WHO HAS PRIORITY? AN EMPIRICAL EXPLORATION OF THE FIRST TO FILE RULE

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ABSTRACT

Recently a bill was introduced into the U.S. House of Representatives that could lead to the biggest change in U.S. patent law in over 50 years. One of the important components of the bill is changing the way patent priority is determined. Unlike all other centers of innovation, the U.S. uses a "first to invent" method rather than "first to file". Opponents of the change argue that first to file disadvantages small inventors and leads to lower quality patents. Those in favor emphasize the clarity and administrative simplicity of first to file. While there has been some theoretical work on this topic, in this paper we use a natural experiment in Canada 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. We obtain data on hundreds of thousands of patent grants from the Canadian IP Office as well as the US Patent and Trademark Office. We find a significant drop in the fraction of patents granted to small inventors in Canada around the time of the law change, and a much smaller contemporaneous decline in the U.S. The results are robust to several different specification checks. In work currently in progress, we additionally examine measures of patent application quality, including number of citations, and use variation by patent class to get further purchase on the impact of the priority system. The findings from this paper should be informative as the U.S. considers this major patent reform.

INTRODUCTION

In the Spring of 2011, the United States Senate and House each passed similar versions of the America Invents Act, perhaps the most sweeping patent reform effort since 1952.[1] One of the most significant pieces of the law's changes is the end of what has been for some time a uniquely American tradition in patent law — the "first-to-invent" system of patent priority rules. Until now, the US has been the only country to deviate from the "first-to-file" system used elsewhere.[2]

The reasons for the U.S.'s outlier status are complex,[3] and — perhaps most importantly — not based on empirical research about the actual impact of a first to file versus a first to invent rule. The study we present here is intended to help fill that gap, to provide some insights into what as switch to first to file might mean. By carefully analyzing the shifts in patenting behavior the last time a major industrialized nation — Canada — switched from first to invent to first to file, we suggest that such a switch will reduce the patenting behavior of individual inventors, although whether this is ultimately good for innovation policy or not is a question our study cannot answer.

Patent priority rules establish who (especially among competing inventors) has the right to receive a patent on an invention. At first blush, this seems a remarkably simple question: the inventor should receive the patent grant. But the situation becomes much more

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[1] [cite]

[2] In 1998, the Philippines switched to a first-to-file system, leaving the U.S. as the last country with a first to invent system. Canada's switch in 1989 is regarded as the last major industrialized nation to switch — a fact which we exploit for our study.

[3] Lemley & Chien have a good section on this. See also Mossinghoff and others.

complex when there are multiple inventors independently working in the same area of technology: only one can receive the patent grant. And while it is simple to establish a basic first-in-time rule — the first inventor gets the patent rights — the question is what act triggers the establishment of the rights. This, then, is the basic difference between the US first-to-invent system (FTI system) and the first-to-file system (FTF system) used everywhere else. In the US FTI system, the first "inventor" is given the patent rights, while elsewhere the inventor who first files her application at the patent office will receive the rights. The primary arguments in favor of a first to invent system are (1) that it is more fair, in the sense that it is most likely to grant the rights to the truly *first* inventor, rather than the one who got to the patent office first, (2) that it enables prospective patentees to perfect their invention, application, and/or consider commercial viability prior to filing, and (3) that it prevents larger, well-resourced companies from gaining a systematic advantage in patenting by reaching the patent office first. The arguments in favor of a FTF system are (1) significant administrative simplicity and (2) additional inducement for early patent applications.[4]

As noted above, there is virtually no empirical work on the question of the impact of the FTF rule. Our strategy here is to use a law change in 1989 in Canada to examine the effects of the priority rules on individual inventors. More specifically, in 1989, Canada switched away from a US-style (indeed, almost identical to the US) FTI system to a FTF system, providing a natural experiment of sorts on the effect of such a change. By comparing the change in share of patenting by individual inventors in Canada before and after the law change with the change in share of individual inventors in the US during the same time period, we can isolate and measure the impact of the FTF switch on individual inventors. In doing so, we find strong evidence that the law change reduces patenting behavior by individual

[4] Early patent applications mean earlier disclosure of inventions to the public, as well as earlier expiration of the patent rights themselves.

inventors, implying that some critics of the FTF rule may be at least partially right — though the net policy implications are not so clear.

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

II

FIRST TO INVENT VS FIRST TO FILE: A PRIMER

A. The US System: First to Invent

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

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

This section has been interpreted by the courts to mean that the patent grant is given[5] to a prior inventor (who did not abandon, suppress, or conceal the invention), if that prior inventor can show (1) a first reduction to practice of the invention, or (2) a first conception of the invention, plus reasonable diligence from that time until a time just prior to conception by another.[6] The filing date of the applications, then is not determinative — though the first filer has important evidentiary advantages in these proceedings.

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

[6] [cites]

As established in §102(g), the patent priority rules are highly complex, involving careful definitions of what terms such as "reduce to practice", "conception" and "reasonable diligence" mean. (Not to mention abandonment, suppression, or concealment.) In addition, there are substantial evidentiary complexities: the junior party bears the burden of proof, and corroborating evidence is always required in these areas.

B. The First-To-File Rule

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

> § 28.2 (1)
>
> The subject-matter defined by a claim in an application for a patent in Canada … must not have been disclosed … (c) in an application for a patent that is filed in Canada by a person other than the applicant, and has a filing date that is before the claim date.[7]

There are other provisions that deal with contemporaneously filed applications claiming priority to earlier applications (or foreign applications),[8] but the basic thrust is the same: the patent right goes to the first inventor who files her application with the patent office.

C. Policy Questions

There are important policy questions related to a shift to a first-to-file system. Chief among these is whether a first-to-file system discriminates against individual inventors, small businesses, or non-profits, rendering them less likely to obtain effective patent protection than larger organizations. (A weaker version of this question is whether the current U.S. first-to-invent system in fact favors such

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[7] Canadian Patent Law, § 28.2

[8] [cites]

entities.) The suggestion is that a first-to-invent system — which necessarily allows a later applicant to obtain the patent rights to an invention first claimed in an earlier application by another inventor — allows those with fewer resources (e.g., individuals, small business, and non-profits) to obtain patent protection without the need to "rush" to the door of the patent office. 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. Further, additional resources means more patent attorneys or agents can be dedicated to drafting and filing applications. The inventors themselves may be more able to redirect the time required by the patent application process away from their other duties. Larger organizations may have routinized patenting procedures, designed to yield rapid applications. Smaller organizations and individuals, with constrained patenting resources, may wish to wait until the commercial potential of an invention is clearer prior to filing. Each of these factors, and likely several more, at minimum raise 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 current first-to-invent system may at first glance seem to encourage waiting to apply for a patent (or at least not penalize it), the rules themselves do the opposite. For example, the first applicant in a priority contest (known as the "senior party") gains a presumption that she is the first inventor, forcing the later filer (the "junior party") to present proof of an earlier invention date.[9] Furthermore, other critical patent rules, most prominently those related to prior art,

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

strongly weigh in favor of an early filing — simply, the earlier the filing date, the less prior art will be available.[10] Thus, while the first-to-invent rules offer an important benefit to later patent applicants, their incentive effect is likely to be muted by other, countervailing, incentives built into the patent system.

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

This question has more than distributional import. Although it has been clear for some time that the rate of individual patenting has been decreasing in the US over time, it is widely understood that individuals and small entities have an important impact on the innovation ecosystem — perhaps an outsize impact. 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. Second, in some industries, such as high technology and pharmaceuticals, small companies and individuals serve as important innovative inputs into larger, established companies. 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, nor that we take a position regarding the wisdom of the change to a first-to-file rule. Our point here is to note that there is good reason —

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

and sound evidence — to suggest that if the first-to-file rules indeed disproportionally impact small entities, that is likely to have important changes in innovation. In short, this is an important policy change that appears to have potential impact on long-run innovation.

D. 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.[11] The bill passed the House of Commons on May 6, 1987 and the Senate on November 19, 1987. The law changes became effective on October 1, 1989. Patent applications filed prior to October 1, 1989 were processed under the FTI rules, while applications after that date were processed under the new rules.

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

The 1986 and 1987 patent reform acts also include other important changes to the patent law, some of which we discuss in detail below. For one, the patentability of pharmaceutical drugs was confirmed.[12] For another, the patent term was changed from 17 years from the date of issue to 20 years from the date of filing.[13] And finally, maintenance fees were introduced, requiring annual payments by both

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

[12] [cite]

[13] [cite]

applicants and grantees to maintain their applications and patents, respectively.[14]

E. Prior Literature

Most prior studies investigating the effect of the first-to-file system in the US have been based on data gathered from "interference" proceedings — the complex system implementing the first-inventor priority rules found in 35 U.S.C. § 102(g). In general, these studies have documented little if any impact related to entity size in the current first-to-invent system. For example, Mossinghoff (2005) found no evidence that small entities are advantaged by the FTI system, and indeed concludes that in some ways small entities are disadvantaged by the current system.[15] Specifically, he gathers data on interference proceedings from 1983-2004, and finds that small entities took advantage of the FTI system (by winning an interference contest despite filing an application second) slightly fewer (286 times) than the number of times that such entities were disadvantaged (289 times) by the FTI system (by losing an interference contest despite filing first).[16] Breaking the results out by type of entity, he finds that individual inventors in particular gain no advantage from the FTI system, being disadvantaged about 20 percent more of the time than

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[14] [cite]

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

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

they were advantaged by the system.[17] In a 2002 study, covering the time period 1983-200, Mossinghoff found similar results.[18]

In Are the U.S. Patent Priority Rules Really Necessary, Mark Lemley and Colleen Chien empirically analyze the results of interference proceedings and court cases involving patent priority in the US. They find that the first applicant — the senior party — is usually, but by no means always the first inventor. Indeed, they find that about 40 percent of the time, the junior party wins the priority contest, though they do identify a significant difference between litigated case outcomes and decisions by the USPTO's Board of Patent Appeals and Interferences.[19] Thus, they conclude that, contrary to some scholarly discussion, the priority rules for patent do actually matter, significantly.[20] Lemley and Chien also investigate the grounds on which the victors in the priority contests succeeded, and conclude that in a large majority of cases (about 67-71 percent, depending on the party type), the showing of a first reduction to practice is the grounds for victory.[21] 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.[22] They argue, therefore, that the priority rules could be greatly

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[17] Id. at 519.

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

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

[20] 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;

[21] Id. at 1315.

[22] Id.

streamlined, eliminating much of the complexity and cost, without changing the results in the cases very much.[23]

While Lemley and Chien do not themselves try to determine whether the FTI system benefits or harms small entities or individual inventors, they argue that their findings are consistent with Mossinghoff's suggestion that the system does not greatly benefit these groups.[24] In particular, as noted above, they find that large entities are more likely to initiate interference proceedings, suggesting that "[i]f anything, small entities are getting bogged down in interference proceedings initiated by larger companies." They also argue that their basic findings — that first inventors are sometimes the last to file — would not much change under a first-to-file system: the extra incentives to file more quickly should apply, they say, across categories of inventors, so there is little reason to think that first inventors would themselves be more likely to file early. We are not so sure this makes intuitive sense; if a category of inventors (first inventors) are significantly able to gain benefits from a system (i.e., the FTI system), and that system is changed, then one would expect the incentives to be disproportionally felt by that category of inventors, though they are surely correct that the incentives to file early are uniform and widespread in the patent system.

Thus, the major empirical analyses related to the priority system in the U.S. are limited in their ability to answer the question of whether the system helps or hurts individual inventors and small entities. First, by relying on data related to actual priority contests these studies only tell us what happens when there is a significant claim that a first inventor was the last to file.[25] That is, they don't

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[23] Id. at 1319.

[24] Id. at 1321.

[25] Both interference proceedings and litigation (the two venues by which a priority contest can be resolved) are extremely expensive and thus

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

In addition to these US studies, there is one very interesting study that takes a similar — though not identical — approach to the one we conduct here. In *Does it Matter Who Has the Right to Patent: First to Invent or First to File? Lessons from Canada*, Shih-test Lo and Dhanoos Sutthiphisal investigate whether the Canadian law change in 1989 — from FTI to FTF — has had a measurable impact on innovative output in Canada.[26] By comparing industry-level inventive activity between Canada and the United States, they conclude that the

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involve only a very small fraction of all patents; therefore, when a priority contest does actually occur, the stakes must be substantial.

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

change to FTF had a small negative impact.[27] Lo and Sutthiphisal focus their analysis on the years 1983 and 1994, seeking to avoid entangling their results with other possible policy changes in the US or Canada. Using patent counts, as well as measures of patent value, as a measure of inventive output (and thus their dependent variable) their model attempts to explore the differences in output per R&D inputs in 1983 (under the FTI system) and 1994 (under the FTF system). They also use Americans who seek patents in Canada as a baseline comparator, arguing that Americans' inventive activity will be less impacted by the Canadian FTF reforms than will domestic inventors. Finally, they also look at Canadian patent filings abroad (in the US and Europe) to account for other changes in the 1989 reforms, most especially the inclusion of maintenance fees. In general, they find relatively little impact on patenting behavior attributed to the change to FTF in 1989. The do, however, find that Canadian small businesses and individuals patented less in the US after the law change, implying a decrease in inventive activity.[28] Thus, they tentatively conclude that the changes in the law seemed to channel patenting behavior towards larger businesses.

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[27] Id. at 5.

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

III
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).[29] For both data sets we focus on application dates during the period from 1984 to 1993. 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 so that long-term trends and other changes are likely to introduce excess noise into the data.[30] The U.S. and Canadian datasets are similar, and both include information on application date, patent grant date, inventor, assignee, patent number, and technology classification.[31]

One significant difference between the two datasets is the size: there are 175,058 patents in the Canadian data and 891,887 in the U.S. data. While the total number of patents granted in the U.S. is over five times that of Canada, the disparity goes in the other direction when normalizing for country size. Using 1990 populations[32][33],

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[29] [Cite to data sources.] US data is available at http://www.uspto.gov/products/catalog/patent_services/patdata.jsp

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

[31] [include an appendix with data fields, link to datasets]

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

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

there were 6.32 Canadian patents granted per 1000 people and 3.59 patents per 1000 Americans.[34]

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. In both the Canadian and U.S. data, inventors must be individuals, but assignees can be individuals or corporations. There can be multiple inventors and assignees in both data sets. In the Canadian data, we define a patent as having a corporate inventor — and thus not an individual patentee — if at least one of the assignees as of the grant date is not also an inventor. This is because in the Canadian dataset, individual inventors are also listed assignees, as well as any corporate assignees.[35]

The U.S. data is easier to classify, due to additional data made available by the USPTO. A field is included with that data set that includes a classification of the type of assignee entity. We create a binary variable that is one if the assignee type is an individual. In order to make the coding comparable with the Canadian data we also use a second definition for the US dataset. For this variable, we define an individual inventor as one that has a missing assignee name, implying that no assignment has been made as of grant and thus the inventor is likely an individual.[36] The two definitions we use for US data disagree less than one time in 1000 observations.

With these definitions in place it is useful to compare the base rates of assignment to individuals during the time period studied. In Canada, 9.9% of patents are granted to individuals, while this rate is

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

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

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

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

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

Table 1

Top 25 Countries of Inventor Submitting Canadian Patent Applications 1984 - 1993

Country of First Inventor	Number of Patents from 1984-1993	Fraction of Total
UNITED STATES	85,862	49.05
JAPAN	25,033	14.3
GERMANY	13,173	7.52
CANADA	12,944	7.39
FRANCE	9,497	5.43
UNITED KINGDOM	7,646	4.37
SWITZERLAND	3,490	1.99
ITALY	3,106	1.77
NETHERLANDS	2,898	1.66
SWEDEN	2,233	1.28
AUSTRALIA	1,355	0.77
FINLAND	1,231	0.70
BELGIUM	1,185	0.68
AUSTRIA	907	0.52
DENMARK	596	0.34
ISRAEL	458	0.26
NORWAY	400	0.23
SOUTH AFRICA	378	0.22
UNKNOWN	282	0.16
HUNGARY	270	0.15
SPAIN	267	0.15
SOVIET UNION	209	0.12
REPUBLIC OF KOREA	199	0.11
NEW ZEALAND	185	0.11
LUXEMBOURG	148	0.08

Calculations based on CIPO data

Table 2

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

Country of First Inventor	Number of Patents from 1984-1993	Fraction of Total
UNITED STATES	475,977	53.37
JAPAN	191,182	21.44
GERMANY	71,191	7.98
FRANCE	27,696	3.11
UNITED KINGDOM	25,445	2.85
CANADA	17,805	2.00
SWITZERLAND	12,218	1.37
ITALY	11,702	1.31
NETHERLANDS	8,796	0.99
SWEDEN	7,563	0.85
TAIWAN	7,479	0.84
AUSTRALIA	4,279	0.48
REPUBLIC OF KOREA	4,242	0.48
AUSTRIA	3,450	0.39
BELGIUM	3,270	0.37
ISRAEL	3,007	0.34
FINLAND	2,881	0.32
DENMARK	1,907	0.21
SPAIN	1,319	0.15
NORWAY	1,161	0.13
SOVIET UNION	1,048	0.12
SOUTH AFRICA	1,044	0.12
HUNGARY	876	0.10
UNKNOWN	734	0.08
HONG KONG	537	0.06

Calculations based on USPTO data

A list of top corporate patentees (by assignee name) includes some of the best known companies in the world, for both U.S. and Canadian patents (see Tables 3 and 4). GE, IBM, Canon, Toshiba, and Du Pont are among the firms granted the most patents in both countries. Within the top 100 non-individual patentees in the U.S. (available from the authors) there are a few entities that do not qualify as corporations: parts of the federal government or military and a university (MIT). In the Canadian data, a few erroneous top assignees

result from data entry errors[37], along with the Canadian military, National Research Council of Canada, and 4 individuals (Jean-Francois Grollier[38], David T Green[39], Robert C. Berfield[40], and Josef Pedain[41]). Further investigation is being made to determine whether these individuals were working for a corporation at the time of the patent grants or were in fact working in independent research labs.

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

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

[39]Patents on medical technologies.

[40] Vacuum cleaner related patents

[41] Chemical coatings patents.

Table 3

Top Companies by Canadian Patent Applications 1984 - 1993

Company Name	Number of Patents from 1984-1993
GENERAL ELECTRIC COMPANY	243
AMERICAN TELEPHONE AND TELEGRAPH COMPANY	180
SONY CORPORATION	177
MINNESOTA MINING AND MANUFACTURING COMPANY	176
NV PHILIPS GLOEILAMPENFABRIEKEN	173
INTERNATIONAL BUSINESS MACHINES CORPORATION	158
WESTINGHOUSE ELECTRIC CORPORATION	156
SHELL CANADA LIMITED	156
NEC CORPORATION	143
E I DU PONT DE NEMOURS AND COMPANY	140
THE DOW CHEMICAL COMPANY	128
GAMBLE COMPANY	125
CIBA-GEIGY AG	123
HOECHST AKTIENGESELLSCHAFT	123
EASTMAN KODAK COMPANY	106
THEURER JOSEF	105
UNION CARBIDE CORPORATION	97
FOCKE HEINZ	93
EXXON RESEARCH AND ENGINEERING COMPANY	84
EI DU PONT DE NEMOURS AND COMPANY	84
DOW CORNING CORPORATION	79
CO	79
COMPANY	78
RCA CORPORATION	76
GENERAL MOTORS CORPORATION	72
MITSUBISHI DENKI KABUSHIKI KAISHA	71
CANON KABUSHIKI KAISHA	70
SIEMENS AKTIENGESELLSCHAFT	69
GROLLIER JEAN-FRANCOIS	69
UNILEVER PLC	67
AMERICAN CYANAMID COMPANY	67
FUJITSU LIMITED	67
GREEN DAVID T	67
ALLIED CORPORATION	66
DRENT EIT	66
BASF AKTIENGESELLSCHAFT	64

Table 4

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

Company Name	Number of Patents from 1984-1993
Canon Kabushiki Kaisha	9,115
Kabushiki Kaisha Toshiba	8,303
Hitachi Ltd.	7,814
General Electric Company	7,774
International Business Machines Corporation	7,228
Mitsubishi Denki Kabushiki Kaisha	7,172
Eastman Kodak Company	6,406
Fuji Photo Film Co. Ltd.	6,091
Motorola Inc.	5,372
NEC Corporation	4,703
Matsushita Electric Industrial Co. Ltd.	4,661
U.S. Philips Corporation	4,533
Siemens Aktiengesellschaft	4,444
Bayer Aktiengesellschaft	4,057
Sony Corporation	3,955
Xerox Corporation	3,765
E. I. Du Pont de Nemours and Company	3,646
General Motors Corporation	3,625
The Dow Chemical Company	3,515
Fujitsu Limited	3465
Westinghouse Electric Corp.	3403
Minnesota Mining and Manufacturing Company	3339
Texas Instruments Incorporated	3317
Sharp Kabushiki Kaisha	3225
BASF Aktiengesellschaft	3156
Ciba-Geigy Corporation	2978
Mobil Oil Corporation	2686
Hughes Aircraft Company	2677
Hoechst Aktiengesellschaft	2603
Honda Giken Kogyo Kabushiki Kaisha	2586
Robert Bosch GmbH	2564
AT&T Bell Laboratories	2501
Hewlett-Packard Company	2489
Ricoh Company Ltd.	2343
Shell Oil Company	2339
Toyota Jidosha Kabushiki Kaisha	2160

IV
Analysis and Results

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

A. The Rate of Patenting in the US and Canada

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

Figure 1

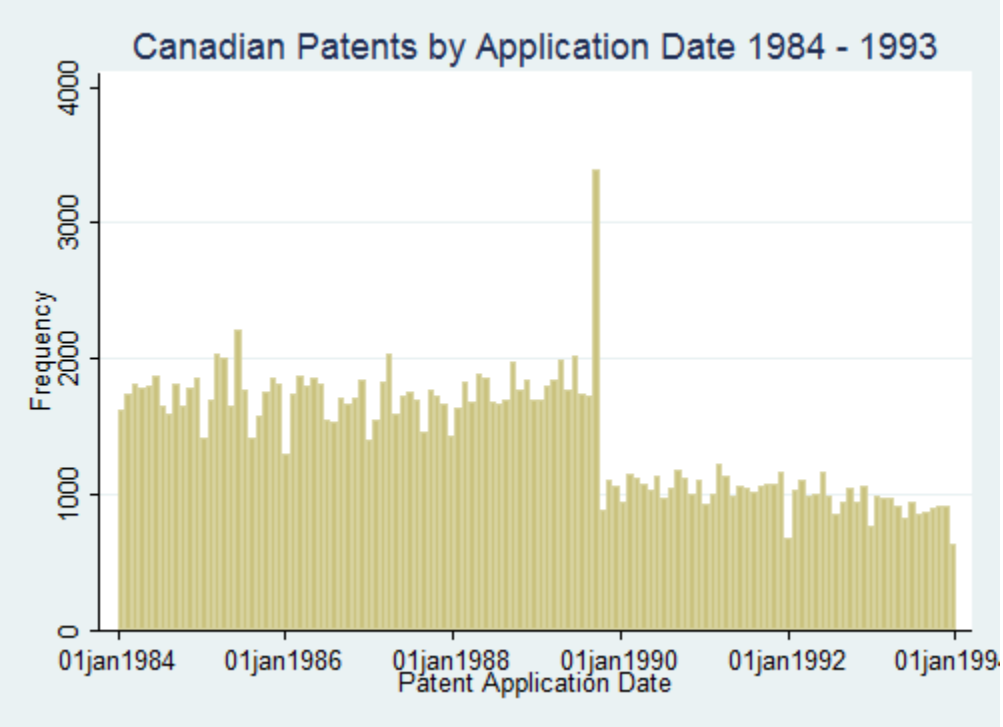
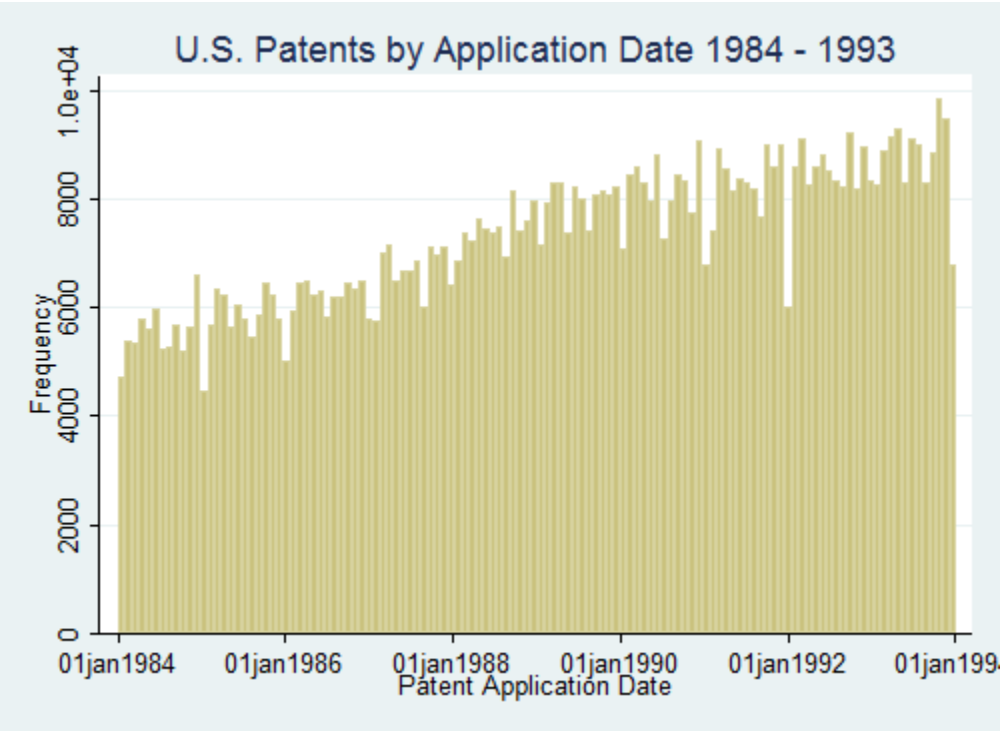


Figure 2



As shown in Figure 1, in Canada, between the beginning of 1984 and mid-1989, the number of subsequently granted applications is relatively stable at around 1700 per month. After a brief spike to 3400 patents in the month immediately before the law change on October 1, 1989, the rate drops to around 1000 per month, which remains stable through 1993. This is in sharp contrast to the pattern in U.S. patents where there is a fairly steady increase in subsequently granted applications from 6000 per month in 1984 to around 9000 in 1993. Below we discuss further the relevance of the large overall drop in applications.[42] For now, we take this as evidence of the

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

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

B. *The Effect of First to File: Individual vs. Corporate Inventors*

The most compelling evidence for the impact of the first-to-file rule on small inventors is a visual difference in difference. The traditional difference–in-difference subtracts of 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 a visual comparison of Figures 3 and 4, which report the representation of individual inventors in the U.S. and Canada. In figure 3 we see a sharp decline in the fraction of individual inventors, from 10.7% prior to the end of 1989 to 7.8% afterward. During the same period in the U.S. the proportion of individual inventors dropped slightly, from 17.4% to 16.5%.

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

Figure 3

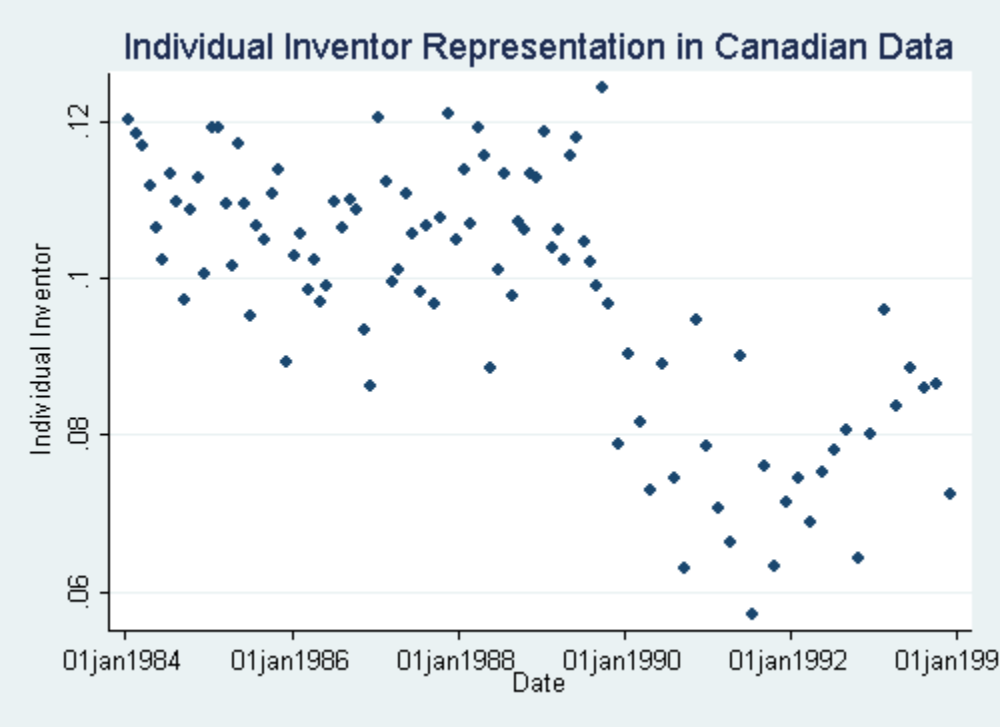
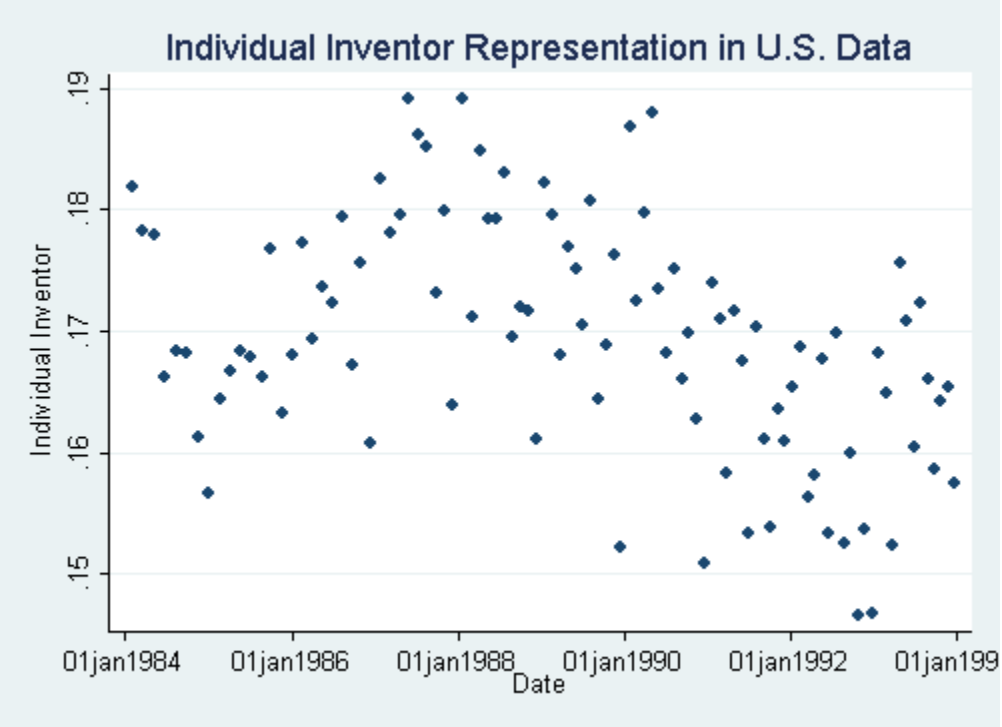


Figure 4



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 fraction of individual inventors following the Canadian law change. This likely represents a long-term increase in the amount of innovation that occurs under corporate auspices.[43] But importantly the magnitude of the decline is over 3 times greater in Canada than in the U.S. This is also relative to a lower baseline share of individual inventors, so in percentage terms, the decline in Canada is almost 30%, compared to about 5% in the U.S. The net effect of the law is reported in the bottom right hand corner of Table 5. The proportion of individual inventors in Canada declined 2.05 percentage points more than the decline in the U.S. following the Canadian law change. This result is statistically significant at well below the 1% level.

Table 5

Difference in Difference: Individual Inventor Representation

	Before	After	After - Before
United States	0.1735	0.1648	-0.0087
	(.00056)**	(.00056)**	(.00079)**
Canada	0.1073	0.0781	-0.0292
	(.00088)**	(.00118)**	(.00156)**
Canada - US	-0.0662	-0.0867	-0.0205
	(.00117)**	(.00168)**	(.00205)**

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

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

[43] Citation.

$$(1) \qquad II_{Ct} = \alpha + \beta C + \gamma * post_t + \delta C * post_t + \epsilon_{Ct}$$[44]

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

The results from estimating this equation by ordinary least squares regression are reported in the first column of Table 6. This result replicates what we have already seen in Table 5, a reduction of about 2.05 percentage points in the fraction of individual inventors after the effective date of the first-to-file rule. The other columns report results from additional regressions. In column 2, rather than the using the effective date to define the before and after periods, we use the date of bill passage, November 19, 1987. The figures indicate that not much occurred around this date, but this specification is included for completeness. Not surprisingly, the coefficient on the interaction term is substantially smaller, although still statistically significant.

Table 6

[44] We could also control for time-varying country characteristics, of which many are potentially relevant. Since we believe the 1989 Canadian law is the major change in this time period, we would not expect these controls to make much difference.

Effect of Priority Rule on Fraction of Individual Inventors

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Base Specification	Date of Passage	Linear time trend	Year dummies	Probit marginal effects	Counts
After	-0.00875	-0.00513	-0.0105	-0.00924	-0.00827	263.0
	(0.000794)**	(0.000856)**	(0.00140)**	(0.00252)**	(0.00075)**	(26.40)**
Canada	-0.0662	-0.0663	-0.0661	-0.0659	-0.0645	-954.4
	(0.00105)**	(0.00129)**	(0.00105)**	(0.00105)**	(0.001)**	(21.89)**
After*Canada	-0.0205	-0.00930	-0.0205	-0.0209	-0.0319	-375.2
	(0.00167)**	(0.00167)**	(0.00167)**	(0.00167)**	(0.00206)**	(26.76)**
Year			0.000374			
			(0.000237)			
Constant	0.174	0.173	-0.569	0.171		1,146
	(0.000561)**	(0.000709)**	(0.471)	(0.00126)**		(21.52)**
Observations	1,066,945	1,066,945	1,066,945	1,066,945	1,066,945	240
R-squared	0.005	0.005	0.005	0.006	0.007	0.964

For columns 1-5, the dependent variable is a dummy that is one for patents granted to individual inventors and zero otherwise; data is at the patent level. Column 6 reports results from data at the month-country level where the dependent variable is the count of patents granted to individuals. Coefficients on year dummies are not reported in column 4. Except for in column 2, After indicates that the patents was applied for subsequent to October 1, 1989, the effective date of the change of Canadian priority rule from first-to-invent to first-to-file. In column 2, the critical date is November 19, 1987, the date of passage. Data is from the USPTO and CIPO from 1984 through 1993. Robust standard errors in parentheses.
* indicates significance at p < 0.05 ** indicates significance at p < 0.01

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

All of the regressions to this point have used a linear probability model. Since the dependent variable is binary, probit may be more appropriate[45], so we run a regression of the form:

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

Column 5 reports the marginal effects from this regression. The magnitude of the coefficient (-.0319) is a bit larger than in the base

[45] 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.

specification, but once again there is a statistically significant negative effect of the law change on individual inventor representation.

In column 6 we report results from a regression of the same form as (1) but where now II_{Ct} is the monthly count of patents granted to individual inventors. The result is consistent with the other specifications: there is a substantial negative impact of the law change on patents granted to individual inventors, yielding 375 fewer of them per month.

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

Variation in Effect by Country of Inventor

	(1)	(2)	(3)
VARIABLES	Canada	U.S.	All other countries
After	0.00120	-0.0122	-0.0124
	(0.00721)	(0.00122)**	(0.000884)**
Canada	0.0177	-0.144	-0.0138
	(0.00730)*	(0.00147)**	(0.00132)**
After*Canada	-0.0522	-0.0134	-0.0244
	(0.0114)**	(0.00235)**	(0.00195)**
Constant	0.364	0.238	0.0913
	(0.00510)**	(0.000872)**	(0.000631)**
Observations	30,749	561,839	474,357
R-squared	0.001	0.017	0.002

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

Each column in the table is a separate regression run only on inventors from the specified country. In all cases, there is a statistically significant decline in individual inventor representation following the Canadian law change. However, as expected, the magnitude of the decline is far larger for Canadian inventors: -.0522, compared to -.0134 for Americans and -.0244 for all others. This should come as no surprise that individual inventors in Canada are most affected by the Canadian law change. The decline in the fraction of individual inventors among other nationalities indicates that Canadian law changes can still have a potential affect among those individuals considering patenting in that country.[46] Together, the empirical results indicate a statistically significant and substantial reduction in patents granted to individual inventors subsequent to the Canadian law change.

C. Limitations and Possible Problems with Our Analysis

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.

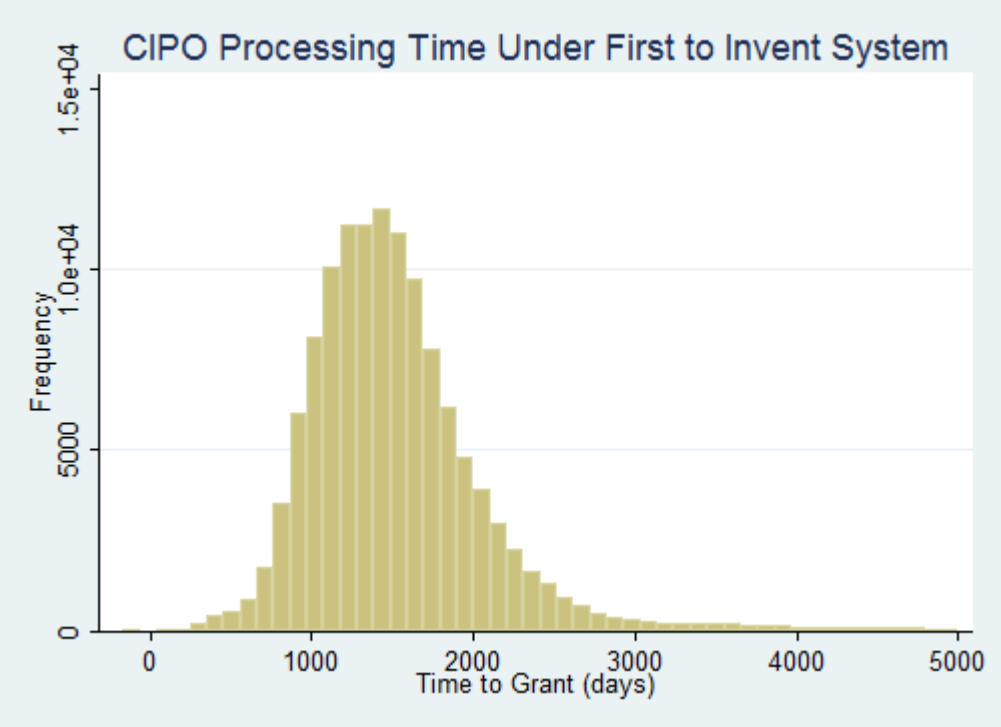
1. The Contemporaneous Patent Term Change

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 17 years from grant date, and became 20 years from application date. This change could potentially impact the fraction of

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

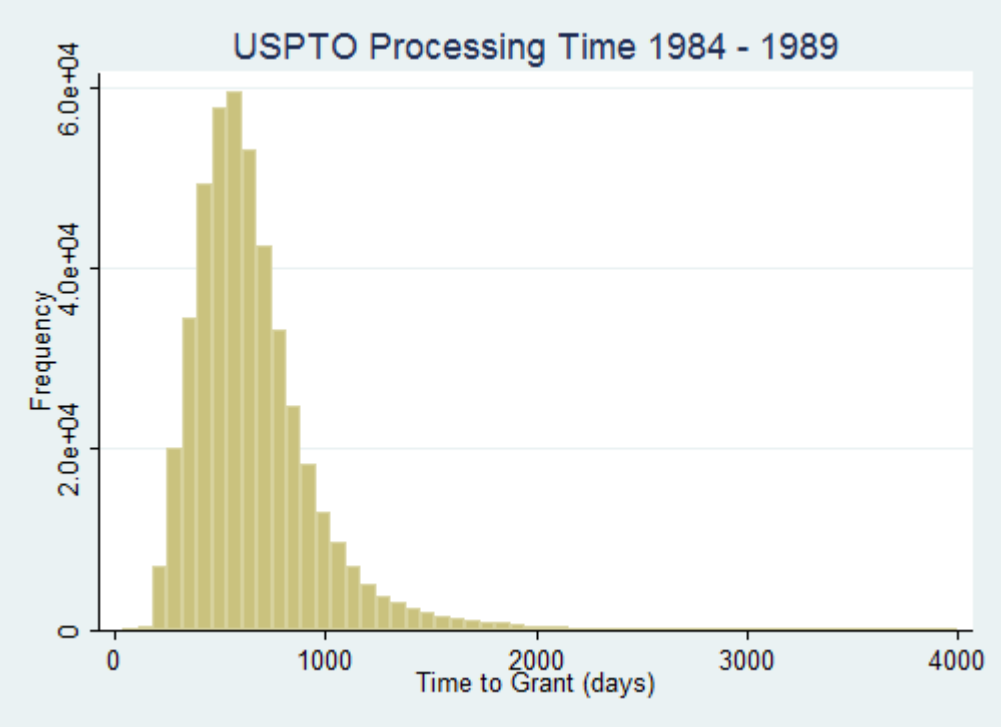
individual inventors granted patents, and therefore explain the results we find, rather than the patent priority system. When the U.S. made the same change in patent term the net effect was an increase in patenting[47], so one might think this could not account for the decline in the rate of individual patenting observed here. But as Figures 5 and 6 make clear, the processing time in Canada is substantially longer than in the U.S. Prior to the Canadian law change the processing time was about 51 months in Canada versus 22 in the U.S. Thus the net effect of the change in patent term is to decrease the effective duration of patent protection and thus decrease the incentive to patent.

Figure 5



[47] See Abrams (2009) UPenn Law Review.

Figure 6



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.[48] 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. There is no a priori reason to expect this correlation, but we plan to investigate it in further work.

[48] See Abrams (2009) for an investigation of this in the U.S. context.

2. The Introduction of Maintenance Fees

As noted in Section II above, one of the legal changes in Canada introduced in 1989 (in the same patent reform bill as the shift to first-to-file) was the introduction of maintenance fees, for both applicants and patent grantees.[49] In general, these fees require applicants (or grantees) to pay annually to maintain their application or their patent rights.[50] 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 patents filed after October 1, 1989 is 3044 days (or about eight years). For individual inventors, this time was shorter, at 2274 days. Under the fee schedule, the maintenance fees would have thus added $500 — or $250 for individual inventors — to the total cost of seeking a patent. However, other fees were reduced at the same time — for example, the "final fee" (due upon grant) dropped from $350 to $150 for small entities, thus almost balancing the impact of the new maintenance fees.[51]

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

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

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

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

[51] [cite fee schedule]

More fundamentally, we think that patent office fees, including maintenance fees, are a relatively small portion of overall patenting costs, which typically averages about $10,000 - $15,000 for a patent of average complexity.[52] (Attorney and agent fees make up the bulk of this cost, though some applications will also incur significant fees if prior art searches are conducted.) 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.[53]

CONCLUSION

The US is currently considering a switch from it's unique (in the world) first-to-invent patent priority system to a first-to-file system, in part to align the US patent law with the rest of the world. In this study, we have attempted to bring the first empirical evidence to bear on a critical policy question related to this change: will a first-to-file system have disproportionate impact on individual inventors and small business? We find, at least on a tentative basis, that the replacement of a very similar first-to-invent system with a first-to-file system in Canada has resulted in a small but significant decline in the number of patents sought by individual inventors. In short, at least some of the critics appear to be correct — the current first-to-invent system in the US is more favorable to individual inventors than the alternative.

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[52] [cites] AIPLA Annual Reports

[53] 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.

We note, however, two important caveats: first, that our conclusions are necessarily tentative in nature; we are seeking additional data and engaging in additional analyses to investigate the nature and cause of this shift in patenting behavior. Second, we do not draw policy conclusions from our results. That is, while it seems that a first-to-file system will disproportionally impact individual inventors, it may well be that the reduction in administrative costs and complexity associated with the change will offset societal losses suffered by the diminishment of individual patentees. Or perhaps the opposite is true: if individual inventors are disproportionally likely to generate socially-valuable inventions, then any legal change which reduces their patenting (and thus almost certainly reduces their marginal incentive to innovate) will be a net los to society. Our study cannot, and does not, answer these questions. What it does, however, is allow the policy debate in the US about the impact of a change to first to file to proceed the benefit of empirical knowledge.