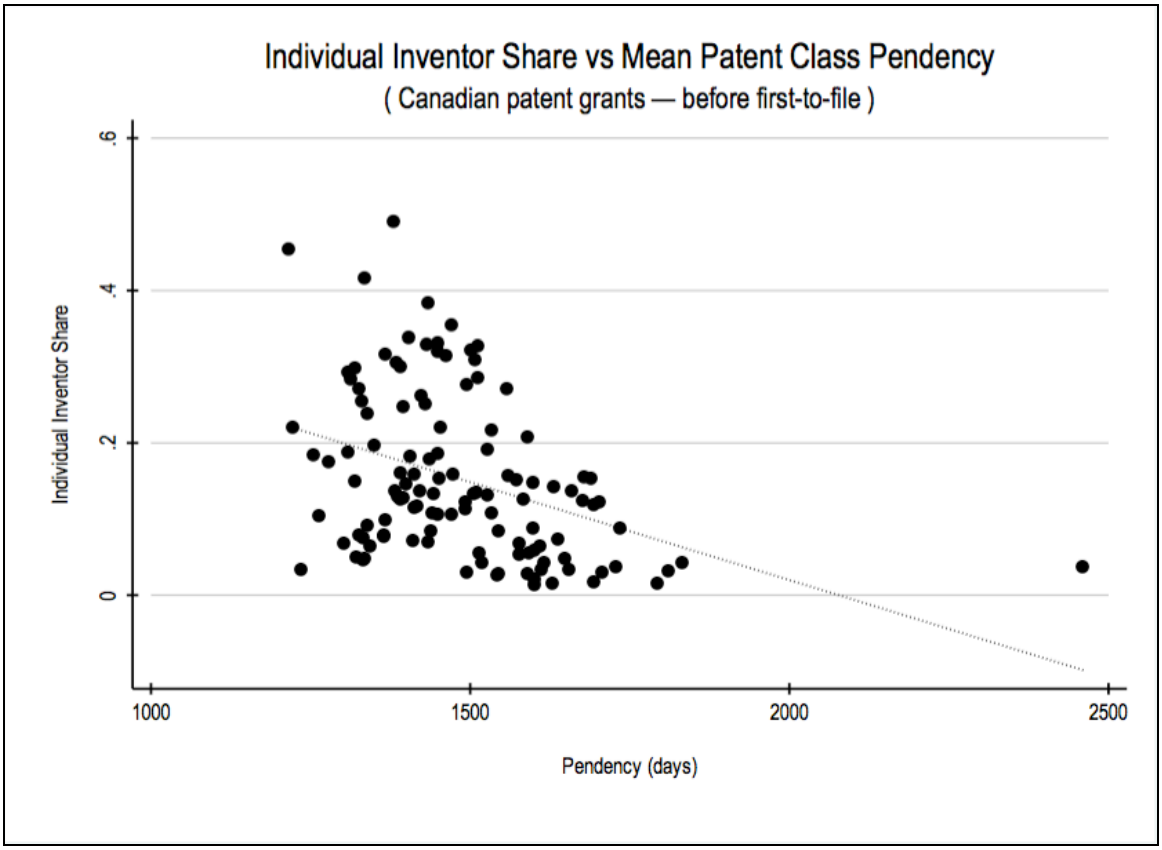
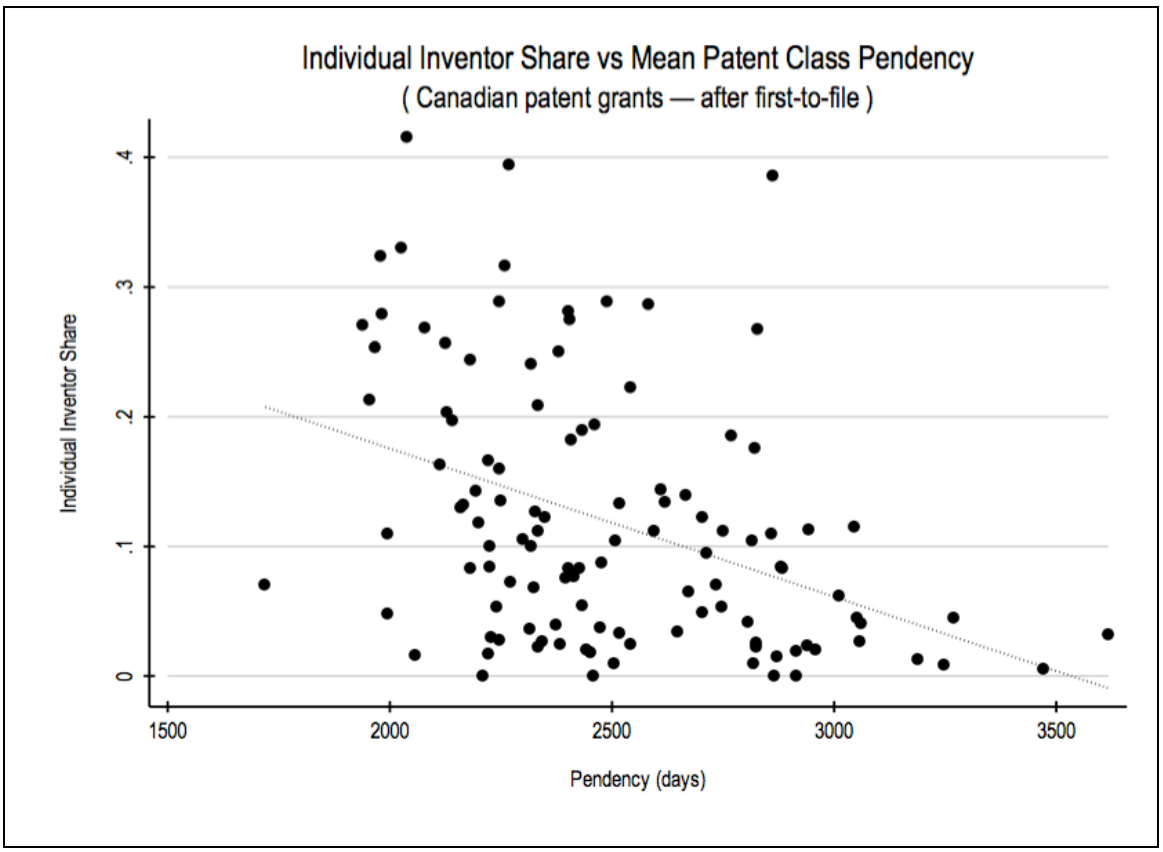


Figure 9



2. The Introduction of Maintenance Fees

As noted in Section II above, one of the legal changes in Canada introduced in 1989 (in the same patent reform bill as the shift to first-to-file) was the introduction of maintenance fees, for both applicants and patent grantees.[99] In general, these fees require applicants (or grantees) to pay annually to maintain their application or their patent rights.[100] One possible concern is that

[99] An Act to Amend the Patent Act and to Provide for Certain Matters in Relation Thereto, R.S.C. 1985 (3rd Supp), c. 33, s. 16.

[100] The annual fee schedule, which has apparently remained unchanged since 1989, is as follows:

Years 2, 3, 4	$100
Years 5,6,7,8,9	$200

the introduction of these fees might reduce patenting behavior, especially for individual inventors. We think this is unlikely for several reasons. First, the amount of fees is small relative to the total costs of filing a patent for most applicants. We find that the median processing time (i.e. the time in the patent office) for patents filed after October 1, 1989 is 3044 days (or about eight years). For individual inventors, this time was shorter, at 2274 days. Under the fee schedule, the maintenance fees would have thus added $500 — or $250 for individual inventors — to the total cost of seeking a patent. However, other fees were reduced at the same time — for example, the "final fee" (due upon grant) dropped from $350 to $150 for small entities, thus almost balancing the impact of the new maintenance fees.[101]

More fundamentally, we think that patent office fees, including maintenance fees, are a relatively small portion of overall patenting costs. Note the contrast, for example, between the fees in footnote 89 and the average $7,000 - $12,000 in attorneys' fees (depending on complexity and technology).[102] Thus, a shift in patent office fees, on the order of $300, should not have substantial impact on the propensity for inventors to patent their inventions.[103]

Years 10,11,12,13,14	$250
Years 15,16,17,18,19	$450

Note that small entities (including individual inventors) pay 50 percent of the listed fees.

[101] See, CIPO, Tariff of Fees – Patents, Part III, available at http://www.cipo.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/eng/wr01105.html

[102] See AIPLA Annual Report 2009 supra note __, at 25.

[103] There are other reasons to doubt the effect of patent fees on patent filings generally. For one thing, a national patent office has a monopoly on the ability to grant patent rights. For another, the substitutes for patent protection – secrecy or unprotected disclosure — are seriously imperfect substitutes for the rights granted by a patent.

3. Deferred Examination

As noted above, Canada also introduced a deferred examination system in the 1989 law changes. Deferred examination systems allow patent applicants to file (thus securing a filing date), and only later request that the patent office conduct the substantive examination of the application. Typically, there is a limited window of opportunity in which the applicant can request examination — in Canada, the 1989 law set that window at seven years after the filing (in 1992 it was changed to five years).

The idea behind deferred examination is that is allows for reduced workload on the patent office — many inventors will file applications but not request examination at all, abandoning the application — and at the same time reduces some of the problematic effects of the first-to-file system — namely, that applicants have strong incentives to file even before their inventions are complete or they have information about commercial viability.

In theory, deferred examination should not have differential effects on patenting behavior across types of applicants. To the extent that it encourages early filings and additional abandonments before examination, the effect should be an overall reduction in the grant rate, and an increase in pendency at the patent office: both of which we do see in our data. However, there is the possibility that the introduction of deferred examination would systematically reduce patenting by individual inventors — perhaps individuals are much more likely than firms to abandon their applications before requesting examination — and thus this change could account for some or all of the effects we observe in the 1989 law change.

To test this possible confounding effect we conducted a cross-sectional analysis based on technology classes in Canada and their increase in pendency as a result of the 1989 law change. If the observed decline in individual inventor share is due to the introduction of deferred examination, we should expect to see more individual inventors in patent classes where there is more

deferred examination — that is, where pendency is longer. We test this in two ways. First, for each patent class, we calculate the share of individual inventors and the pendency in Canada after the 1989 change. Contrary to the deferred examination hypothesis, we find decreasing relationship between individual inventor share and pendency.[104] We then attempt to control for the possibility of a preexisting relationship between individual inventor share and patent pendency. We do so by regressing the change in individual inventor share on the change in pendency. Here we find no significant relationship between the two variables.[105] Overall, the mean pendency time in Canada post-1989 is 6.2 years for individuals and 7.3 years for corporations.

Contrary to the hypothesis that deferred examination results in lower individual inventorship share, we find no correlation between individual inventorship share and the increase in pendency resulting from the 1989 law. Indeed, we find that individual inventorship share correlates with *reduced* processing time after the 1989 law change, suggesting that, if anything, individual inventors are not utilizing the deferred examination process as much as are firms.

There is another way to test the deferred examination hypothesis. Immediately before the October 1, 1989 law change, there was substantial surge in patenting behavior by individuals just prior to the enactment of the law change. Specifically, in the seven days prior to the October 2, 1989 implementation date, there was on average a threefold increase in patents applied for than on a typical day earlier in 1989 — about 300 applications per day as opposed to 88 per day throughout 1989. That surge of applications

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[104] A regression of individual inventor share on pendency yields a coefficient of -.0001145 with a standard error of . 0000245. This means that for an extra 1000 days of pendency in a patent class, the share of individual inventors will be about 1.1 percentage points lower.

[105] The regression of change in individual inventor share in Canada on change in pendency yields a coefficient of - 0000244 with a standard error of .0000181, which is statistically insignificant.

was disproportionally comprised of individuals — 12.5 percent, as opposed to 10.8 percent for the five years up to that point (and 8.3 percent after). This is significant because it suggests that individuals in particular were responding to the priority rule change (which was mandatory) rather than the deferred examination change (which is optional). Again, this strongly suggests that changes in individual patenting behavior resulted from the priority rule change rather than deferred examination.

G. Interpretation and Analysis of Our Results

As explained above, we find a significant drop in patenting behavior by individual inventors associated with the Canadian patent law's change from first-to-invent to first-to-file in 1989. These results survive a number of alternative analyses and robustness tests, including investigations into the other changes that occurred in the same reform of the Canadian patent laws. In short, we find with some confidence that a shift to first-to-file from first-to-invent results in a reduction of patenting by individual inventors relative to firms.

What is less clear from our results is (a) the mechanism by which this occurs — why are individual inventors patenting less? — and (b) the overall welfare implications. We briefly outline our thoughts on these questions below.

1. Possible Mechanisms

Why do individual inventors patent (relatively) less under a first-to-file regime as opposed to a first-to-invent priority system? Our data cannot answer that question definitively, but there are several possibilities, which we note in brief below.

Fewer Resources to Allocate to Patents. As we've suggested in Section II above, a first-to-file priority rule places a premium on speed in completing an invention, identifying it as patentable,

preparing an application, and filing. Firms will clearly have an advantage in this regard, so perhaps firms will simply win a disproportionate share of the 'races' to the patent office. Note that this theory conflicts to come degree with the results of interference cases in the US, where party type does not appear to correlate with success under the first-to-invent rule.[106] But given the small number of interferences, it is difficult to draw much strong evidence from this source.

Less Invention by Individual Inventors. One possible interpretation of our results is that the change to first-to-file results in fewer inventions created by individual inventors, perhaps because of the marginal additional costs required to be successful patentees in a first-to-file regime. While this may be the case, there are alternative interpretations. Patents don't tell the whole story about innovative activity. Inventors can (and do) utilize a number of alternative approaches to protecting themselves in the marketplace, such as trade secrecy and first mover advantage. Therefore the actual decline in innovative activity by individual inventors is likely to be lower than the decline in patents they are granted.

Demoralization. It's also possible that individual inventors after the change to a first-to-file system become demoralized or disillusioned with the patent system, and accordingly seek fewer patents. Perhaps they view the first-to-file rule as unfairly tilted in favor of firms, especially those with resources. Or perhaps they view the patenting process as increasingly related to luck as a result of the first-to-file rule. Note that this mechanism suggests that the effect on individual inventors may be independent of the real impact of the law, and that theory is consistent with the disproportionate surge of patenting by individual inventors we observe in the several days prior to the implementation of the first-to-file rule.

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[106] See Mossinghoff, supra note __, at xx; Lemley & Chien, supra note __, at xx.

Individual Inventors Join Firms. It is possible that we find less patenting by individual inventors because they join firms after the implementation of the first-to-file rule, and their applications filed after 1989 are characterized as firm inventions rather than individual inventions. It might be possible to test this theory empirically, by matching up inventor names across the 1989 law change, and we note this as an avenue for future research.

In short, our data does not provide a clear answer to the question of why the first-to-file rule yields relatively fewer individual inventors. It does, however, suggest that individual inventors *thought* that the change to priority rules was going to be harmful to them — and filed applications just before the implementation date accordingly. (Note that although the individual inventors' share was higher during this surge in applications, firm filings make up the vast majority of the surge filings.)

2. Welfare Implications

Opponents of a change to the first-to-file priority rule often suggest that the change will harm overall welfare by harming individual inventors (or small business), decreasing patent quality, or both. Our results show that the rule change does appear to reduce patenting behavior by individuals — though as noted above in Section IV.E, we cannot determine why — but that it does not appear to negatively affect patent quality (at least on some metrics of patent quality).

What, then, are the overall welfare implications of our findings? We urge caution. While we are confident that we've identified a real effect on patenting behavior by individuals as a result of the shift to first-to-file, there is nothing in our results that suggests that this has resulted in less invention overall. That said, if one felt strongly that individual inventors are uniquely productive, or unusually likely to create socially valuable innovations, then one might interpret our findings as showing negative welfare effects

from the first-to-file rule. Another caveat, as outlined above: we can't rule out that more individual inventors either join firms or utilize alternative protection mechanisms.

Further, even if the decrease in individual inventor share of patenting was understood to be a welfare loss, the first-to-file rule might nonetheless be a net benefit to society — by virtue of reducing the complexity and administrative costs associated with the first-to-invent rule. That is, the savings from the reduction in administrative costs might well outweigh any losses associated with the reduction in patenting behavior by individual inventors.

What we can say with some confidence is that the change to a first-to-file rule must indeed have welfare implications; the current first-to-invent rule is costly and complex, so its elimination will have a substantial impact. Further, our point estimate suggests perhaps a two percent reduction in the share of individual inventors receiving patents as a result of the first-to-file rule.[107] Together, these two changes will have, we think, an impact on innovation and social welfare, though the direction and magnitude is unknown. Indeed, the difficult — and potentially uncomfortable — question for supporters of the *America Invents Act of 2011* raised by our study is how much individual inventors' share of patenting should weigh on our patent policy decisions.

CONCLUSION

When President Obama argued that the *America Invents Act of 2011* would simplify the US patent system, "cut[ting] the red tape that stops too many inventors and entrepreneurs from quickly turning new ideas into thriving businesses — which holds our whole economy back.,"[108] he was almost surely alluding (at least in

[107] See supra Section IV.A.

[108] The White House Blog, *Putting Americans Back to Work: President Obama Speaks on the Debt Compromise*, Aug. 2, 2011, available at

part) to the change from first-to-invent to first-to-file. As we've shown, this change will surely simplify and streamline the US patent system — but at a cost. Whether the reduction in individual patenting translates into a net reduction in innovation — or if it does, whether that loss is offset by the simplification of the priority rules — is a question we cannot answer.

In the end, how much do individual inventors matter? That, we think, is the critical question suggested by our study. To date, most observers seem to have assumed that a shift to the first-to-file rule, though a substantial change in US patent law practice, would have little impact on who seeks and receives patents. This is wrong. A change to the first-to-file rule in the US should be expected to result in the reduction of individual inventors' share of patents. Thus, the cost savings yielded by the change away from first-to-invent will not, we suggest, be free.

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http://www.whitehouse.gov/blog/2011/08/02/putting-americans-back-work-president-obama-speaks-debt-compromise