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Poisoning the Next Apple? How the America Invents Act Harms Inventors

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POISONING THE NEXT APPLE? THE AMERICA INVENTS ACT AND INDIVIDUAL INVENTORS

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The Leahy-Smith America Invents Act, the most significant patent law reform effort in two generations, may have a dark side: it seems likely to decrease the patenting behavior of individual inventors, a category which occupies special significance in American innovation history. In this Article, we empirically predict the effects of the major change in the law, which shifts the patent priority rules from the United States' traditional "first-to-invent" system to the internationally predominant "first-to-file" system. While there has been some theoretical work on this topic, we use an analogous law change in Canada 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 U.S. Patent and Trademark Office, we find a significant drop in the share of patents granted to individual inventors in Canada coincident with the implementation of a first-to-file system. We find no measurable changes in patent quality and perform several additional analyses to rule out alternative explanations. While the net welfare impact that can be expected from a shift to first-to-file is unclear, our results re-

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veal that, contrary to the conventional wisdom, the March 2013 implementation of a first-to-file rule in the United States is likely to result in a reduced share of patents granted to individual inventors.

INTRODUCTION

The garage inventor is an American icon. The image of the solitary genius tinkering away in order to perfect her idea captures our imagination, and the long line of world-changing inventors and their companies—from Thomas Edison (in Menlo Park, N.J. and West Orange, N.J.)[1] to Bill Hewlett and David Packard (in Palo Alto)[2] to Steve Wozniak and Steve Jobs (in Los Altos)[3]—only confirms this uniquely American vision of innovation. The patent system works hand in hand with this sense of the small inventor by providing those who have little more than good ideas much-needed clout in the commercial marketplace.

1. *See* THOMAS A. MEYER, INNOVATE!: HOW GREAT COMPANIES GET STARTED IN TERRIBLE TIMES 30-31, 36, 38 (2010) (explaining that Edison's first invention resulted from moonlighting after twelve-hour workdays as a telegraph operator for Western Union).

2. *See* ASHLEE VANCE, GEEK SILICON VALLEY: THE INSIDE GUIDE TO PALO ALTO, STANFORD, MENLO PARK, MOUNTAIN VIEW, SANTA CLARA, SUNNYVALE, SAN JOSE, SAN FRANCISCO 23-26 (2007) (describing the beginnings of the computer giant Hewlett-Packard in a garage in Palo Alto).

3. *See* JAN GOLDBERG, CAREERS FOR HOMEBODIES & OTHER INDEPENDENT SOULS 17 (2d ed. 2007) ("Wozniak and Jobs designed what would be the Apple I in Jobs's bedroom, and they built the prototype in Jobs's garage.").

Indeed, without the protection of inventions by the patent system, the world might never have known General Electric, Hewlett-Packard, or Apple.[4]

On September 16, 2011, President Barack Obama signed into law the Leahy-Smith America Invents Act (AIA or the Act),[5] almost certainly the most sweeping set of changes to the U.S. patent system in almost sixty years.[6] The most important provision of the Act, and the subject of this Article, is the change in the rules used to establish priority between competing inventors.[7]

Until March 16, 2013, the United States used a *first-to-invent* (FTI) priority rule.[8] This means that when there was a dispute as to patent priority, the party that had the inventive idea first was entitled to the patent. This could be established by using lab notebooks, emails, and other documentation of the date of invention. By contrast, a *first-to-file* (FTF) rule relies on the date (and possibly

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4. For a critique of this idea, see Mark A. Lemley, *The Myth of the Sole Inventor*, 110 MICH. L. REV. 709, 710-11 (2012) ("The canonical story of the lone genius inventor is largely a myth. . . . Invention appears in significant part to be a social, not an individual, phenomenon.").

5. Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) (amending scattered sections of 35 U.S.C.).

6. The 1952 Patent Act was the last major reform of the patent system. *See* Jason Rantanen & Lee Petherbridge, Commentary, *Toward a System of Invention Registration: The Leahy-Smith America Invents Act*, 110 MICH. L. REV. FIRST IMPRESSIONS 24, 24 (2011), http://www.michiganlawreview.org/assets/fi/110/rantanenpetherbridge.pdf ("The recently enacted Leahy-Smith America Invents Act . . . represents the most significant legislative event affecting patent law and practice in more than half a century."). President Obama made reform of the patent law one of the centerpieces of his 2011 economic policy agenda. *See* Remarks on the Federal Budget, 2011 DAILY COMP. PRES. DOC. 542, at 2 (Aug. 2, 2011) (video of address available at http://www.whitehouse.gov/videos/2011/August/080211_DebtCompromise.mp4) ("Through patent reform, we can cut the red tape that stops too many inventors and entrepreneurs from quickly turning new ideas into thriving businesses, which holds our whole economy back."). Thus, the structure of the U.S. 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 last summer was transfixed by a series of blockbuster deals involving patents. *See, e.g.*, Quentin Hardy, *Google Buys Motorola for Patent Parts*, FORBES (Aug. 15, 2011), http://www.forbes.com/sites/quentinhardy/2011/08/15/google-buys-motorola-for-patent-parts; Chris V. Nicholson, *Apple and Microsoft Beat Google for Nortel Patents*, N.Y. TIMES DEALBOOK (July 1, 2011), http://dealbook.nytimes.com/2011/07/01/apple-and-microsoft-beat-google-for-nortel-patents. Even National Public Radio's popular *This American Life* program joined the fray, with an hour-long program in July 2011 on "patent trolls." *See When Patents Attack!*, THIS AM. LIFE (Chicago Public Media radio broadcast, July 22, 2011), *available at* http://www.thisamericanlife.org/radio-archives/episode/441/when-patents-attack.

7. *See* Rantanen & Petherbridge, *supra* note 6, at 24 (noting the "AIA's imposition of a first-to-file-or-first-to-publicly-disclose system, which replaces an over 200-year-old first-to-invent tradition").

8. Different provisions of the new law became effective at different times, ranging from the date of enactment of the AIA on September 16, 2011, until March 16, 2013. The relevant provisions here—the new priority rules—are effective for patent applications filed on or after March 16, 2013. *See* Leahy-Smith America Invents Act § 3(n)(1) (codified at 35 U.S.C. § 100 note (2011)).

time) when a patent application was filed with the U.S. Patent Office for the priority determination. As we explain further below, the AIA implements a modified version of the traditional FTF rule, wherein in most cases the first inventor to publish his invention will be given the rights (as long as he follows the publication with a timely application to the U.S. Patent Office).[9] But in broad strokes, the Act implements a shift in American patent law from FTI to FTF; the United States is the last country to make this change in its patent system.[10]

Although the FTF system has advantages—it is simpler and less costly to administer, and it encourages earlier patent applications[11]—it may have a darker side for small inventors.[12] Since they are likely to be slower in turning an invention into a patent application than larger corporations, they will be less likely to win a patent race. Under the FTI rule, this was not especially relevant, because the date of invention determined patent priority and the scope of prior art. But under FTF, a successful patentee must not only invent, but also win the race to draft and submit a patent application that satisfies the requirements of the patent law. Companies with significant research and development (R&D) operations are more likely to have patent attorneys on staff with experience working with the company's inventors. This can substantially cut down the time necessary to transform an invention into an application. Small inventors are much more likely to be resource constrained, and much less likely to have staff attorneys or existing relationships with outside counsel—placing the small inventor at a potential disadvantage in a FTF regime.

What impact will this major patent reform have? Although there were years of debate prior to the passage of the AIA, there has been virtually no em-

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9. *See infra* notes 46-56 and accompanying text.

10. In 1998, the Philippines switched to a first-to-file system, leaving the United States as the last country with a first-to-invent system. Gerald J. Mossinghoff & Vivian S. Kuo, *World Patent System Circa 20XX, A.D.*, 38 IDEA 529, 548 & n.38 (1998). Canada's switch in 1989 is regarded as the last major industrialized nation to switch before the U.S.'s recent shift—a fact which we exploit for our study.

11. *See, e.g.*, Mark A. Lemley & Colleen V. Chien, *Are the U.S. Patent Priority Rules Really Necessary?*, 54 HASTINGS L.J. 1299, 1313, 1331 & n.99 (2003) (noting that a FTF system encourages an inventor "to file her patent application as early as possible" and describing the costs of patent litigation under the FTI system). Switching to FTF also harmonized the U.S. patent system with that of the rest of the world, arguably as required by international treaty obligations.

12. As we make clear in our discussion of our study, the data we used allowed us to compare patenting behavior of *individual inventors*—those inventors filing patent applications on their own behalf—versus other types of patent applicants (such as corporations, governments, educational institutions, and nonprofit organizations). Thus, although our discussion applies most directly to individual inventors, there will plainly be implications from our findings for small entities seeking patents, such as small companies or (small) nonprofits. Thus, we use the term "small inventors" to include these smaller patenting entities as well as individual inventors.

pirical work completed to date.[13] In this Article we aim to correct that deficiency and predict that the AIA will have a negative impact on small inventors. We do so by examining the effect of a very similar law change in Canada, the last major country preceding the United States to change to first-to-file,[14] which it did with the Canadian Patent Act reforms that took effect in 1989.[15] By examining data on over one million patents in both Canada and the United States, and by using sophisticated econometric methodology, we are able to estimate the effects of the Canadian law change.[16] Like the AIA, the Canadian Patent Act made several other changes to patent law besides the priority rule, and we therefore go to some pains to establish that the results we find are due to the priority rule change.

We find that the Canadian change to FTF generally harmed individual inventors. One simple measure of its impact is a drop in the share of patents granted to individuals after the law change. However, we note that this drop could be due to general long-term trends (like an increase in R&D funding among larger entities) rather than the priority rule change itself. Thus we use a difference-in-difference technique,[17] which allows us to address any overall trends by using U.S. patenting behavior as a control group. Patenting in the United States generally follows similar patterns to those in Canada, but the United States did not change its patent law around 1989.[18] Thus, comparing the

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13. *See* Lemley & Chien, *supra* note 11, at 1301-05 (discussing the politics of the first-to-invent versus first-to-file rules); *see also* Gerald J. Mossinghoff, *The U.S. First-to-Invent System Has Provided No 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).

14. Michael F. Martin, *The End of the First-to-Invent Rule: A Concise History of Its Origin*, 49 IDEA 435, 439 n.16 (2009) (explaining that after Canada's change, the United States was the only country with a FTI system).

15. *See* An Act to Amend the Patent Act and to Provide for Certain Matters in Relation Thereto, R.S.C. 1985 (3d Supp.), c. 33 (Can.) (amending Canadian Patent Act, R.S.C. 1985, c. P-4); *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).

16. For more information on the impact of the Canadian law change, see generally ROBIN COSTER, FROM FIRST-TO-INVENT TO FIRST-TO-FILE: THE CANADIAN EXPERIENCE (2002), *available at* http://www.torys.com/Publications/Documents/Publication%20PDFs/ARTech-19T.pdf; Philip C. Mendes da Costa, *NAFTA—The Canadian Response or Why Does the Canadian Patent Act Keep Changing?*, 22 AIPLA Q.J. 65 (1994); 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); Shih-tse Lo & Dhanoos Sutthiphisal, *Does It Matter Who Has the Right to Patent: First-to-Invent or First-to-File? Lessons from Canada* (Nat'l Bureau of Econ. Research, Working Paper No. 14926, 2009), *available at* http://www.nber.org/papers/w14926.

17. *See* JEFFREY M. WOOLDRIDGE, INTRODUCTORY ECONOMETRICS: A MODERN APPROACH 450-54 (4th ed. 2009) (discussing the use and implementation of the difference-in-difference approach in analyzing policy).

18. Although Canada has a much smaller population than the United States, and a correspondingly smaller economy, the two economies are very "highly integrated"—for reasons that include geographic proximity of the Canadian population and expansive free trade agreements between the countries, such as the North American Free Trade Agreement

difference between the differences in individual grant rate in the United States and Canada will isolate the net effect of the Canadian law change. We find that there is a substantial decline in patents granted to individuals due to the change in priority rule: *about a fourteen-percent drop*.[19]

Our findings do not augur well for small inventors in the United States. While the AIA differs in important ways from the Canadian law, there are enough similarities that we should see parallel effects.[20] In addition to harming small inventors, some have suggested that the AIA may also encourage lower-quality patent applications. One of the purposes of the patent document is to disclose information about the invention to the public: this is what a patentee provides in exchange for the exclusive right to make, use, and sell her invention.[21] In preliminary work, we explore this potential effect of FTF in the Canadian context by performing a basic linguistic analysis of patents before and after the law change. We use word count, sophistication of words, and similar measures as proxies for how much information a patent conveys. We find no evidence of a substantial impact of the law change on patent quality.

The America Invents Act changes the United States to the first-to-file system, but fortunately there are provisions in the Act that call for studies such as this to help inform its implementation.[22] In the rest of this Article, we detail why we expect the Act to be harmful to small inventors in its current form. In addition, we empirically estimate, for the first time, the effect of the priority rule on patenting behavior and patent quality.

The balance of the Article follows in three Parts. In Part I, we detail the policy questions surrounding the FTI versus FTF systems, as well as discuss

(NAFTA). *See* IAN F. FERGUSSON, CONG. RESEARCH SERV., RL33087, UNITED STATES-CANADA TRADE AND ECONOMIC RELATIONSHIP: PROSPECTS AND CHALLENGES 1 (2006). The United States and Canada also have similar economic sectoral components, and cross-border trade to the other is a major component of each country's economy. *See id.* at 1, 3-8. *But see id.* at 1-6 (noting that the U.S. and Canadian economies, although similar in many respects, diverge in others). Although productivity in Canada is lower than in the United States—perhaps as a result of lower capital intensity, *see, e.g.*, Someshwar Rao et al., *Measuring the Canada-U.S. Productivity Gap: Industry Dimensions*, INT'L PRODUCTIVITY MONITOR, Fall 2004, at 3, 13-14 (discussing the "productivity gap" and noting the contribution of capital intensity)—in our view, the very close economic similarities (indeed, integration) between the countries make the Canadian-U.S. comparison especially apt.

19. *See infra* note 143 and accompanying text.

20. The most important difference is that the AIA includes a so-called "first-to-publish" exception. *See* Leahy-Smith America Invents Act, Pub. L. No. 112-29, § 3(b)(1), 125 Stat. 284, 286 (2011) (to be codified at 35 U.S.C. § 102(b)(2)). This means that inventors have a one-year grace period from publication of an invention before they must submit their patent application.

21. *See* Alan Devlin, *The Misunderstood Function of Disclosure in Patent Law*, 23 HARV. J.L. & TECH. 401, 407-10 (2010).

22. Leahy-Smith America Invents Act § 26 (requiring a U.S. Patent and Trademark Office study to determine the effect of the AIA "with respect to patent rights, innovation in the United States, competitiveness of United States markets, access by small businesses to capital for investment, and such other issues").

the changes implemented by the America Invents Act and the Canadian Patent Act in greater detail. Part II introduces our datasets, obtained from the U.S. Patent and Trademark Office (USPTO) and the Canadian Intellectual Property Office (CIPO). In Part III we detail our empirical strategy and present the main results. Part III also explores some possible shortcomings of our analysis, and seeks to address the main objections to our results. We end with a brief Conclusion with discussion of the possible policy implications and suggestions for further research.

I. FIRST-TO-INVENT VERSUS FIRST-TO-FILE: A PRIMER

Patent priority is a relatively straightforward concept, determining the question of who, 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.[23] 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.[24] Thus, the system of allocating priority matters—significantly.[25]

To date, modern patent systems have used one of two systems for allocating priority to patent rights. The first, known as the first-to-invent system, attempts to grant the rights to the inventor who can prove the earliest date of invention.[26] What this means is that the decisionmaking body, whether the Patent

23. The ensuing competition to obtain a patent is called a "patent race." *See, e.g.*, Drew Fudenberg et al., *Preemption, Leapfrogging and Competition in Patent Races*, 22 EUR. ECON. REV. 3, 3 (1983); Mark F. Grady & Jay I. Alexander, *Patent Law and Rent Dissipation*, 78 VA. L. REV. 305, 312 (1992).

24. *See* Grady & Alexander, *supra* note 23, at 313.

25. 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, 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 discourage 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.

26. *See infra* notes 30-35 and accompanying text.

Office or the courts, must weigh various kinds of evidence relating to the inventive process and its timing. The second, and dominant, approach has been the first-to-file system, wherein the first inventor to file his application in the relevant jurisdiction is awarded the patent.[27] 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, a system might instead grant the rights to the inventor best suited to commercialize the technology.[28] Michael Abramowicz and John 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 private patent offices, rather than from the centralized USPTO) be awarded priority.[29] Or perhaps the patent rights could be auctioned or shared among closely competing inventors. For our purposes, however, we do not consider these other approaches, and instead investigate the relative effects between the first-to-invent system (the historic U.S. system) and the first-to-file approach (used elsewhere and now in the United States as well, after the effective date of this portion of the AIA).

A. *First-to-Invent: U.S. and Canadian Approaches*

The U.S. patent priority system before the AIA became effective was codified at 35 U.S.C. § 102(g), which, until March 16, 2013, read in relevant part:

> A person shall be entitled to a patent unless— . . . .
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> . . . .
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> . . . 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.[30]

This section has been interpreted by the courts to mean that the patent grant under the FTI system was given[31] to a prior inventor (who did not abandon,

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27. *See infra* notes 42-45 and accompanying text.

28. *See generally* Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265 (1977).

29. Michael Abramowicz & John F. Duffy, *Ending the Patenting Monopoly*, 157 U. PA. L. REV. 1541, 1606 (2009).

30. 35 U.S.C. § 102, 102(g)(2) (2011).

31. Note that there were two possible procedural postures of priority contests. In the first—known as an "interference"—the USPTO conducted a proceeding under 35 U.S.C. § 102(g) to determine which of those who filed applications claiming the same subject matter would receive the patent grant. In the second, during postgrant litigation, a court will de-

suppress, or conceal the invention), if that prior inventor could 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.[32] In contrast, invention in Canada's FTI regime was defined as the date that the inventor "first formulated the knowledge necessary to enable an ordinary skilled workman to duplicate the invention and obtain the benefits from it."[33] For systems basing patent priority on the date of invention, the filing date of the application was not determinative—though the first filer had some important evidentiary advantages in these proceedings.[34]

In both countries, if the patent office believed that a pending patent application overlapped with another patent or application, it was necessary for an adjudication to occur to determine the first inventor. On the whole, Canadian proceedings to determine priority were much simpler than their American counterparts.[35]

The American FTI priority rules, as established in § 102(g), were highly complex, involving careful definitions of what terms such as "reduce to practice,"[36] "conception,"[37] and "reasonable diligence"[38] meant. (Not to mention abandonment, suppression, or concealment.)[39] In addition, there were substan-

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termine whether the provisions of § 102(g) have been violated, and thus whether the patent is invalid because of a prior inventor. *See* 35 U.S.C. § 282; PATENT & TRADEMARK OFFICE, U.S. DEP'T OF COMMERCE, MANUAL OF PATENT EXAMINING PROCEDURE, at ch. 2300 (8th ed., 9th rev. 2012) (describing interference proceedings).

32. *See, e.g.*, Brown v. Barbacid, 276 F.3d 1327, 1337 (Fed. Cir. 2002); Eaton v. Evans, 204 F.3d 1094, 1097 (Fed. Cir. 2000); Mahurkar v. C.R. Bard, Inc., 79 F.3d 1572, 1577-78 (Fed. Cir. 1996).

33. Charles P. Curphey & Norris M. Eades, *Canadian Patent Practice—How Different Is It?*, 57 J. PAT. OFF. SOC'Y 4, 15-16 & n.45 (1975) (quoting Christiani & Nielsen v. Rice, [1930] S.C.R. 443, 456 (Can.)) (internal quotation marks omitted) ("The holding here, therefore, is that by the date of discovery of the invention is meant the date at which the inventor can prove he has first formulated, either in writing or verbally, a description which affords the means of making that which is invented.").

34. For the American presumption in favor of the first filer under the FTI system, see 37 C.F.R. § 41.207(a)(2) (2012) (requiring that any party seeking to prove an earlier date of invention bear the burden of proof), and Price v. Symsek, 988 F.2d 1187, 1192 & n.2, 1193-94 (Fed. Cir. 1993). For the Canadian presumption, see COSTER, *supra* note 16, at 7-8.

35. *See* Robert A. Wilkes, *The Canadian Viewpoint: A New Perspective Bridging the First-to-Invent and First-to-File Worlds*, 18 AIPLA Q.J. 18, 20 (1990) (explaining that the American interference procedure was more complex than the Canadian conflict because the latter "is handled on the basis of a written record only; there are no provisions for motions, discovery, and the like, and there is no hearing (either before the Commissioner or the Patent Appeal Board) in the entire process within the Patent Office").

36. *See, e.g.*, *Eaton*, 204 F.3d at 1097.

37. *See, e.g.*, *Brown*, 276 F.3d at 1332; Estee Lauder Inc. v. L'Oreal S.A., 129 F.3d 588, 594 (Fed. Cir. 1997).

38. *See, e.g.*, Griffith v. Kanamaru, 816 F.2d 624, 626 (Fed. Cir. 1987); 3A DONALD S. CHISUM, CHISUM ON PATENTS: A TREATISE ON THE LAW OF PATENTABILITY, VALIDITY AND INFRINGEMENT § 10.07[4][d], [f] (2012).

39. *See* Peeler v. Miller, 535 F.2d 647, 654-55 (C.C.P.A. 1976).

tial evidentiary complexities: proving earlier dates of invention (typically most important for the later filer) required each party to bear the burden of proof, and in some cases, the later filer would face a heightened ("clear and convincing evidence") standard.[40] Further, corroborating evidence was always required in these areas.[41]

B. *First-to-File: U.S. and Canadian Approaches*

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

> The subject-matter defined by a claim in an application for a patent in Canada . . . must not have been disclosed
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> . . . .
>
> (c) in an application for a patent that is filed in Canada by a person other than the applicant, and has a filing date that is before the claim date . . . .[42]

There are other provisions that deal with contemporaneously filed applications claiming priority to earlier applications (or foreign applications),[43] but the basic thrust is the same: the patent right goes to the first inventor who files her application with the patent office.

However, the Canadian Patent Act recognizes a significant exception to the first-to-file rule. If an inventor discloses his invention to the public, he has a one-year grace period in which he alone can patent the disclosed material.[44] Others seeking to patent the disclosed material will be barred from patenting, as the material would be novelty-defeating prior art.[45]

The U.S. FTF rules are similar in basic approach[46]: the patent grant is given to the inventor with the earliest "effective filing date,"[47] but is subject to some additional exceptions—including a provision similar to the Canadian grace period 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.[48]

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40. *See* 37 C.F.R. § 41.207(a)(2) (2012).

41. *Brown*, 276 F.3d at 1335.

42. Patent Act, R.S.C. 1985, c. P-4 § 28.2(1).

43. *See id.* § 28.2(1)(d)(i)-(iv).

44. *See id.* § 28.2(1)(a); CANADIAN ENCYCLOPEDIC DIGEST: PATENTS IV(4)(b)(ii) (4th ed. 2008) (describing the grace period).

45. *See* Wiggs, *supra* note 16, at 496-97.

46. Leahy-Smith America Invents Act, Pub. L. No. 112-29, § 3(b)(1), 125 Stat. 284, 285-87, 293 (2011) (amending 35 U.S.C. § 102) (removing rules establishing a first-to-invent system and replacing them with a first-to-file system).

47. 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 id.*

48. *See id.* (to be codified at 35 U.S.C. § 102(b)(2)). In a sense this creates something of a "first to publish" system by making first disclosure an important defense against a first

Tucked into the disclosure exception of the AIA is a derivation clause protecting an inventor if a third party discloses his invention. Specifically, the statute states that if the disclosure derives from the work of the potential patentee it cannot be used as prior art against the original inventor and source of information.[49] Unfortunately, "disclosure" and "derivation" are left somewhat unclear in the Act.[50] It is clear, however, that interference proceedings are now replaced with derivation proceedings.[51] Derivation proceedings will allow potential patentees to challenge a third-party patent on the grounds that the contained subject derived from the petitioner's patent.[52]

The AIA also implements a two-track application system. For a significant fee, a patentee may request expedited review of her application.[53] Similarly, Canada requires inventors to opt in to a formal examination of their patent for an additional fee.[54] The request may be made up to five years after filing, though after that period, the patent is considered abandoned.[55] Both Canada and the United States reduce fees for small entities.[56]

The Canadian and American transitions from first-to-invent to first-to-file are, in a broad sense, identical. The first-to-invent priority rules of both nations were a complex jungle, aimed at seeking out the true first inventor. In their

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filer. Jim Longacre, *35 USC § 102 and the First to File System*, LEXISNEXIS EMERGING ISSUES ANALYSIS, Oct. 2011, *available at* 2011 Emerging Issues 5978.

49. Leahy-Smith America Invents Act § 3(b)(1) (to be codified at 35 U.S.C. § 102(b)(2)).

50. *See* John E. Schneider, *Leahy-Smith America Invents Act—Patent Reform 2011 Is Finally Here*, LEXISNEXIS EMERGING ISSUES ANALYSIS, Sept. 2011, *available at* 2011 Emerging Issues 5929.

51. *See* Leahy-Smith America Invents Act § 3(i) (to be codified at 35 U.S.C. § 135(a)) ("An applicant for patent may file a petition to institute a derivation proceeding in the Office. The petition shall set forth with particularity the basis for finding that an inventor named in an earlier application derived the claimed invention from an inventor named in the petitioner's application and, without authorization, the earlier application claiming such invention was filed.").

52. *Derivation Proceedings*, SUGHRUE MION, PLLC, at 1, http://www.sughrue.com/files/uploads/documents/fadi_article_derivation.pdf (last visited Feb. 24, 2013).

53. Edward Fan & Karen Townsend, *United States Converts to First-to-File Patent System*, TORYS LLP 1-2 (Sept. 22, 2011), http://www.torys.com/Publications/Documents/Publication%20PDFs/IP2011-4.pdf (explaining that the current fee for prioritized review for large-entity applicants is set at $4800).

54. *See Tariff of Fees—Patents*, CAN. INTELL. PROP. OFF., http://www.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/eng/wr00142.html (last modified Jan. 2, 2013).

55. *How Your Patent Application Is Processed*, CAN. INTELL. PROP. OFF., http://www.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/eng/wr03002.html (last modified Apr. 4, 2011).

56. *See* David Black, *Size Matters Under the America Invents Act*, PAT. REFORUM (Jan. 20, 2012), http://americainventsact.com/size-matters-under-the-america-invents-act (explaining that "for many years" small entities benefited from a fee reduction of 50% and that the AIA increases the fee reduction for microentities to 75%); *Tariff of Fees*, *supra* note 54 (describing the two-track fee structure for small and large entities for reexamination requests).

transition to first-to-file, both nations retained a flavor of the FTI system through a disclosure exception.

As a statute, the AIA remains unclear. Numerous commentaries speak to the potential complexities and statutory ambiguities.[57] Only as courts work through the AIA's challenges and contours will we definitively know its scope and content. However, these details and intricacies pale in comparison to the broad-based structural change inherent in the AIA.

C. *The Policy of Patent Priority Rules*

There are a variety of important policy questions related to a shift to a first-to-file system, including issues of efficiency and international harmonization.[58] The policy question we address here is whether a first-to-file system discriminates against individual inventors, small businesses, or nonprofits, rendering them less likely to obtain effective patent protection than larger organizations.[59] (A weaker version of this question is whether the U.S. first-to-invent system could favor such entities.)[60] 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—permits those with fewer resources (e.g., individuals, small business, and nonprofits) to obtain patent protection without the need to "rush" to the door of the patent office.[61] 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.[62] Further, additional resources allow more patent attorneys or

57. *See* Eric E. Bensen, *America Invents Act*, LEXISNEXIS EMERGING ISSUES ANALYSIS, Sept. 2011, *available at* 2011 Emerging Issues 5900; Longacre, *supra* note 48; Donald S. Chisum, *America Invents Act of 2011: Analysis and Cross-References* (Dec. 5, 2011), http://www.chisum.com/wp-content/uploads/AIAOverview.pdf; Donald S. Chisum, *Priority Among Competing Patent Applicants Under the American Invents Act* (Dec. 5, 2011), http://ssrn.com/abstract=1969592.

58. *See supra* notes 23-29 and accompanying text (discussing policy implications of FTI versus FTF); *see also* Robert W. Pritchard, *The Future Is Now—The Case for Patent Harmonization*, 20 N.C. J. INT'L L. & COM. REG. 291, 300 (1995).

59. *See, e.g.*, Donald S. Chisum, *Introduction* to Symposium, *The Harmonization of International Patent Law*, 26 J. MARSHALL L. REV. 437, 447-48 (1993); Lemley & Chien, *supra* note 11, at 1304-05.

60. *See, e.g.*, Gerald J. Mossinghoff, *The First-to-Invent Rule in the U.S. Patent System Has Provided No Advantage to Small Entities*, 87 J. PAT. & TRADEMARK OFF. SOC'Y 514, 515 (2005) (updating earlier work).

61. *See, e.g.*, Dana Rohrabacher & Paul Crilly, *The Case for a Strong Patent System*, 8 HARV. J.L. & TECH. 263, 267 (1995) ("Independent inventors, who are often the backbone of new companies, will be especially vulnerable against large multinational corporations who can afford to mount continuing legal challenges.").

62. 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 $7000, and that filing a patent of relative complexity costs between $9000 and

agents to be dedicated to drafting and filing applications. The inventors in larger organizations may be more able to redirect the time that would otherwise be required by the patent application process toward 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.

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 first-to-invent system may at first glance seem to have encouraged waiting to apply for a patent (or at least not penalized it substantially),[63] the rules themselves did the opposite. For example, the first applicant in a priority contest (known as the "senior party") gained a de facto presumption that he is the first inventor, forcing the later filer (the "junior party") to present proof of an earlier invention date.[64] Furthermore, other critical patent rules, most prominently those related to prior art, strongly encouraged an early filing—simply, the earlier the filing date, the less prior art would be available.[65] Thus, while the first-to-invent rules offered 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 former 35 U.S.C. § 102(g) and found that junior parties—later filers of applications—win over forty percent of the time, a somewhat surprising number, given the evidentiary advantages given to the first applicants.[66] Interestingly, the size of the parties seems to have relatively little effect on the win rates in priority contests.[67]

Priority rules may have a substantial impact for another reason: the determination of what is included in "prior art." Under the FTI system, a person could lose the right to a patent if the invention was known, used, or described in print before the claimed date *of invention*.[68] Under a first-to-file system, the

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$12,000. *See* AM. INTELLECTUAL PROP. LAW ASS'N, REPORT OF THE ECONOMIC SURVEY 25 (2009); *see also* Stuart J.H. Graham et al., *High Technology Entrepreneurs and the Patent System: Results of the 2008 Berkeley Patent Survey*, 24 BERKELEY TECH. L.J. 1255, 1309-14 (2009) (discussing the sensitivity of startups to the costs of patenting and enforcement).

63. *See* 35 U.S.C. § 102(g) (2011).

64. *See id.*

65. *See, e.g.*, *id.* § 102(a), (b).

66. *See* Lemley & Chien, *supra* note 11, at 1309 (reporting that junior parties won forty-three percent of the time based on a sample population of 100 cases).

67. *See, e.g.*, *id.* at 1321-22; Mossinghoff, *supra* note 60, at 517-18.

68. 35 U.S.C. § 102(a).

key date becomes not the date of invention, but the filing date. Because a filing date will obviously be later than an invention 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 is clear that the rate of individual patenting has been decreasing in the United States over time,[69] it is widely believed that individuals and small entities have an important impact on the innovation ecosystem—perhaps an outsized impact.[70] 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.[71] Second, in some industries, such as high technology and pharmaceuticals, small companies and individuals serve as important innovation inputs into larger, established companies.[72] Finally, even if small entities are no more effective than their larger counterparts at 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, or that we take a position regarding the wisdom of the change in the United States 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 disproportionately 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-term innovation.

II. RESEARCH DESIGN

As the foregoing suggests, there is a need to empirically investigate one of the major (if not the major) claims related to the shift from first-to-invent to first-to-file in the United States: that the change will adversely affect the patent-

69. *See* U.S. PATENT & TRADEMARK OFFICE, ALL TECHNOLOGIES REPORT: JANUARY 1, 1986—DECEMBER 31, 2010, at A2-1 (2011).

70. *See* Mark D. Janis, *Patent Abolitionism*, 17 BERKELEY TECH. L.J. 899, 910-11 (2002); Michael J. Meurer, *Inventors, Entrepreneurs, and Intellectual Property Law*, 45 HOUS. L. REV. 1201, 1202-03 (2008).

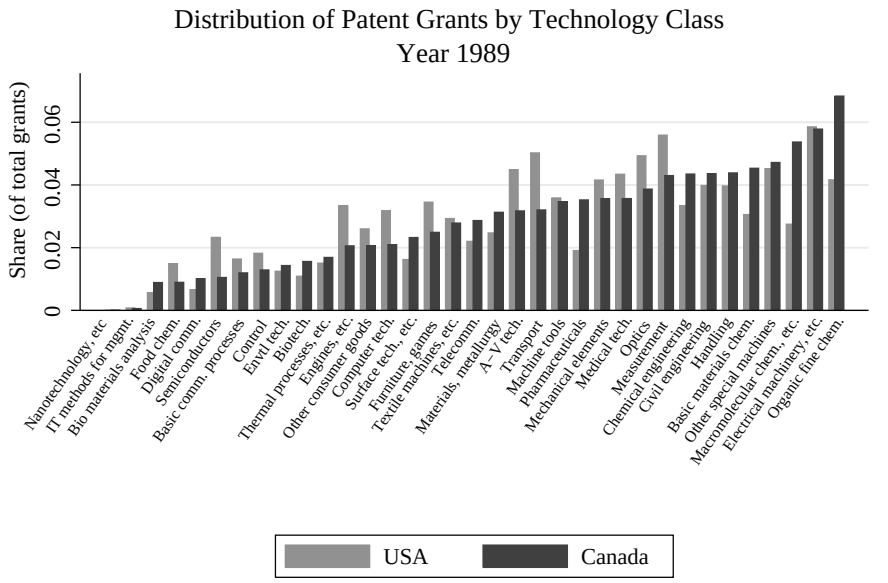
71. *See* JOSEPH A. SCHUMPETER, CAPITALISM, SOCIALISM AND DEMOCRACY 131-34 (3d ed. 1950) (discussing the stationary state that would result without entrepreneurs); *see also* ERIC VON HIPPEL, THE SOURCES OF INNOVATION 3-10 & tbl.1-1 (1988).

72. *See* ZOLTAN J. ACS & DAVID B. AUDRETSCH, INNOVATION AND SMALL FIRMS 1-8, 147-54 (1990); CHI RESEARCH, INC., SMALL SERIAL INNOVATORS: THE SMALL FIRM CONTRIBUTION TO TECHNICAL CHANGE (2003); *see also, e.g.*, Adam B. Jaffe et al., *Knowledge Spillovers and Patent Citations: Evidence from a Survey of Inventors*, 90 AM. ECON. REV. 215, 218 (2000).

ing behavior of individuals and small entities, as compared to larger organizations. An obvious obstacle in conducting this investigation is the fact that the United States has just changed its priority rules, so there is no way to directly compare the U.S. first-to-invent system with the first-to-file system found in the America Invents Act.

Although the United States had not undertaken a change in priority rules until now, the most recent such shift in a highly-developed country occurred in Canada in 1989, and this law change offers an opportunity for empirical investigation. Canada has a patent system very similar to that of the United States, has similar economic features to the United States, close geographic proximity, and a similar innovation environment to the United States—making it a good control.[73] Since the focus of this Article is patenting behavior, in order for the United States to serve as a good control group, a similar patenting environment is critical. Figure 1 shows the share of patents by technology category in the United States and Canada. As can be seen, there is a strong correlation between the shares of technology classes in the United States and in Canada.

FIGURE 1



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 impact that shift in the United States might have. Specifically, we investigate how the law

73. *See supra* note 18 and accompanying text.

change affected the patenting behavior of individual inventors relative to larger entities.

However, simply comparing the patenting behavior of Canadian individual inventors before and after the law change allows only limited insight into the question. For example, one would not be able to rule out the possibility that any change in activity was related to an array of other factors, for example, changes in the macroeconomy. Thus, we need a control group to help isolate the effect of the Canadian law change. For this we use the United States. Since the United States did not change its priority rules during the time of the Canadian law change, and given the similarities between the U.S. and Canadian patent systems (not to mention economies), the United States serves as a good control. The research design we employ is a modern econometric technique known as a difference-in-difference analysis,[74] which is used 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 United States 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 spurious effects, such as those related to global changes in innovation.[75]

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.[76] 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

74. *See, e.g.*, JOSHUA D. ANGRIST & JÖRN-STEFFEN PISCHKE, MOSTLY HARMLESS ECONOMETRICS: AN EMPIRICIST'S COMPANION 227-43 (2009).

75. A good control group must be similar to the treatment group in the absence of the treatment. In this case, given the similarity of the economies and innovation in the two countries, we believe the United States satisfies the requirements of a good control.

76. *See* An Act to Amend the Patent Act and to Provide for Certain Matters in Relation Thereto, R.S.C. 1985 (3d Supp.), c. 33 (Can.).

October 1, 1989, were processed under the FTI rules, while applications after that date were processed under the new rules.[77]

For our purposes here, the important change was the shift in Canada from a FTI system to the current FTF system noted above. Prior to the enactment of the changes in 1989, Canada's patent priority system was similar to the U.S. FTI system, including a procedure (called a "conflict proceeding") to sort out the priority of co-pending applications.[78]

The 1987 patent reform act also included other important changes to Canadian patent law, several of which we discuss in detail below. For one, the patentability of pharmaceutical drugs was confirmed.[79] For another, the patent term was changed from seventeen years from the date of issue to twenty years from the date of filing.[80] The law also introduced a deferred examination process whereby applicants can file applications but request that the CIPO not begin examining them until some time later, now as much as five years later.[81] And finally, maintenance fees were introduced, requiring annual payments by both applicants and grantees to maintain their applications and patents, respectively.[82]

B. *Prior Literature on Priority Rules*

Most prior studies investigating the effect of the first-to-file system in the United States 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 former first-to-invent system. For example, Gerald Mossinghoff found no evidence that small entities are advantaged by the FTI system, and indeed concluded that in some ways small entities in the United States were disadvantaged by the FTI system.[83] Specifically, he gathered data on interference proceedings from 1983 to 2004 and found that small entities took advantage of the FTI system (by winning an interference contest despite filing an application second) slightly less often (286 times) than the

77. *See id.* §§ 8-10.

78. *See* ROGER T. HUGHES & JOHN H. WOODLEY, HUGHES AND WOODLEY ON PATENTS 595 (1984) (describing the Canadian first-to-invent system).

79. *See* An Act to Amend the Patent Act and to Provide for Certain Matters in Relation Thereto § 6.

80. *See id.* § 16.

81. *See id.* § 12. What was initially a seven-year window was reduced to five years in 1992.

82. *See id.* § 16.

83. Specifically, he argued that interference proceedings, which were complex and lengthy, favored larger entities. *See* Mossinghoff, *supra* note 60, at 520. Mark Lemley and Colleen Chien confirmed in their study that large entities initiated interference proceedings more than small entities and reached a similar conclusion. *See* Lemley & Chien, *supra* note 11, at 1323.

number of times that such entities were disadvantaged (289 times) by the FTI system (by losing an interference contest despite filing first).[84] Breaking the results out by type of entity, he found that individual inventors in particular gained no advantage from the FTI system, and rather were disadvantaged about 10% more often than they were advantaged by the system.[85] In a 2002 study, covering the time period 1983 to 2000, Mossinghoff obtained similar results.[86]

In their article entitled *Are the U.S. Patent Priority Rules Really Necessary?*, Mark Lemley and Colleen Chien empirically analyzed the results of interference proceedings and court cases involving patent priority in the United States. They found that the first applicant—the senior party—was usually, but by no means always, the first inventor. Indeed, they found that just over 40% of the time, the junior party won the priority contest, though they did identify a significant difference between outcomes in cases litigated before the Federal Circuit and decisions by district courts and the USPTO's Board of Patent Appeals and Interferences.[87] Thus, they concluded that, contrary to some scholarly discussion, the priority rules for patents do actually matter significantly.[88] Lemley and Chien also investigated the grounds on which the victors in the priority contests succeeded and concluded that in a large majority of cases (67% to 76% depending on the party type), the showing of a first reduction to practice is the grounds for victory.[89] 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.[90] Lemley and Chien argued, 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.[91]

While Lemley and Chien did not themselves try to determine whether the FTI system benefited or harmed small entities or individual inventors, they argued that their findings were consistent with Mossinghoff's suggestion that the system did not greatly benefit these groups.[92] In particular, as noted above, they found that large entities were more likely to initiate interference proceedings, suggesting that "[i]f anything, small entities are getting bogged down in interference proceedings initiated by larger companies."[93] They also argued that their basic findings—that first inventors are sometimes the last to file—

84. Mossinghoff, *supra* note 60, at 517.

85. *See id.* at 519 & fig.5 ((167 − 139)/(167 + 139) = 0.0915).

86. *See* Mossinghoff, *supra* note 13, at 430.

87. Lemley & Chien, *supra* note 11, at 1309.

88. *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 (1997).

89. Lemley & Chien, *supra* note 11, at 1315.

90. *See id.*

91. *Id.* at 1318-19.

92. *Id.* at 1323.

93. *Id.*

would not much change under a first-to-file system: the extra incentives to file more quickly should apply, they said, across categories of inventors, so there is little reason to think that first inventors would themselves be more likely to file early.[94] We are not so sure this makes intuitive sense.

Assume there is variation in the cost to file quickly (e.g., hiring attorneys, preparing the patent application, etc.) for different types of inventors. When the filing date is irrelevant, this heterogeneous cost will not impact filing dates very much—other considerations or just random variation will determine filing dates, leading to no systematic difference in filing dates across the types of inventors under a FTI system. A change to FTF would substantially increase the incentives for both types of inventors to file early. This would be much cheaper for the low-cost inventors to achieve, and thus we would expect to see more patents filed sooner by this class, which we assert, corresponds well to large corporations.

Thus, the major empirical analyses related to the former FTI priority system in the United States 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 happened when there was a significant claim that a first inventor was the last to file.[95] That is, they do not measure the effects that the FTI system versus the FTF system might have on the basic incentives to file for patents. Second, although Lemley and Chien do not read their study this way, some of their 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 businesses are somewhat less likely on the margin to file quickly, lends some weight to the suggestion that small entities were 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 was not 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 U.S. studies, there is one 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*

94. *Id.* at 1313.

95. 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.

from Canada, Shih-tse Lo and Dhanoos Sutthiphisal investigated whether the Canadian law change in 1989—from FTI to FTF—had a measurable impact on innovative output in Canada.[96] By comparing industry-level inventive activity between Canada and the United States, they concluded that the change to FTF had a "small negative impact."[97] Lo and Sutthiphisal focused their analysis on the years 1983 to 1994, seeking to avoid entangling their results with other possible policy changes in the United States or Canada.[98] Using patent counts as a measure of inventive output, their model attempted to explore the differences in output per R&D inputs in 1983 (under the FTI system) and 1994 (under the FTF system).[99] They also used Americans who sought patents in Canada as a baseline comparator, arguing that Americans' inventive activity would be less impacted by the Canadian FTF reforms than would domestic inventors'.[100] Finally, they also looked at Canadian patent filings abroad (in the United States and Europe) to account for other changes in the 1989 reforms, most especially the inclusion of maintenance fees.[101] In general, they found relatively little impact on patenting behavior attributed to the change to FTF in 1989.[102] They did, however, find that Canadian small businesses and individuals patented less in the United States after the law change, implying a decrease in inventive activity.[103] Thus, they tentatively concluded that the changes in the law seemed to channel patenting behavior towards larger businesses.[104]

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).[105] For both datasets we focus on applications filed during the

96. Lo & Sutthiphisal, *supra* note 16, at 4-5.

97. *Id.* at 5.

98. *Id.* at 10-11.

99. *Id.* at 11-13.

100. *Id.* at 15.

101. *Id.* at 16-17.

102. *Id.* at 22-23.

103. *Id.* at 26. Although Lo and Sutthiphisal used Canadian patenting in the United States as their measure in order to avoid picking up effects related to the maintenance fees, their result seems equally explained by the rise in costs of Canadian patenting as a result of the new fees. That is, larger entities can expect to see a shift in patenting in their direction when the costs of patenting rise, and since many Canadian inventors file both in the United States and Canada, increases in the costs of patenting in Canada will likely have a similar effect on the costs of patenting—to Canadian companies—in the United States.

104. *Id.* at 27.

105. Canadian data are available in bulk form from CIPO. *See IP Data Products*, CAN. INTELL. PROP. OFF., http://www.cipo.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/eng/h_wr01933.html (last modified Dec. 14, 2012). The U.S. data are available in bulk form

period from 1984 to 1993.[106] This period is chosen to allow a long enough timespan to detect changes in patenting behavior due to the law change, but not so long that long-term trends and other changes are likely to introduce excess noise into the data.[107] 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.

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 United States is over five times that of Canada, the disparity goes in the other direction when normalizing for country size or GDP. Using 1990 populations,[108] there were 6.32 patents granted per 1000 Canadians and 3.59 patents per 1000 Americans.[109] Additionally, through the ten-year period of the data, there were 294 patents granted in Canada per billion dollars (1989 U.S. dollars) of annual GDP compared with 162 patent grants in the United States per billion dollars of annual GDP.[110]

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.[111] 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 datasets. In the Canadian data, we define a patent as having a corporate inventor—and thus not an 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, in addition to any corporate assignees.

The U.S. data is easier to classify, due to additional data made available by the USPTO.[112] A "small entity status" field is included with that dataset that includes a classification of the type of assignee entity. We create a binary vari-

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from the USPTO. *See Electronic Data Products*, U.S. PAT. & TRADEMARK OFF., http://www.uspto.gov/products/catalog/index.jsp (last modified Jan. 2, 2013).

106. For both datasets, the application date is the actual filing date of the patent application.

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

108. *See Estimated Population of Canada, 1605 to Present*, STAT. CANADA, http://www.statcan.gc.ca/pub/98-187-x/4151287-eng.htm (last modified July 6, 2009); *1990 Census*, U.S. CENSUS BUREAU, http://www.census.gov/main/www/cen1990.html (last modified Oct. 15, 2012).

109. Note that these are total patents granted in each country, regardless of country of origin of patentee or inventor. One important reason for the higher per capita grant rate in Canada is that a much greater proportion of Canadian patents are granted to non-Canadians.

110. GDP data are available at the International Monetary Fund website. *World Economic Outlook Databases*, INT'L MONETARY FUND, http://www.imf.org/external/ns/cs.aspx?id=28 (last visited Feb. 24, 2013).

111. All assignment data for both countries are as of the patent issue date.

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

able that is assigned a value of 1 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 U.S. 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 the grant and thus the inventor is likely an individual.[113] The two definitions we use for U.S. 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 United States 23.2% of American entities receiving patents are individuals. The higher overall rate of individuals in the U.S. data may therefore reflect the greater proportion that 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.

Another way to compare inventive activity in the United States and in Canada is by looking at the country of origin of inventors and assignees. In Table 1, we see that U.S. inventors make up nearly 50% of Canadian patent grantees, followed by Japanese inventors with 15%. Canadian inventors are fourth in their country, with about 7% of the total. The pattern in the United States is similar (Table 2), with U.S. inventors comprising just over half of granted patentees. This is followed by Japanese inventors, who make up 21%. Canadian inventors account for 2% of the U.S. patent grants, but were actually granted about 38% more patents in the United States (17,805) than in Canada (12,944). In both countries, inventors from five large European nations (Germany, France, the United Kingdom, Switzerland, and Italy) together comprise many of the remaining inventors. The distribution of the home country of top assignees (not reported in the article) is very similar to that for inventors.

113. For consistency with the Canadian data, this second definition is used in the results presented in this Article.

TABLE 1
Top Twenty-Five Countries by Inventor Submitting Granted Canadian Patent Applications, 1984-1993

Country of First Inventor	Number of Patents Granted from 1984-1993	Percentage of Total
United States	80,332	49.14
Japan	23,829	14.58
Germany	12,186	7.45
Canada	12,055	7.37
France	8598	5.26
United Kingdom	7123	4.36
Switzerland	3154	1.93
Italy	2813	1.72
Netherlands	2683	1.64
Sweden	2108	1.29
Australia	1296	0.79
Finland	1163	0.71
Belgium	1098	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

TABLE 2
Top Twenty-Five Countries by Inventor Submitting Granted U.S. Patent Applications, 1984-1993

Country of First Inventor	Number of Patents Granted from 1984-1993	Percentage 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	8775	0.99
Sweden	7552	0.85
Taiwan	7474	0.84
Australia	4269	0.48
Republic of Korea	4236	0.48
Austria	3443	0.39
Belgium	3259	0.37
Israel	3004	0.34
Finland	2875	0.32
Denmark	1906	0.21
Spain	1319	0.15
Norway	1160	0.13
Soviet Union	1047	0.12
South Africa	1044	0.12
Hungary	871	0.10
Unknown	733	0.08
Hong Kong	537	0.06

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, below). General Electric (GE), International Business Machines (IBM), Canon, Toshiba, and DuPont are among the firms granted the most patents in both countries. Within the top 100 nonindividual patentees in the United States,[114] 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,[115] along with the Canadian military, the National Research Council of Canada, and four individuals (Jean-Francois Grollier,[116] David T. Green,[117] Robert C. Berfield,[118] and Josef Pedain[119]).

114. A list of these companies and the corresponding number of patent applications is available from the authors.

115. These include "Co.," "Company," "Co. KG," "Co-Conn," "Co. Inc.," and "Sons Inc."

116. Grollier is a chemist who has directed R&D for L'Oreal since 1994. *Jean-Francois Grollier: Executive Profile*, BLOOMBERG BUSINESSWEEK, http://investing.businessweek.com/research/stocks/people/person.asp?personId=8155200 (last visited Feb. 24, 2013).

117. Green holds patents on medical technologies. *See* Patents Related to David T. Green, GOOGLE PATS., http://patents.google.com (search for "David T. Green").

118. Berfield holds vacuum cleaner-related patents. *See* Patents Related to Robert C. Berfield, GOOGLE PATS., http://patents.google.com (search for "Robert C. Berfield").

119. Pedain holds chemical coatings patents. *See* Patents Related to Josef Pedain, GOOGLE PATS., http://patents.google.com (search for "Josef Pedain").

TABLE 3
Top Companies by Number of Granted
Canadian Patent Applications, 1984-1993

Company Name	Number of Patents from 1984-1993
General Electric Company	235
E.I. du Pont de Nemours and Company	215
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
The Dow Chemical Company	127
Hoechst Aktiengesellschaft	118
Ciba-Geigy AG	116
Gamble Company	110
Eastman Kodak Company	105
Union Carbide Corporation	96
Dow Corning Corporation	78
Exxon Research and Engineering Company	77
RCA Corporation	76
General Motors Corporation	72
Mitsubishi Denki Kabushiki Kaisha	71
Canon Kabushiki Kaisha	70
Siemens Aktiengesellschaft	69
American Cyanamid Company	67
Unilever PLC	67

TABLE 4
Top Companies by Number of Granted
U.S. Patent Applications, 1984-1993

Company Name	Number of Patents from 1984-1993
Canon Kabushiki Kaisha	9189
Hitachi Ltd.	8986
Kabushiki Kaisha Toshiba	8342
General Electric Company	7769
International Business Machines Corporation	7210
Mitsubishi Denki Kabushiki Kaisha	7104
Eastman Kodak Company	6409
Fuji Photo Film Co. Ltd.	6122
Motorola Inc.	5333
Matsushita Electric Industrial Co. Ltd.	4693
NEC Corporation	4692
U.S. Philips Corporation	4529
Siemens Aktiengesellschaft	4446
Bayer Aktiengesellschaft	4075
Sony Corporation	3978
Xerox Corporation	3763
E.I. du Pont de Nemours and Company	3662
General Motors Corporation	3643
Fujitsu Limited	3594
The Dow Chemical Company	3524
Westinghouse Electric Corp.	3400
Minnesota Mining and Manufacturing Company	3341
Texas Instruments Incorporated	3312
Sharp Kabushiki Kaisha	3225
BASF Aktiengesellschaft	3156

III. ANALYSIS AND RESULTS

As described in Part II 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 United States is chosen because of its geographic proximity, economic similarity, and close economic ties.

A. *The Rate of Patenting in the United States 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 2 and 3 report these rates for Canada and the United States for the period from 1984 to 1993. There is a substantial difference in the time series of patent applications in the two countries.

FIGURE 2

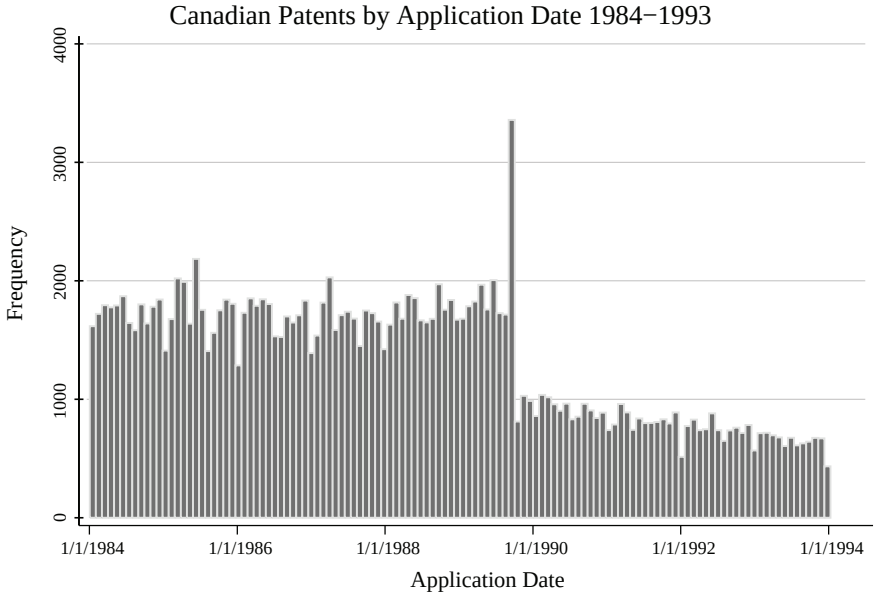
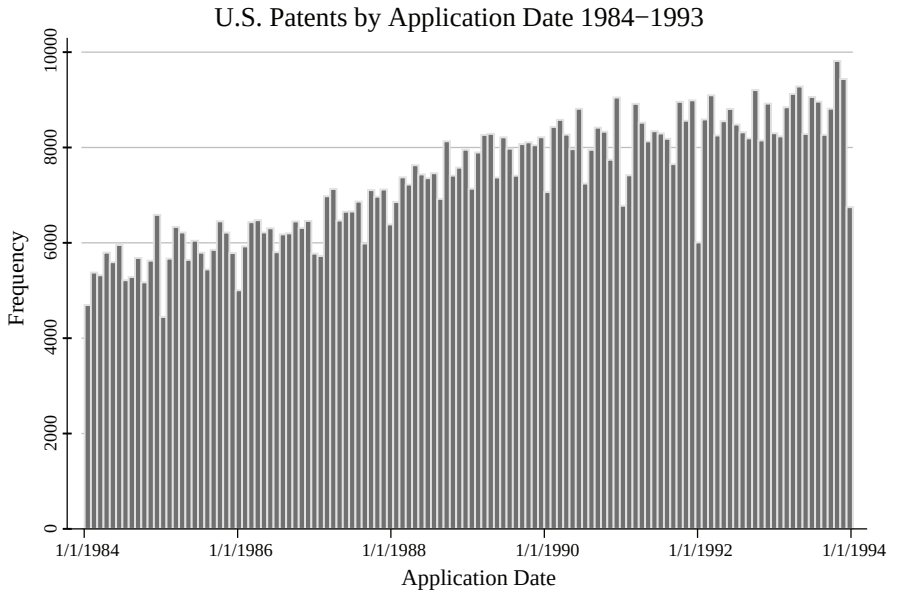


FIGURE 3



As shown in Figure 2, in Canada, between the beginning of 1984 and mid-1989, the number of subsequently granted applications was 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 dropped to less than 1000 per month, which remained roughly stable (with a slight decline) through 1993. This is in sharp contrast to the pattern in U.S. patent applications, where there was a fairly steady increase in subsequently granted applications from 6000 per month in 1984 to around 9000 in 1993. In Part III.D.3 below, we discuss further our view on the primary cause of the large overall drop in applications—the introduction of deferred examination as part of the 1989 law change.[120] For now, we take this as evidence of the substantial impact of the

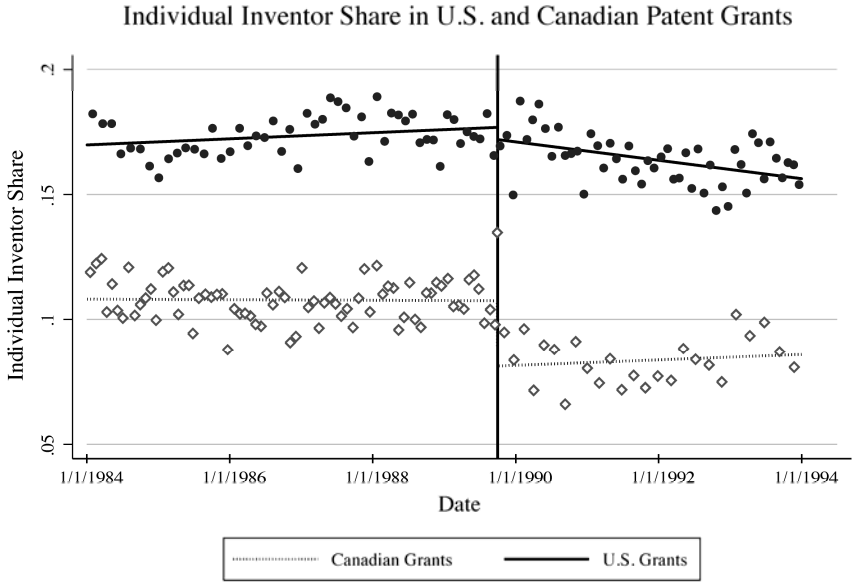
120. As discussed in more detail in Part III.D.3 below, we believe we can rule out any disproportionate impact on individual inventors related to the drop in the rate of patenting. For example, we control for potential differences in patenting rate due to variation in representation of individuals by technology class. We do so by running regressions including terms for technology class interacted with a post-law change dummy variable and find that the impact of the law change on individual share 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 dummy. In fact, we find it to be statistically significant and a large negative value.

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

B. *The Effect of First-to-File: Individual Versus 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 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 4, which reports the representation of individual inventors in the United States and Canada. In Figure 4 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 United States, the proportion of individual inventors dropped slightly, from 17.4% to 16.5%.

FIGURE 4



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 the fraction of individual inventors following the Canadian law change. This likely represents a long-term increase in the amount of innovation occurring under corporate auspices. But importantly, the magnitude of the decline is about three times greater in Canada than in the United States. 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 United

States. 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 United States following the Canadian law change. This result is statistically significant at well below the 1% level.[121]

TABLE 5
Difference in Difference: Individual Inventor Representation

	Before	After	After − Before
United States	0.1734	0.1639	-0.0095
	(0.00056)**	(0.00056)**	(0.00079)**
Canada	0.1077	0.0832	-0.0245
	(0.00088)**	(0.00118)**	(0.00156)**
Canada − United States	-0.0657	-0.0807	-0.0150
	(0.00117)**	(0.00168)**	(0.00205)**

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.

* 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

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

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 United States and thus β is the Canadian fixed effect. We code $post_t$ as 1 if the application was filed after the effective date and 0 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 inventors after the effective date of the first-to-file rule.[122] 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,

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

122. Reported standard errors are heteroskedasticity-consistent (White Standard Errors).

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

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	Base Specification	Date of Passage	Linear Time Trend	Year Dummies	IPC Class Controls	Probit Marginal Effects	Counts
After (γ)	-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 (β)	-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
(δ)	(0.00181)**	(0.00172)**	(0.00181)**	(0.00181)**	(0.00175)**	(0.00229)**	(26.34)**
Year			0.00023				
			-0.000238				
Constant (α)	0.173	0.173	-0.238	0.171	0.17		1,144
	(0.000561)**	(0.000709)**	-0.474	(0.000126)**	(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 1 for patents granted to individual inventors and 0 otherwise; data are 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. Robust standard errors are 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 United States 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,[123] so we run a regression of the form:

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

Column 6 reports the marginal effects from this regression. The magnitude of the coefficient (-0.0243) 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 column 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 countries, 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.

123. 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
Effect of Priority Rule on the Fraction of Individual Inventors

VARIABLES	(1) Canada	(2) United States	(3) All Other Countries
After (γ)	0.000523	-0.0131	-0.0131
	-0.00722	(0.00122)**	(0.000882)**
Canada (β)	0.0256	-0.143	-0.0136
	(0.00736)**	(0.00147)**	(0.00132)**
After − Canada (δ)	-0.0488	-0.00852	-0.0222
	(0.0119)**	(0.00254)**	(0.00209)**
Constant (α)	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. The dependent variable is a dummy that is 1 for patents granted to individual inventors and 0 otherwise; data are at the patent level. "After" indicates that the patents were 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. Robust standard errors are 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: -0.0488, compared to -0.0085 for Americans and -0.0222 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 effect among foreign individuals considering patenting in that country.[124] Together, the empirical results indicate a statistically significant and substantial reduction in patents granted to individual inventors subsequent to the Canadian law change.

124. There are alternative explanations as well, which we discuss further in the next Subpart.

C. *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.

Patent quality is of course an extremely difficult characteristic to measure (and define), and it is beyond the scope of this Article to develop new techniques. However, our datasets do allow us to test certain relationships that may (arguably) relate to the quality of patents; while by no means definitive, we think that these metrics provide at least a rough-cut evaluation of any patent quality changes as a result of the 1989 Canadian law change.

Because our measurement of interest in this Article is how the shift to the FTF system affected individual inventors, we define "patent quality" as an input into granted patent characteristics: the effort (resources) dedicated to the patent by the applicant.[125] Thus, our metrics include:

> *The length (in words) of the first claim of each patent*. Here, we expect a higher-quality patent to be more complex, and—all other things being equal—to have more words in the first claim.
>
> *Total number of claims*. Again, we expect a higher-quality patent to be more detailed, and thus have more claims.
>
> *Claim language complexity*. Here we utilized standard metrics of language complexity—the Flesch-Kincaid index and the Fog index—to measure claim language complexity.[126] As before, the more complex, the higher quality.

Given these metrics, if a "rush to patent" theory—where applicants limit time and other resource expenditure to hastily apply for patents—is correct, we should see a measurable decline in each of these measures.

However, we find no significant change in patent quality due to the 1989 Canadian law change using any of these measures.[127] For illustration, note

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125. This is of course not the only way to define patent quality.

126. For a description of the Flesch-Kincaid index, see J. PETER KINCAID ET AL., DERIVATION OF NEW READABILITY FORMULAS (AUTOMATED READABILITY INDEX, FOG COUNT AND FLESCH READING EASE FORMULA) FOR NAVY ENLISTED PERSONNEL 18-19, 38-39 (1975) (modifying the Flesch Reading Ease formula to create a new measure of readability that relates the complexity of the writing to grade level). For the Fog index, see ROBERT GUNNING, THE TECHNIQUE OF CLEAR WRITING 31-35 (rev. ed. 1968). The advantage of these measures is that they are standard, require only limited programming to utilize, and are well understood. The disadvantage is that patent claim language does not adhere to standard conventions of grammar and sentence structure, meaning these metrics are at best useful for identifying changes in claim language patterns rather than measures of claim complexity directly.

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

Figures 5 and 6 below, which depict the word count of the first claim of each granted patent in Canada and the United States, respectively.

FIGURE 5

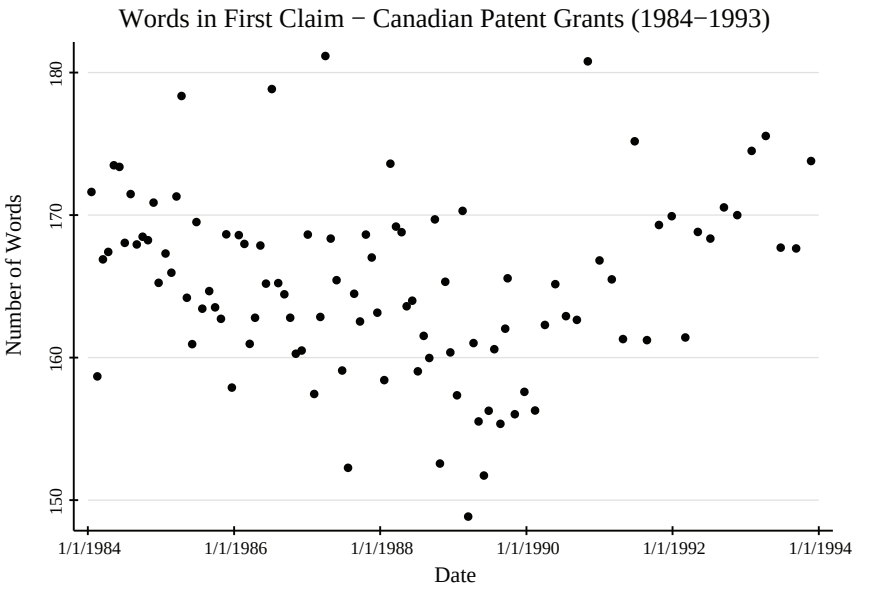
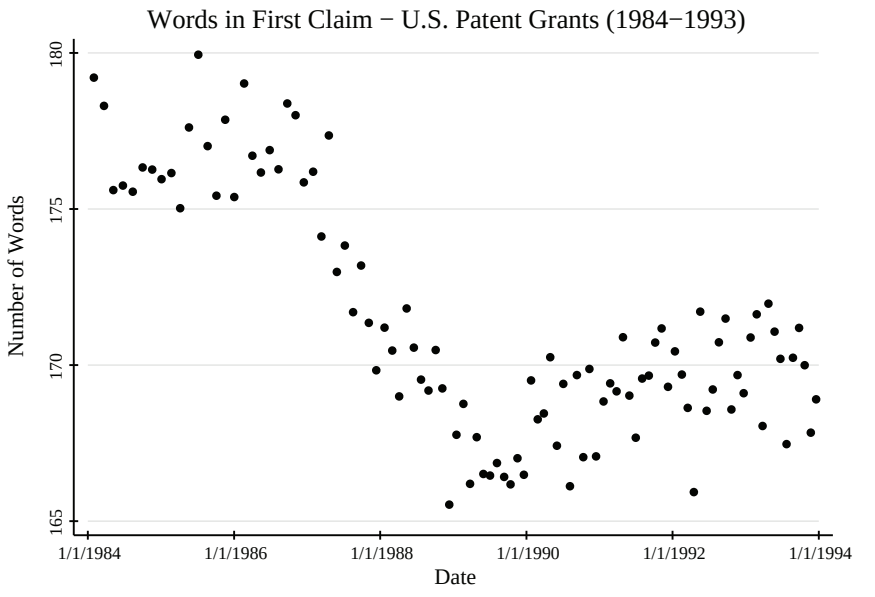


FIGURE 6



What we find, and can be seen in Figures 5 and 6, is a large drop in first claim word count during the time period of our analysis in U.S. patents. This is an interesting pattern, and one that suggests further research well beyond the scope of this project.[128] 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).

D. *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. The patent term had been seventeen years from the grant date, and became twenty years from the application date.[129] This change could potentially impact the fraction of individual inventors seeking patents, and therefore could explain the results we find, rather than the patent priority system. When the United States made the same change in patent term, the net effect was an increase in patenting,[130] so one might think lengthening the patent term could not account for the decline in the rate of individual patenting observed here. But as Figures 7 and 8 make clear, the processing time in Canada is substantially longer than in the United States. Prior to the Canadian law change, the processing time was about fifty-one months in Canada versus twenty-two in the United States. 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.[131]

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128. We believe that this pattern in the U.S. data may be a response by inventors to changes in U.S. patent law wrought by the creation of the U.S. 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. *See, e.g.*, R. Polk Wagner & Lee Petherbridge, *Is the Federal Circuit Succeeding? An Empirical Assessment of Judicial Performance*, 152 U. PA L. REV. 1105, 1116-17 (2004). As we note in the text, this is an avenue for future research.

129. *See* An Act to Amend the Patent Act and to Provide for Certain Matters in Relation Thereto, R.S.C. 1985 (3d Supp.), c. 33, § 16 (Can.); Ludlow, *supra* note 15, at 104.

130. *See* David S. Abrams, *Did TRIPS Spur Innovation? An Analysis of Patent Duration and Incentives to Innovate*, 157 U. PA. L. REV. 1613, 1614, 1642 (2009).

131. See *id.* at 1622-26 for a discussion of the incentive effects of patent term changes.

FIGURE 7

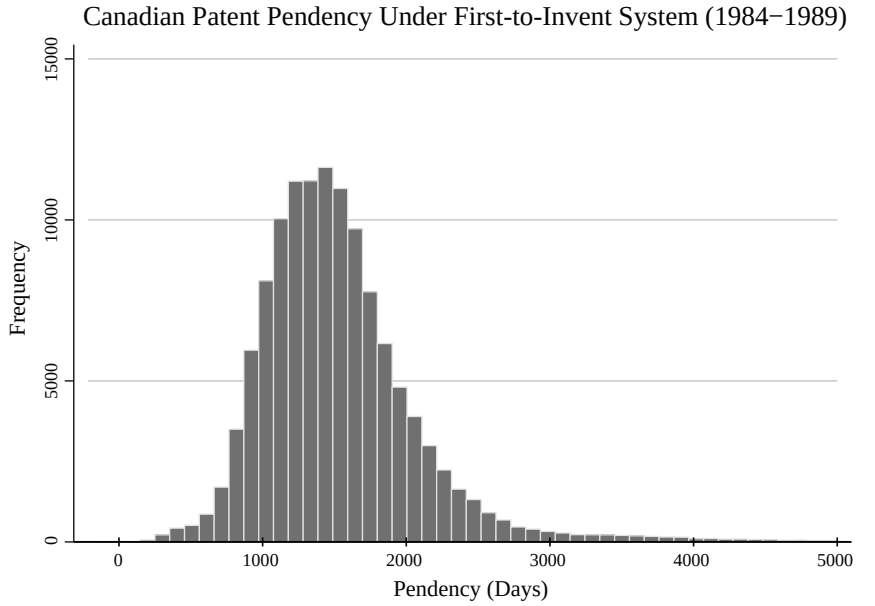
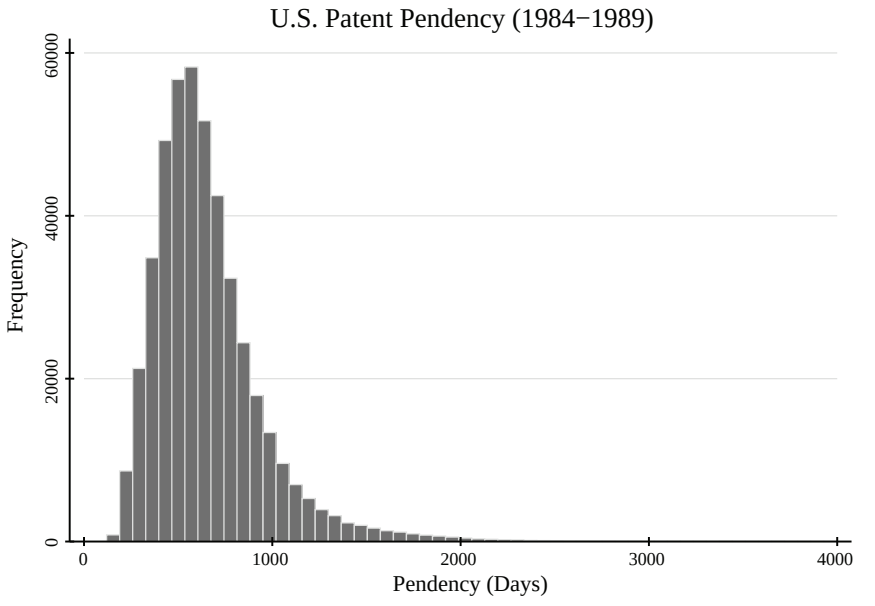


FIGURE 8



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.[132] 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 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 9 and 10 depict these results graphically, before and after the shift to first-to-file, respectively.

132. See *id.* at 1641-42 for an investigation of this phenomenon in the U.S. context.

FIGURE 9

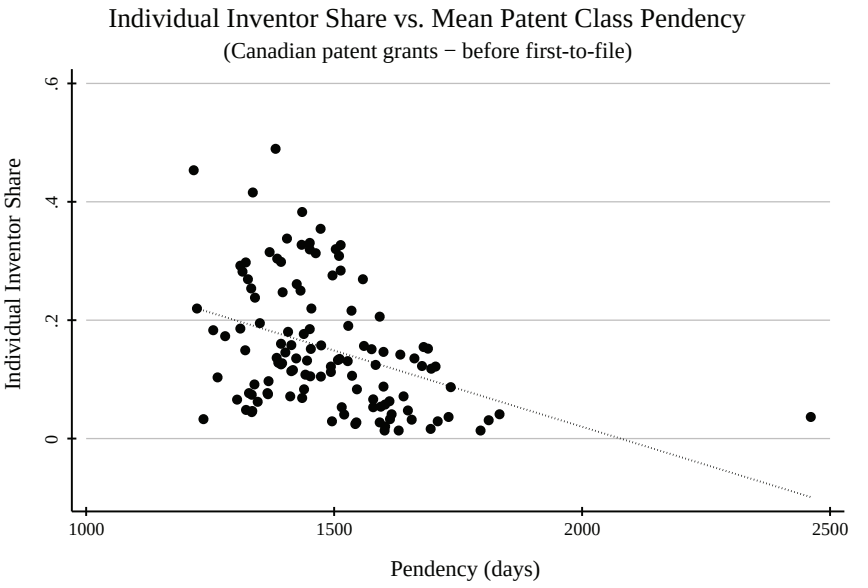
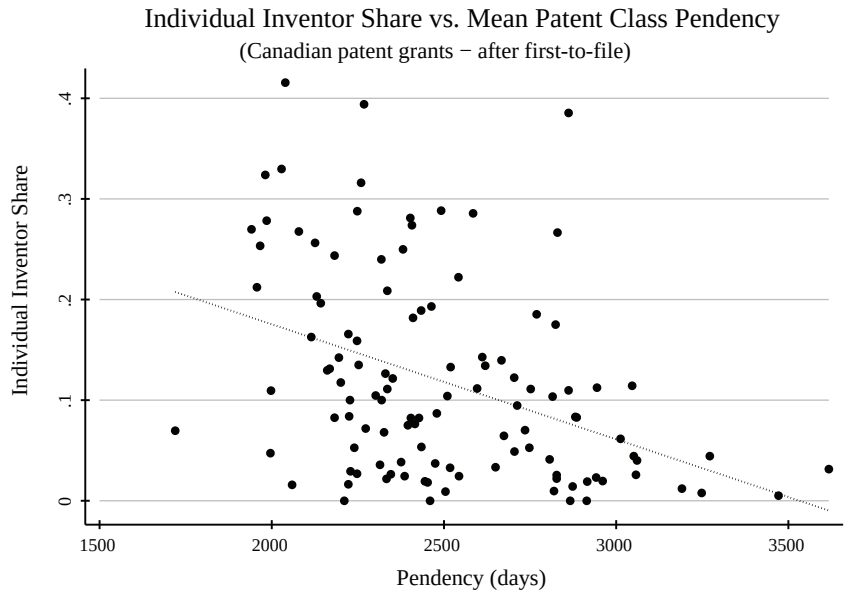


FIGURE 10



2. *The introduction of maintenance fees*

As noted in Part II above, one of the legal changes introduced in Canada 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.[133] In general, these fees require applicants (or grantees) to pay annually to maintain their applications or their patent rights.[134] One possible concern is that 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 Canadian patents filed after October 1, 1989, was 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.[135]

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 maintenance fees and the average of $7000 to $12,000 in attorneys' fees for filing original patent applications (depending on complexity and technology).[136] 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.[137]

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133. *See* An Act to Amend the Patent Act and to Provide for Certain Matters in Relation Thereto, R.S.C. 1985 (3d Supp.), c. 33, § 16 (Can.).

134. The annual fee schedule for Canadian patent applications, which has apparently remained unchanged since 1989, is as follows:

Years 2, 3, 4	$100
Years 5, 6, 7, 8, 9	$200
Years 10, 11, 12, 13, 14	$250
Years 15, 16, 17, 18, 19	$450

Note that small entities (including individual inventors) pay fifty percent of the listed fees. *See Tariff of Fees—Patents*, *supra* note 54.

135. *See id.*

136. *Compare supra* note 134 and accompanying text (detailing maintenance fees), *with* AM. INTELLECTUAL PROP. LAW ASS'N, *supra* note 62, at 25 (detailing typical charges for intellectual property-related legal services).

137. 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, but in 1992 it was changed to five years.[138]

The idea behind deferred examination is that it allows for reduced workload on the patent office—many inventors will file applications but not request examination at all, abandoning the application. At the same time, deferred examination 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.

Although we think that deferred examination can account for most of the large drop in the rate of patenting in Canada shown in Figure 2, in theory, this change 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 a decreasing relationship between individual inventor share and pendency.[139] 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

138. *See supra* note 81 and accompanying text.

139. A regression of individual inventor share on pendency yields a coefficient of -0.0001145 with a standard error of 0.0000245. 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.

variables.[140] 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 firms are.

There is another way to test the deferred examination hypothesis. Immediately before the 1989 Canadian law change, there was a substantial surge in patenting behavior by individuals. Specifically, in the seven days prior to the October 1, 1989, implementation date, there was a threefold increase in patent applications as compared to a typical day in 1989 prior to that time—about 300 applications per day as opposed to 88 per day earlier in 1989. That surge of applications was disproportionately comprised of individuals—12.5%, as opposed to 10.8% for the five years up to that point (and 8.3% 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.

E. *Interpretation and Analysis of Our Results*

As explained above, we find a significant decline in patenting by individual inventors relative to larger entities that is caused by the change in Canadian patent law from a first-to-invent to first-to-file priority rule. 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.

140. The regression of change in individual inventor share in Canada on change in pendency yields a coefficient of -0.0000244 with a standard error of 0.0000181, which is statistically insignificant.

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 Part 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 some degree with the results of interference cases in the United States, where party type does not appear to correlate strongly with success under the first-to-invent rule.[141] But given the small number of interferences and highly selected cases, 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, so any conclusions here should be cautious. Most importantly, patent counts 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. It is possible (and even likely) that if the cost of patenting rises (as a result of the change to a FTF system), individual inventors in particular will continue to invent, but shift to alternative methods for protecting their inventions. 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.

Individual Inventors Join Firms. It is possible that we find less patenting by individual inventors because they joined firms after the implementation of

141. *See* Lemley & Chien, *supra* note 11, at 1320-23; Mossinghoff, *supra* note 13, at 428.

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.

Shift to Patenting in the United States. While the impediments to patenting rose for individuals in Canada, there was no change in U.S. patenting standards. Thus, one possible explanation of our findings is that individual Canadian inventors chose to forego patenting in Canada and patented in the United States instead. This hypothesis may be tested by examining only U.S. patent data before and after the Canadian law change.

TABLE 8
Impact on U.S. Patents by Country of Inventor

Variables	Coefficients & Standard Errors
After (γ)	-0.0124
	(0.00113)**
Canadian Inventor (β)	0.0805
	(0.00486)**
After-Canadian Inventor (δ)	0.0191
	(0.00686)**
Constant (α)	0.239
	(0.000803)**
Observations	492,784
R-squared	0.162

This regression is restricted to U.S. data in order to investigate the impact of the Canadian law change on patenting behavior of Canadian and U.S. inventors in the United States. The dependent variable is 1 for patents granted to individual inventors and 0 otherwise; data are at the patent level. "After" indicates that the patents were 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. IPC class controls are included. Robust standard errors are in parentheses.

* indicates significance at $p < 0.05$

** indicates significance at $p < 0.01$

Table 8 indicates the results of this investigation. The dependent variable is the same as Tables 6 and 7, an indicator for whether the patent was granted to an individual. The key difference in this table (besides the data only including U.S. patents) is that the regressor of interest is the interaction term between after and Canadian inventor. This indicates the differential effect of the Canadian law change on the individual inventor share granted to Canadians relative to Americans *in the United States*.

The result is that the share of U.S. patents granted to individual Canadians rose almost two percentage points relative to the individual American share.[142] This is a substantial increase and points to a change in patenting behavior, whereby individual inventors in Canada may have continued to innovate, but focused their patenting efforts on the United States. The ability to turn to an alternate patent system will not be open to U.S. inventors, as it was the last major country to use the FTI priority system.

In short, our data do 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 in 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 businesses), 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 Subpart III.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 former first-to-invent rule was

142. The regression reported includes IPC technology class controls. Other specifications, including year dummies, time trends, or no controls yield similar results.

costly and complex, so its elimination will have a substantial impact. Further, our point estimate suggests perhaps a fourteen-percent reduction in the share of individual inventors receiving patents as a result of the first-to-file rule.[143] 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 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 would simplify the U.S. 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,"[144] he was almost surely alluding (at least in part) to the change from first-to-invent to first-to-file. As we've shown, this change will surely simplify and streamline the U.S. 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, but which obviously calls for further study.

Notwithstanding the images of Edison, Hewlett and Packard, Jobs and Wozniak, how much do individual inventors matter to American innovation? That, we think, is the critical question suggested by our study. To date, most observers seem to have assumed that our shift to the FTF rule, though a substantial change in U.S. patent law practice, will have little impact on who seeks and receives patents. We demonstrate that this is wrong. The change to the first-to-file rule in the United States will likely result in a reduction of individual inventors' share of patents. Thus, the cost savings yielded by the priority rules changes in the America Invents Act will not, we suggest, be free.

143. *See supra* Part III.B. In Table 6, the coefficient for the base specification is -0.0149. That represents a 1.49 percentage point reduction in the share granted to individuals in Canada relative to the share the law change. Because the pre-law change rate was about 10.8%, that in turn suggests about a 14% drop in relative share. (The ratio of 1.49% to 10.8% is about 14%.)

144. Remarks on the Federal Budget, *supra* note 6.