The Leahy-Smith America Invents Act: A Preliminary Examination of Its Impact on Small Businesses

by

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Table of Contents

List of Exhibits

Abbreviations

AIA	Leahy-Smith America Invents Act
AE	Accelerated Examination
CAR	cumulative abnormal return
DiD	difference-in-differences
DiDD	difference-in-differences-in-differences
FITF	first-inventor-to-file
FTI	first-to-invent
FTF	first-to-file
IPR	*inter partes* review
NAICS	North American industrial classification system
NPE	non-practicing entity
PAE	patent assertion entity
PGR	post-grant review
PTMT	Patent Technology Monitoring Team
SIC	standard industrial classification
SNQ	substantial new question [of patentability]
USPC	U.S. Patent Classification System
USPTO	U.S. Patent and Trademark Office
VC	venture capital

1. Executive Summary

The Leahy-Smith America Invents Act of 2011 (AIA) was enacted into law on Sept. 16, 2011. Section 3 of the AIA amended U.S. patent law by changing the "first-to-invent" (FTI) system to a "first-inventor-to-file" (FITF) system, arguably the most substantive change in U.S. patent law since the Patent Act of 1952. Cognizant of the potential economic effects of this change, Congress mandated in AIA that the Small Business Administration (SBA) conduct a study of the impact of the law on small businesses in the United States. The Bella Research Group was awarded a contract by the SBA Office of Advocacy to carry out this important work.

To understand these small business impacts, we proceed in four parts: a literature review and three empirical studies.

The literature review shows no clear consensus with regard to the law's impact on small businesses. Many experts articulated the promise of the AIA to improve the patenting prospects of small businesses, while others criticized the law as a barrier to small business innovation. The debate among experts is inconclusive for four reasons:

- The law is complex in nature, and its various reforms will likely have different impacts on small businesses.
- The language of certain provisions is ambiguous and leaves the magnitude of the consequences of the reforms uncertain until courts clarify the interpretation.
- Achievement of the goals established in the law is still uncertain.
- Certain provisions may improve the innovative capabilities of small businesses in certain industries while impeding or not affecting them in other industries, especially given inter-industry differences in patenting behavior in the pre-AIA patent system.

We next empirically explore the impact that the AIA has had and/or is expected to have on small businesses. The empirical analyses, however, are complicated by a number of factors:

- Only a small amount of data exists for patent activity under the FITF rules since (a) the FITF provision became effective on March 16, 2013 and (b) there was still, at that point,

a major backlog of patents under the old system because the patenting process — from application to issue/abandonment — took close to 2.5 years for fiscal year 2013.[1]

- The complexity of the law has led to varying interpretations from small businesses and small business investors, which has likely been reflected in varying responses.
- There are many provisions in the law whose effects on specific industries may be masked when looking at the small business community as a whole.
- Macroeconomic trends unrelated to the AIA may obscure the changes that can be fully attributed to the AIA.[2]
- Our empirical analyses employ various definitions of small businesses given the nature of the study and its respective data limitations.

Given the variety of empirical challenges identified above, we approach this analysis from three different perspectives: a study of public market response around key dates related to the enactment of the AIA; a study of the venture capital response to the enactment of the law; and a study of patenting activity among small inventors in Canada around a similar shift in patent law. We do not find consistent results among our studies, which are described in more detail below.

Public Company Event Study

One area in which the impact of the AIA might appear would be in the market prices of publicly traded firms. If investors expected that the AIA would benefit smaller, patent-intensive companies, they might value these firms more highly as the AIA moved through its approval process. Similarly, if investors believed the opposite, the prices of these public stocks would fall. To test this theory, we study the response of the public markets to smaller and larger public patent-intensive firms around key dates related to the enactment of the AIA. Among our sample of companies with at least 40 patents in the 2010 calendar year (the year prior to enactment) that were traded on a U.S. exchange, we find negligible differences in the impacts on smaller versus larger firms. We note, however, that this study is hindered by a number of conceptual and data limitations. In particular, we find that (a) publicly traded firms may not exhibit the types of financial constraints encountered by small private firms

[1] U.S. Patent and Trademark Office (USPTO), "Performance and Accountability Report Fiscal Year 2013," p. 76.
[2] See Appendix 2 (Section 8.2) for a review of one such technique that we employ (difference-in-differences regressions).

and thus may be less affected by the law, (b) few patent-intensive public firms meet standard criteria to qualify as a small business (e.g., having fewer than 500 employees), and (c) the market may not have correctly anticipated the law's impact or the effect may have been masked by contemporaneous changes in the economic environment. Given the severity of these constraints, our finding of no differences in market reactions of smaller and larger firms to the enactment of the law must be interpreted with caution.

Venture Capital Financing Study

Another possible area of impact could be the availability of venture capital financing to patent-intensive companies. If small, high-potential, patent-intensive companies received more financing, we might suppose that venture capitalists expect the AIA to benefit these firms; likewise if the impacts were reversed, we might suppose that they expect the opposite. To explore this dynamic, we compare changes in the financing of patent-intensive and patent-light sectors around the enactment of AIA in the United States, and contrast them to similar patterns in Europe. A shift in the proportion of deals or equity invested in patent-intensive industries in the United States relative to Europe from before to after the AIA would, all else equal, signal a response to the AIA from the private capital market. Among our sample of almost 14,000 U.S. and European deals, we find minimal movements in the proportion of VC financing going to patent-intensive (and patent-light) industries in the United States, when compared to Europe. We do find some evidence, however, that the proportion of seed and early stage VC deals going to the firms of the highest patent intensity level increased post-enactment for the United States compared to Europe. Although the analysis cannot control for all variables that might affect VC activity, the study suggests that venture capitalists did not significantly shift their investment activity after the enactment of the AIA.

Canadian First-to-File Study

Canada's 1989 change in patent law from FTI to first-to-file (FTF) serves as a fitting "case study" for the AIA because of Canada's numerous similarities with the United States, including close geographic proximity, a similar initial patent system, and a relatively common innovative environment. We study the impact of Canada's change on patent activity and patent quality in smaller versus larger patentees in Canada and the United Kingdom (as a

control). We find that larger Canadian firms experienced a statistically significant increase in patenting activity compared to smaller firms, relative to the pattern in the United Kingdom. We also find no evidence that the relative quality of patents filed by smaller patentees improved, which would reflect a change in the propensity to patent rather than a change in the number of innovations produced. While we cannot control for all variables that might affect patent activity, the results are generally robust to a variety of controls and checks.

The heterogeneity of opinion found in our literature review and the inconsistent results of our empirical analyses suggest that it is premature to conclude the AIA will have either a positive or a negative net impact on small businesses.

Given the uncertainty surrounding the act, we suggest three new projects that could shed a brighter light on its impact on small businesses. First, a series of interviews with independent Canadian VC fund managers that operated both before and after the Canadian switch to first-to-file could help predict the future response of U.S. VC fund managers. For an improved empirical perspective on the U.S. VC environment post-AIA, an update to our study on VC financing in the United States in three to five years could account for a potential lag in the response from the U.S. VC community. Finally, using the same methodology as our study on the impact of the Canadian switch to a FTF patent system, a study looking at the changes in patenting activity of small and large U.S. businesses could be conducted in roughly five years.

2. Introduction[3]

On Sept. 16, 2011, President Barack Obama signed into law the Leahy-Smith America Invents Act, the first major overhaul of the U.S. patent system since the U.S. Patent Act of 1952. The act — which most notably shifted priority in the granting of patents from "first-to-invent" (FTI) to "first-inventor-to-file" (FITF) — marked a major shift in priority rules. Under an FTI system, patents are granted to the original inventor.[4] In other words, if two inventors claimed the same invention, the patent would be granted, generally speaking, based on the earlier date of invention. In contrast, an FITF system generally establishes priority among true inventors based on the effective filing date[5] of the patent application, with the exception of when certain disclosures are made within a year of this date, which we discuss in more detail in Section 4 of this report.

At the heart of the switch to first-inventor-to-file was an effort to align the U.S. patent law with that of the rest of the world. The motivation is explicitly outlined in the AIA under Sec. 3(p):

> It is the sense of the Congress that converting the United States patent system from "first to invent" to a system of "first inventor to file" will…promote harmonization of the United States patent system with the patent systems commonly used in nearly all other countries throughout the world with whom the United States conducts trade and thereby promote greater international uniformity and certainty in the procedures used for securing the exclusive rights of inventors to their discoveries.[6]

[3] We thank Steve Dew and James Tighe for their helpful comments; and Chris Allen, Felix Serlin, and Christine Rivera for research assistance. We also thank Jonathan Porat, Dr. Winslow Sargeant, Dr. Christine Kymn, and the other staff members of the SBA Office of Advocacy for their thoughtful feedback.

[4] While the Patent Act of 1790 stated that patents would be repealed if the patentee was shown to not be the "first and true" inventor, we can more clearly see the first-to-invent system in the Patent Acts of 1836 and 1870. For example, Sec. 42 of the latter law states: "…whenever an application is made for a patent which, in the opinion of the commissioner, would interfere with any pending application, or with any unexpired patent, he shall give notice thereof to the applicants, or applicant and patentee, as the case may be, and shall direct the primary examiner to proceed to determine the question of priority of invention. And the commissioner may issue a patent to the party who shall be adjudged the prior inventor." The full text of the Patent Act of 1790 can be found in P.J. Federico, "Operation of the Patent Act of 1790," *Journal of the Patent Office Society* XIV, no. 4, April 1932. For the full text of the Patent Act of 1870, see http://ipmall.info/hosted_resources/lipa/patents/Patent_Act_of_1870.pdf, accessed April 14, 2015.

[5] The "effective filing date" is defined as the earlier of the actual filing date of the patent or application containing a claim to the invention; or the filing date of the earliest application for which the patent or application is entitled to a right of foreign priority or domestic benefit as to such claimed invention. See http://www.piug.org/resources/documents/an/AIA_workshop_USPTO_PIUG_AN2013.pdf.

[6] Leahy-Smith America Invents Act of 2011, Pub. L. No. 112-29, sec. 3(p), 125 Stat. 293, 2011.

In addition, proponents noted that the law's many reforms would also streamline the waiting time and combat the current patent backlog, reduce litigation, and improve patent quality.[7]

The AIA could, however, fundamentally skew the innovation environment in the United States away from small businesses. Despite assurances that the AIA would "…help startups and small business owners turn their ideas into products three times faster…[and] give entrepreneurs the protection … they need to attract investment and grow their businesses,"[8] many opponents have argued that the AIA implicitly favors larger corporations at the expense of small businesses. Lending support to such opponents, separate empirical studies from professors at McGill University in 2009 and the University of Pennsylvania in 2013 both suggested that a very similar patent change that became effective in Canada in 1989 had an adverse effect on smaller inventors.[9]

At the most basic level, critics argued that the patent system put in place by AIA pits the well-funded multinational corporation against the resource-constrained startup in a clearly unfair race to the U.S. Patent and Trademark Office (USPTO). In fact, the Small Business Coalition on Patent Legislation, a group of organizations representing small businesses, contended in 2009 that the legal shift toward FITF was being "advanced mostly by large firms, who…seized the agenda due to their growing dominance of the U.S. patent system."[10] Not only would an FITF model "shift costs and uncertainty risks from large firms to small patenting firms," the law's arguably weakened grace period protection seemed to come at the expense of the smaller, weaker competitors who rely on external funding.[11]

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[7] The White House, "President Obama Signs America Invents Act, Overhauling the Patent System to Stimulate Economic Growth, and Announces New Steps to Help Entrepreneurs Create Jobs," Sept. 16, 2011.
[8] Diane Bartz, "Obama Signs Patent Bill, Sees Boost for Innovators," Reuters, Sept. 16, 2011.
[9] 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 14926*, April 2009; and David S. Abrams and R. Polk Wagner, "Poisoning the Next Apple? The America Invents Act and Individual Inventors," *Stanford Law Review* 65, no. 3, 2013.
[10] The Small Business Coalition on Patent Legislation includes representatives from CONNECT, the National Small Business Association, IP Advocate, The American Innovators for Patent Reform, the National Association of Patent Practitioners, and The Professional Inventors Alliance USA, and the United Inventors Association. See Small Business Coalition on Patent Legislation, "Patent Reform Act of 2009: Summary of Positions, 2009, p. 4.
[11] The Small Business Coalition, "Summary of Positions," p. 2. For similar positions, see Todd McCracken, "Patent Reform Bill Hurts Small Business," *Patents in the 21st Century*, Westlaw Journal Expert Commentary Series, *Thomson Reuters*, 2012, pp. 35-36. See also, David Boundy, "Why the America Invents Act is Bad for Entrepreneurs, Startups and for America," *Patents in the 21st Century*, pp. 38-41.

Small businesses play an integral part in the aggregate well-being of the United States. Given the AIA's potential to diminish the innovative capacity of small businesses, it is important to examine the effects of prioritizing filing dates in determining whether a true inventor is entitled to a patent under Title 35, U.S. Code, in addition to the impact of the additional reforms in the act.

To study the AIA's past and potential effects on small businesses, we undertake both qualitative and empirical analyses. We first synthesize the literature related to the AIA. This literature review draws from reports, academic journal articles, *Federal Register* documents, Congressional hearings, patent law blogs, press releases, and USPTO training materials. We also undertake three empirical studies, described below, to examine the impact of the AIA on small businesses.

First, we explore the public market reaction to the AIA around key dates related to its enactment. In this study, we collect data from companies with at least 40 patents in the 2010 calendar year (the year prior to enactment) that traded on a U.S. exchange, and measure abnormal returns around the selected dates. We interpret these results cautiously, however, given that (a) publicly traded firms may not exhibit the types of financial constraints encountered by small private firms and thus may be less affected by the law, (b) few patent-intensive public firms meet the more traditional definitions of small businesses (fewer than 500 employees), and (c) the market may not have correctly anticipated the law's impact or the effect may have been masked by contemporaneous changes in economic environment.

Second, we study the venture capital market's response to the financing of patent-intensive and patent-light sectors around the enactment of the AIA in the United States and Europe (as a control), to capture how financing availability changed for certain high-potential small firms. A shift in the proportion of deals or equity invested in patent-intensive industries in the United States relative to Europe from before to after the AIA would, all else equal, signal a response to the AIA from the private capital market. Although the analysis cannot control for all variables that might affect the allocation of VC activity, we conclude that if the AIA were to be "game changing" for small businesses, we would see some type of sustained shift in U.S. financing relative to Europe.

Finally, we study the patenting activity and patent quality of small and large firms around a law change similar to the AIA that became effective in Canada in 1989. Canada's change in patent law serves as a fitting "case study" for the AIA because of Canada's numerous similarities with the United States, including close geographic proximity, a similar patent system prior to its switch to first to file, and a relatively common innovative environment. We collect data on over 7,000 firms and test whether Canadian small patentees experienced a statistically significant change in patenting activity, compared to large patentees, relative to the United Kingdom (as a control). We also test for differences between larger and smaller firms in citations per patent received after the reform in Canada relative to the United Kingdom. While the Canadian shift included some provisions not contained in the AIA and we cannot control for all variables that might affect patent activity, our analysis could provide evidence to support whether firm size mattered with respect to the benefits or disadvantages of the reform.

Our studies each have a number of limitations and conclusions are preliminary. A few key challenges are identified below.

- Limited patent data under the new regime: Because the final section of the AIA only became operational in March 2013, the large majority of issued patents to date (Sept. 2014) had been filed under the old patent regime. Without reliable data on granted patents and patent quality (from patent citations, for example), patent application data becomes hard to interpret. For example, decreased patent activity from small firms relative to large firms could be a signal of greater selectivity in patent decisions (i.e., higher quality patents) or diminished patenting abilities. On the other hand, increased patent activity from small firms relative to large firms could signal lower selectivity in patent decisions (i.e., lower quality patents) or improved patenting abilities.
- Uncertainty surrounding the law: The complexity of the law still leaves uncertainty regarding the eventual interpretation of certain provisions in federal court. This lack of clarity not only impairs our ability to examine the law's theoretical impact, but also complicates "market responses," as small businesses and small business investors likely had varying reactions to the law based on their own interpretations.
- Scope of the law: There are many provisions in the law — priority rules, joinder rules, prior use rules, and prioritized examination procedures, to name a few — whose effects

on specific industries may be masked when looking at the small business community as a whole.

- "Attribution" difficulty: Since patenting and innovative activity reflect the impact of many macroeconomic variables, it is extremely difficult to define with high precision the changes which can be fully attributed to the AIA. It is important to note, however, that in each study we employ various methods in an attempt to overcome this barrier.
- Our empirical analyses employ various definitions of small businesses given the nature of the study and its respective data limitations. Our event study is unable to look directly at small businesses, but instead considers differential market reactions among patent intensive publicly traded companies along the spectrum of employee counts and market capitalizations. Our VC study proxies for small businesses given that VC firms generally target the startup community. Finally, our study of the Canadian shift to FTF looks at firm size by number of successful patent applications prior to the reform.

Given these challenges, we emphasize that no definitive conclusions on the effects of the law can be made at the time of this report. The remainder of the paper is organized as follows: Section 3 briefly establishes the importance of patents to small businesses; Section 4 gives an overview of the AIA and explains the impact that each key provision has had or may have on small businesses; Section 5 presents four hypotheses; and Section 6 contains our three empirical studies. In each study we explain our methodology, data limitations, results, and key conclusions. In Section 7, we present our final conclusions drawn from our collective analyses and offer recommendations for future research.

We also include four Appendices. Appendix 1 gives further background information and analysis for the event study. Appendix 2 explains our difference-in-differences methodology used in this report for the latter two studies. Appendices 3 and 4 respectively add further detail to both of these empirical analyses.

3. Setting the Context: The Importance of Patents to Small Business Innovation

Innovation is essential to the continued growth of an economy. The patent system plays a critical role in protecting and incentivizing innovation. The rationale behind the patent system is twofold: (1) to stimulate invention through the granting of intellectual property rights and (2) to diffuse technological knowledge to the public.[12]

Addressing the first purpose, the patent system creates an environment in which innovators are protected and encouraged to develop new technologies and turn them into commercially viable products. Without these protections, developers of a new technology could invest heavily in R&D, only to have competitors replicate the innovation and reap the monetary rewards without having incurred any of the related costs.[13] This system would create a clear disincentive to allocate significant resources to innovation, because the costs would more often outweigh the potentially limited financial returns. This concept is especially relevant to many critical, research-intensive industries like pharmaceuticals, in which the costs of developing a new drug can be astronomical.[14]

The patent system's second, related purpose is to provide a vehicle through which inventors can publicly disclose discoveries[15] while protecting their innovations. Without this protection,

[12] For an overview of the rationale behind the patent system and empirical evidence of its effectiveness, see Bronwyn H. Hall and Dietmar Harhoff, "Recent Research on the Economics of Patents," *Annual Review of Economics* 4, 2012. On page 542, the authors noted, "…when the government grants a patent, it trades off short-term exclusion (monopoly) rights to the use of an invention in return for two things: *(a)* an incentive to create the invention in the first place and *(b)* early publication of the invention rather than the use of secrecy to protect its misappropriation."

[13] This motivation is spoken of extensively in Graham et al., "Results of the 2008 Berkeley Patent Survey."

[14] Pharmaceutical Research and Manufacturers of America, "2013 Biopharmaceutical Research Industry Profile," PhRMA, July 2013. The average cost to develop a drug in the early 2000s, including the cost of failures, was $1.2 billion. The importance of patents for pharmaceuticals is also explored in Henry Grabowski, "Patents, Innovation and Access to New Pharmaceuticals," *Journal of International Economic Law* 5, no. 4, 2002.

[15] Section 2 of the 1790 Patent Law states: "…That the grantee or grantees of each patent shall…deliver to the Secretary of State a specification in writing, containing a description, accompanied with drafts or models, and explanations and models (if the nature of the invention or discovery will admit of a model) of the thing or things…[The] specification shall be so particular, and said models so exact, as not only to distinguish the invention or discovery from other things before known and used, but also to enable a workman or other person skilled in the art or manufacture…to make, construct, or use the same, to the end that the public may have the full benefit thereof, after the expiration of the patent term." Federico, "Patent Act of 1790," pp. 250-51.

inventors might hide new technologies, thus diminishing the innovative capacity within a society and slowing the pace of further innovation.[16]

For startups in many industries, having a patent is vital in the procurement of venture capital (VC). This point is explicitly noted in the 2008 Berkeley Patent Survey. The survey used a sample of early stage technology companies in the biotechnology, medical device, software, and hardware/IT sectors. It found that over 90 percent of the biotechnology, medical device, and IT hardware startups with VC backing either held patents or had applied for them, while patenting was less important for software companies (See Exhibit 1).

Exhibit 1: Prevalence of Patents in VC-backed Startups

	All VC-Backed Companies	VC-Backed Companies by Industry			
		Biotech	Medical Device	Software/ Internet	IT Hardware
Share of companies holding patents or applications	82%	97%	94%	67%	91%
Average number of patents or applications held by all companies	18.7	34.6	25.2	5.9	27.4
Average number filed by companies with patents	15.8	22.9	16.1	7.1	23.6

Source: Stuart J.H. Graham et al., "High Technology Entrepreneurs and the Patent System: Results of the 2008 Berkeley Patent Survey," *Berkeley Technology Law Journal* 24, no. 4, 2010, p. 1277 (Table 1).

In line with these statistics, the authors found that the procurement of investment capital was the second leading motivation among all startups in the survey for filing patents (behind protection from copying).[17]

A few academic papers that study the connection between VC and patents generally found that patents helped attract VC funding. One of the major themes that emerged from this literature was the role of patents in reducing information asymmetries between startups and external financers,

[16] For a review of "the disclosure debate" and research on the cost savings to follow-on inventors as a result of disclosures from patent literature, see Alfonso Gambardella, Dietmar Harhoff, and Sadao Nagaoka, "The Social Value of Patent Disclosure," unpublished manuscript, LMU Munich, as cited in Hall and Harhoff, "Recent Research," p. 550. Gambardella et al. found in a cross-country survey of over 22,000 inventors that time savings from disclosures follow a highly skewed distribution, with chemicals and pharmaceuticals being particularly important. A theoretical model that supports the disclosure effects of patents can be found in Vincenzo Denicolò and Luigi Alberto Franzoni, "The Contract Theory of Patents," *International Review of Law and Economics* 23, 2004.
[17] Graham et al., "Results of the 2008 Berkeley Patent Survey," p. 1299.

both from the information in the patents themselves and by "signaling" quality and/or credibility.[18] When the patent system functions as intended, worthy entrepreneurs receive quality patents quickly and can use them to help finance a new business, contributing to economic growth and job creation.[19] If the patent system is unhealthy, an entrepreneur may have to wait many years for a patent, potentially delaying the procurement of VC.[20] Such a delay in fast-paced technology markets may render the innovation obsolete by the time a patent is awarded.

The strength and reliability of patents is particularly important to small businesses. Larger firms tend to have more resources with which to litigate patent infringement. If the quality of issued patents diminishes, enforcement of such patents can lead to complicated litigation. Large firms will be well-positioned to defend their patents effectively, while small businesses will struggle to finance effective legal representation. If more patents are invalidated in court, the assurance that comes with possession of a patent is eroded, and its value to small business and society decreases.[21]

[18] For relevant discussions, see Dirk Engel and Max Keilbach, "Firm-Level Implications of Early Stage Venture Capital Investment – An Empirical Investigation," *Journal of Empirical Finance* 14, 2007; Carolin Häussler, Dietmar Harhoff, and Elisabeth Müller, "To Be Financed or Not … - The Role of Patents for Venture Capital-Financing," *Centre for European Economic Research Discussion Paper No. 09-003*, 2012; Jerry X. Cao and Po-Hsuan Hsu, "The Informational Role of Patents in Venture Capital Financing," 2011.

[19] The connections between small/young businesses and job growth are studied in John Haltiwanger, Ron S. Jarmin, and Javier Miranda, "Who Creates Jobs? Small Versus Large Versus Young," *The Review of Economics and Statistics* 95, No. 2, May 2013. For a literature review of the subject matter and cross-country evidence that young firms contribute positively to aggregate job creation, see Chiara Criscuolo, Peter N. Gal, and Carlo Menon, "The Dynamics of Employment Growth: New Evidence from 18 Countries," *OECD Science, Technology and Industry Policy Papers No. 14*, May 21, 2014.

[20] For evidence of how venture capital can add value to small businesses, see Thomas Hellmann and Manju Puri, "Venture Capital and the Professionalization of Start-Up Firms: Empirical Evidence," *The Journal of Finance* 57, No. 1, February 2002. The authors argue that VCs helped professionalize startups beyond what traditional financial intermediation theory would suggest. In addition, VC-backed IPO firms are shown to have superior governance practices than their non-VC-backed counterparts. See Yael V. Hochberg, "Venture Capital and Corporate Governance in the Newly Public Firm," *Review of Finance* 16, 2012.

[21] The impact of costly litigation on small firms is discussed in Josh Lerner, "Patenting in the Shadow of Competitors," *Journal of Law and Economics* 38, October 1995. In addition, research suggests smaller firms pay higher legal costs due to "higher financing costs and higher reliance on external legal counsel." See Jean O. Lanjouw and Josh Lerner, "Preliminary Injunctive Relief: Theory and Evidence from Patent Litigation," *NBER Working Paper 5689*, July 1996, as cited in Jean O. Lanjouw and Mark Schankerman, "Characteristics of Patent Litigation: A Window on Competition," *The RAND Journal of Economics* 32, no. 1, Spring 2001, p. 132.

4. An Overview of the America Invents Act and its Impact on Small Businesses

The AIA's headline provision was a shift in priority rights from FTI to FITF. In addition, the law revised reexamination procedures, disclosure protections, fees/incentives, litigation defenses, and application requirements. Below we summarize the AIA's major provisions and conduct a literature review of their potential impacts on small businesses. This literature review draws from reports, academic journal articles, *Federal Register* documents, Congressional hearings, patent law blogs, press releases, and USPTO training materials. For certain provisions we include the text of the law to help illuminate key reforms made by the AIA.

4.1. Patent Priority Rights and Prior Art/Grace Period: A Shift From FTI to FITF

4.1.1. Overview of Provisions

The AIA's headline reform is the switch in how priority rights are determined when multiple inventors file applications claiming the same invention. Under pre-AIA law, the United States granted priority, generally speaking, to the "first and true" inventor; that is, the original creator of the invention. In case of a dispute, the USPTO would engage in a notoriously expensive, technical, and time-consuming "interference proceeding" to establish priority of "inventorship."[22] The interference proceeding determined priority among competing inventors with "the same or substantially the same" technologies when inventors had pending applications for the same invention, or when one inventor had a pending application while another had held the disputed patent for less than one year prior to the filing date of the pending application.

By contrast, the AIA's FITF system generally uses the earliest filing date[23] as the basis of patent grants, which brings the United States closer to conformity with the priority rules in the rest of

[22] For a concise overview of interference proceedings (pre-AIA), see Herbert D. Hart III, "An Interference: What, When, and How Much Does it Cost?," Presented at the 22nd Annual Intellectual Property Law Conference, April 2007. The median litigation cost of a two-party interference proceeding according to the AIPLA Report of the Economic Survey (2013) was $463,000 in 2009, $338,000 in 2011, and $300,000 in 2013 (p. 36). For some of the nuances of interference proceedings, see Mark A. Lemley and Colleen V. Chien, "Are the U.S. Patent Priority Rules Really Necessary?," *Hastings Law Journal* 54, July 2003.

[23] As noted previously, the "effective filing date" is the earlier of: The "effective filing date" is defined as the earlier of the actual filing date of the patent or application containing a claim to the invention; or the filing date of the earliest application for which the patent or application is entitled to a right of foreign priority or domestic benefit as

the world. There are, however, important exceptions to this general rule that distinguish the U.S. system from the pure FTF regime, similar to that used in Europe and elsewhere.

Among the important changes in the AIA that are directly connected with the FITF system, interference proceedings have been replaced with "derivation proceedings." Rather than attempting to discover the *first* inventor, the derivation proceedings discern whether the first person to file an application is indeed *a true* inventor (i.e., did not derive the invention from another).[24]

The AIA *broadened* provisions pertaining to what constitutes "prior art," or information pertaining to an invention that has been disclosed before the date of filing and which may invalidate a patent. Whereas pre-AIA, prior art pertained globally to printed publications, but only domestically to public use or sales activity,[25] the AIA eliminates geographic limits, so all the prior art categories (e.g., printed publication, public use, and sales activity) extend to events regardless of where they occurred.[26]

In addition, the AIA also (arguably) expanded the scope of content that *counts* as prior art. Pre-AIA, prior art consisted of information about the invention in a printed publication, or public use/sale activity of the invention itself. Post-AIA, however, an invention that was in a "printed publication, or in public use, on sale, *or otherwise available to the public*" would be un-patentable. The practical implications of what activity falls under the "otherwise available to the public" clause are uncertain.[27]

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to such claimed invention. See, http://www.piug.org/resources/documents/an/AIA_workshop_USPTO_PIUG_AN2013.pdf.

[24] House Committee on the Budget report consenting to H.R. 1249, June 1, 2011, p. 42. For further description of derivation proceedings, including their rationale, see *Federal Register* 77, no. 28, Feb. 10, 2012, p. 7029.

[25] For a technical description, see pre-AIA 35 U.S.C. § 102(b), from http://www.uspto.gov/web/offices/pac/mpep/s2133.html, accessed Nov. 29, 2014.

[26] 35 U.S.C. § 102(a)(1). This change is also described in Robert P. Merges, "Priority and Novelty Under the AIA," *Berkeley Technology Law Journal* 27, 2012, p. 1027.

[27] Ammon Lesher, "The New Grace Period Under the America Invents Act," in *Patents in the 21st Century*, Westlaw Journal Expert Commentary Series, *Thomson Reuters*, 2012, pp. 11-12. The interpretation of this phrase is also discussed extensively in Melissa Cerro, "Navigating a Post America Invents Act World: How the Leahy-Smith America Invents Act Supports Small Businesses," *Journal of the National Association of Administrative Law Judiciary* 34, no. 1, May 15, 2014.

The AIA strays from a pure FTF system by retaining a grace period — a one-year period before the filing date during which certain prior art claims are restricted. The AIA grace period, however, is arguably weaker than in the past. Pre-AIA, the grace period fully protected the applicant from patent-invalidating third-party disclosures of prior art made anytime during the year preceding the filing date as long as the applicant could produce evidence of an earlier invention date using a procedure known as "swearing behind a reference."[28] Post-AIA, third-party disclosures constitute prior art unless the inventors previously publically disclosed the invention.[29] We also note that inventors can no longer "swear behind" the invention by establishing an earlier invention date, since third-party disclosures prior to the effective filing date constitute prior art unless they were *derived* from the inventor,[30] which can oftentimes be extremely difficult to prove. Again, the practical implications of differences in grace period under a FITF regime are still to be determined.

Exhibit 2 compares the text of the pre-AIA and AIA patent codes to highlight the aforementioned changes.

[28] USPTO, "Swearing Behind a Reference," in *Manual for Patent Examining Procedure,* Ninth Edition, Chapter 715, March 2014, from http://www.uspto.gov/web/offices/pac/mpep/s715.html#sect715, accessed Nov. 29, 2014.
[29] Merges, "Priority and Novelty," pp. 1031-32.
[30] Peter Schechter et al., "Grace Period for Patents," International Association for the Protection of Intellectual Property (AIPPI) U.S. National Group, May 15, 2013, from https://www.aippi.org/download/commitees/233/GR233usa.pdf, accessed Nov. 29, 2014.

Exhibit 2: Key Sections of the AIA Relating to Changes in Priority Rights, Prior Art, and Grace Period

Pre-AIA	Post-AIA
Priority Rules and Prior Art	
Pre-AIA 35 U.S.C. 102(a): A person shall be entitled to a patent unless – (a) the invention was known or used by others *in this country*, or patented or described in a printed publication in this or a foreign country, *before the invention* thereof by the applicant for a patent. [italics added for emphasis]	**AIA 35 U.S.C. 102(a)(1):** A person shall be entitled to a patent unless – (a)(1) the claimed invention was patented, described in a printed publication, or in public use, on sale, or *otherwise available to the public before the effective filing* date of the claimed invention. [italics added for emphasis]
Grace Period	
Pre-AIA U.S.C. 102(b): A person shall be entitled to a patent unless — (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States.	**AIA U.S.C. 102(b)(1)(B):** (1) DISCLOSURES MADE 1 YEAR OR LESS BEFORE THE EFFECTIVE FILING DATE OF THE CLAIMED INVENTION.—A disclosure made 1 year or less before the effective filing date of a claimed invention shall not be prior art to the claimed invention under subsection (a)(1) if— o (B) the subject matter disclosed had, before such disclosure, been publicly disclosed by the inventor or a joint inventor or another who obtained the subject matter disclosed directly or indirectly from the inventor or a joint inventor.

4.1.2. The Potential Impact of the Priority Shift on Small Businesses

Priority disputes and a weakened grace period

A major concern of critics of the FITF system is that it pits small, resource-constrained businesses against their larger counterparts, which possess in-house attorneys, ample cash, and possibly experience in dealing with early patent applications from operations abroad. These circumstances may doom small firms in the "race to the patent office" to be the first to file. As noted by some scholars, a firm with more resources, such as readily available access to patent lawyers, can file applications at a much quicker rate than a startup with limited resources to navigate the patenting process.[31]

This "race" to the USPTO extends beyond questions of novelty and into the realm of obviousness. In simpler terms, even if differences do exist between the earlier-filed Invention A

[31] See, for example, Jason Rantanen and Lee Petherbridge, "The America Invents Act Jeopardizes American Innovation," in "Debate: America Invents, More or Less?," *University of Pennsylvania Law Review* 160, 2012, p. 232.

and later-filed but earlier-invented Invention B, Invention B may still be unpatentable if the differences between the two are "obvious." [32] Because obviousness is largely subjective, the USPTO has set the "lens" of obviousness to someone "having ordinary skill in the art."[33] Whereas under the pre-AIA regime Inventor B still could have rights to the patent if records could prove prior invention, the new rules under the AIA determine obviousness as of the effective filing date.[34] Gene Quinn, a patent prosecution attorney and the founder of IPWatchdog.com, has argued that this may translate into a much more substantial number of lost patents to resource-constrained firms. He noted, for example, that if Inventor B discloses a "jacket that uses snaps as a closing mechanism," it could render Inventor A's earlier invented/disclosed "Velcro closing mechanism" as obvious, which would inhibit Inventor A's ability to obtain a patent.[35]

To put the change in priority rights in context, it is important to establish the frequency of such disputes. Gerald J. Mossinghoff studied data collected by the USPTO from the initiation of the small entity status in FY 1983 through FY 2004 and found that of the 4.50 million patent applications and 2.46 million patent grants, there were 3,253 disputes between two true inventors — 0.1 percent of patent applications and 0.2 percent of patent grants. Small businesses (not including independent inventors or nonprofits) were involved in just 189 disputes, 97 of which were advantaged and 92 of which were disadvantaged by the first-to-invent system.[36]

Because these priority disputes have been rare, many commentators find that the "race to the patent office" is a fallacy and not particularly relevant to smaller inventors. Others argue, however, that although priority disputes themselves are rare, the FITF grace period represents a

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[32] For a discussion on the AIA's potential impact on "obvious variants," see Joshua D. Sarnoff, "Derivation and Prior Art Problems with the New Patent Act," *Patently-O.com Patent Law Journal* 12, 2011; and Dennis Crouch, "With 102(f) Eliminated, Is Inventorship Now Codified in 35 U.S.C. 101? Maybe, but not Restrictions on Patenting Obvious Variants of Derived Information," *Patentlyo.com*, Oct. 4, 2012.

[33] Roger Ford, "Patent Invalidity versus Noninfringement," *Cornell Law Review* 99, 2013.

[34] The USPTO noted that as a practical matter the Office pre-AIA used the filing date as a proxy for the invention date and thus inventors had to give evidence of invention prior to the filing date. See *Federal Register* 78, No. 144, Feb. 2013, p. 11082.

[35] Gene Quinn, "A Simple Guide to the AIA Oddities: First to File," *IPWatchdog.com*, Sept. 11, 2013.

[36] "Advantaged" is defined as when a small business was second to file a patent application on the invention but received a *favorable* decision. "Disadvantaged" is defined as when a small business was the first to file a patent application on the invention but received an adverse decision. See Hon. Gerald J. Mossinghoff, "The First-To-Invent Rule in the U.S. Patent System Has provided No Advantage to Small Entities," *Journal of the Patent and Trademark Office Society* 87, no. 7, July 2005.

key change from the pre-AIA grace period due to its potential impact on the scope of protection. The importance that had been conferred on invention dates now rests on disclosure dates. The argument is as follows: If Inventor X fails to disclose each and every iteration of an invention, and a third-party Inventor Y subsequently discloses an iteration that Inventor X has not already disclosed, then Inventor X may be confined solely to what she had previously disclosed. The USPTO described this aspect of the FITF grace period using the following example:

> [If] the inventor or a joint inventor had publicly disclosed elements A, B, and C, and a subsequent intervening grace period disclosure discloses elements A, B, C, and D, then only element D of the intervening grace period disclosure is available as prior art under AIA 35 U.S.C. 102(a)(1).[37]

Thus, although the prior art grace period under the AIA theoretically still allows the inventor to use and perfect the invention, some argue that in reality the new grace period rules — which stem directly from the switch to FITF — could impose serious costs, especially with respect to cases of obviousness, and force the inventor to choose between early, iterative disclosures or secrecy. For example, Quinn advised that because inventions are typically composed of a "stream of conceptions and reductions to practice," inventors should "[f]ile often… [e]ven if that means filing serial provisional patent applications prior to filing a non-provisional patent application that wraps everything together."[38]

David Boundy, former vice president and assistant general counsel for intellectual property at Cantor Fitzgerald, also made the "file early, file often" point and argued that under the new grace period firms are forced to successively file patent provisions, even on incremental improvements.[39] In addition, he found that while under the pre-AIA system, the provisional application was key evidence of conception, the post-AIA provisional patent application will

[37] See *Federal Register* 78, no. 144, Feb. 2013, p. 11077. This is also drawn out by specific example from USPTO, "First Inventor to File (FITF) Comprehensive Training," n.d., slide 41, from http://www.uspto.gov/aia_implementation/fitf_comprehensive_training_prior_art_under_aia.pdf, accessed Nov. 30, 2014.
[38] Quinn, "A Simple Guide."
[39] David Boundy, "Leahy-Smith Patent Act: Survival Manual for First-Inventor-to-File Provisions," Oct. 2012, p. 38.

need to be prepared with much more care and sophistication — and therefore escalated attorney fees — to get the proper protection.[40]

Boundy also contended that the AIA's modification of the grace period may add risk to a firm's ability to disclose its innovations to investors and talk with outsiders about, for example, financing and marketing. This is because, as previously noted, any third-party public disclosures that cannot be proved to be *derived* from the original inventor count as prior art.[41] Todd McCracken, president of the National Small Business Association, similarly contended:

> The AIA gives an inventor a Hobson's choice: either file a patent application before beginning outside discussions, or publish all details of an invention before beginning to discuss with outsiders. But several prematurely filed patent applications are prohibitively expensive and publishing a full roadmap to an invention just as a project begins is commercial suicide."[42]

The extremely costly nature of patent litigation — typically between $3 million and $6 million per litigant from filing through appeal — makes the risk of third-party disclosure and the crippling impact of proving derivation quite clear.[43]

It is important to note, however, that there is not universal agreement on the impact of these changes in prior art and grace period. Many practitioners have reported that the provisions have little to no effect on small businesses. For example, some argued that small businesses focusing

[40] David Boundy, "Why the 2011 America Invents Act is Bad for Entrepreneurs, Bad for Startups, and Bad for America—and How to Fix It," *International In-house Counsel Journal* 5, No. 19, Spring 2012, p. 7. This point is further articulated in Ron D. Katznelson, "Surviving the America Invents Act's Overhaul of U.S. Patent Law – Startup and Small Business Perspective," Feb. 2013, slides 21-22.
[41] Boundy, "Why the 2011 America Invents Act is Bad," pp. 8-9.
[42] McCracken, "Patent Bill Hurts Small Businesses," p. 35.
[43] Estimation of patent infringement costs for suits with over $1 million at stake from Graham et al., "Results of the 2008 Berkeley Patent Survey," p. 1315, citing AILPA, "Report of the Economic Survey 2009," p. 29. Using more updated data, we find that the median cost of a patent infringement suit in 2013 (all varieties, all costs) ranged between $700,000 for cases with less than $1 million at risk to $5.5 million for cases with more than $25 million at risk. See AIPLA, "Report of the Economic Survey 2013," July 2013, p. 34.

on global protection already operated under an FITF mindset,[44] while others have claimed that provisional patent applications are sufficient to protect ideas.[45]

International harmonization

Academics and practitioners generally agree that the alignment of patent regimes around the world is essential for optimal development of innovative businesses, both large and small.[46] Although several international treaties and harmonization efforts currently exist — such as the Paris Convention, the Patent Cooperation Treaty (PCT), the European Patent Convention (EPC), Trade-Related Aspects of Intellectual Property Rights (TRIPS), and Group B+ — the economic impact of the underlying dissimilarities in patent law are substantial. A study commissioned by the U.K.'s Intellectual Property Office (IPO) found that each year of delay in pendency at the patent offices in Europe, United States and Japan costs around $11.4 billion.[47]

Although harmonization (and "worksharing" among country offices) is a pivotal effort at the macro-level — and the AIA certainly makes strides towards moving the United States to a more simplified global system (e.g., FITF priority, broadened prior art, etc.) — many have noted that the grace period substantially deviates from international norms.[48] Still, others feel that the AIA (and its FITF provision in particular) is a critical component in a globalized intellectual property system, helping to simplify the international patenting process.[49] Some experts have noted, however, that small companies that patent internationally likely operated under a first-to-file

[44] This point is also addressed by Rantanen and Petherbridge, "Act Jeopardizes," in "Debate: America Invents," p. 246. It is also made with respect to drug companies by Christine A. Goddard, "1st-to-File System Isn't New to Drug Companies," *Law360*, March 4, 2013.
[45] For a brief study of provisional patents filed pre-AIA, see Dennis Crouch, "Claiming Priority to Provisional Applications," *Patentlyo.com*, April 8, 2014. See also, Dennis Crouch, "Disclosure under the AIA: Introducing the Poor Man's Provisional Patent Application," Sept. 21, 2011.
[46] See, for example, David J. Kappos, "Patent Law Harmonization: The Time is Now," *Landslide*, July/August 2011. In this article he writes: "Harmonization…is a prerequisite to maximizing the development and dissemination of innovation and thereby improving quality of life for all the world's people" (pp. 16-17).
[47] London Economics, "Economic Study on Patent Backlogs and Mutual Recognition," Report Commissioned by Intellectual Property Office, Jan. 2010. The figure is reported in U.S. dollars in the USPTO press release, "USPTO and UKIPO Announce Plan to Reduce Global Patent Backlogs," March 10, 2010.
[48] This point comes up in a debate among Rantanen and Petherbridge versus Jay P. Kesan, see "Debate: America Invents," pp. 235-36, 245-47. Charles Eloshway, Senior Patent Counsel for the Office of Policy and External Affairs of the USPTO, also discusses this point in Charles Eloshway, "An Opportunity for Harmonization," USPTO, 2013. Issues with harmonization are also addressed from the EPO perspective in Sylvie A. Strobel, "The America Invents Act 2011 and Substantive Patent Law Harmonization: A European Perspective," April 26, 2012.
[49] Kappos, "The Time is Now." See also, World Intellectual Property Organization, "The Global Impact of the America Invents Act," *WIPO Magazine*, December 2011.

framework prior to the AIA.[50] As a result, many find that the AIA does not materially reduce the foreign transaction costs and complexity associated with filing patents abroad.

4.2. Reexamination Procedures

4.2.1. Overview of Provisions

The AIA also changed the methods by which issued patents can be challenged. Granted patents can be invalidated if the patent was illegitimate due to gaming on the part of the applicant (for example, modifying patent claims under an old priority date via continuation and divisional applications) or through poor work by under-trained examiners.[51] It is important first to distinguish the new procedures from the two processes that were in effect pre-AIA:

1. *Ex Parte Reexamination* (enacted in 1981): A patent owner or third party could ask the USPTO's Central Reexamination Unit to examine an already-granted patent based on patents and/or printed publications that establish a "substantial new question of patentability" (SNQ). Importantly, the proceeding involved only the patent owner and the USPTO (i.e., the third-party petitioner was excluded from participation).[52]
2. *Inter Partes Reexamination:* (enacted in 1999): This proceeding, which is based on the same SNQ criteria as the *ex parte* reexamination, had to be requested by a third party. This proceeding included estoppel limitations,[53] which prevented third parties from subsequently challenging the same patent on all the issues that were raised or could have been raised during the *inter partes* reexamination.[54] This procedure allowed third parties to participate in the proceedings. Critics had previously found that resource-rich patent owners could often skew *ex parte* proceedings in their favor due to the limited role afforded the party who initiated the complaint, which often dissuaded third parties from

[50] This point is also addressed in Rantanen and Petherbridge, "Debate: America Invents," p. 246. It is also made with respect to drug companies by Goddard, "1st-to-File System."
[51] Adam B. Jaffe and Josh Lerner, *Innovation and its Discontents: How Our Broken Patent System is Endangering Innovation and Progress, and What To Do About It*, (Princeton, NJ: Princeton University Press, 2007), p. 151.
[52] See 35 U.S.C. sections 301-305. http://www.uspto.gov/web/offices/pac/mpep/mpep-9015-appx-l.html#d0e30649, accessed Nov. 30, 2014.
[53] Estoppel is an equitable principle that prohibits a party from denying a fact due to that party's prior conduct or allegations.
[54] USPTO, "Report to Congress on *Inter Partes* Reexamination," Dec. 20, 2004, from http://www.uspto.gov/web/offices/dcom/olia/reports/reexam_report.htm, accessed Nov. 30, 2014.

pursuing the procedure altogether.[55] *Inter partes* reexamination also tended to take large amounts of time, averaging over three years (from inception to Q3 2011).[56]

The AIA left the *ex parte* reexamination process virtually unchanged (aside from fee increases), but replaced the *inter partes* reexamination procedure with two new proceedings: post-grant review (PGR) and *inter partes* review (IPR).[57] PGR and IPR proceedings are run through the Patent Trial and Appeal Board (rather than the Central Reexamination Unit), which is composed of three technically trained administrative law judges. Decisions must be issued within 12 months (plus a 6-month extension for good cause).

1. *Post-grant Review* (PGR): This process expands the scope of material that can be used to challenge a patent grant. Unlike *inter partes* reexamination, this procedure is not limited to challenges based on patents or printed publications, but instead may be founded on virtually any grounds that could render a patent invalid (e.g., novelty, obviousness, written description, enablement, etc.) with the exception of a lack of best mode disclosure. PGRs, however, raise the legal standard from the SNQ criteria formerly used, as petitioners now must show "that it is more likely than not that at least one of the claims challenged in the petition is unpatentable" or that the request "raises a novel or unsettled legal question that is important to other patents or patent applications."[58] This procedure must be initiated within nine months of the issuance of the challenged patent and also includes an estoppel provision that is similar in nature to that of the former *inter partes* reexamination process and limits subsequent challenges before the USPTO or a federal court.[59]
2. *Inter Partes Review* (IPR)*:* This process may only be initiated nine months after issuance (i.e. after the period for post-grant review has elapsed), or after the termination date for a PGR proceeding, whichever is later. Similar to the pre-AIA *inter partes* reexamination

[55] Matthew A. Smith, "Inter Partes Reexamination," *Edition 1E*, Jan. 31, 2009, pp. 12-13.
[56] Eric J. Rogers, "Ten Years of Inter Partes Patent Reexamination Appeals: An Empirical View," *Santa Clara High Technology Law Journal* 29, no. 2, 2012, p. 326
[57]Lawrence A. Stahl and Donald H. Heckenberg, "The Scope and Ramifications of the new Post-Grant and *Inter Partes* Review Proceedings at the USPTO," Dec. 2011, p. 1; "Inter Partes Review," *Fish & Richardson*, n.d., from http://fishpostgrant.com/inter-partes-review/, accessed Nov. 30, 2014.
[58] *Federal Register* 76, no. 157, Aug. 14, 2012, p. 48685.
[59] Robert G. McMorrow Jr., "Post-Grant Review: A Preview," in *Patents in the 21st Century*, p. 19.

> procedure, the nullification of the patent in question may only be grounded on obviousness or lack of novelty based on prior patents or printed publications. The petitioner seeking to initiate the *inter partes* review must demonstrate a "reasonable likelihood of success that the requestor will prevail with respect to at least one of the claims challenged in the request."[60] (Contrast this with the standard for the old *inter partes* reexamination, which merely required the petitioner to satisfy the SNQ criteria outlined above.) The scope of the IPR's estoppel provision, though identical in language to the PGR's,[61] is much narrower in practice. A party to an IPR does not waive the right to raise invalidity defenses in subsequent litigation, except for those based on prior patents and printed publications that were available at the time of the IPR.[62]

The AIA also instituted a new procedure known as supplemental examination. This procedure allows the patent owner to request that the USPTO "consider, reconsider, or correct" information (e.g., a journal article, a patent, a transcript of audio/video recording) relating to any issue that the patent owner believes is relevant to the patent.[63] The process allows patent owners to (1) have examiners consider questions of enforceability so that they are not used against them by potential infringers and (2) fix what may otherwise be considered grounds for inequitable conduct.[64]

We chart the major similarities and differences among the key reexamination procedures in Exhibit 3.

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[60] *Federal Register* 76, no. 185, Sept. 23, 2011, p. 59055.
[61] Scott A. Mckeown, "Congress to Tackle AIA Fixes," *Patentspostgrant.com*, Nov. 15, 2012.
[62] "Inter Partes Review," *Fish & Richardson*, 2014, from http://fishpostgrant.com/inter-partes-review/, accessed Nov. 14, 2014.
[63] Federal Register 76, no. 157, Aug. 14, 2012, p. 48828.
[64] Michael Dixon, "The Sweeping Changes of the 2011 America Invents Act," in *Patents in the 21st Century*, pp. 4-7. These points are also raised by Anthony J. Lombardi, "The Role of Supplemental Examination," *The Intellectual Property Strategist*, March 2013.

Exhibit 3: Comparison of Patent Reexamination Procedures Pre-AIA and Post-AIA

	Ex parte reexamination	*Inter partes* reexamination	Post-grant review	*Inter partes* review
Pre- and/or Post-AIA?	Pre-AIA and post-AIA	Pre-AIA to Sept. 16, 2012 (replaced by post-grant and *inter partes* review)	Post-AIA (effective Sept. 16, 2012, but not usable until March 16, 2013)	Post-AIA (effective Sept. 16, 2012)
When commenced?	Any time during enforceability of the patent	Any time during enforceability of the patent	Within nine months of patent grant	After nine months from patent grant or conclusion of PGR
Standing requirement	Substantial new question of patentability (SNQ)	Pre-AIA: SNQ	More likely than not at least one claim is unpatentable *or* raises a novel or unsettled legal question	Reasonable likelihood petitioner will prevail on at least one challenged claim
Grounds for invalidity	Previously issued patents and printed publications	Previously issued patents and printed publications	Any evidence of invalidity	Previously issued patents and printed publications
Petitioner involved?	Limited	Yes	Yes	Yes
Examining authority	Central Reexamination Unit	Central Reexamination Unit	Patent Trial and Appeal Board (PTAB)	Patent Trial and Appeal Board
Estoppel effects	None	Bars claims that reasonably could have been raised based on previously issued patents and printed publications	Bars all claims that were raised or reasonably could have been raised	Bars claims that reasonably could have been raised based on previously issued patents and printed publications
Percent Granted (as of Sept. 30, 2011)	92 (as of Sept. 30, 2011)[a]	95 (as of Sept. 30, 2011)[b]	N/A	N/A
USPTO Base Fees (Post-AIA is as of March 19, 2013)[c]	Pre-AIA: $2,520 Post-AIA: $12,000[d]	Pre-AIA: $8,800 Post-AIA (before termination): $8,800	$12,000 request fee (up to 20 claims) + $18,000 post-institution fee[e]	$9,000 request fee (up to 20 claims) + $14,000 post-institution fee (up to 15 claims)[f]

a http://ptolitigationcenter.com/wp-content/uploads/2010/02/EP-quarterly-report-Sept-2011.pdf, accessed April 16, 2015.

b http://ptolitigationcenter.com/wp-content/uploads/2010/02/IP-quarterly-report-September-2011.pdf, accessed April 16, 201.5

c We use March 19, 2013 fees since this was the effective date of the new fee structure post effective data for change in priority rights. Fees have since changed. For the most recent information, see http://www.uspto.gov/learning-and-resources/fees-and-payment/uspto-fee-schedule, accessed April 16, 2015.

d On Sept. 16, 2012, the fee for ex parte reexamination increase to $17,750.

e On Sept. 16, 2012, the post grant review base filing fee was $35,800 (up to 20 claims).

f On Sept. 16, 2012 the inter partes review base filing fee was $27,200 (up to 20 claims).

Note: "Institution fees" are refunded if the petitioner's request are not instituted by the PTAB.

4.2.2. The Potential Impact of the Modifications to Reexamination Procedures on Small Businesses

As of Sept. 2014, no data yet exists on post-grant reviews, since they must be applied to patents with an effective filing date of March 16, 2013, but one study by Steve Moore looked at data on *inter partes* reviews to measure their impact on small businesses.[65] The author expressed his concern with the higher fee structure of IPRs, relative to the old *inter partes* reexamination procedure.[66] Consistent with his concern, Moore found that while 67 percent of the 201 *inter partes* reexamination requests made prior to the AIA were from small entities, only about 33 percent of the 230 *inter partes* review requests made post-AIA were from small entities. Conversely, whereas 85 percent of the patents being challenged under his sample of *inter partes* reexaminations were owned by small entities, the number spiked to 94 percent for *inter partes* reviews. Moore concluded that the hefty fees of *inter partes* review in essence protect the patents of larger companies from being challenged by their smaller counterparts.[67]

With respect to ex parte reexamination — which increased from $2,500 to $6,000 for small entities — the author reported that the proportion of small entity patents being challenged spiked from 22 percent pre-AIA to 31 percent post-AIA, and that this spike is not attributed to more filings against patents issued to NPEs. Overall, the author concluded that the hiked fees enacted by USPTO for reexamination are indeed a barrier for small corporate entities.

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[65] See Steve Moore, "Part 1 - Boon for David of Goliath?," *IPWatchdog.com*, Aug. 15, 2013; and Moore, "Part 2 - Boon for David or Goliath?"

[66] Moore, "Part 1 - Boon for David or Goliath?," p. 2. Whereas the USPTO standard (large-entity) filing fee for *inter partes* reexamination was $12,000 (recently decreased from $17,750), IPR requires a filing fee of $27,200 for up to 20 claims (with no refund) if filed prior to March 19, 2013 and $23,000 for up to 15 claims (including post-institution fee) if filed on or after March 19, 2013 (with the post-institution fee refundable if not instituted by the Patent Trial and Appeal Board). For details on the fee structure, see *Federal Register* 78, no. 13, Jan. 18, 2013, p. 4233.

[67] Moore, "Part 1 - Boon for David of Goliath?" We note, however, that the percentage of inter partes reexamination requests (67 percent) from small entities in Moore's sample is inconsistent with USPTO figures that indicate that parent patents known to be owned by a small entity represented between roughly 25 percent and 37 percent of patents for which inter partes reexamination was requested and a filing date granted in fiscal years 2007-2011. This discrepancy may be best explained by differing sample populations. Moore used 201 randomly selected requests for inter partes reexamination, while the USPTO's data included only those requests for inter partes reexamination that met the USPTO's criteria for the grant of a filing date. See Table 1 in Federal Register 77, No. 157, Aug. 14, 2012, p. 48711-48712. See also, USPTO, "Manual of Patent Examining Procedure," ch. 2600, section 2627, http://www.uspto.gov/web/offices/pac/mpep/s2627.html, accessed May 11, 2015.

4.3. Joinder Modifications

4.3.1. Overview of Provisions

The AIA amended the permissive "joinder rule" in patent infringement cases.[68] Prior to the AIA, patent assertion entities (PAEs),[69] derisively known as patent trolls, which held patents for the sole purpose of licensing or enforcing them, could join seemingly unrelated defendants in the same suit, as long as they infringed upon the same patent.[70] This activity was made possible by the loose interpretation of the previous statute's Rule 20 by a few federal district courts. The new AIA provision was aimed at requiring the minority of district courts that permitted multiple parties to join patent infringement lawsuits to conform to the majority of jurisdictions' stricter interpretation of Rule 20 (See Exhibit 4).[71] Pre-AIA, this minority heard a high concentration of patent cases; in fact, the Eastern District of Texas — a notorious district for PAEs[72] — was the venue in which a staggering 25 percent of all defendants named in patent cases in 2010 were sued.[73] Even more illuminating, the Eastern District of Texas had on average 13.0 defendants per patent case (excluding false marking cases, in which a product is falsely marked as patented or patent pending) in 2010[74] — suggesting that this district was home to an overwhelming number of cases brought by PAEs. The AIA's joinder provision sets a higher bar for the joining of defendants; merely infringing upon the same patent is insufficient grounds for combining defendants.

Exhibit 4 compares the text of the pre-AIA and AIA patent codes to highlight the changes.

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[68] Tracie L. Bryant, "The America Invents Act: Slaying Trolls, Limiting Joinder," *Harvard Journal of Law & Technology* 25, no. 2, 2012, p. 695.

[69] It is important to distinguish between PAEs and non-practicing entities (NPEs). As noted by Colleen Chien, "[u]nlike the term 'non-practicing entity' ('NPE'), 'PAE' excludes universities, startups, and others who seek to commercialize or transfer their technology." See Colleen V. Chien, "Startups and Patent Trolls," *Stanford Technology Law Review* 17, Winter 2014. In another work, Chien defines PAEs as "…focused on the enforcement, rather than the active development or commercialization of their patents." See Colleen V. Chien, "From Arms Race to Marketplace: The New Complex Patent Ecosystem and Its Implications for the Patent System," *Hastings Law Journal* 62, 2010, pp. 297, 328.

[70] Bryant, "Slaying Trolls, Limiting Joinder," pp. 688-89.

[71] In H.R. Rep. No. 112-98 (June 2011, p. 55), the discussion of joinder explicitly notes that the joinder provision "abrogates the construction of Rule 20(a)" adopted in various districts (such as Eastern District of Texas) to "effectively [conform] these courts' jurisprudence to that followed by a majority of jurisdictions."

[72] Whereas the PAE overall success rate from 1995-2012 is roughly 24.3 percent, the Eastern District of Texas success rate is 46.7 percent. See Chart 9a in Chris Barry et al., "2013 Patent Litigation Study: Big Cases Make Headlines, While Patent Cases Proliferate," *PwC*, 2013, p. 24.

[73] James Pistorino, "Concentration of Patent Cases in Eastern District of Texas Increases in 2010," *Patent, Trademark & Copyright Journal*, April 15, 2011, p. 3.

[74] Pistorino, "Concentration in Eastern District of Texas," Table 2.

Exhibit 4: Key Sections of the AIA Relating Joinder

Pre-AIA	Post-AIA
Joinder Provision	
Federal Rule of Civil Procedure 20(a)(1). Permissive Joinder of Parties [Rule 20] (a) Persons Who May Join or Be Joined. (1) *Plaintiffs.* Persons may join in one action as plaintiffs if: (A) they assert any right to relief jointly, severally, or in the alternative with respect to or arising out of the same transaction, occurrence, or series of transactions or occurrences; and (B) any question of law or fact common to all plaintiffs will arise in the action.	AIA 35 U.S.C. 299. Joinder of parties. (a) JOINDER OF ACCUSED INFRINGERS. --With respect to any civil action arising under any Act of Congress relating to patents, other than an action or trial in which an act of infringement under section 271(e)(2) has been pled, parties that are accused infringers may be joined in one action as defendants or counterclaim defendants, or have their actions consolidated for trial, or counterclaim defendants only if -- (1) any right to relief is asserted against the parties jointly, severally, or in the alternative with respect to or arising out of the same transaction, occurrence, or series of transactions or occurrences relating to the making, using, importing into the United States, offering for sale, or selling of the same accused product or process; and (2) questions of fact common to all defendants or counterclaim defendants will arise in the action. (b) ALLEGATIONS INSUFFICIENT FOR JOINDER.--For purposes of this subsection, accused infringers *may not be joined in one action as defendants or counterclaim defendants, or have their actions consolidated for trial, based solely on allegations that they each have infringed the patent or patents in suit.* [Italics added for emphasis]

4.3.2. The Potential Impact of the Joinder Provision on Small Businesses

Because the joinder provision aimed to inhibit PAEs' abilities to bring together virtually unrelated parties for economic (e.g., economies of scale) and strategic (e.g., reducing administrative complexity, limiting the ability of defendants to re-locate) reasons, we first investigate the extent to which PAEs targeted small businesses historically. James Bessen and Michael J. Meurer examined over 9,000 companies in a database of "non-practicing entity" (NPE) lawsuits, which were "overwhelmingly" filed by PAEs,[75] and found that from 2005-2011,

[75] NPEs also include individual inventors, universities, and noncompeting entities (operating companies asserting patents well outside the area in which they make products and compete). See James Bessen and Michael J. Meurer, "The Direct Costs from NPE Disputes," *Cornell Law Review* 99, 2014, p. 397.

82 percent of defendants made less than $100 million in revenue.[76] In fact, Bessen found that in 2011 the median defendant firm had revenues of $10.3 million per year.[77] In addition, Colleen Chien found that 55 percent of unique defendants in cases filed by PAEs made $10 million or less in revenue.[78] Other studies indeed find that PAE demands are not an infrequent phenomenon among startups.[79]

Chien also documented the detrimental impact of PAEs on small businesses. She reasoned that entrepreneurial companies are particularly vulnerable to PAEs, as PAEs divert scarce resources and managerial time away from core business activities. She surveyed 79 companies — largely from the technology industry and most of which had less than $10 million in annual revenue — that received PAE demands in 2012 and found material monetary impacts. In particular, Chien noted that the smallest companies in the dataset were least able to absorb a PAE demand without a "significant operational impact." [80] In fact, Bessen and Meurer's analysis (noted above) found that smaller companies pay proportionally more in direct NPE-litigation costs for their size.[81] Catherine E. Tucker found additional damaging impacts; her analysis of VC investment from 1995 through 2012 found that litigation by frequent patent litigators (a proxy for PAEs) in a given district is directly associated with decreased VC funding in that district.[82] Another study, which surveyed roughly 200 venture capitalists and their portfolio companies, found that roughly half of venture capitalists found that an existing patent demand (of any sort) would qualify as a "major deterrent" for investments.[83]

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[76] This figure may be an overestimate, however, as all firms with unreported revenue (26 percent of the sample) were assumed to have revenue under 100 million. Bessen and Meurer, "Direct Costs," pp. 397-398.
[77] Jim Bessen, "Op-ed: How Patent Trolls Doomed Themselves by Targeting Main Street," *arstechnica.com*, Sept. 12, 2013.
[78] Chien, "Startups and Patent Trolls." This paper also outlines a broad overview of the strategic role of small companies in troll campaigns (pp. 477-478).
[79] Robin Feldman found in his survey that roughly 33 percent of startups report receiving patent demands and that 66 percent of startups reported that "all or most demands" come from entities that license or litigate patents as their core activity. See Robin Feldman, "Patent Demands & Startup Companies: The View from the Venture Capital Community." *Yale Journal of Law & Technology* 16, no. 2 (2014), pp. 242, 266, 280.
[80] Chien, "Startups and Patent Trolls," p. 475.
[81] Bessen and Meurer, "Direct Costs," p. 400.
[82] Catherine E. Tucker, "The Effect of Patent Litigation and Patent Assertion Entities on Entrepreneurial Activity," *MIT Sloan School Working Paper* 5095-14, June 22, 2014. In her study, PAEs were proxied by entities that filed 20 or more patent lawsuits.
[83] Feldman, "Patent Demands & Startup Companies," p. 280.

Given that PAEs clearly are relevant to small businesses, we next examine the literature to determine how the joinder provision can (or has) affected the PAE situation. James Pistorino and Susan J. Crane collected data on the number of defendants per case (excluding false marking cases) in the pre- and post-AIA periods and reported considerably diminished figures for districts with historically high rates of PAE litigation (Exhibit 5).

Exhibit 5 shows that in the Eastern District of Texas the number of defendants per patent litigation case went from between 10.0 and 13.1 prior to the AIA (from 2010 to the day before the Act) to between 2.09 and 2.7 in the post-AIA period (from the day of enactment to September 10, 2013). Furthermore, whereas plaintiffs brought together over 14 defendants per case on average in the District Court of Delaware in the week prior to enactment, the figure decreased to between 1.97 and 2.2 in the post-AIA period. This drop in defendants per case in traditionally PAE-friendly courts suggests that PAEs had to discontinue multi-defendant infringement suits and instead file separate suits.

Exhibit 5: Defendants per Case in Select Time Periods, Pre-AIA and Post-AIA (Excluding False Marking Cases)

	Pre-AIA			Post-AIA		
	2010	**Jan. 1, 2011-Sept. 15, 2011**	**Sept. 8-15, 2011***	**Sept. 16, 2011-Dec. 31, 2011**	**2012**	**Jan. 1, 2013-Sept. 10, 2013**
Eastern District of Texas	13.0	10.0	13.1	2.7	2.09	2.17
District of Delaware	3.5	7.2	14.6	2.2	2.08	1.97

*The week prior to the AIA's enactment.

Source: Pistorino, "Concentration in Eastern District of Texas"; James C. Pistorino and Susan J. Crane, "2011 Trends in Patent Case Filings: Eastern District of Texas Continues to Lead Until America Invents Act is Signed," *Perkins Coie*, March 2012; James Pistorino, "2012 Trends in Patent Case Filings and Venue: Eastern District of Texas Most Popular for Plaintiffs (Again) But 11 Percent Fewer Defendants Named Nationwide," *Perkins Coie*, Feb. 2013; James Pistorino, "Unprecedented Patent Case Concentration," *Perkins Coie*, Sept. 16, 2013.

Note: Authors from the above sources used the PACER dataset. The data explicitly excludes false marking cases for 2010-2011, and Pistorino noted that these types of cases were effectively eliminated post-AIA (though they do not discard the few that might still exist from the dataset).

Given the smaller number of defendants per case, as well as an overall 11 percent decrease in the total number of defendants named in 2012 over 2011, Pistorino and Crane argued that

"…plaintiffs found that benefits from suing marginal defendants did not justify the increased burdens."[84] Mid-year figures for 2013 further suggest that the number of defendants has remained relatively unchanged.[85]

Although these figures suggest that the joinder rule is imposing significant costs on PAEs, Chien points out that small companies that do end up facing litigation are likely disadvantaged due to fewer joint defense options, which allow defendants to share work and expenses and collaborate on their strategies.[86] Furthermore, substantial evidence suggests that PAEs are filing cases separately — as evidenced by higher numbers of same-day, same-district plaintiffs from 2011 to 2012 — only to be subsequently consolidated for all pre-trial purposes, which partially defeats the purpose of the joinder provision.[87]

Evidence of the "chilling" effect of the AIA on PAEs is mixed. One study found that from 2010 to 2012, the number of defendants accounted for by PAEs (as defined by "large patent aggregators," such as the Acacia companies, and patent holding companies formed solely to enforce a patent or a small portfolio of patents), increased from 3,370 in 2010 to 3,716 in 2012.[88] We note, however, that this data does not specify the proportional increase among the subset of small companies. On the other hand, Chien found that PAEs (though likely not using the same definition as the previous study) have reached fewer defendants during the period from Oct. 1, 2011 through Aug. 31, 2012 than from Oct. 1, 2010 through Aug. 31, 2011; critically, she also found that the share of small companies among unique defendants also dropped, which suggests that "…fewer of them are worth pursuing under the new rules."[89]

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[84] The authors note that although there could simply have been fewer defendants to name in 2012, they find that scenario unlikely. See James C. Pistorino, "Eastern District of Texas Most Popular," p. 5.
[85] James Pistorino, "Unprecedented Patent Case Concentration," *Perkins Coie*, Sept. 16, 2013.
[86] Colleen Chien, "Patent Trolls by the Numbers," *Patentlyo.com*, March 14, 2013.
[87] For data of same-day, same-district plaintiffs, see Pistorino, "Eastern District of Texas Most Popular," p. 5. For several examples of cases consolidated for pretrial purposes, see Scott W. Doyle, Jonathan R. Defosse, Michel E. Souaya, Kyle Noonan, "The Impact of the America Invents Act on Litigation by Non-Practicing Entities," *Shearman & Sterling*, May 9, 2013. Several cases also discussed in Pistorino, "Eastern District of Texas Most Popular," pp. 7-8.
[88] Christopher A. Cotropia, Jay P. Kesan, and David L. Schwartz, "Unpacking Patent Assertion Entities (PAEs)." *Minnesota Law Review* 99, no. 2 (2014), pp. 669-670, 695.
[89] Chien, "Startups and Patent Trolls," p. 484.

Given the detrimental effect that PAEs can have on small businesses, the extent to which the joinder provision dissuades the former from pursuing (suing *or* threatening to sue[90]) the latter is critical to small business innovation. This is particularly true for those sectors most vulnerable to PAE patent demands, such as computers and communications.[91] While not unanimous, analyses to date (described above) suggest that AIA and its joinder provision have exacted a cost on PAEs and thereby helps small businesses avoid PAE interference.

4.4. Fee Modifications and New Incentives

4.4.1. Overview of Provisions

In an attempt to reduce the financial burden of the patent application process, the AIA modifies patent filing fees on micro-entities; this newly defined subset of small entities based on the number of previous patent applications, the gross income of applicants/inventors, and the gross income of other parties with an ownership interest in the application.[92] Whereas the pre-AIA system offered 50 percent discounts to small entities, the new system offers additionally discounts of 75 percent to the subclass of micro-entities.[93] Importantly, however, the AIA also imposed a 15 percent surcharge on most fees to allow the USPTO to resume hiring new examiners and personnel to address the backlog of patents, as well as to improve the overall quality level of patents.

Importantly, the AIA also established a Patent Pro Bono Program to cover legal fees, which specifically required the USPTO to "…work with and support intellectual property law associations across the country in the establishment of pro bono programs designed to assist financially under-resourced independent inventors and small businesses."[94] While eligibility requirements vary for each regional program, applicants generally are required to (i) earn below a certain threshold, (ii) possess knowledge of the patent system (for example, by having a current provision/non-provisional patent application or successfully completing the online Certificate Training Course), and (iii) have an invention, rather than just an idea, which is to say that the

[90] Chien, "Startups and Patent Trolls," p. 462.
[91] Feldman, "Patent Demands & Startup Companies," p. 682.
[92] USPTO, "Certification of Micro Entity Status (Gross Income Basis)," [Form for Patent Applicants], from http://www.uspto.gov/forms/sb0015a.pdf, accessed Nov. 30, 2014.
[93] USPTO, "Small Entity Compliance Guide," Jan. 18, 2013, from http://www.uspto.gov/aia_implementation/AC54_Small_Entity_Compliance_Guide_Final.pdf, accessed Nov. 30, 2014.
[94] Leahy-Smith America Invents Act of 2011, Pub. L. No. 112-29, sec. 32(a), 125 Stat. 340, 2011. For a brief history of the program, see, John Calvert, "Pushing Ahead with the Pro Bono Assistance Program," *The John Marshall Review of Intellectual Property Law* 12, no. 2 (2013): 286-288.

inventor could describe the invention so that someone could make and use it. We also note the AIA requires that the USPTO establish and maintain a Patent Ombudsman Program for Small Business Concerns to provide "…support and services relating to patent filings."[95] More specifically, this program helps pro se patent applicants (i.e., those without attorneys) or applicants' representatives with issues that arise during patent prosecution.[96]

To further combat the backlog, the AIA also created an "electronic filing incentive," such that paper applications for utility patents incur a $400 fee ($200 for small entities).[97] In addition, the AIA established a prioritized examination option to reduce patent pendency to roughly 12 months on average — from roughly 34 months in FY 2011— for a $4,800 fee ($2,400 for small entities).[98]

4.4.2. The Potential Impact of the Fee Modifications and New Incentives on Small Businesses

Given that USPTO fees comprise a relatively small fraction of the total cost of a patent, it is unclear that the micro-entity status fee reductions will have a significant impact.[99] The Patent Pro Bono Program, however, has indeed made substantial progress and can alleviate the legal costs (not filing fees) for under-resourced inventors. In February 2014, the White House announced an Executive Order to have the USPTO expand the AIA pro bono program to cover all 50 states. As of March 2015, the program has reached 45 states and the District of Columbia.[100] Under the program, inventors are offered services from volunteer registered patent attorneys related to the filing and prosecution (through allowance/final rejection) of patent applications, though litigation is not covered. Critically, the program is set up to screen and match inventors — given the subject matter of their respective inventions — with attorneys who possess relevant expertise. It is important to note, however, that the income threshold limits participation exclusively to the truly micro end of small businesses/independent inventors, as, generally speaking, inventors must earn less than 300 percent of federal poverty levels. The Patent Ombudsman Program additionally aids the patent prosecution process for pro se applicants and applicants' representatives when the normal channels are ineffective.

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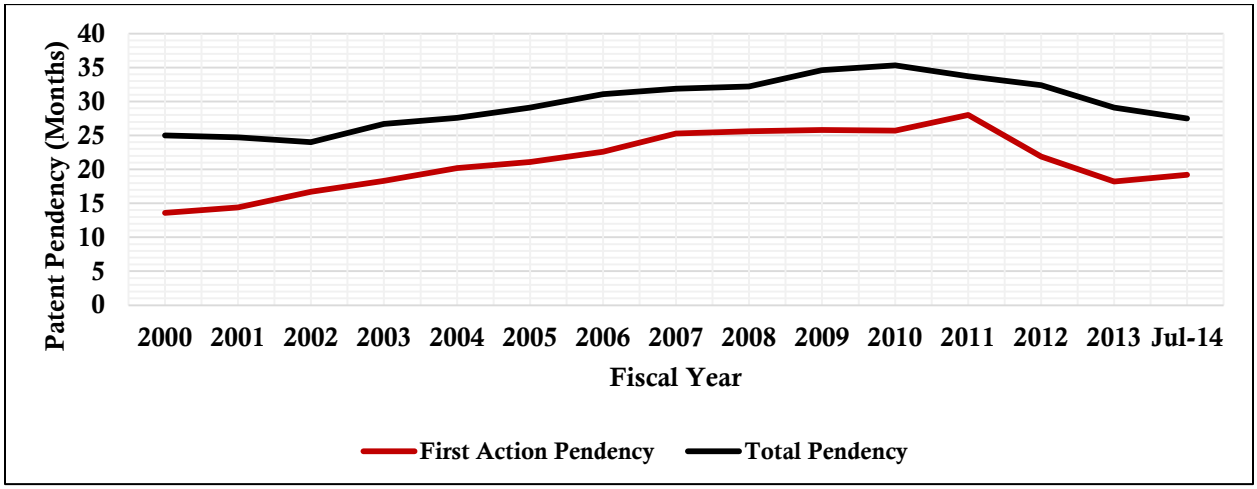
[95] Leahy-Smith America Invents Act of 2011, Pub. L. No. 112-29, sec. 28, 125 Stat. 340, 2011.
[96] For a more comprehensive overview, see Mindy Bickel, "Keeping the Road Clear: The Patents Ombudsman Program," *Inventors Eye* 3, no. 4, Oct. 2012.
[97] Richard Maulsby, "President Obama Signs the America Invents Act," *Inventors Eye* 2, no. 5, Oct. 2011.
[98] Prioritized examination applications are limited to four independent claims and 30 total claims. See USPTO, "Performance and Accountability Report Fiscal Year 2011," p. 162 (table 4). The USPTO has since reduced its fees as of March 19, 2013 to $4,000 for non-small entities and $2,000 for small entities.
[99] For an estimate of attorney fees based on the complexity of the patent, see Gene Quinn, "The Cost of Obtaining a Patent in the US," *IPWatchdog.com*, April 30, 2013.
[100] See http://www.uspto.gov/patents-getting-started/using-legal-services/pro-bono, accessed March 31, 2015.

In addition, a significant reduction in patent pendency — from the combination of new examiners, the electronic filing incentive, and the prioritized examination option — could provide tangible benefits to small businesses seeking patent protection. With the help of the AIA and earlier initiatives, including the Patent Prosecution Highway and Accelerated Examination (AE), the USPTO aims to greatly improve the patent backlog. Its goal is to reduce the average first action pendency (from filing to an examiner's initial determination of patentability) to 10 months by FY 2016 and the total pendency (from filing to final disposition) to 20 months by FY 2017.[101] Exhibit 6 tracks the movement in patent pendency from 2000 and suggests that the AIA has begun improving the speed of the patent system. In addition, the backlog of unexamined patent applications decreased from 669,625 in September 2011 to 617,704 in July 2014.[102]

Exhibit 6: USPTO Patent Pendency, FY 2000 - July 2014



Source: July 2014 figure from USPTO Dashboard. These numbers are for utility, plant, and reissue applications (not design) and do not include applications in which a Request for Continued Examination (RCE) has been filed. Data is from USPTO Performance & Accountability Reports for the respective fiscal years.

Nonetheless, the USPTO estimates that an application filed in July 2014 will still have "Forward-Looking" First Action pendency (i.e., the expected number of months it would take on average to receive first office action) of roughly 15.6 months, which suggests that the expedited examination option for companies seeking speedy patent review is still important. As of March 2014, there have been 16,525 requests for prioritized examination, with an average total pendency of 6.55 months.[103]

[101] USPTO, "FY 2014 President's Budget," April 10, 2013, p. 8.
[102] Unexamined patent application backlog includes utility, plant, and reissue patent application that are awaiting a First Office Action by the patent examiner. See, USPTO Dashboard.
[103] USPTO statistics, from http://www.uspto.gov/patents/init_events/Track_One.jsp, accessed Sept 4, 2014.

We note that there is a key difference between the AIA's prioritized examination provisions and accelerated examination, or AE. AE requires applicants to conduct a "pre-examination search" to defend the patent claims against known prior art; this involves a thorough search of U.S. patent and patent application publications, foreign patent documents, and non-patent literature which can potentially extend to hundreds of databases.[104] Although a smoother review process could potentially offset these up-front costs, there have been under 5,200 requests for AE since its inception in 2006 through April 2012.[105] Not only has prioritized examination received three times the requests in a fraction of the time, but a preliminary analysis in December 2012 by attorneys at Foley & Lardner found that prioritized examinations were still cost effective for small entities relative to AE even after including prosecution costs (office actions, petition costs, etc.).[106]

4.5. Expanded "Prior User" Rights

4.5.1. Overview of Provisions

Prior user rights historically have referred to a defense against charges of patent infringement for those who have "secretly" made *internal* commercial use (or an arm's length sale/transfer of a useful end result of the commercial use) within the United States of a *business method* prior to its being independently patented by a third party. Although "robust" prior user rights (i.e., beyond those for business methods) in a FTI regime were not necessary (in fact, prior user defenses were rarely, if ever, the bases of a court decision[107]), the new FITF system gives potentially increased importance to this defense.[108]

Under the AIA, the prior user defense has been expanded from protection of business methods to encompass almost all technologies, as long as the prior use began at least one year prior to the

[104] It should be noted, however, that these up-front costs of search and examination could potentially be offset by fewer office actions.
[105] USPTO Accelerated Examination Statistics, from http://www.uspto.gov/patents/process/file/accelerated/ae_petition_status_2012apr09.pdf, accessed Nov. 30, 2014.
[106] See Max Colice, Matthew A. Smith, and Andrew Cheslock, "Expediting Prosecution: Comparing Track 1 Prioritized Examination, Accelerated Examination, the Patent Prosecution Highway, and Petitions to Make Special Based on Age," *Patentlyo.com*, Dec. 27, 2012.
[107] Comments from Paul Morgan, PTO Requested Comments on the AIA "Prior Commercial Use" Defense Legislation, Oct. 13, 2011, from http://www.uspto.gov/sites/default/files/aia_implementation/pur-2011oct13-paul_morgan.pdf.
[108] See Sen. Roy Blunt of Missouri, speaking on H.R. 1249, *Cong. Rec.* 157, no. 132, p. S5426 (daily ed. Sept. 8, 2011), from http://www.gpo.gov/fdsys/pkg/CREC-2011-09-08/html/CREC-2011-09-08-pt1-PgS5402-2.htm, accessed Nov. 30, 2014.

earlier of the effective filing date or the earliest publication by the patent owner.[109] In the words of Sen. Roy Blunt (R-Mo.), the provision thereby "allow[s] developers of innovative technologies to keep internally used technologies in-house without publication in a patent."[110] In other words, the AIA offers more robust protection to companies that find it suboptimal to disclose an internal product via patent — especially given the difficulty of monitoring the use of patented processes abroad — and instead use the process or equipment, etc., in secret.

Exhibit 7 compares the text of the pre-AIA and AIA patent codes to highlight the changes.

Exhibit 7: Comparison of Prior User Rights, Pre- and Post-AIA

Pre-AIA	Post-AIA
Prior User Rights	
Pre-AIA 35 U.S.C. 273. Defense to infringement based on earlier inventor. (1) In general.—It shall be a defense to an action for infringement under section 271 of this title with respect to any subject matter that would otherwise infringe one or more claims for a method in the patent being asserted against a person, if such person had, acting in good faith, actually reduced the subject matter to practice at least 1 year before the effective filing date of such patent, and commercially used the subject matter before the effective filing date of such patent.	AIA 35 U.S.C. 273. Defense to infringement based on prior commercial use. In General.— A person shall be entitled to a defense under section 282(b) with respect to subject matter consisting of a process, or consisting of a machine, manufacture, or composition of matter used in a manufacturing or other commercial process, that would otherwise infringe a claimed invention being asserted against the person if— (1) such person, acting in good faith, commercially used the subject matter in the United States, either in connection with an internal commercial use or an actual arm's length sale or other arm's length commercial transfer of a useful end result of such commercial use; and (2) such commercial use occurred at least 1 year before the earlier of either-- "(A) the effective filing date of the claimed invention; or "(B) the date on which the claimed invention was disclosed to the public in a manner that qualified for the exception from prior art under section 102(b).

[109] Previously the law allowed for prior user defense if the prior user reduced the invention to practice one year before the filing data of the patent and commercially used the invention in the United States before the effective filing data of the patent. For a detailed discussion of the prior user defense pre- and post- AIA, see USPTO, "Report on the Prior User Rights Defense," January 2012.

[110] See *Cong. Rec.* 157, no. 132, p. S5426 (daily ed. Sept. 8, 2011), from http://www.gpo.gov/fdsys/pkg/CREC-2011-09-08/html/CREC-2011-09-08-pt1-PgS5402-2.htm, accessed Nov. 30, 2014.

4.5.2. The Potential Impact of the Expanded Prior User Rights on Small Businesses

In January 2012 the USPTO prepared a comprehensive report[111] on the implications of the prior user rights defense under the AIA and found no substantial evidence that this provision would have any disproportionately negative impact on small businesses generally, or on venture financing. Its findings were largely based on the following evidence:

- A 2009 study on behalf of the European Commission (DG Research) cited minimal defenses used in litigation in Europe.
- The 2008 Berkeley Survey suggested that the risk analyses of venture capitalists already account for trade secrecy.
- Contradictory scholarly research on the relationship of prior user rights defenses to small-businesses (and individual inventors) and performance.
- A synthesis of comments from *Federal Register* notes and submissions to the USPTO from higher education associations revealed no consensus in opinion. While some believed the one year of commercial use requirement is inherently discriminatory against startups, others found that prior user rights could offer protection from "patent acquisition companies" for small manufacturing businesses that do not, and often cannot, patent each and every component, or those that supply such components to larger businesses.[112]

A major point of opposition from the small business community holds that prior user rights diminish the value of their patents. For example, Rep. Tammy Baldwin (D-Wis.) in the pre-AIA Congressional hearing argued that the AIA obscures the abilities of inventors and prospective investors to determine whether a given process or product has previously been developed, which in effect could render patents worthless and inhibit fundraising.[113] Furthermore, the litigation costs associated with presenting "clear and convincing evidence" of valid prior use can, like

[111] USPTO, "Prior User Rights."
[112] USPTO, "Prior User Rights."
[113] U.S. Representative Tammy Baldwin speaking on H.R. 1249, *Cong. Rec.* 157, no. 91, June 23, 2011, p. H4483.

other types of litigation costs, cripple small businesses and thus increase the risk of relying on such defenses altogether.[114]

In contrast, for those industries more oriented to trade secrets (often to avoid copying by foreign competitors), small companies may see tangible benefits. For example, certain representatives of companies in the green technology domain contend that they are often forced to rely on trade secrets in order to avoid copying by resource-rich and government-subsidized foreign companies.[115] Robert Barr and Richard T. Ogawa voiced these concerns in a November 2011 letter to the Under Secretary of Commerce for Intellectual Property, David Kappos:

> …patents are often not an effective way to protect intellectual property in our environment. This is both because of the difficulty of detecting the use of these processes in secret by others and because the manufacturing activity will often happen overseas. If we patent the inventions, the details will be published, and foreign competitors could copy our inventions and implement the processes in their countries, most likely with cheaper labor and government subsidies, and certainly without the research and development expense we have incurred. Even if we could obtain patent protection worldwide, which is of course extremely expensive, we would have difficulty detecting infringement and proving it in foreign courts.[116]

The greentech representatives explicitly stated prior user rights are an "absolute necessity" to secure future fundraising and protect against the risk of prior art being created that render their inventions un-usable.[117] Given the expanded scope of prior art under the AIA, their concerns, without the appropriate prior user rights, would have been amplified.[118]

4.6. Collective Analysis

The literature summarized above reveals considerable disagreement among experts, practitioners, and business people on the AIA's impact on small businesses. There are four principal reasons for this ongoing debate:

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[114] Nicholas Mattingly, "Prior User Rights: The Uncertainty will Cost You," *IPWatchdog.com*, April 16, 2012.
[115] This point was also noted in USPTO, "Prior User Rights," p. 40.
[116] Robert Barr and Richard T. Ogawa, "Prior User Rights for Venture Capital Backed Greentech Industry," [E-mail to David J. Kappos], Nov. 6, 2011.
[117] Robert Barr and Richard T. Ogawa, "Rights for Greentech Industry."
[118] Similar comments were also offered by the Chief Intellectual Property Counsel of Space Exploration Technologies Corp. See James F. Kurkowski, "Written Comments of James F. Kurkowski on the Topic of Prior User Rights," Nov. 8, 2011, from http://www.uspto.gov/sites/default/files/aia_implementation/pur-2011nov08-space_exploration_tech_corp.pdf.

- The law is complex in nature, and its various reforms will likely have different impacts on small businesses.
- The language of certain provisions is ambiguous and leaves the magnitude of the reforms' consequences uncertain until courts clarify interpretation.
- Achievement of the goals established in the law is still uncertain.
- Certain provisions may improve the innovative capabilities of small businesses in certain industries while hindering or not affecting the innovative capabilities of small businesses in other industries, especially given inter-industry differences in patenting behavior in the pre-AIA patent system.

We next move into an empirical evaluation of the AIA's impact on small businesses. As previously noted, we attempt to measure the patenting activity of small firms relative to large ones in a variety of ways to give some indicators of potential shifts in patenting behavior.

5. Hypotheses on the AIA's Impact on Small Businesses

As described in Section 4, the AIA has been a source of controversy among small businesses and their advocates.

Given such stark differences in opinion, Bella Research Group will explore the following hypotheses:

1. The AIA will benefit small businesses.
2. The AIA will be detrimental to small businesses.
3. The AIA will be neutral to small businesses.
4. The AIA will have a varied impact on small businesses operating within different industries.

These hypotheses are designed to illuminate the spectrum of possible impacts of the AIA on small businesses that are patent holders, patent applicants, or both. The points made below apply to current and/or prospective patent holders that are small businesses. We summarize the various positions explained in Section 4 in Exhibit 8.A – 8.D.

Exhibit 8: A Summary of Hypotheses of the AIA Effects on Small Businesses

Exhibit 8.A:
Hypothesis 1: The AIA will benefit small businesses

Switch to FITF, grace period and prior art changes	• FITF brings the U.S. patent system closer to international rules, which will decrease costs associated with international patent rights for small businesses.
Joinder modification	• Joinder modification protects vulnerable small businesses against patent assertion entities (i.e., patent trolls).
Micro-entity fee discount	• Micro-entity fee discounts will make the patent application process more cost effective for small businesses.
Patent Pro Bono Program and Patents Ombudsman Program	• The Patent Pro Bono Program offers free legal services related to patent application filing and prosecution for small businesses and independent inventors who qualify. The Patents Ombudsman Program also facilitates patent prosecution process should issues arise.
Prioritized examination	• Prioritized examination provides a cost-effective alternative to small businesses (especially those seeking VC financing) seeking a speedy decision on a non-provisional patent.
Prior user rights	• Prior user rights help protect small businesses from patent assertion entities.

Exhibit 8.B:
Hypothesis 2: The AIA will be detrimental to small businesses

Switch to FITF, grace period and prior art changes	• The collective impact of these measures creates a race to the USPTO, which favors resource-rich companies relative to small businesses. • Firms that do not have in-house legal counsel will be less aware of the details of when to publish and file and how to make sure the application is fully descriptive. • Weakened grace period requires iterative provisional disclosures for full protection. • Irrespective of grace period changes, the costly nature of derivation procedures and the inability to "swear behind a reference" amplifies disclosure risk to investors.
Reexamination procedures	• Increased cost of *inter partes* review relative to *inter partes* reexamination inhibits the ability of cash-constrained firms to take advantage of the procedure. • The level of involvement required by petitioners in post-grant reviews favors resource-rich firms.
Joinder provision	• Small businesses facing litigation by patent assertion entities lose what were previously cost-effective joint defenses.
Prior user rights	• Prior user rights can strip inventions relating to a commercial process of their value given the inability to ensure monopoly status on the invention. • The cost of litigation to assert a prior use defense discriminates against the resource-constrained firm.

Exhibit 8.C:
Hypothesis 3: The AIA will be neutral to small businesses

Switch to FITF, grace period and prior art changes	• Provisional patents offer a cost-effective method for small businesses to safely protect an invention without racing to the patent office. • Priority disputes are extremely rare occurrences for small businesses. • The post-AIA patent system is lacking in several dimensions with respect to international harmonization, which still makes international patent rights complicated for small businesses. • Small businesses that file abroad typically have been working under a first-to-file mindset prior to the AIA. • Disclosure with third parties will remain unchanged in an FITF system since an invention disclosed in confidence would not count as prior art or start the clock ticking on the one-year grace period.
Reexamination period	• The increased cost of reexaminations under the AIA is relatively minor for small businesses in the context of the total cost of reexaminations through to the Patent Trial and Appeal Board.
Joinder Modification	• Patent assertion entities can dodge the joinder provision by requesting that district courts consolidate cases for pretrial purposes, which leaves small businesses equally vulnerable. • The joinder provision may not inhibit PAEs from merely threatening to sue, which still imposes operational costs and takes an emotional toll on management.
Micro entity fee	• The relative savings of fee discounts are negligible once accounting for attorney fees, so the total cost of the patenting process remains relatively unchanged for small businesses.

Exhibit 8.D:
Hypothesis 4: The AIA will have a varied impact on small businesses operating within different industries

Switch to FITF, grace period and prior art changes	• The FITF provision may place an increased burden on small businesses in those industries in which iterative invention practices are common, e.g., IT hardware development, if the value of a provisional patent is diminished. • Many small businesses operate in industries (such as software) that are not particularly sensitive to patents altogether, while others (such as biotechnology) operate in industries that are highly reliant on patents.
Joinder provision	• Small businesses that operate in industries particularly susceptible to patent assertion entities may benefit to the extent of the success of the new joinder provision.
Prior use rights	• Prior use rights may be particularly beneficial to small businesses operating in industries that are reliant on trade secrets, such as green technology and space exploration.

6. Empirical Evaluations

6.1. Overview of Empirical Studies

Judging the impact of policy interventions is often difficult. Efforts to encourage innovation, such as reforms of the patenting system — unlike, for instance, government programs to boost the planting of wheat — take a long time to yield returns: in some cases, decades or more. While economists have developed a variety of tools for addressing these issues, these are imperfect.

In the context of policy changes, the AIA is extremely young, as it became fully effective on March 16, 2013. The timeframe for this evaluation poses difficulties in that most studies look at the generation of patents before and after a policy change. Patents have historically taken roughly two to three years to issue and several additional years to generate a reasonable number of citations that will allow systematic analysis of importance. This timing poses difficulties in directly measuring the effects of the AIA at this time.

We can gain a preliminary sense of the impact of the change, however, by examining:

- Measurable immediate impacts, which may serve as a proxy for longer run changes,
- The effects of similar policy changes elsewhere, and
- Qualitative impact as reported by affected small businesses.

We therefore employ the following three approaches:

1. Event study of the public market reaction to the AIA

We identify critical dates related to the legislative history of the AIA and calculate how the market valuation of smaller and larger patent-intensive firms reacted around those dates. A differential public market response among firms of varying sizes would indicate a perceived differential impact of the AIA on the patenting ability of smaller versus larger firms. This analysis must be interpreted cautiously, however, given the extremely limited data on traditionally defined “small” firms (e.g., fewer than 500 employees) that are both publicly traded and patent intensive, the potentially unique financial position of the subset of traditionally defined small firms that are publicly traded, and the possibility of an incorrect perception of the impact of the law on small businesses given its many nuances.

2. Examination of VC financing before and after the AIA

Given the important role of VC investors in financing traditionally defined small companies, we explore how the relative proportion of VC deals and equity going to patent-intensive industries changed post-AIA. To control for changes in the overall pattern of VC financing, we also collect VC financing data for Europe, which has long used a FTF system. A substantial deviation in VC financing trends in the proportion of deals and equity going to patent-intensive sectors, net of changes in Europe, would indicate that the VC community perceived the AIA to have a material impact on the patenting prospects of small businesses.

3. Analysis of the effects of the Canadian shift to first to file

We add to the limited empirical literature on the impact of the Canadian switch to first to file that became effective in 1989 and conduct a study on the patenting rates and patenting quality of small and large firm patents in pre-reform and post-reform periods. In this study, we control for international trends in patenting activity by collecting data from the United Kingdom. We first explore whether the number of successful patent applications in the pre-reform period differed significantly from that in the post-reform period for firms in Canada compared to the United Kingdom. Because patenting rates can be confounded by patent quality (i.e., filing fewer patents due to higher levels of selectivity or filing increased numbers of patents due to lower levels of selectivity), we also examine how patent quality changed in the post-reform period relative to the pre-reform period for smaller and large firms in Canada, again compared to the United Kingdom.

It is important to emphasize that our empirical analyses employ various definitions of small businesses given the nature of the study and its respective data limitations. Our event study is unable to look directly at small businesses, but instead considers a differential market reactions among patent intensive publicly traded companies along the spectrum of employee counts and market capitalizations. Our VC study proxies for small businesses given that VC firms generally target the startup community. Finally, our study of the Canadian shift to FTF looks at firm size by number of successful patent applications prior to the reform.

6.2. Public Company Event Study of the AIA's Impact on Small Businesses

6.2.1. Executive Summary

We conduct an "event study" to explore whether the public market reacted differently to smaller firms relative to larger firms around key dates related to the enactment of the AIA. We present data on the stock market performance of patent-intensive public firms identified by the USPTO and find that the AIA had negligible differential impact on smaller versus larger firms in our sample. Using six key dates between when the AIA was reported by the Senate Judiciary Committee and its ultimate enactment, abnormal returns (market model and market adjusted[119]) suggest no substantial impact on firms of different sizes.

Our results, however, must be interpreted cautiously because (a) public firms likely do not exhibit the type of financial constraints encountered by small private firms and thus are arguably less affected by the law, (b) there are very few small patent-intensive public firms (i.e., with fewer than 500 employees), and (c) the market may not have correctly anticipated the law's impact or the effect may have been masked by contemporaneous changes in the economic environment. While the above limitations constrain our ability to clearly investigate the AIA's impact on traditionally defined small firms, the analysis offers a backdrop for responding to claims that the largest patent-intensive firms disproportionally benefit from the AIA relative to more moderately sized firms.

6.2.2. Introduction

A standard approach to examining the economic consequences of policy changes is an "event study," which involves a comparison of the impact of a policy change on the equity market values of more- and less-affected firms. Assuming that the market is efficient[120] — i.e., that it correctly anticipates the impact of the policy shift — the market reaction should give a sense of whether the policy change was more or less beneficial/detrimental to certain subsets of firms.

[119] These are explained in detail our methodology section.

[120] For an overview of the efficient market hypothesis, see the seminal works of Eugene F. Fama, "Efficient Capital Markets: A Review of Theory and Empirical Work," *Journal of Finance* 25, no. 2, May 1970, and Eugene F. Fama, "Efficient capital Markets: II, *Journal of Finance* 46, no. 5, Dec. 1991. For a more recent work, see Burton G. Malkiel, "The Efficient Market Hypothesis and its Critics," *Journal of Economic Perspectives* 17, no. 1, Winter 2003.

Event studies have a long history in the fields of finance and economics. The first major event study was published in 1933 in the *Harvard Business Review* and studied the nominal price changes of a sample of stock splits.[121] The modern methodology, however, can largely be attributed to a 1969 paper by Eugene F. Fama, et al. who also studied the impact of stock splits, as well as a 1968 study by Ray Ball and Philip Brown, who studied market reaction to announcements of earnings numbers in interim and annual reports.[122] Event studies have since become a "ubiquitous" technique in assessing the impact of regulatory changes on firms,[123] with regulatory examples including studies on such topics as bans on cigarette advertising,[124] deregulation of cable television,[125] limitations on emissions in greenhouse cases,[126] and health care coverage reforms.[127]

An event study, as explained by A. Craig MacKinlay, is generally structured as follows:

- Identification of an "event of interest," such as corporate mergers and acquisitions, earnings announcements, or regulatory changes.
- Selection of an "event window," which is the period in which stock prices are examined. The event window is typically longer than just the day of the event, to account for announcements after the stock market closes and the possibility that the event was anticipated prior to the actual event date.
- Determination of the "selection criteria" for the sample. Characteristics often included are firm market capitalization, industry representation, or listing on a particular exchange.

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[121] James Clay Dolley, "Characteristics and Procedures of Common Stock Split-Ups," *Harvard Business Review* 11, no. 3, April 1933, as cited in A. Craig MacKinlay, "Event Studies in Economics and Finance," *Journal of Economic Literature* 35, March 1997.

[122] Eugene F. Fama, Lawrence Fisher, Michael Jensen, and Richard Roll, "The Adjustment of Stock Prices to New Information," *International Economic Review* 10, February 1969; and Ray Ball and Philip Brown, "An Empirical Evaluation of Accounting Income Numbers," *Journal of Accounting Research* 6, no. 2, Autumn 1968, as cited in A. Craig MacKinlay, "Event Studies in Economics."

[123] Charles J. Corrado, "Event Studies: A Methodology Review," *Accounting and Finance* 51, 2011.

[124] Douglas J. Lamdin, "Event Studies of Regulation and New Results on the Effect of the Cigarette Advertising Ban," *Journal of Regulatory Economics* 16, 1999.

[125] Robin A. Prager, "The Effects of Deregulating Cable Television: Evidence From the Financial Markets," *Journal of Regulatory Economics* 4, 1992.

[126] James B. Bushnell, Howard Chong, and Erin T. Mansur, "Profiting from Regulation: An Event Study on the EU carbon market," *NBER Working Paper 15572*, Dec. 2009.

[127] Patricia Foo and Wichsinee Wibulpolprasert, "Who Bears the Burden of the U.S. Health Reform? An Event Study Incidence Analysis," *Stanford Institute for Economic Policy Research Discussion Paper No. 12-028*, April 29, 2013.

- Analysis of the "event impact," which involves some calculation of an abnormal return, that is, the actual return of the event window less the return to be expected over the event window had the event not taken place.[128]

Given that the AIA received much attention in the time leading up to its passage and implementation, it serves as an event study candidate.[129] Many voices commented on its potential impact on patenting firms, large and small. Thus, one way to examine the relative effects of the AIA on larger and smaller businesses is to look at the public market reaction to patent-intensive firms around the law's key dates of passage and implementation. Although the most frequent patentees among public firms are heavily concentrated at the larger end of the spectrum, an event study can potentially capture any differential market reaction between "larger" and "smaller" patent-intensive firms within the sample.

In this section of the study, we identify relevant publicly traded businesses, collect stock price data for the selected companies over appropriate windows around key dates associated with the AIA, and analyze and evaluate the data for relevant patterns:

- First, we compile a list of patent-intensive businesses in a variety of industries. Selection is based on recent patenting activity.
- Second, key dates in the legislative history of the AIA are identified by a careful review of press accounts of the act. The stock price data are collected from the University of Chicago's Center for Research in Securities Prices (CRSP) database. We examine the reaction of the stock market within a three-day window (from the trading day before the event to the trading day after) and a five-day window (from two trading days before the event to two trading days after).
- Third, we characterize measures of firm scale (specifically, employment and market capitalization).
- Finally, we analyze the data in multiple ways. We use scatterplots to qualitatively assess potential patterns in the data. We then use simple regressions to compare returns for each key date for smaller and larger firms, based on set cut-offs of employment and market

[128] See A. Craig MacKinlay, "Event Studies in Economics."
[129] We identified nearly 1,000 articles and/or Congressional documents on the AIA published from Feb. 2011 to Sept. 16, 2011 (the date of enactment) from Factiva.

capitalization. We also regress returns against employment and market capitalization as continuous variables.

If the valuations changed similarly for both smaller and larger patent-intensive public firms, our analysis would suggest that the AIA had no differential impact for firms of different sizes within our sample. If the stock prices of smaller firms fall more or rise less than those of larger firms, however, it would indicate a perceived disadvantage for more modestly scaled entities, while the opposite would indicate a perceived advantage. In other words, differential reactions to smaller and larger patenting firms may indicate that the market perceived a relative advantage or disadvantage caused by the AIA's policy changes.

6.2.3. Methodology, Data, and Data Limitations

Procedure

We first researched the legislative history of the AIA and identified six key dates around which publicly traded companies would likely display a market response, given a perceived positive or negative impact on the (potential) change in patent law for firms of different sizes. The key dates and accompanying events are chronologically identified in Exhibit 9. We include vote counts for all relevant key dates, as such information influences how the market reacts, as they indicate the likelihood of the law ultimately becoming enacted. The vote counts show that in each step of the legislation the AIA was passed with an overwhelming majority. It is important to note that the underlying assumption of an efficient market would suggest that at the time of implementation the market would have "already reacted" (based on the expected future cash flows of the firm) to the AIA. In other words, at the point of implementation the asset prices will have already adjusted in anticipation of the event. We therefore do not include "effective" dates in this event study.

Exhibit 9: Key Dates of the America Invents Act

Event	Date	Event	Vote
1	Feb. 3, 2011	AIA (S. 23) is reported by the Senate Judiciary Committee	*15-0*
2	March 8, 2011	AIA (S. 23) is passed by the Senate	*95-5*
3	April 14, 2011	AIA (H.R. 1249) is reported by the House Judiciary Committee	*32-3*
4	June 23, 2011	AIA (H.R. 1249) is passed the House[a]	*304-117*
5	Sept. 8, 2011	AIA (H.R. 1249) is passed by Senate	*89-9*
6	Sept. 16, 2011	AIA (H.R. 1249) is signed into law	n.a.

a. While the core reforms were mostly consistent, one politically charged change from the Senate bill to the House bill was with respect to "fee division," or the ability of Congress to set the USPTO's budget and divert fees collected from patent applicants to other government programs. While the Senate bill granted the USPTO full control over its revenue, the House bill rejected removal of the USPTO from Congress' appropriation process. The House proposed that fees collected in excess of the appropriated amount in a given fiscal year be deposited in a "Patent and Trademark Fee Reserve Fund," which would only be made available "[t]o the extent and in the amounts provided in appropriations Acts." While some regarded this language as a compromise, others maintained that the USPTO still forfeited control of its revenue.[130] Other ways in which the House bill differed from the Senate bill included: the addition expanded prior user rights and the joinder provision; modifications to the *inter partes* review process; introduction of a seven-year "sunset" for the USPTO's abilities to set/adjust fees; extension of the business-method-patent review program from four to eight years; and a clarification of the standard for patent term restoration procedures. Importantly, the House bill's FITF provisions were identical to those in the Senate bill. For a legislative history, see Joe Matal, "A Guide to the Legislative History of the America Invents Act: Part I of II," 21 Fed. Cir. B.J. 435 (2012).

We then utilized the 2010 "Patenting by Organizations" report from the Patent Technology Monitoring Team (PTMT) of the USPTO to generate the list of firms to be examined in the event study.[131] The list ranks all organizations (globally) that were issued 40 or more patents in the 2010 calendar year (the year before the enactment of the AIA). For every company on the list, we extracted key pieces of information from S&P Capital IQ, such as the country of its headquarters, year-end market capitalization, employee count for 2009-2012, industry codes

[130] For a relevant discussion, see *Leahy-Smith America Invents* Act. H.R. 1249. 112th Cong., 1st sess., *Congressional Record* 157, no. 131, S5353-S5377. See also, Gene Quinn, "Lack of Commitment on PTO Funding is Killing Patent Reform," IPWatchdog.com, June 22, 2011.

[131] The full list can be obtained from http://www.uspto.gov/web/offices/ac/ido/oeip/taf/topo_10.htm#PartB, accessed July 13, 2014. We offer a sample of our list of companies, with their ultimate parent companies used for our analysis, in Appendix 1.

(SIC), and the name of any parent companies.[132] We then collected the stock market returns of all parent companies from the University of Chicago's CRSP database, using three- and five-day windows around each key date, which is consistent with the literature.[133] We refined our final list to include only those parent companies traded on a U.S. exchange and contained in the databases of the CRSP.[134]

The dependent variable in our analysis is the cumulative abnormal return (CAR). The CAR, typically used in event studies,[135] is defined as the sum of differences between the actual return of a security and that security's expected return. In this analysis, we use both "market model" and "market-adjusted" abnormal returns. The market model returns subtract the expected returns using estimated parameters from historical data from the actual return, while market-adjusted returns simply net out the market return. In other words, whereas the market-adjusted model assumes the expected return is just the return of the overall market (e.g. implicitly assuming the firm has a β of 1), market model returns take into account the security's risk relative to the market by using estimated coefficients (e.g., the firm's individual alpha and beta, as estimated using daily data during the one year prior to the estimation period).

We explore how returns changed for firms of different sizes around each of the key dates identified in Exhibit 9 using four key statistical techniques:

- Scatterplots of CARs by employee count and market capitalization to illustrate any key patterns in the data (See Appendix 1).
- Regressions of CARs for large capitalization/large employee companies relative to smaller companies. "Larger" is defined as those firms whose market capitalization or

[132] We manually cross-checked the list to ensure proper documentation of firms that were listed as subsidiaries from Capital IQ (using the most up-to-date information) but were actually standalone companies at the time of the AIA. All non-publicly traded subsidiaries were matched with their ultimate parent company.
[133] Nonna Sorokina, David E. Booth, and John H. Thornton, Jr., "Robust Methods in Event Studies: Empirical Evidence and Theoretical Implications," *Journal of Data Science* 11, 2013.
[134] Only those identified firms with stock price information were included in our final dataset.
[135] See Abagail McWilliams and Donald Siegel, "Event Studies in Management Research: Theoretical and Empirical Issues," *Academy of Management Journal* 40, no. 3, 1997. For an earlier, highly regarded work discussing these measures, see Stephen J. Brown and Jerold B. Warner, "Using Daily Stock Returns: The Case of Event Studies," *Journal of Financial Economics* 14, 1985.

employee count (as of the end of 2010[136]) are above the median for the dataset. We also repeat the analysis comparing the bottom 10 percent of firms with all other firms.

- Regressions of CARs on the market capitalization and employee count as continuous variables, as well as industry and country dummies. We replicate this analysis using the logarithms of market capitalization and employment.
- We finally "stack" the observations to create a new dataset with six times as many observations, as every "firm-return" combination for each of six events is represented. The output gives a general market reaction among all key dates related to the law.

It is important to note that we run weighted least square (WLS) regressions to maximize the precision of our coefficients. We weight each observation by the inverse of the variance of the adjusted market returns in the year before the event window to down-weight companies that have exhibited substantial variation in returns prior to the event. In other words, we put greater weight on the abnormal returns in our event window from firms with stable stock prices over the past year, and less weight on firms with less stable stock prices over the past year. Our procedure is summarized in Exhibit 10.

Exhibit 10: AIA Event Study Procedure

Event	Leahy-Smith America Invents Act
Event Windows	Three- and five-day windows around six dates critical in the legislative history, as identified in Exhibit 9.
Selection Criteria	Patent intensive firms
Analysis of Event Impact	Scatterplots, t-tests, and weighted least square regressions with respect to market-model and market-adjusted abnormal returns

Methodological challenges and data limitations

Three data and methodological challenges limit robust interpretation of the results.

- Timing the anticipation of the market:

Proper selection of the "event window(s)" is a major challenge of regulatory event studies. G. William Schwert, who was one of the first academics to publish a regulatory event study,

[136] If these data for 2010 are not available, we use data for 2009. If 2009 data are also not available, we use data from 2011 or 2012.

cautioned that "[i]f regulation has implications for the value of securities, the effects of regulation are impounded into prices at the time when they are first anticipated."[137] Given that the effective date of a regulation typically follows a number of papers, hearings, and other legislative approvals, each of which increases the probability of enactment, the efficient market hypothesis suggests that the market will be adjusting stock prices along the way. As a result, it is difficult to determine the exact timing in the market's expectation of changes about the law's passage. Consistent with the literature, we therefore look at six different event dates around which we study market reactions, as noted in Exhibit 9. In addition, the effect also may have been masked by contemporaneous changes in the economic environment around the key dates of the law.

- Using the public market reaction to determine the impact of the law:

Given the complexity of the law (in terms of number of reforms and the subtlety of certain modifications), as well as public uncertainty regarding the courts' exact interpretation of key clauses, the market may not have correctly anticipated the law's collective impact on firms of different sizes.[138]

- Using public market data to study the impact on small businesses:

A major challenge of an event study analysis of this sort is the need to focus on firms that are publicly traded and patent intensive. The vast majority of small businesses (using criteria such as those with fewer than 500 employees) are privately held, and many of the publicly traded small businesses are not patent intensive (e.g., many software firms). Exhibit 11 reports the size distribution of our dataset.

[137] G. William Schwert, "Using Financial Data to Measure Effects of Regulation," *The Journal of Law and Economics* 121, 1981, p. 122.

[138] For example, much debate has surrounded the grace period provisions in 35 U.S.C. 102(b)(1) and 35 U.S.C. 102(b)(2). For a discussion of post-enactment clarifications of these (and other) provisions, see the *Federal Register* 77, no. 144, July 26, 2012, p. 43767; and *Federal Register* 78, no. 31, Feb. 14, 2013, p. 11061.

Exhibit 11: Descriptive Statistics of Event Study Dataset

Firm Size Percentile	Firm Size (number of employees)	Market Capitalization (billions of U.S. dollars)
1	98	0.207
5	731	1.103
10	1942	1.933
25	9336	5.577
50	36,450	15.981
75	93,500	41.474
90	179,232	108.673
95	260,100	173.636
99	410,000	238.785
Observations	172	217
Observations with Return Data	150-51	197-98

Exhibit 11 shows that the event study analysis leans heavily towards large companies, as, for example, a firm at the 25th percentile by employee count still had roughly 9,000 employees. At best, we therefore can only speak of differences in CARs between smaller and larger firms within the dataset. In addition, our dataset includes two listed PAEs (as noted in Appendix 1) – Rambus (390 employees/$2.3 billion market cap in 2010) and InterDigital (300 employees/$1.8 billion market cap in 2010).

Along the same lines, listed companies typically are not bound as intensively by the resource constraints that are said to disadvantage small businesses, as they have accessed the public markets at least once already. In other words, even if we had a dataset of "small" listed companies, they might not exhibit the very characteristics of private small businesses that academics and practitioners note when explaining why small businesses are disadvantaged by the law.

In light of these challenges, however, the collective analysis may still point towards a differential impact based on firm size. A clear difference of impact on "smaller" and "larger" firms within our dataset, for example, would suggest that the AIA had a significant impact on small businesses. Failure to find a substantial connection, however, does not imply that the AIA had no impact on small businesses.

6.2.4. Results

A. Firm Scale by Employment

Simple Regressions (T-tests)

We first run simple regressions (i.e., with no control variables) and code firms above the median employment as "larger," and firms below the median employment as "smaller." The regression is of the form:

$$(1)\ CAR_{id} = \beta_0 + \beta_1(largeremp_i) + \varepsilon_{id},$$

where "cumulative abnormal return" (CAR) is estimated separately for market model returns and market-adjusted returns for company (i) on each of the six key event dates (d) and "largeremp" equals one if the firm's employment is above the median level among the sample firms. The regression output (for β_1) is summarized in Exhibit 12.

The results show a negligible market reaction of the AIA for larger employee firms, relative to smaller employee firms. The relative CARs for the subset of larger firms by employee count had a slight boost after the Senate first passed the bill (Event 2), though they experienced a drop after the bill passed the House and then passed the Senate with the House amendments (Events 4 and 5). The enactment of the bill (Event 6) showed no statistically significant market response.

To focus more closely on the market reaction to the subset of the smallest firms in the sample, we replicate the above regression, this time defining small firms as those in the bottom 10 percent of our sample. The regression output (for β_1) is summarized in Exhibit 13.

Exhibit 12: Weighted Least Squares Analysis of Abnormal Returns for Firms with Employment Above the Median Level, Relative to Those with Smaller Employment (Below Median) for Key Dates Related to AIA

Dependent Variable: Cumulative Abnormal Returns				
	Market Model		**Market Adjusted**	
	3-Day Window	5-Day Window	3-Day Window	5-Day Window
Event 1: Feb. 3, 2011 **S. 23 Reported by Senate Judiciary Committee**	-0.0112 (-2.47)*	-0.0108 (-1.93)	-0.0122 (-2.59)*	-0.0164 (-2.73)**
Event 2: March 8, 2011 **S.23 Passed Senate**	0.0138 (3.40)**	0.0135 (2.58)*	0.0140 (3.37)**	0.0200 (3.49)**
Event 3: April 14, 2011 **H.R. 1249 Reported by House Judiciary Committee**	-0.0056 (-1.70)	-0.0030 (-0.71)	-0.0065 (-1.97)	0.0002 (0.04)
Event 4: June 23, 2011 **H.R. 1249 Passed House**	-0.0117 (-3.16)**	-0.0163 (-3.81)**	-0.0086 (-2.29)*	-0.0170 (-3.76)**
Event 5: Sept. 8, 2011 **H.R. 1249 Passed Senate**	-0.0152 (-4.13)**	-0.0267 (-4.48)**	-0.0151 (-4.04)**	-0.0282 (-4.60)**
Event 6: Sept. 16, 2011 **Enactment**	0.0039 (1.08)	0.0014 (0.30)	0.0035 (0.97)	0.0005 (0.12)
Industry Fixed Effects	No	No	No	No
Country Fixed Effects	No	No	No	No
Observations	150-151	150-151	150-151	150-151

t stat noted in parentheses
**** indicates significance at p < 0.05***
*****indicates significance at p < 0.01***

Note: All observations are weighted by the inverse of the variance of the adjusted market returns of the stock in the year before the event window.

Exhibit 13: Weighted Least Squares Analysis of Abnormal Returns for Firms with Employment in the Top 90 percent, Relative to Those with Smaller Employment (Bottom 10 percent) for Key Dates Related to AIA

Dependent Variable: Cumulative Abnormal Returns				
	Market Model		**Market Adjusted**	
	3-Day Window	5 Day Window	3-Day Window	5 Day Window
Event 1: Feb. 3, 2011 **S. 23 Reported by Senate Judiciary Committee**	-0.0139 (-1.25)	-0.0071 (-0.52)	-0.0145 (-1.41)	-0.0111 (-0.85)
Event 2: March 8, 2011 **S.23 Passed Senate**	0.0231 (2.21)*	0.0419 (3.20)**	0.0223 (2.40)*	0.0455 (3.62)**
Event 3: April 14, 2011 **H.R. 1249 Reported by House Judiciary Committee**	-0.0079 (-0.95)	-0.0013 (-0.12)	-0.0072 (-1.00)	0.0034 (0.36)
Event 4: June 23, 2011 **H.R. 1249 Passed House**	-0.0334 (-3.45)**	-0.0379 (-3.35)**	-0.0286 (-3.29)**	-0.0380 (-3.58)**
Event 5: Sept. 8, 2011 **H.R. 1249 Passed Senate**	-0.0212 (-2.08)*	-0.0415 (-2.51)	-0.0156 (-1.74)	-0.0336 (-2.28)*
Event 6: Sept. 16, 2011 **Enactment**	0.0109 (1.15)	0.0179 (1.46)	0.0105 (1.29)	0.0169 (1.67)
Industry Fixed Effects	No	No	No	No
Country Fixed Effects	No	No	No	No
Observations	150-151	150-151	150-151	150-151

t stat noted in parentheses
**** indicates significance at p < 0.05***
*****indicates significance at p < 0.01***

Note: All observations are weighted by the inverse of the variance of the adjusted market returns of the stock in the year before the event window.

Similar to those results shown in Exhibit 13, the refined regression shows a slightly positive relative market response for larger firms when the AIA first passed the Senate (Event 2) and a slightly negative relative market response to the AIA's passage in the House (Event 4). Though no statistically significant results are present for Event 6, the sign again switches at enactment. The output from this refined regression therefore gives ambiguous results, again pointing towards little, if any, differential impact.

Regressions with Additional Controls

To investigate further, we run another set of regressions with employment and (separately) log employment as *continuous* variables. The regression is of the form:

$$(2)\ CAR_{id} = \beta_0 + \beta_1(employment_i) + \beta_2(country_i) + \beta_3(industry_i) + \varepsilon_{id}$$

or

$$(3)\ CAR_{id} = \beta_0 + \beta_1(\ln(employment_i)) + \beta_2(country_i) + \beta_3(industry_i) + \varepsilon_{id},$$

where the CARs are analyzed separately for market model returns and market-adjusted returns for each company (i) on each of the six key event dates (d), "employment" is the total number of employees in thousands, "country" is a control based on the location of the firm's headquarters, and "industry" is a control based on the firm's SIC code (grouped at the two-digit level).

If there were a market perception that the AIA was better for larger businesses, we would expect the β_1 to be positive, while a negative β_1 would suggest the opposite market perception. The regression output is summarized in Exhibit 14. Panel A shows the market response with three-day and five-day windows for each key date, using employment as the key independent variable of interest (equation 2). Panel B reports similar figures for log employment (equation 3).

The results suggest a minimal differential impact based on firm size. Consistent with the above regressions, the output for Panel A show no consistent trend in the market reaction for smaller versus larger firms. Whereas Event 2 suggests that, holding all else constant, CARs increased as company size increased, the sign flips for Events 4 and 5 (i.e., CARs decreased as company size increased). The coefficient sign switches back to positive for Event 6. Collectively, the results suggest that the market was ambivalent to the impact of the AIA on firms with respect to their size.

Exhibit 14: Weighted Least Squares Analysis of Abnormal Returns by Employment Level (in Thousands) for Key Dates Related to the AIA

Dependent Variable: Cumulative Abnormal Returns								
	Panel A: Employment				**Panel B: Log Employment**			
	Market Model		**Market Adjusted**		**Market Model**		**Market Adjusted**	
	3-Day Window	*5-Day Window*	*3-Day Window*	*5-Day Window*	*3-Day Window*	*5-Day Window*	*3-Day Window*	*5-Day Window*
Event 1: Feb. 3, 2011 **S. 23 Reported by Senate Judiciary Committee**	-0.000034 (-1.23)	-0.000034 (-1.03)	-0.000039 (-1.27)	-0.000052 (-1.40)	-0.0031 (-1.77)	-0.0027 (-1.24)	-0.0033 (-1.81)	-0.0035 (-1.55)
Event 2: March 8, 2011 **S.23 Passed Senate**	0.000093 (4.24)**	0.000083 (2.77)**	0.00010 (4.18)**	0.00012 (3.43)**	0.0068 (4.80)**	0.0089 (4.78)**	0.0064 (4.44)**	0.0102 (5.27)**
Event 3: April 14, 2011 **H.R. 1249 Reported by House Judiciary Committee**	-0.000031 (-1.58)	-0.000007 (-0.28)	-0.000038 (-1.80)	-0.000005 (-0.19)	-0.0017 (-1.29)	0.0002 (0.14)	-0.0019 (-1.49)	0.0005 (0.30)
Event 4: June 23, 2011 **H.R. 1249 Passed House**	-0.000012 (-0.54)	-0.000046 (-1.78)	0.0000014 (0.06)	-0.000052 (-1.86)	-0.0038 (-2.71)**	-0.0057 (-3.47)**	-0.0032 (-2.35)*	-0.0064 (-3.88)**
Event 5: Sept. 8, 2011 **H.R. 1249 Passed Senate**	-0.000056 (-2.37)*	-0.00010 (-2.80)**	-0.000054 (-2.13)*	-0.000110 (-2.68)**	-0.0049 (-3.28)**	-0.0093 (-4.01)**	-0.0043 (-2.88)**	-0.0089 (-3.76)**
Event 6: Sept. 16, 2011 **Enactment**	0.000047 (2.11)*	0.000064 (2.28)*	0.000033 (1.42)	0.000045 (1.53)	0.0038 (2.71)**	0.0049 (2.72)**	0.0032 (2.35)*	0.0040 (2.30)*
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	150-151	150-151	150-151	150-151	150-151	150-151	150-151	150-151

t stat noted in parentheses
**** indicates significance at p < 0.05***
*****indicates significance at p < 0.01***

Note: All observations are weighted by the inverse of the variance of the adjusted market returns of the stock in the year before the event window.

B. Firm Scale by Market Capitalization

Simple Regressions (T-tests)

We repeat our AIA event study analysis by changing the metric by which we measure firm size from employment to market capitalization. We first run simple regressions and mark firms above the median market cap as "larger," and firms below the median market cap as "smaller." The regression is of the form of either:

$$(4) CAR_{id} = \beta_0 + \beta_1(largermktcap_i) + \varepsilon_{id},$$

where "cumulative abnormal return" (CAR) is run separately for market model returns and market-adjusted returns for company (i) on each of the six key event dates (d) and "largermktcap" equals one if the firm had a market capitalization which was above the median for the sample population in 2010. The regression output is summarized in Exhibit 15.

The results in Exhibit 15 are qualitatively similar to our output for firm size by employment. The data suggest that around Event 2, the CARs for larger firms were higher than for smaller firms on average. The sign then switches for Events 4 and 5, suggesting a negative market reaction among larger firms. At Event 6, we observe mostly non-significant results, though the sign switches back to positive.

Looking more closely into the market reaction to the subset of "small" firms, we replicate the above regression, this time defining small firms as those in the bottom 10 percent of our sample. The regression output is summarized in Exhibit 16. Still, the flip-flop in positive and negative reactions suggests no major, or definitive, market response.

Exhibit 15: Weighted Least Squares Analysis of Abnormal Returns for Firms with Market Capitalization Above the Median Level, Relative to Those with Smaller Market Capitalization (Below Median) for Key Dates Related to AIA

Dependent Variable: Cumulative Abnormal Returns				
	Market Model		Market Adjusted	
	3-Day Window	5-Day Window	3-Day Window	5-Day Window
Event 1: Feb. 3, 2011 **S. 23 Reported by Senate Judiciary Committee**	-0.0104 (-2.48)*	-0.0068 (-1.33)	-0.0129 (-2.91)**	-0.0186 (-3.37)**
Event 2: March 8, 2011 **S.23 Passed Senate**	0.0124 (2.66)**	0.01136 (2.17)*	0.0154 (3.17)**	0.0256 (4.56)**
Event 3: April 14, 2011 **H.R. 1249 Reported by House Judiciary Committee**	-0.0031 (-1.05)	-0.0005 (-0.13)	-0.0057 (-1.92)	0.0053 (1.28)
Event 4: June 23, 2011 **H.R. 1249 Passed House**	-0.0147 (-4.57)**	-0.0178 (-4.57)**	-0.0077 (-2.31)*	-0.0203 (-4.94)**
Event 5: Sept. 8, 2011 **H.R. 1249 Passed Senate**	-0.0118 (-3.39)**	-0.0179 (-3.15)**	-0.0088 (-2.48)*	-0.0141 (-2.38)*
Event 6: Sept. 16, 2011 **Enactment**	0.0064 (1.79)	0.0108 (2.35)*	0.0058 (1.60)	0.0082 (1.80)
Industry Fixed Effects	No	No	No	No
Country Fixed Effects	No	No	No	No
Observations	197-198	197-198	197-198	197-198

t stat noted in parentheses
**** indicates significance at p < 0.05***
*****indicates significance at p < 0.01***

Note: All observations are weighted by the inverse of the variance of the adjusted market returns of the stock in the year before the event window.

Exhibit 16: Weighted Least Squares Analysis of Abnormal Returns for Firms with Market Capitalization in the Top 90 percent, Relative to Those with Smaller Market Capitalization (Bottom 10 percent) for Key Dates Related to AIA

Dependent Variable: Cumulative Abnormal Returns				
	Market Model		Market Adjusted	
	3-Day Window	5-Day Window	3-Day Window	5-Day Window
Event 1: Feb. 3, 2011 **S. 23 Reported by Senate Judiciary Committee**	-0.0189 (-1.73)	-0.0252 (-1.92)	-0.0200 (-1.94)	-0.0318 (-2.48)*
Event 2: March 8, 2011 **S.23 Passed Senate**	0.0178 (1.43)	0.0253 (1.81)	0.0179 (1.54)	0.0353 (2.59)*
Event 3: April 14, 2011 **H.R. 1249 Reported by House Judiciary Committee**	0.0056 (0.73)	0.0116 (1.14)	0.0023 (0.34)	0.0185 (1.95)
Event 4: June 23, 2011 **H.R. 1249 Passed House**	-0.0298 (-3.44)**	-0.0393 (-3.77)**	-0.0216 (-2.73)**	-0.0411 (-4.08)**
Event 5: Sept. 8, 2011 **H.R. 1249 Passed Senate**	-0.0126 (-1.38)	-0.0325 (-2.20)*	-0.0051 (-0.62)	-0.0209 (-1.52)
Event 6: Sept. 16, 2011 **Enactment**	0.0152 (1.67)	0.0287 (2.46)*	0.0122 (1.48)	0.0247 (2.38)*
Industry Fixed Effects	No	No	No	No
Country Fixed Effects	No	No	No	No
Observations	197-198	197-198	197-198	197-198

t stat noted in parentheses
**** indicates significance at p < 0.05***
*****indicates significance at p < 0.01***

Note: All observations are weighted by the inverse of the variance of the adjusted market returns of the stock in the year before the event window.

Regressions with Additional Controls

To investigate further, we run another set of regressions with market capitalization and the logarithm of market capitalization as continuous variables. The regressions are of the form:

$$(5) CAR_{id} = \beta_0 + \beta_1(mktcap_i) + \beta_2(country_i) + \beta_3(industry_i) + \varepsilon_{id} \ ,$$

or

$$(6) CAR_{id} = \beta_0 + \beta_1(\ln(mktcap_i)) + \beta_2(country_i) + \beta_3(industry_i) + \varepsilon_{id},$$

where "cumulative abnormal return" (CAR) is estimated separately for market model returns and market-adjusted returns for companies (i) on each of the six key event dates (d), "mktcap" is the company's market capitalization in billions, "country" is a control based on the firm's headquarters, and "industry" is a control based on the firm's SIC code (grouped at the two-digit level).

The regression output for β_1 is summarized in Exhibit 17. Panel A shows the market response with three-day and five-day windows for each key date using market capitalization as the key independent variable of interest (equation 5). Panel B reports similar analyses using log employment (equation 6).

The results in Exhibit 17 appear roughly consistent with those in Exhibit 14, suggesting minimal differential impact with regard to firm size. In contrast to Exhibit 14, however, Event 4 appears to have generated the sharpest market response, as it is the only row with all statistically significant results. The data for Event 4 suggest a negative relative response for large firms, holding all else constant. Again, the sign reverses with the enactment (Event 6), which shows a slightly positive relative response for larger firms.

Exhibit 17: Weighted Least Squares Analysis of Abnormal Returns by Market Capitalization (in USD billions) for Key Dates Related to AIA

Dependent Variable: Cumulative Abnormal Returns								
	Panel A: Market Capitalization				Panel B: Log Market Capitalization			
	Market Model		Market Adjusted		Market Model		Market Adjusted	
	3-Day Window	*5-Day Window*	*3-Day Window*	*5-Day Window*	*3-Day Window*	*5-Day Window*	*3-Day Window*	*5-Day Window*
Event 1: Feb. 3, 2011 **S. 23 Reported by Senate Judiciary Committee**	-0.00004 (-1.31)	0.00002 (0.55)	-0.00005 (-1.39)	-0.00003 (-0.68)	-0.0033 (-1.98)	-0.0017 (-0.87)	-0.0036 (-2.10)*	-0.0043 (-2.02)*
Event 2: March 8, 2011 **S.23 Passed Senate**	0.00004 (1.01)	0.000006 (0.15)	0.00005 (1.22)	0.00008 (1.67)	0.0038 (2.13)*	0.0040 (1.95)	0.0042 (2.29)*	0.0074 (3.53)**
Event 3: April 14, 2011 **H.R. 1249 Reported by House Judiciary Committee**	-0.00002 (-0.96)	-0.00002 (-0.76)	-0.00003 (-1.40)	-0.000004 (-0.13)	-0.0005 (-0.46)	0.00042 (0.28)	-0.0011 (-0.96)	0.0014 (0.88)
Event 4: June 23, 2011 **H.R. 1249 Passed House**	-0.00009 (-3.86)**	-0.00007 (-2.32)*	-0.00005 (-2.15)*	-0.00007 (-2.24)*	-0.0057 (-5.00)**	-0.0057 (-4.01)**	-0.0039 (-3.25)**	-0.0063 (-4.16)**
Event 5: Sept. 8, 2011 **H.R. 1249 Passed Senate**	-0.00002 (-0.80)	-0.00001 (-0.27)	-0.00001 (-0.34)	0.00001 (0.21)	-0.0022 (-1.64)	-0.0022 (-1.02)	-0.0010 (-0.72)	-0.00078 (-0.35)
Event 6: Sept. 16, 2011 **Enactment**	0.00005 (1.84)	0.00008 (2.38)*	0.00004 (1.52)	0.00006 (1.72)	0.0033 (2.60)*	0.0049 (2.89)**	0.0029 (2.20)*	0.0039 (2.24)*
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	197-198
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	197-198	197-198	197-198	197-198	197-198	197-198	197-198	Yes

t stat noted in parentheses
**** indicates significance at p < 0.05***
*****indicates significance at p < 0.01***

Note: All observations are weighted by the inverse of the variance of the adjusted market returns of the stock in the year before the event window.

6.2.5. Combining the Events

Rather than separately looking at each event and comparing results around each date, we also look at the overall market response to the six events collectively.

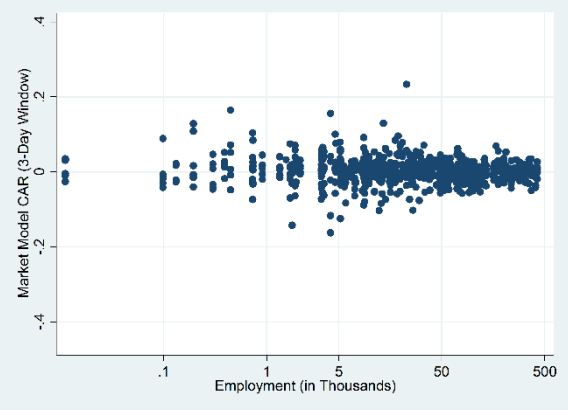
A. Qualitative Overview

We first consider another set of scatter plots of the CARs by employee levels/market capitalizations among all six key events together. Any differential market response would be indicated by a drop or hike in CARs for smaller or larger firms. It is important to note that the scatterplots show CARs for *each* of the key event dates, such that each firm is represented by six points on the graph. Exhibit 18 shows *market model* CARs for the three-day window for both employment and market capitalizations.

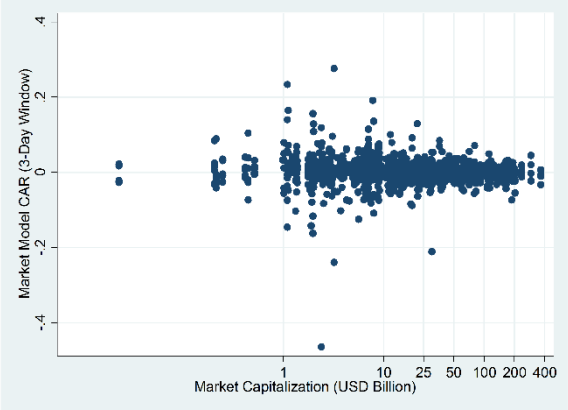
The graphs fail to show apparent return differences among smaller versus larger firms, as the data shows no clear pattern. The CARs for smaller firms seem to be roughly in line with those of larger firms.

Exhibit 18: Scatterplots of Market Model Returns for a Three-Day Window Around the Six Key Event Days, by Employment and Market Cap.

Market model CARs by employee count for 3-day window around key events



Market model CARs by market capitalization for 3-day window around key events



B. Simple Regressions (T-tests)

We run the stacked data using regression equations (1) and (4), with the exception that the CAR for all key dates are taken into account, rather than running the regression for each date individually. The results are summarized in Exhibit 19. The results for this stacked data suggest a statistically significant negative market reaction for larger firms by employment, holding all else constant. Using market capitalization, the coefficients are not statistically significant, except for the three-day window market model returns.

Exhibit 19: Weighted Least Squares Analysis of Abnormal Returns for Firms with Market Cap/Employment Above the Median Level, Relative to Those with Smaller Market Cap/Employment (Below Median) for All Key Dates Related to AIA

Dependent Variable: Cumulative Abnormal Returns				
	Market Model		Market Adjusted	
	Employment	Market Cap	Employment	Market Cap
3-Day Window	-0.0044 (-2.76)**	-0.0036 (-2.33)*	-0.0042 (-2.59)**	-0.0025 (-1.54)
5-Day Window	-0.0071 (-3.35)**	-0.0035 (-1.78)	-0.0069 (-3.13)**	-0.0028 (-1.34)
Industry Fixed Effects	No	No	No	No
Country Fixed Effects	No	No	No	No
Event Date Controls	No	No	No	No

t stat noted in parentheses
**** indicates significance at p < 0.05***
*****indicates significance at p < 0.01***

Note: All observations are weighted by the inverse of the variance of the adjusted market returns of the stock in the year before the event window.

We redefine "smaller" using our more restrictive definition (i.e., only firms below the 10 percentile rank in our dataset in employment and market capitalization) and compare results. The results are shown in Exhibit 20. Under the more restrictive definitions, we find no statistically significant differential market reaction to smaller or larger firms in our dataset.

Exhibit 20: Weighted Least Squares Analysis of Abnormal Returns for Firms with Market Capitalization/Employment in the Top 90 percent, Relative to Those with Smaller Market Capitalization/Employment (Bottom 10 percent) for All Key Dates Related to AIA

Dependent Variable: Cumulative Abnormal Returns				
	Market Model		Market Adjusted	
	Employment	Market Cap	Employment	Market Cap
3-Day Window	-0.0071 (-1.74)	-0.0041 (-1.00)	-0.0058 (-1.60)	-0.0030 (-0.79)
5-Day Window	-0.0043 (-0.80)	-0.0057 (-1.09)	-0.0027 (-0.55)	-0.0035 (-0.71)
Industry Fixed Effects	No	No	No	No
Country Fixed Effects	No	No	No	No
Event Date Controls	No	No	No	No

t stat noted in parentheses
**** indicates significance at p < 0.05***
*****indicates significance at p < 0.01***

Note: All observations are weighted by the inverse of the variance of the adjusted market returns of the stock in the year before the event window.

C. Regressions with Additional Controls

In unreported analysis, we re-run the earlier regression with all key dates taken into account together, rather than running the regression for each date individually. We re-estimate the CAR by employee counts and market capitalization by "stacking" the data by window period to observe an "overall" market reaction, with fixed effects for country and industry, as well as event date controls. The results point strongly in the direction of minimal, if any, return differences between larger and smaller businesses as a result of the AIA. Neither output shows statistically significant results.[139]

6.2.6. Conclusion

Our event study of the market reaction to publicly traded patent intensive companies found a minimal differential impact of the AIA on firm size within our sample. Across our regressions, we tend to find positive and statistically significant results around Event 2, negative and statistically significant results around Event 4, and some evidence of positive and statistically significant coefficients around Event 6. While the flip-flop in sign could be attributable to

[139] We also re-ran these analyses with standard errors clustered at (a) industry and (b) country levels and again (in each case) find no systematic pattern in returns with respect to either market capitalization or employment.

differences in the bills themselves — from the Senate bill (S.23) to the House bill (H.R. 1249) to public law (Pub. Law 112-29) — we suggest that it likely reflects "noise" in the market that our model was not able to capture. The major reforms (such as the FITF provision) were largely consistent across the bills, especially those that would likely have a material differentiated impact on smaller and larger firms in our sample. In other words, without consistent results across the six events, our analysis suggests no differentiated impact for larger versus smaller firms in our sample. In addition, when we examine results across all six events in combined regressions, most evidence again points to minimal differentiated market reaction to smaller versus larger firms on the dataset. Collectively, we therefore find no definitive market reaction for firms of different sizes within our sample around key dates related to the AIA.

Because our dataset is not necessarily representative of the population of patent-intensive "small" firms (due to the limitations of using public market data), our conclusions must be interpreted cautiously. Moreover, the very nature of publicly traded companies (i.e., able to raise capital on public markets), may mask the impact of the financial constraints faced by private, patent-intensive small businesses which the AIA might exacerbate. The complexity of the many reforms, as well as public uncertainty surrounding how courts will interpret these reforms, also could have contributed to an overall market reaction that incorrectly anticipated the law's impact on small businesses. We now turn to look more closely at privately held businesses by examining how the venture capital community responded to the AIA.

6.3. Venture Capital Financing Study of the AIA's Impact on Small Businesses

6.3.1. Executive Summary

We conducted a study to explore how the venture capital (VC) community reacted to the AIA. We match data on patent grants by industry from the USPTO with quarterly VC financing data in the United States and Europe to track whether the proportion of VC financing going to patent-intensive industries shifted in response to the AIA in the United States, relative to Europe.

Overall, we fail to find any significant change in the proportion of VC deals or the dollars invested by VC firms in industries highly reliant on patents from before the enactment of the AIA (i.e., prior to Q1 2011) to post enactment (i.e., after Q3 2011). We check the robustness of the results in two ways: (a) we restrict our analysis to just seed and early stage VC investments, and (b) we change our "post-AIA" period to the effective date of the FITF provision (i.e., after Q1 2013). In addition, we investigate whether any movement in the proportion of deals among industries in patent-intensive categories occurred, and we fail to find substantial change. Each test, with few exceptions, further supports the hypothesis that the VC community continued to go about "business as usual" in the aftermath of the adoption of the AIA.

6.3.2. Introduction

Venture capital is intricately related to small businesses and patenting. The significance of patents to VC firms is highlighted in the 2008 Berkeley Patent Survey, which, as discussed on page 11, surveyed startups (founded in 1998 or after) in the biotechnology, medical device, software and hardware/IT sectors. The researchers found that almost all VC-backed companies in certain industries held patents or had applied for them (97 percent of biotechnology companies, 94 percent of medical device companies, and 91 percent of IT hardware companies), as did large shares of other industries (67 percent of software/internet companies).[140] Given that the National Venture Capital Association (NVCA) reported that roughly 89 percent of all deals in 2013 took place in the information technology and medical/health/life sciences spaces, patents seem to play a key role in VC financing.[141] In addition, the academic literature offers a theoretical basis for the significance that venture capitalists place on patents held by prospective

[140] Graham, et al., "Results of the 2008 Berkeley Patent Survey."
[141] See Figure 5 from National Venture Capital Association Yearbook 2014, p. 12.

portfolio companies, indicating that patents serve as various "signals" from young firms, as discussed in Section 3.[142]

Furthermore, research suggests that patenting activity does not stop after the deal is closed. One study looked at the patenting activity within 20 manufacturing industries between 1965 and 1992 and found that one dollar of venture funding generates as much patenting activity as roughly three dollars of traditional corporate R&D spending.[143] The authors also found that among 122 VC-backed and 408 non-VC-backed companies based in Massachusetts, VC-backed patents also tended to be of higher quality, as evidenced by the fact that they are cited and litigated more frequently than patents from non-venture-backed firms.[144]

In addition, VC firms invest in small companies. We find that among U.S. VC deals from 2009 to 2013 roughly 33 percent were in companies with 50 or fewer employees, 51 percent were in companies with 100 or fewer employees, and 86 percent were in companies with 500 or fewer employees.[145]

Because venture capitalists generally invest in smaller companies that tend to rely on and produce patents, examining VC investment in patent-heavy sectors provides an immediate and measurable metric by which we can examine the effects of the AIA.

In this section of the study, we identify patent-intensive industries and compare patterns in VC financing in those industries before and after the policy change. Our methodology is detailed below:

- First, we rank industries according to their number of issued patents for the five years prior to the enactment of the AIA (i.e., 2006-2010). Since the businesses in these industries are directly affected by the AIA's policy changes, they are the focus of this analysis.

[142] For a literature review of the informational role of patents to VCs, see Cao and Hsu, "Patents in Venture Capital Financing."
[143] Sam Kortum and Josh Lerner, "Assessing the Contribution of Venture Capital to Innovation," *Rand Journal of Economics* 31, 2000, p. 691
[144] Kortum and Lerner, "Assessing the Contribution of Venture Capital," 674-92.
[145] U.S. companies defined as those with a U.S. head office. Statistics based only on those deals with disclosed employee counts. VC deals include startup/seed, early, expansion, and later stage deals or any non-venture-stage investment made by traditionally venture focused firms. The respective figures for the subset for VC-stage deals are 34 percent, 53 percent, and 90 percent. VentureXpert data, accessed Oct. 29, 2014.

- Second, we compile data from the Thomson Reuters VentureXpert database (now Thomson ONE) on financings within both patent-intensive (broken down into "patent-super-heavy" and "patent-heavy") and patent-light subsectors. We collect data for each quarter over the past 10 years, from Q1 2004 through Q2 2014.
- Third, we analyze the patterns in VC financing — specifically, deal counts and investment dollars — before and after the AIA for both the United States and Europe.
- Finally, we extend our analysis in three ways to check for robustness of our results. We (a) narrow the scope of VC to only seed and early stage, (b) change our "post-AIA" period from post-enactment (Q4 2011) to post effective date for the new FITF priority rules (Q2 2013), and (c) check for any noticeable shifts in the proportion of deals within the patent-super-heavy and patent-heavy categories.

Changes in the VC financing patterns before and after the AIA for industries exhibiting high patent rates would reflect the impact of the AIA on the ability of high-potential startup firms to attract VC funding—and thus on their potential viability, as judged by experienced investors. A relative increase in VC investments in the patent-intensive industries would indicate that the new policies have benefited small high-potential businesses, while a decrease would indicate that these firms are perceived to be disadvantaged by the new policies.

The changes above, however, could reflect the changing interest of venture investors in particular sectors. Therefore, the patterns of VC financing of European firms serve as a control group against which the American trends can be benchmarked. European businesses should show less impact from the AIA's changes, as almost all firms on the continent initially file for patents in Europe, which has long had a "first to file" system. By examining the relative changes in VC financing patterns between these two regions, we can roughly isolate shocks caused by the AIA from those caused by other exogenous factors.

We thoroughly examine and analyze the data to find patterns that might indicate significant impacts of the AIA policy changes. Calling on our familiarity with venture capital trends and practices, we put these patterns in context and draw conclusions to the extent allowed by the data.

6.3.3. Methodology and Data

Patent data for this study has been obtained from the Patent Technology Monitoring Team (PTMT) of the USPTO, which utilizes a database composed of 5.4 million U.S. utility patent[146] grants since 1963. In 2012, the PTMT released updated statistics that aggregate patent grants within 26 distinct North American Industry Classification System (NAICS) manufacturing categories.[147] The PTMT uses a concordance between the U.S. Patent Classification System (USPC) categories to assign a NAICS industry code to each patent.[148] Our classification of industries is based only on granted U.S. patents owned by U.S. corporations.[149]

We analyze trends in VC financing by grouping industries into three categories based on the number of patents granted in the five years prior to the AIA enactment (2006-2010): (a) "patent-super-heavy," (b) "patent-heavy" and (c) "patent-light" manufacturing industries.

We define our industry categories as follows:

- Patent-super-heavy: Industries in the top 20 percent of patent grant counts.
- Patent-heavy: Industries contributing above the median amount, but below the top 20 percent.
- Patent-light: Industries contributing below the median amount.

[146] Utility patents are "[i]ssued for the invention of a new and useful process, machine, manufacture, or composition of matter, or a new and useful improvement thereof." See, http://www.uspto.gov/web/offices/ac/ido/oeip/taf/patdesc.htm, accessed April 22, 2015.

[147] Patent applications, rather than patent grants, may provide a clearer picture of the importance of patents within different industry groups, as patent grants are often issued roughly 32 months on average after filing at the USPTO. The USPTO, however, only reports industry patent counts by the year in which the patents were granted. Because many patents filed post-2004 were still pending at year-end 2012, the USPTO estimates that utility patent data distributed by the year of application is roughly 89 percent complete for 2005, 80 percent complete for 2006, 67 percent complete for 2007, 49 percent complete for 2008, 26 percent complete for 2009, and 19 percent complete for 2010. For more information, see http://www.uspto.gov/web/offices/ac/ido/oeip/taf/naics/doc/naics_info.htm, accessed July 7, 2014.

[148] It is important to note that because of substantial differences between the classification systems, the USPTO often assigns USPC classifications to multiple NAICS categories. We utilize a "fractional count" table that proportionally divides patent counts among the matched NAICS categories, such that a single patent matched with three NAICS categories counts as a third of a patent in each of the associated NAICS categories. The fractional count table avoids confusion in the number and scale of patent grants, as in a "whole count" table one patent matched with three NAICS categories counts as a whole patent in each of the associated categories. Because the fractional count table does not count the same patent multiple times, the USPTO recommends a fractional count table for most general analyses.

[149] The ownership category is based on the first-named assigned owner at the time of the grant. Determination of which corporations are considered domiciled in the United States is determined by the address provided at the time of the grant for the first-named assignee.

For a list of the industries within each category, along with their respective share of total U.S. corporate patent grants, see Appendix 3.

We utilize the Thomson Reuters VentureXpert database to match the NAICS classifications used by the USPTO with quarter-by-quarter VC activity in the United States and Europe.[150] We limit our dataset to deals over the past 10 years, from Q1 2004 to Q2 2014 (the most recent data available). We also provide statistics for the subset of our sample used in our regression analysis (Q1 2008 - Q2 2014). Descriptive statistics for the dataset are summarized in Exhibit 21. See Appendix 3 for additional sample statistics for the breakdown of deals and equity invested by the level of patent intensity of the industry.

Exhibit 21: Descriptive Statistics for VC Financing Dataset

Date range	Q1 2004 - Q2 2014
Type of Private Equity	Venture Capital[a]
Industries	Manufacturing only, matched from USPTO[b]
No. of European Deals *Subset: Q1 2008 - Q2 2014*	6,962 *3,481*
No. of U.S. Deals *Subset: Q1 2008 - Q2 2014*	17,026 *10,446*
Equity ($B)[c] from European Deals *Subset: Q1 2008 - Q2 2014*	34.38 *22.10*
Equity ($B) from U.S. Deals *Subset: Q1 2008 - Q2 2014*	143.18 *78.96*

a. Our VentureXpert search specifically examined "companies involved in venture capital deals," which is composed of all "venture-related investments." Venture-related investments include startup/seed, early, expansion, and later stage deals, and any non-venture stage investment made by traditionally venture focused firms. From 2008 to 2013, the median quarterly percentage of VC-stage deals in our dataset (i.e., excluding non-venture stage investments made by traditionally venture focused firms) was roughly 87 for Europe and 75 for the United States. During this same time period, the median quarterly percentage of VC-stage equity invested was roughly 89 for Europe and 84 for the United States.

b. The USPTO only classifies utility patents among industries in the manufacturing sector (NAICS codes 31-33). The analysis is restricted to the manufacturing sector to properly match VC financing with the industry groups.

c. Equity invested used instead of total deal size due to greater data availability.

[150] U.S. and European VC activity is defined as VC deals in all companies whose head office is respectively located in the United States and Europe. It is important to note that the VC financing reflects only that activity in the NAICS-coded industry groups as identified by the USPTO.

We explore the changes in the *share* of VC financing among the three industry groups, relative to Europe, from the pre-AIA period (i.e., before the bill passed the Senate in March 2011) to post-AIA (i.e. after the enactment in September 2011).[151]

To capture the AIA's impact on VC financing, we run "difference-in-differences" (DiD) regressions, which is a popular technique that economists use to measure the impact of a law on a particular group. DiD analyses attempt to isolate the impact of a policy change with respect to some variable of interest (i.e., wages, employment levels, or, in this case, VC financing) on some group exposed to the law change (i.e., the "treatment group"). To avoid "noise" from temporal or macroeconomic trends not related to the policy, DiD analyses employ a "control group" that (a) exhibits similar trends with respect to the variable of interest, but (b) was either immune or not exposed to the law. The control group roughly represents the growth pattern with respect to the variable of interest that the treatment group would have exhibited had the law not been enacted. We subtract out the changes that also occurred in the control group, thereby isolating the relative changes between the two groups that can roughly be attributed to the law. For a more detailed explanation of DiD analyses with examples from classic studies employing this technique, see Appendix 2.

It is important to note that in any "difference-in-differences" model we ideally would like to see "parallel paths"[152] between the treatment group and the control group. In this case, the parallel paths assumption would suggest that the difference in the proportion of VC financing going to each industry category between the United States (the treatment group) and Europe (the control group) followed a consistent trend before the AIA. Perfectly parallel paths in the pre-AIA period, for example, would generate the most precise DiD estimate in response to the change. The model also requires that no other factor, outside of the AIA, significantly affected the proportion of VC financing going to each of the industry categories during the sample period. We examine the soundness of using a DiD analysis to help determine the net effect of the AIA on VC financing in the United States in Appendix 3.

[151] See Exhibit 9 in the Event Study for a list of key AIA dates.
[152] See Ricardo Mora and Iliana Reggio, "The Often (Unspoken) Assumptions Behind the Difference-in-Difference Estimator in Practice," [Blog post], *The World Bank*, Nov. 21, 2013.

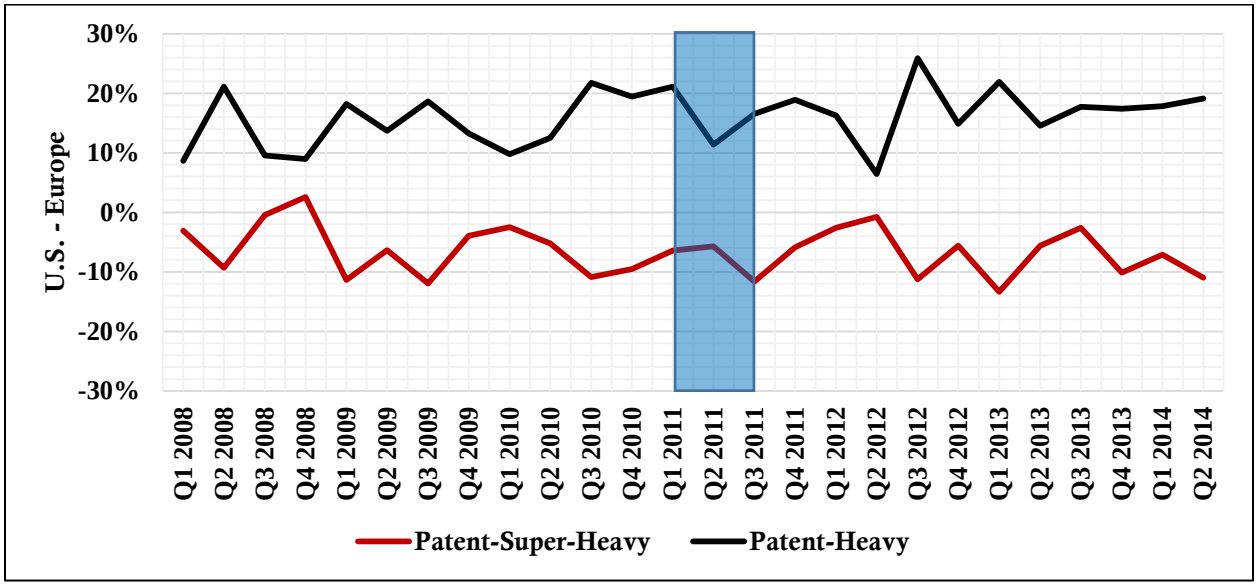
6.3.4. Results

A. The Impact of the AIA on VC Deals[153]

A.1. Qualitative Overview

Exhibit 22 gives a visual representation of this DiD analysis to illustrate the VC environment for patent-super-heavy and patent-heavy industries. The graph shows the *difference* in the relative share of VC deals for patent-super-heavy (red line) and patent-heavy (black line) industries over the sample period; the blue bar covers all six of the "key dates" associated with the act from Q1 2011 to Q3 2011. If the VC community believed that the AIA would dampen the probability of success for small firms, the lines would likely *drop* substantially, as fewer deals would occur for these types of companies in the United States relative to Europe. The graph clearly shows that the relative share of VC financing going to patent-super-heavy and patent-heavy industries appears relatively unchanged.

Exhibit 22: Difference in Percentage of Total VC Deals Going to Patent-Intensive Industries for the United States and Europe, Q1 2008 - Q2 2014



Source: VentureXpert, accessed July 16, 2014. The blue bar covers all six of the key dates associated with the AIA from Q1 2011 to Q3 2011.

[153] As noted previously, our dataset is primarily composed of VC-stage investments, but also includes any non-venture stage deals in which traditionally venture focused firms participated.

A.2. Quantitative Analysis

Exhibit 23 reports summary information on how the relative share of VC deals has fluctuated since 2008 in the three industry groups. Columns I and II report the proportion of deals for the United States and Europe, respectively. Column III shows the difference in the proportion of these deals between the two regions. Bolded numbers are the "difference-in-differences" (DiD) estimators and hint at the net effect of the AIA. We subsequently test for statistical significance in the regressions, with output displayed in Exhibit 24.

Exhibit 23: Average Percentage of VC Deals in Patent-Intensive and Patent-Light Manufacturing Industries, Pre- and Post-AIA

	(I) United States	(II) Europe	(III) Difference (United States – Europe)
Deals in patent-super-heavy industries as percentage of all industries			
Pre-AIA (Q1 2008 – Q4 2010)	38.23	44.24	-6.01
Post-AIA (Q4 2011-Q2 2014)	37.44	44.34	-6.90
Difference (Post – Pre)	-0.80	0.10	**-0.90**
Deals in patent-heavy industries as percentage of all industries			
Pre-AIA (Q1 2008 – Q4 2010)	52.74	38.12	14.63
Post-AIA (Q4 2011-Q2 2014)	54.38	37.02	17.36
Difference (Post – Pre)	1.63	-1.10	**2.73**
Deals in patent-light industries as percentage of all industries			
Pre-AIA (Q1 2008 – Q4 2010)	9.02	17.64	-8.62
Post-AIA (Q4 2011-Q2 2014)	8.19	18.64	-10.46
Difference (Post – Pre)	-0.84	1.00	**-1.84**

As suggested by Exhibit 22, the data reveal minimal change in VC deals in the United States following the AIA's passage. While the share of deals in patent-super-heavy industries in the United States dropped from 38.23 percent to 37.44 percent, the share in Europe rose from 44.24

percent to 44.34 percent. In other words, the spread between relative shares of VC deals going to the industries with the highest rate of patenting (i.e., the DiD estimator) decreased by just 0.9 percent relative to Europe. In patent-heavy industries, the United States saw a slight increase in VC deals, while Europe saw a slight decrease.

To add a higher degree of rigor and test the statistical significance of the mean differences in the proportion of VC deals between the United States and Europe from the pre-AIA period to the post-AIA period for each industry category, we run the DiD regression:

$$VC\ Deals_{ct} = \alpha + \beta_1(U.S._C) + \beta_2(Post\ AIA_t) + \beta_3(U.S._C * Post\ AIA_t) + \varepsilon_{Ct}\ ,$$

where $VC\ Deals_{ct}$ is the share of total deals for each country (c) and time period (t), by industry group, from Q1 2008 to Q2 2014; "U.S." is a dummy variable that equals one for U.S. deals; and "Post-AIA" is a dummy variable that equals one for all deals (irrespective of region) that occurred after the enactment of the AIA (Q4 2011-Q2 2014) and equals zero for all deals before the AIA was reported by the Senate Judiciary Committee (Q1 2008-Q4-2010). The coefficient β_3 on "U.S. * Post-AIA" will therefore be the DiD estimator. The regression output by industry group is summarized in Exhibit 24.

Exhibit 24: OLS DiD Regression: Impact of AIA on VC Deals in Each Industry Category, Pre- and Post-AIA

	Patent-Super-Heavy	Patent-Heavy	Patent-Light
Intercept (α)	0.4424	0.3812	0.1764
	(45.12)**	(34.82)**	(23.44)**
U.S. (β_1)	-0.0601	0.1463	-0.0862
	(-4.33)**	(9.45)**	(-8.10)**
Post-AIA (β_2)	0.0010	-0.0110	0.0100
	(0.07)	(-0.69)	(0.92)
U.S.*Post-AIA(β_3)	**-0.0090**	**0.0273**	**-0.0184**
	(-0.45)	**(1.22)**	**(-1.19)**

t stat noted in parenthesis
** indicates significance at p < 0.05*
*** indicates significance at p < 0.01*

Note: Autocorrelation checked by a standard Durbin-Watson (DW) analysis. The DW statistic (2.4) for patent-super-heavy deals did suggest autocorrelation. We therefore ran an additional regression correcting for autocorrelation by including as an independent variable a one quarter lagged dependent variable, which leaves the coefficient to the DiD indicator as not statistically significant.

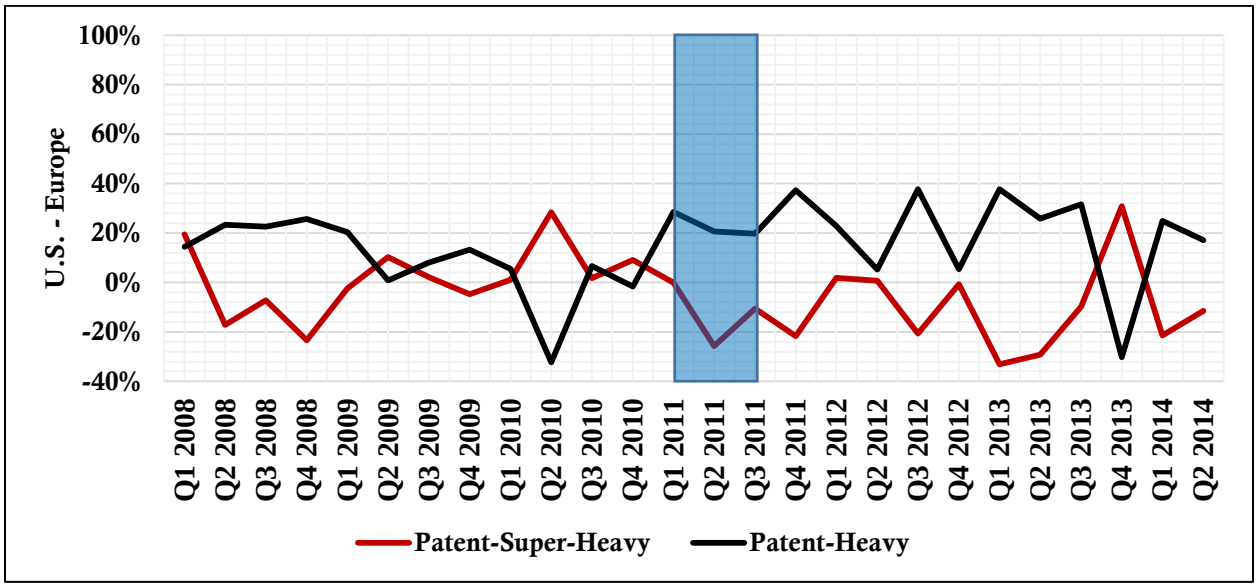
The results show that following the AIA's enactment (Q4 2011 – Q2 2014), the relative proportion of VC deals going to patent-super-heavy industries decreased by roughly 0.9 percent in the United States compared to Europe (as previously shown in Exhibit 23), though the figure is not statistically significant. The data also suggest no statistically significant change in the relative proportion of VC deals going to patent-light or patent-heavy industries post-AIA.

B. The Impact of the AIA on Venture Capital Equity Dollars

B.1. Qualitative Overview

Exhibit 25 shows the difference in the proportion of equity invested in VC deals of patent-super-heavy (red line) and patent-heavy (black line) companies from Q1 2008 to Q2 2014. A significant AIA impact would be shown by a sustained shift in proportion of equity invested, which would appear distinct from the usual fluctuations.

Exhibit 25: Difference in the Percentage of Patent-Intensive Investments to Total VC Investments in the United States and Europe, Q1 2008 - Q2 2014



Source: VentureXpert, accessed July 16, 2014. The blue bar covers all six of the key dates associated with the AIA from Q1 2011 to Q3 2011.

Although there appears to be an increase in the proportion of patent-heavy VC equity dollars relative to Europe in the post-AIA period, there appears to be a slight relative dip in the proportion of patent-super-heavy equity investment. The differences, however, are not out of line with those in the earlier portion of the pre-AIA period.

B.2. Quantitative Analysis

Exhibit 26 reports summary information on how the relative share of VC equity dollars fluctuated since 2008 in the three industry groups. Columns I and II report the proportion of equity for the United States and Europe respectively. Column III shows the difference in the proportion of equity between the two regions. Bolded numbers are the DiD estimators and hint at the net effect of the AIA. We subsequently test for statistical significance in regressions, with output displayed in Exhibit 27.

Exhibit 26: Average Percentage of VC Equity Dollars in Patent-Oriented Manufacturing Industries, Pre- and Post-AIA

	(I) United States	(II) Europe	(III) Difference (United States – Europe)
Deals in patent-super-heavy industries as a percentage of all industries			
Pre-AIA (Q1 2008 – Q4 2010)	39.63	38.20	1.44
Post-AIA (Q4 2011-Q2 2014)	36.61	47.04	-10.43
Difference (Post – Pre)	-3.03	8.84	**-11.87**
Deals in patent-heavy industries as a percentage of all industries			
Pre-AIA (Q1 2008 – Q4 2010)	53.65	44.75	8.90
Post-AIA (Q4 2011-Q2 2014)	58.37	38.81	19.56
Difference (Post – Pre)	4.72	-5.95	**10.66**
Deals in patent-light industries as a percentage of all industries			
Pre-AIA (Q1 2008 – Q4 2010)	6.71	17.05	-10.34
Post-AIA (Q4 2011-Q2 2014)	5.02	14.16	-9.13
Difference (Post – Pre)	-1.69	-2.89	**1.21**

The data reveal significant variation in VC equity dollars in the United States following the AIA. While the share of deals in patent-super-heavy industries in the United States dropped from 39.63 percent to 36.61 percent, the share in Europe rose from 38.20 percent to 47.40 percent. In other words, the spread between relative shares of equity dollars going to the industries with the

highest rate of patenting decreased by 11.87 percent. In contrast, the United States saw an increase in VC equity dollars in patent-heavy industries, while Europe saw a slight decrease. The difference in patent-light industries was minimal.

To add a higher degree of rigor and test the statistical significance of the mean differences in the proportion of VC equity dollars between the United States and Europe from the pre-AIA period to the post-AIA period for each industry category, we run the DiD regression (with output summarized in Exhibit 27). Coefficients of particular interest are bolded.

$$VC\ Equity_{ct} = \alpha + \beta_1(U.S._c) + \beta_2(Post\ AIA_t) + \beta_3(U.S._c * Post\ AIA_t) + \varepsilon_{Ct}\ ,$$

Exhibit 27: OLS DiD Regression: Impact of AIA on Each Industry Category – VC Equity, Pre- and Post-AIA

	Patent-Super-Heavy	Patent-Heavy	Patent-Light
Intercept (α)	0.3820 (11.31)**	0.4475 (12.09)**	0.1705 (8.72)**
U.S. (β_1)	0.0144 (0.30)	0.0890 (1.70)	-0.1034 (-3.74)**
Post-AIA (β_2)	0.0884 (1.81)	-0.0595 (-1.11)	-0.0289 (-1.02)
U.S.*Post-AIA(β_3)	**-0.1187** **(-1.72)**	**0.1066** **(1.41)**	**0.0121** **(0.30)**

t stat noted in parenthesis.
** indicates significance at p < 0.05*
*** indicates significance at p < 0.01*

Note: Autocorrelation checked by a standard Durbin-Watson (DW) analysis.

The results show that following the AIA (Q4 2011 – Q2 2014), the relative proportion of VC equity going to patent-super-heavy industries decreased by roughly 11.87 percent in the United States compared to Europe (as previously shown in Exhibit 26), but the decrease was not statistically significant. The data also suggest no statistically significant change in the relative proportion of VC deals in patent-heavy or patent-light industries post-AIA.

C. Difference-in-Differences-in-Differences (DiDD) Analysis[154]

We next look at these data in a difference-in-differences-in-differences (DiDD) analysis. We compare the trends before and after the adoption of the AIA for European and U.S. firms and in patent-heavier and -lighter industries. In other words, this analysis tests the statistical significance of the difference in our DiD estimators for VC financing in patent-intensive sectors and patent-light sectors.

We run the DiDD regression for both VC deals and equity dollars of patent-super-heavy and patent-heavy industries versus patent-light industries:

$$VC\ Financing_{ict} =$$
$$\alpha + \beta_1(U.S._c) + \beta_2(Patent\ Intensive_i) + \beta_3(U.S._c * Patent\ Intensive_i) +$$
$$\beta_4(Post\ AIA_t) + \beta_5(Post\ AIA_t * U.S._c) + \beta_6(Post\ AIA_t * Patent\ Intensive_i) +$$
$$\beta_7(Post\ AIA_t * U.S. * Patent\ Intensive_i) + \varepsilon_{iCt}\ ,$$

where $VC\ Financing_{ct}$ is the share of total deals/equity dollars for each country (c) and time period (t), by industry group (i), from Q1 2008 to Q2 2014; "U.S." is a dummy variable that equals one for U.S. deals, and "Post-AIA" is a dummy variable that equals one for all deals (irrespective of the region) that occurred after the enactment of the AIA (Q4 2011-Q2 2014) and zero for all deals before the AIA was reported by the Senate Judiciary Committee (Q1 2008-Q4-2010). "Patent Intensive" is a dummy variable that equals one for patent-intensive industries and zero for patent-lighter industries. The coefficient β_7 on "Post-AIA*U.S.*Patent Intensive" will therefore be the DiDD estimator.

We again see no statistically significant changes in the relative proportion of VC deals in patent-intensive versus patent-lighter industries. Our regression output is summarized in Exhibit 28.

We repeat this process for VC equity dollars, with the regression output summarized in Exhibit 29. We see no statistically significant changes in the relative proportion of VC equity invested in patent-intensive versus patent-lighter industries.

[154] For an example of a DiDD estimator in the literature, see Jonathan Gruber, "The Incidence of Mandated Maternity Benefits," *The American Economic Review* 84, no. 3, 1994, p. 630-632.

All coefficients on the triple interaction are not statistically significant. In other words, they fail to support the hypothesis that post-AIA venture capitalists in the United States disproportionately avoided or favored those firms highly reliant on patents.

Exhibit 28: OLS DiDD Regression: Impact of AIA on Patent-Intensive Industries Relative to Other Industries – VC Deals, Pre- and Post-AIA

	Patent-Intensive = Super-Heavy	**Patent-Intensive = Heavy**
Intercept (α)	0.1764 (20.18)**	0.1764 (18.78)**
U.S. (β_1)	-0.0862 (-6.97)**	-0.0862 (-6.49)**
Patent-Intensive (β_2)	0.2660 (21.52)**	0.2048 (15.41)**
U.S.*Patent-Intensive (β_3)	0.0261 (1.49)	0.2325 (12.37)**
Post AIA (β_4)	0.0100 (0.79)	0.0100 (0.74)
Post AIA*U.S. (β_5)	-0.0184 (-1.03)	-0.0184 (-0.96)
Post AIA*Patent-Intensive (β_6)	-0.0090 (-0.50)	-0.0210 (-1.09)
Post AIA*U.S.*Patent-Intensive(β_7)[a]	**0.0094** **(0.37)**	**0.0457** **(1.68)**

t stat noted in parenthesis.
* *indicates significance at p < 0.05*
** *indicates significance at p < 0.01*

Note: Autocorrelation checked by a standard Durbin-Watson (DW) analysis.

a. These coefficients can be verified manually. For the Super-Heavy category: [The DiD for super-heavy in U.S.-Europe from pre-AIA period to the post-AIA period (-0.9)] – [The DiD for super-heavy in U.S.-Europe from pre-AIA period to the post-AIA period (-1.84)] = 0.0094. For an example, see Table 3 in Gruber, "Mandated Maternity Benefits," p. 632.

Exhibit 29: OLS DiDD Regression: Impact of AIA on Patent-Intensive Industries Relative to Other Industries – VC Equity Invested, Pre- and Post-AIA

	Patent-Intensive = Super-Heavy	Patent-Intensive = Heavy
Intercept (α)	0.1705 (6.18)**	0.1705 (5.76)**
U.S. (β_1)	-0.1034 (-2.65)**	-0.1034 (-2.47)*
Patent-Intensive (β_2)	0.2115 (5.42)**	0.2770 (6.62)**
U.S.*Patent-Intensive (β_3)	0.1178 (2.13)*	0.1924 (3.25)**
Post AIA (β_4)	-0.0289 (-0.73)	-0.0289 (-0.68)
Post AIA*U.S. (β_5)	0.0121 (0.21)	0.0121 (0.20)
Post AIA*Patent-Intensive (β_6)	0.1173 (2.08)*	-0.0305 (-0.50)
Post AIA*U.S.*Patent-Intensive (β_7)[a]	**-0.1308** **(-1.64)**	**0.0946** **(1.10)**

t stat noted in parenthesis.
* *indicates significance at p < 0.05*
** *indicates significance at p < 0.01*

Note: Autocorrelation checked by a standard Durbin-Watson (DW) analysis.

a. These coefficients can be verified manually. For the Super-Heavy category: [The DiD for super-heavy in U.S.-Europe from pre-AIA period to the post-AIA period (11.87)] – [The DiD for super-heavy in U.S.-Europe from pre-AIA period to the post-AIA period (0.0121)] = -0.1308. See Table 3 in Gruber, "Mandated Maternity Benefits," p. 632.

D. Extension 1: AIA Impact on "Formative Stage" VC Financing

Venture capital financing can be broken down further to more precisely proxy for small-business investments. The VentureXpert dataset identifies four sub-categories under VC, ordered in terms of company maturity:

1. Formative stage
    a. Seed stage – Portfolio companies without fully-established commercial operations.
    b. Early stage – Portfolio companies in need of product development, initial marketing, manufacturing and sales activities.

2. Post-formative stage
    a. Expansion stage – Portfolio companies that require additional capital to boost production.
    b. Later stage – Portfolio companies with a well-established product/service in need of operational improvement.[155]

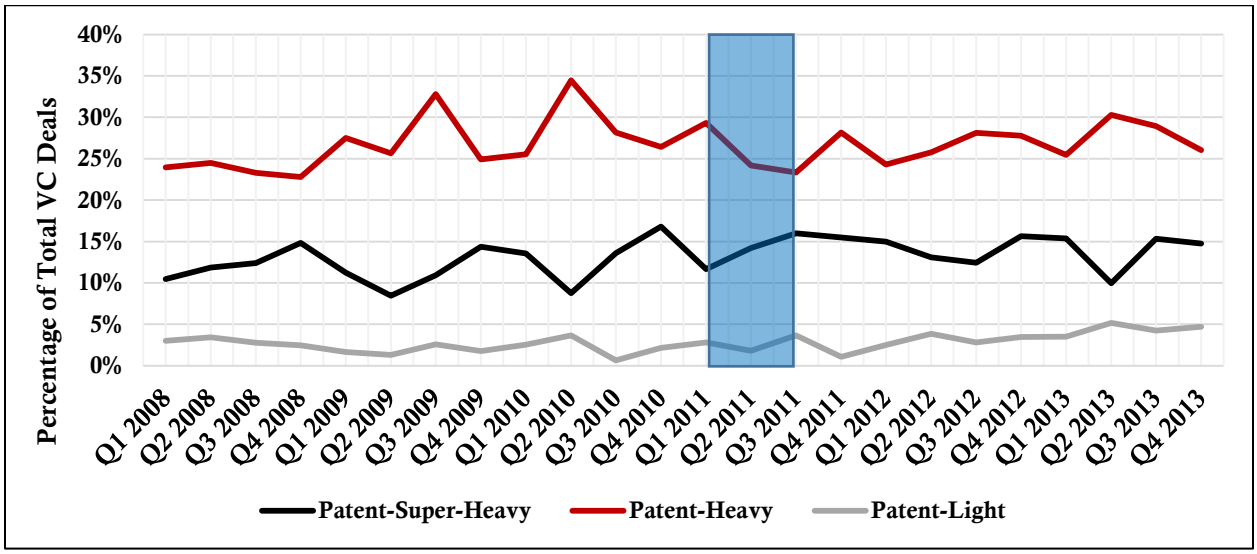
It is important to emphasize that the dataset from our previous analysis included all VC-stage investments (seed stage through later stage), as well as a minority of non-venture stage deals in which traditionally venture focused firms participated. In this extension, we exclusively look at financing of seed and early stage VC investments.

To give a rough sense of the size differences of these firms, we look at the median pre-money valuations of U.S. VC-backed companies from 1994 to 2013. Taking the average of yearly median pre-money valuations, we find that seed stage companies are typically valued at roughly $6 million, early stage at $11 million, expansion stage at $33 million ($26 million excluding the spike in 2012-13), and later stage at $47 million ($42 million excluding the spike in 2012-13).

Category (1) — or formative stage VC financing — may more closely proxy for the type of small businesses potentially affected by the AIA. We therefore collected data on VC deals by industry and stage to explore whether the proportion of formative stage VC financing in patent-super-heavy and patent-heavy industries shifted after the AIA. We first qualitatively assess changes of formative stage VC deals as a percentage of total deals for each industry category in the United States only. Given that we observed minimal changes in the proportion of patent-super-heavy and patent-heavy deals in our analysis of all VC data, any major change in the proportion of formative stage VC would suggest a disproportionate impact on the smaller end of VC financing. We look at data only up to Q4 2013, as stage-level data for the first two quarters of 2014 is highly incomplete. Exhibit 30 shows the proportion of total U.S. VC deals (with no control) in formative stage companies in each industry category.

[155] Definitions from VentureXpert glossary, found athttp://vx.thomsonib.com/VxComponent/vxhelp/VEglossary.htm, accessed July 16, 2014.

Exhibit 30: "Formative Stage" U.S. VC Deals as a Percentage of Total Deals by Industry Group, Q1 2008 - Q4 2013[156]



Source: VentureXpert, accessed Aug. 15, 2014. U.S. data for deals by stage for U.S. Q1-Q2 2014 is sparse.

We see no noticeable "break" in formative stage VC deal proportions from pre-AIA (Q1 2008-Q4 2010) to post-AIA (Q4 2011-Q4 2013) in any category. In fact, the mean proportion of VC deals for patent-super-heavy industries from pre-AIA to post-AIA stayed virtually identical, changing by less than 2 percent.

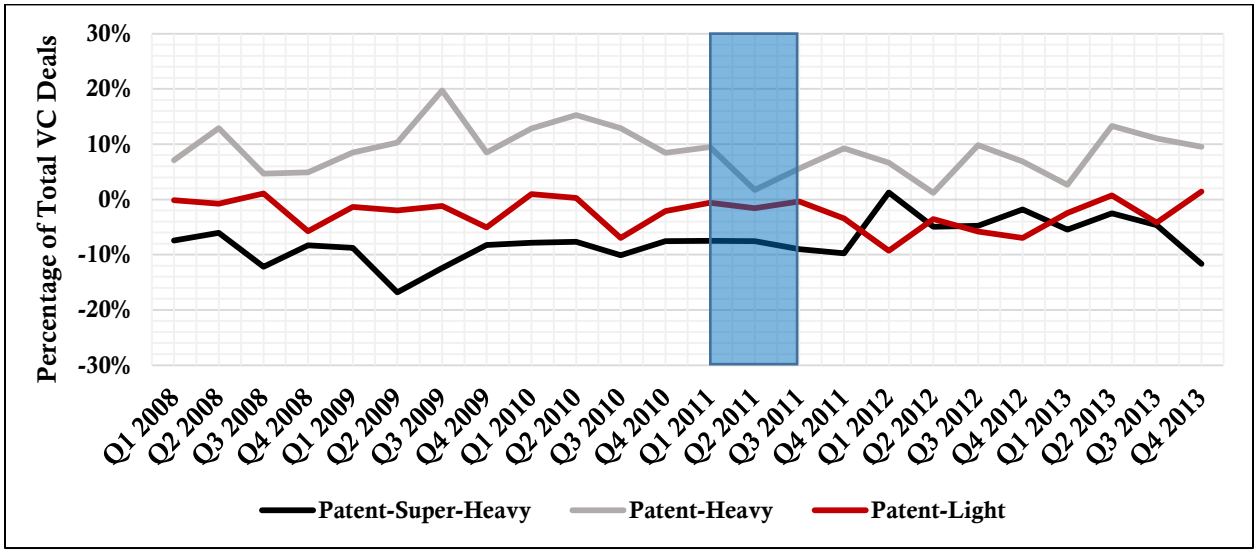
We next use Europe as a control group to see any major differences in the proportion of formative stage VC deals. In other words, did the *difference* in the proportion of VC deals going to patent-intensive industries substantially change post-AIA? If the AIA hurt the patenting ability of small businesses, we would expect to see a *drop* in the United States minus Europe difference in VC deals going to patent-intensive industries. Unfortunately, European data at this level of specificity is easily distorted, as many quarters have a very small number of deals for a given industry group, which makes proportions highly volatile. Thus, our data should be interpreted cautiously.[157]

[156] VentureXpert, accessed Aug. 15, 2014. U.S. data for deals by stage for U.S. Q1-Q2 2014 is sparse. Whereas stage-level VC data (i.e., VC deals with an investment stage specified) average roughly 77 percent of all VC data (i.e., VC deals irrespective of whether the investment stage is disclosed) from Q1 2004 to Q4 2013, stage-level data average just 33 percent of all VC data in Q1-Q2 2014. We therefore only use data through 2013. The blue bar covers all six of the key dates associated with the AIA from Q1 2011 to Q3 2011.

[157] For example, the total number of formative stage deals in patent-super-heavy industries in Europe is under 25 from 2008-2013, whereas in the United States the average is roughly 40.

We see no substantial changes in the differences of the proportion of VC formative stage deals in patent-intensive industries. Our data shows that the proportion of patent-super-heavy formative stage deals slightly increased in the United States relative to Europe from pre-AIA (i.e., Q1 2008 - Q4 2010) to post-AIA (i.e., Q4 2011-Q4 2013). Exhibit 31 illustrates our results, with each line representing the difference in formative stage (i.e., seed and early stage) deals for the United States less Europe within each category of patent intensity.

Exhibit 31: Difference in "Formative Stage" VC Deals as a Percentage of Total Deals by Industry Group for United States less Europe, Q1 2008 - Q4 2013



Source: VentureXpert, accessed Aug. 15, 2014. U.S. data for deals by stage for U.S. Q1-Q2 2014 is sparse. Whereas stage-level VC data (i.e., VC deals with an investment stage specified) average roughly 77 percent of all VC data (i.e., VC deals irrespective of whether the investment stage is disclosed) from Q1 2004 to Q4 2013, stage-level data average just 33 percent of all VC data in Q1-Q2 2014. We therefore only use data through 2013. The blue bar covers all six of the key dates associated with the AIA from Q1 2011 to Q3 2011.

We perform a DiD regression and the coefficients for the patent-heavy and patent-light categories are not statistically significant. The DiD estimator (β_3) for the patent-super-heavy category, however, is significant at the 5 percent level and suggests that formative stage deals have spiked 4.5 percent in the post-AIA period relative to the pre-AIA period in the United States compared to Europe. The results are summarized in Exhibit 32.

Exhibit 32: OLS DiD Regression: Impact of AIA on Each Industry Category – VC "Formative Stage" (Early and Seed Stage) Deals, Pre- and Post-AIA

	Patent-Super-Heavy	Patent-Heavy	Patent-Light
Intercept (α)	0.2172 (24.16)**	0.1617 (19.58)**	0.0425 (7.69)**
U.S. (β_1)	-0.0945 (-7.43)**	0.1050 (8.99)**	-0.0192 (-2.46)*
Post-AIA (β_2)	-0.0268 (-1.96)	0.0322 (2.55)*	0.0295 (3.49)**
U.S.*Post-AIA(β_3)	**0.0453** **(2.33)***	**-0.0268** **(-1.51)**	**-0.0180** **(-1.51)**

t stat noted in parenthesis.
* indicates significance at p < 0.05
** indicates significance at p < 0.01

Note: Autocorrelation checked by a standard Durbin-Watson (DW) analysis. The DW statistic (2.38) for patent-light deals did suggest autocorrelation. We therefore ran an additional regression correcting for autocorrelation by including as an independent variable a one quarter lagged dependent variable, which leaves the coefficient to the DiD indicator as not statistically significant.

E. Extension 2: AIA Impact Post-FITF Implementation

We next look at our data through a slightly different lens and assume that the VC community would react to the AIA around the *effective* date of the FITF implementation (March 16, 2013), instead of the enactment of the legislation.

We re-run the DiD regression:

$$VC\ Deals_{ct} = \alpha + \beta_1(U.S._c) + \beta_2(Post\ AIA_t) + \beta_3(U.S._c * Post\ AIA_t) + \varepsilon_{Ct}\ ,$$

where $VC\ Deals_{ct}$ is the share of total deals for each country (c) and time period (t), by industry group, from Q1 2008 to Q2 2014; "U.S." is a dummy variable that equals one for U.S. deals; and "Post-AIA" is a dummy variable that equals one for all deals (irrespective of the region) that occurred after the FITF provisions from the AIA became effective (Q2 2013-Q2 2014) and zero for all deals that occurred prior to the FITF effective date (Q1 2008-Q4 2012). The coefficient β_3 on "U.S. * Post-AIA" will therefore be the DiD estimator.

We again see no statistically significant changes in the relative proportion of VC deals in patent-intensive industries. Our regression output is summarized in Exhibit 33.

Exhibit 33: OLS DiD Regression: Impact of AIA Post Effective Date on Each Industry Category – VC Deals, Pre- and Post-AIA Implementation

	Patent-Super-Heavy	Patent-Heavy	Patent-Light
Intercept (α)	0.4423 (61.75)**	0.3802 (46.08)**	0.1775 (28.95)**
U.S. (β_1)	-0.0610 (-6.02)**	0.1535 (13.15)**	-0.0925 (-10.66)**
Post-AIA (β_2)	0.0029 (0.18)	-0.0142 (-0.77)	0.0113 (0.82)
U.S.*Post-AIA(β_3)	**-0.0119** **(-0.52)**	**0.0198** **(0.76)**	**-0.0079** **(-0.41)**

t stat noted in parenthesis.
* indicates significance at p < 0.05
** indicates significance at p < 0.01

Note: Autocorrelation checked by a standard Durbin-Watson (DW) analysis.

With respect to formative stage deals only, Exhibit 31 clearly shows that post-Q1 2013 the relative proportion of VC deals going to patent-intensive industries in the United States relative to Europe exhibited no substantial differences.

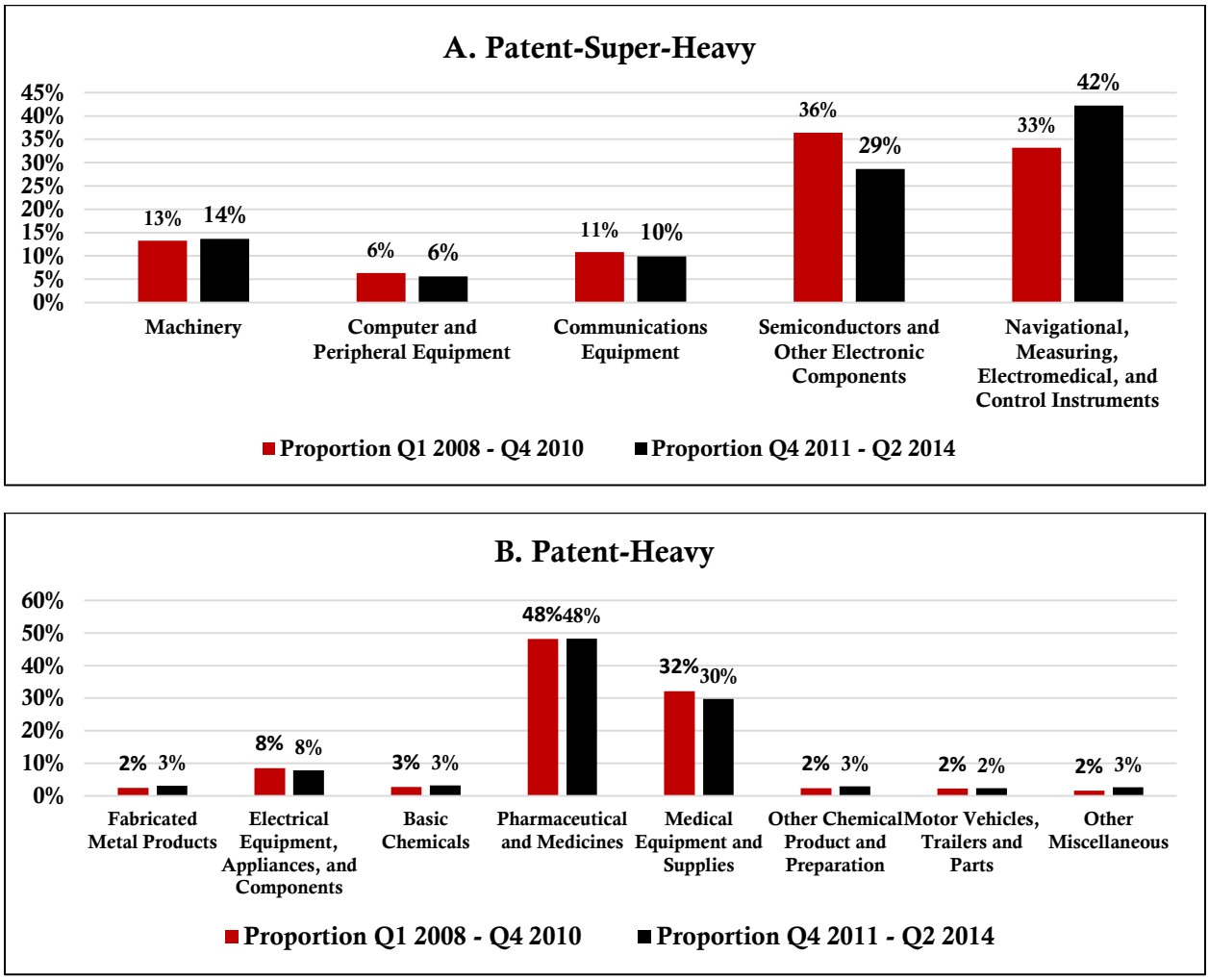
In unreported statistics, we re-ran this regression for equity dollars and similarly found no statistically significant results. We therefore find no meaningful differences in our analysis by setting the post-AIA date to March 16, 2013, which further supports the conclusion that the VC community did not view the AIA as a materially positive or negative change with respect to small businesses.

F. Extension 3: Movement of Deals within Industries

Although on average there appear to be minimal changes in the proportion of VC deals with respect to the patent-intensive categories, there may have been movement *within* certain categories. In other words, it is also important to look for changes in the proportion of deals for each industry from before the AIA to after the AIA. A large shift within a patent-intensive category may suggest that the AIA benefitted certain industries over others.

Exhibit 34 provides a graphical look at the percentage of deals within the patent-intensive categories. Within the patent-super-heavy (36.A) and the patent-heavy (36.B) categories, we find minimal changes in the categories altogether, with the exceptions of more moderate changes in "Semiconductors and Other Electronic Components" (-7.8 percent) and "Navigational, Measuring, Electromedical, and Control Instruments" (9.0 percent). As with our analyses above, however, it is important to consider changes in European VC as well.

Exhibit 34: Pooled Percentage of Deals within the Patent-Super-Heavy (A) and Patent-Heavy (B) Categories in the United States, Pre- to Post-AIA[158]



After accounting for the changes that also occurred in Europe, we similarly find minimal variation in the number of industry deals. Exhibit 35 looks at the difference in the pooled proportion of deals for each industry in its respective category. As noted in Exhibit 34, 29 percent of patent-super-heavy deals in the United States were in the "Semiconductors and Other Electronic Components" industry in the post-AIA period, relative to 36 percent before. The proportion of deals in this same industry also dropped in Europe from 30 percent pre-AIA to 24 percent in the post-AIA period. Thus, the net drop in the proportion of deals was 1.66 percent. In addition, given that Europe saw an increase in the proportion of deals in the "Navigational, Measuring, Electromedical, and Control Instruments" industry, the net increase for the United States is under 3 percent.

[158] For descriptions of industries, see Appendix 3.

Exhibit 35: Pooled Percentage of Deals within Each Industry Category, Pre- to Post-AIA

	United States: Post - Pre	Europe: Post-Pre	DiD: Post-Pre in U.S. less Post-Pre in Europe
Patent-Super-Heavy			
Machinery	0.37	-1.98	2.34
Computer and Peripheral Equipment	-0.71	2.03	-2.73
Communications Equipment	-0.89	-0.07	-0.82
Semiconductors and Other Electronic Components	-7.79	-6.13	-1.66
Navigational, Measuring, Electromedical, and Control Instruments	9.02	6.15	2.87
Patent-Heavy			
Fabricated Metal Products	0.63	-0.34	0.97
Electrical Equipment, Appliances, and Components	-0.63	4.39	-5.01
Basic Chemicals	0.55	-1.60	2.15
Pharmaceutical and Medicines	0.08	0.52	-0.45
Medical Equipment and Supplies	-2.38	-1.50	-0.88
Other Chemical Product and Preparation	0.63	-0.95	1.59
Motor Vehicles, Trailers and Parts	0.09	-3.04	3.12
Other Miscellaneous	1.03	2.52	-1.49

Note:

$$\textbf{\textit{Pooled Average}} = \frac{\textbf{\textit{Total Number of Deals in Industry X}}}{\textbf{\textit{Total Number of Deals in Relevant Category}}}$$

6.3.5. Conclusion

The AIA does not appear to have had a substantive impact on the VC funding prospects of small businesses. We categorized manufacturing industries into three groups according to their patent grant rates from 2006 to 2010 and found that the proportion of VC deal counts and equity invested within each of these groups showed no statistically significant difference post-AIA (whether looking at the enactment date or post-effective date of the FITF provision) relative to Europe. Our analysis of VC activity in seed and early stage deals — those that focus on the particularly small firms within VC — also gives virtually no indication that the VC community saw a change in the prospects of companies operating in patent-intensive industries, with the exception of a modest increase in patent-super-heavy deals in the United States relative to Europe after enactment. Finally, within the patent-super-heavy and patent-heavy categories, we see no major movement in the proportion of deals among their constituent industries. Although the analysis cannot control for all the variables that might affect VC activity, the study suggests that venture capitalists did not significantly shift their investment activity after the enactment of the AIA.

6.4. The Impact of the Canadian Shift to First-to-File on Small Inventors

6.4.1. Executive Summary

Another way to understand the impact of the AIA is to examine the 1989 Canadian patent law reform. Canada's reform did not include all the reforms in the United Sates legislation, but, much like the AIA, it initiated a switch in patent priority rules from first-to-invent to first-to-file. Unlike the case of the AIA, here we can look at the long-run effect of the policy change on patent-related behavior by small and large inventors.

We collect USPTO patent data from 1984 to 1988 (the pre-reform period) and 1990 to 1994 (the post-reform period) on firms from Canada, as well as the United Kingdom to control for broader shifts in patenting activity. We then assess how patent activity for smaller and larger inventors changed in response to the law. Using the number of successful patent applications in the pre-reform period as a proxy for inventor size and limiting our dataset to include only those firms with at least one patent prior to the reform, we find that larger Canadian firms experienced a statistically significant increase in patenting activity, compared to smaller firms, and relative to the pattern in the United Kingdom.

In other words, larger firms in Canada saw an increase in patenting activity relative to smaller firms after the reform, net of patent activity changes in the United Kingdom. The baseline results collectively imply that firms that patented more frequently before the reform, which we believe to be larger firms, typically patented more in the post-reform period in Canada relative to small firms and controlling for changes elsewhere. We find no evidence that the relative quality of patents filed by smaller patentees improved, which might reflect a change in the propensity to patent rather than in the number of innovations produced. Our results are generally robust to a variety of controls and checks.

6.4.2. Introduction

It is difficult to completely ascertain the policy changes of the AIA so soon after its implementation. Luckily, one of America's neighbors, Canada, implemented a similar change in 1987, which became effective in 1989. While the findings of the first two studies shed light on the effects of the AIA on U.S. small businesses, this section will provide further context by examining the Canadian switch to a first-to-file patent system 25 years ago.

Canada is an ideal case study because of its numerous similarities with the United States, including close geographic proximity, a similar patent system prior to its switch to first to file, and a relatively common innovative environment.[159] There are few studies that offer detailed evaluations of the effects of this switch in Canadian patent policy, and just one study directly addresses its effect on the relative patenting activity of small firms.[160] Another study approached the topic by looking at the patenting activity of individual inventors,[161] but those results may be quite different from the effect on small businesses.

In this section of the study, the Bella Research Group (a) collected data on U.S. patenting activity of Canadian and U.K. companies, (b) compared the volume of successful patent applications of smaller versus larger inventors before and after the Canadian policy change, (c) compared the number of forward citations attributed to patents granted to smaller firms versus larger firms before and after the Canadian policy change, and (d) analyzed the collected data for relevant patterns in the differences between the two countries.

We employ "difference-in-differences-in-differences" (DiDD) regressions (a modified version of the DiD regressions used in the VC financing study), which is a popular technique economists use to measure the impact of a law on particular group. As with DiD analyses, DiDD analyses attempt to isolate the impact of a policy change with respect to some variable of interest (i.e., wages, employment levels, or, in this case, patenting activity and patent citations) on some group exposed to the law change (i.e., the "treatment group"). To avoid "noise" from temporal or macroeconomic trends not related to the policy, DiDD analyses employ a "control group" that (a) exhibits similar trends with respect to the variable of interest, but (b) was either immune or not exposed to the law. The "control group" represents the growth pattern with respect to the variable of interest that the "treatment group" would have exhibited had the law not been enacted. We subtract out the changes that also occurred in the "control group," thereby isolating the relative changes between the two groups that can roughly be attributed to the law.

The DiDD regressions in this analysis look at the *relative* changes within two types of firms in the treatment and control group. Whereas the DiD regressions in the VC financing study examine the change in X (i.e., U.S. deals) relative to the change in Y (i.e., European deals)

[159] This observation is explained at greater length in Abrams and Wagner, "Poisoning the Next Apple."
[160] Lo and Sutthiphisal, "Lessons from Canada."
[161] Abrams and Wagner, "Poisoning the Next Apple."

before and after the legislation, this study looks at the changes in "X_1 less X_2" (Canadian patents from firms of size X_1 less Canadian patents from firms of Size X_2) relative to "Y_1 less Y_2" (U.K. patents from firms of size Y_1 less U.K. patents from firms of size Y_2) from before the legislation to after. For a more detailed explanation of difference-in-differences-in-differences (DiDD) analyses, with examples from classic studies employing this technique, see Appendix 2.

Our methodology is detailed below:

- First, we look at the U.S. patenting activity of Canadian and U.K. companies, due to the greater accessibility and tractability of U.S. patent data and the fact that these data have been widely used in earlier research. We access this data through the National Bureau of Economic Research (NBER) patent database. We look at the number of patent applications by these companies in the five years before (1984-1988) and after (1990-1994) the implementation of the first to file system in Canada.
- Second, we collect data on the number of forward (subsequent) citations of these patents to evaluate their quality, a well-accepted approach in patent research.[162]
- Third, we use difference-in-differences-in-differences (DiDD) regression analysis to examine any changes in the patenting activities of small and large inventors around the implementation of the first-to-file policy in Canada. We estimate three regression specifications: OLS, "log-log" OLS, and negative binomial, the latter of which has been found to be the preferred specification for patent count and citation data.[163]
- Finally, we test for robustness in two ways. First, we include in the regressions those firms that did not have any patents in the pre-reform period. Second, we "group" firms by the number of successful patent applications in the pre-reform period, namely, firms with (1) one patent in the pre-reform period, (2) two to five patents in the pre-reform period,

[162] The seminal work relating patent citations and patent quality is Manuel Trajtenberg, "A Penny For Your Quotes: Patent Citations and the Value of Innovations," *RAND Journal of Economics* 21, no. 1, Spring 1990. For a more recent work, see Jean O. Lanjouw and Mark Schankerman, "Patent Quality and Research Productivity: Measuring Innovation with Multiple Indicators," *The Economic Journal* 114, 2004.

[163] Negative binomial regressions are the preferred method to analyze count data that exhibits overdispersion (i.e., where the conditional variance exceeds the conditional mean). It is important to note that the model does not assume a normal distribution and can properly fit a line for overdispersed data since it does not assume homogeneity in variance. Overdispersion is typically the result of strongly skewed dependent variables, in this case due to the majority of firms having zero patents post-reform, while some large firms have hundreds. For more information on negative binomials with respect to patents, see Peiming Wang, Iain M. Cockburn, and Martin L. Puterman, "Analysis of Patent Data: A Mixed-Poisson-Regression Model Approach," *Journal of Business & Economic Statistics* 16, no. 1, 1998.

and (3) six or more patents in the pre-reform period. We then assess patent activity and citations per patent in Groups 2 and 3 relative to Group 1 in Canada compared to the United Kingdom.

A significant decrease in the patenting activity of smaller compared to larger inventors for Canada relative to the United Kingdom could indicate that the change made it relatively more difficult for small Canadian firms to receive patents, or that the new system created disincentives for small firms to file patent applications. In addition, this could indicate that the reform made it relatively easier for large inventors to secure patents, or increased the incentives to file patent applications. On the other hand, small inventors might demonstrate a relative increase in patenting activity compared to larger ones, suggesting that the policy change had a favorable effect on small firms and provided them greater access to patents or greater incentive to file patent applications.

Similarly, a higher number of citations per patent would indicate that a patent is valuable and contributed greatly to knowledge in its subject matter, and has thus been cited by subsequent patents that have expanded on this knowledge. A relative increase in patent quality of small firms compared to large firms between Canada and the United Kingdom could indicate that the reform incentivized increased selectivity in the patent process for smaller companies compared to larger firms, while the opposite would show that the policy change incentivized the filing of *lower* quality patents for small compared to larger companies.

6.4.3. Methodology and Data

We obtained patent data for the study from the National Bureau of Economic Research (NBER) Patent Data Project.[164] The NBER has compiled and cleaned USPTO data on over 3.2 million unique utility patents from 1976 to 2006, along with the roughly 23.6 million citations of these patents.[165] This database has been used extensively in the literature. A working paper describing this database by Bronwyn Hall, Adam Jaffe, and Manuel Trajtenberg, the database's developers, has been cited over 2,100 times on Google Scholar.[166] The database adopts the USPTO patent

[164] Although there has since been an update to the database, the main work discussing the database's features is Bronwyn H. Hall, Adam B. Jaffe, and Manuel Trajtenberg, "The NBER Patent Citations File: Lessons, Insights and Methodological Tools," *NBER Working Paper* 8498, Oct. 2001.
[165] The database can be found at http://eml.berkeley.edu/~bhhall/NBER06.html, last visited Nov. 30, 2014.
[166] Hall et al., "The NBER Patent Citations File."

classification system, which identifies the type and location of the entities that have the property rights to the patent (i.e., assignees) into seven categories.[167]

We analyze patent data only from "Classification 3" entities, that is, those patents assigned to non-U.S. and non-governmental organizations, which allows us to focus on patents assigned to both small and large corporations.[168]

We look only at U.S. patents for three key reasons:

- The United States is an extremely important market for significant inventions and thus helps focus our study on higher quality inventions from foreign inventors.
- Documentation of U.S. patent records is much richer, and U.S. patent data has been extensively used in economic research.
- Patent systems differ across nations; this in turn leads to different patenting behaviors. For example, the number of claims per patent application varies significantly. In 2010, the figure stood at 13.4 for the European Patent Office, 9.6 for the Japan Patent Office, 10.7 for the Korean Intellectual Property Office, and 18.5 for the USPTO.[169] As a result, looking at patent counts within each country's representative patent office gives a distorted view of patent activity.

We look at Canadian patenting in the U.S. (i.e., U.S. patents of Canadian firms) relative to U.K. patenting in the U.S. (i.e., U.S. patents of U.K. firms) to avoid any issues regarding changes in the propensity of foreign companies to file in the United States.

We look specifically at Canadian patents filed in the United States for the five years before (1984-1988) and after (1990-1994) the effective year (1989) of the Canadian patent reforms, which is consistent with prior studies.[170] The United Kingdom was chosen as our control country given its many shared features with Canada, most importantly its shared common law tradition

[167] Hall et al., "The NBER Patent Citations File," p. 11.
[168] This category is dominated by corporations but also includes universities.
[169] Four Office Statistics Report, 2010 Edition, Oct. 2011, p. 47.
[170] Shih-tse Lo and Dhanoos Sutthiphisal look at patenting activity from 1983 to 1994, and David S. Abrams and R. Polk Wagner studied patenting activity from 1984 to 1993. See Lo and Sutthiphisal, "Lessons from Canada."; and Abrams and Wagner, "Poisoning the Next Apple."

and similar trends in levels of GDP per capita.[171] Patents are assigned to nations by the nationality of the first entity to which the patent is assigned.

Descriptive statistics are summarized in Exhibit 36.

Exhibit 36: Descriptive Statistics for the Canadian Reform Dataset

Date range	Pre-reform: 1984-1988 and Post-reform: 1990-1994
Type of assignee	Non-U.S., non-governmental organizations (mostly corporations)
Definition of firm size	Number of successful patent applications in pre-reform period
Number of Canadian firms *Subset: Excluding firms with no patents in pre-reform period*	3,285 *1,496*
Number of U.K. firms *Subset: Excluding firms with no patents in pre-reform period*	3,985 *2,284*
Number of patents for Canadian firms *Subset: Excluding firms with no patents in pre-reform period*	9,810 *6,927*
Number of patents for U.K. firms *Subset: Excluding firms with no patents in pre-reform period*	18,033 *14,652*
Level of Data for Patent Rate Study	Firm-by-firm
Level of Data for Patent Citation Study	Patent-by-patent

We first study the difference in patenting rates among more and less frequent patentees from Canada and the United Kingdom in the Canadian pre-reform period (1984-1988) and the Canadian post-reform period (1990-1994). A difference in the trends of patenting activity from frequent versus infrequent pre-reform patentees in Canada relative to the United Kingdom would suggest that the Canadian reforms had a relative impact on the patenting activity of different-sized inventors.

This analysis alone, however, does not give a complete picture. For example, less growth in the patenting activity of infrequent patentees (relative to more frequent patentees) in the pre-reform

[171] Data from International Monetary Fund World Economic Outlook Database, April 2014. Gross domestic product based on purchasing power parity (PPP) per capita for Canada was roughly 77 percent of the United Kingdom's from 1984 to 1994 on average, though it steadily increased during this period from 71 percent to 83 percent.

period for Canada compared to the United Kingdom could either suggest that the law stifled the patenting capacities of small inventors relative to large inventors or alternatively could suggest that small inventors became more selective in their patenting decisions. We therefore also measure how the difference in citations per patent between frequent and infrequent patentees (in the pre-reform period) differed from the pre-reform to post-reform periods in Canada compared to the United Kingdom.

It is important to note that patent citations are a well-established economic indicator of the importance of a patent. Bronwyn Hall et al., for example, found that an extra citation per patent increased a firm's market value by 3 percent, and that firms with two or three times the median number of citations (i.e., forward citations) per patent had a 35 percent value premium.[172] In addition, Dietmar Harhoff et al. used survey data on U.S. and German patents and similarly found that "patents reported to be relatively valuable by the companies holding them [were] more heavily cited in subsequent patents."[173]

As a result, if, for example, the Canadian patent applications from infrequent patentees in the pre-reform period dropped relative to the United Kingdom, *and* the average number of citations per patent from these patentees diminished, the "selectivity" argument would be less convincing. On the other hand, if the average number of citations per patent for our proxy for small firms increased relative to the United Kingdom, the argument could be supported.

As noted in the VC financing study, it is important to examine the trend of the variables of interest (i.e., patent applications and patent citations) in the pre-reform period to help guide our interpretation of the results. Importantly, if we find substantial variation in the trends of successful patent application and their respective citations in Canada compared to the United Kingdom in the pre-reform period, then the results we obtain for the post-reform period should be interpreted more cautiously. We suggest, however, that no major pre-reform trends or external variables in one country make isolation of the law change implausible. For more details on this analysis, see Appendix 4. We begin with a review of related literature and follow with an analysis of the Canadian change.

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[172] Bronwyn H. Hall, Adam Jaffe, and Manuel Trajtenberg, "Market Value and Patent Citations," *RAND Journal of Economics* 36, no. 1, Spring 2005.

[173] Dietmar Harhoff, Francis Narin, F.M. Scherer, and Katrin Vopel, "Citation Frequency and the Value of Patented Inventions," *The Review of Economics and Statistics* 81, no. 3, Aug. 1999. This approach is also recognized in the OECD Patent Statistics Manual, 2009, pp. 137-38.

6.4.4. Literature Review

The impact of the Canadian reforms on small businesses has been examined in two key empirical studies, both of which suggested that the priority changes had an adverse impact on smaller (i.e. small corporations/individuals) inventors.

Shih-tse Lo and Dhanoos Sutthiphisal of McGill University collected USPTO patent data of small and large firms[174] from 1983 to 1994 and found that in the post-reform period (1990-1994) the share of patents granted to small firms (as well as individual inventors) declined relative to large businesses. The authors noted that this divergence in post-reform patenting suggested that the FTF system stifled inventive activity from independent inventors and small businesses while facilitating the process for large corporations.[175]

A similar study undertaken by David S. Abrams and R. Polk Wagner[176] looked at subsequently granted patent application data from the Canadian Intellectual Property Office (CIPO) and the USPTO filed by individuals from 1984 to 1993 and also found that the law exerted a substantial negative impact on their patenting activity. The authors found that individual inventor representation in the United States dropped from 17.34 percent before the law (prior to Oct. 1, 1989) to 16.39 percent after the law, whereas in Canada the figure fell from 10.77 percent before the law to 8.32 percent afterward. In other words, the relative share of individual inventor representation dropped 1.5 percent (significant at the 1 percent level) in Canada relative to the United States in the post-reform period.[177]

The authors also explored potential changes in patent quality among individual inventors by examining a number of linguistic characteristics — specifically (a) the word length of the first claim of each patent, (b) the total number of claims, and (c) claim language complexity — but found no significant change in patent quality.

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[174] The authors defined large corporations as those that either were listed on a major stock exchange or that had more than 500 employees. Small corporations were all those firms that did not meet the criteria of large firms. The authors noted that because their data collection included mostly recent data (post-2005). As a result, what were truly small firms in the earlier years could appear as large firms in their dataset.

[175] Lo and Sutthiphisal, "Lessons from Canada." These results are robust across a number of models, as illustrated in Table 7. See footnote 45 in their paper for the methodology of the coefficients for the interaction term.

[176] Abrams and Wagner, "Poisoning the Next Apple."

[177] See Abrams and Wagner, "Poisoning the Next Apple," p. 547 (Table 5). The difference in differences was calculated by subtracting the "before minus after" difference in Canada (-2.45 percent) from that in the United States (-0.95 percent).

The authors performed a number of tests to see whether their results were potentially confounded by other reforms in Canadian law, specifically:

- Patent term change: The law changed the patent term from 17 years from grant date to 20 years from application date.
- Introduction of maintenance fees: The law introduced annual maintenance fees (discounted for small businesses and individual inventors) for both applicants and patent grantees.
- Deferred examination: The law introduced the option to file an application only to have it later examined (initially set at seven years post-filing date, but later changed to five years in 1992).

The authors, however, defended the robustness of their results against each of these potentially confounding variables and concluded that, "[A] shift to first-to-file from first-to-invent results in a reduction of patenting behavior by individuals relative to firms."[178]

6.4.5. Results of Patent Count Study

A. Qualitative Overview

Exhibit 37 provides a visual representation of the patenting activity of the proportion of total firms with one successful application in the pre-reform period (1984-1988). As expected, we see a substantial decline in the number of patents generated by those firms in Canada and the United Kingdom with only one successful patent. This is a function of our methodology, as we are conditioning for firms that had exactly one patent in the pre-reform period, so it is likely there were a number of market exits (i.e., bankruptcies, acquisitions, etc.), irrespective of the country of interest.

[178] Abrams and Wagner, "Poisoning the Next Apple," p. 559.

Exhibit 37: "Small Firm" Patents as a Percentage of Total Patents, Pre-Reform (1984-1988) and Post-Reform (1990-1994) in Canada and the U.K.

Note: "Patents" are defined as successful patent applications. "Small Firm" is defined as a firm with one successful patent application in the pre-reform period.

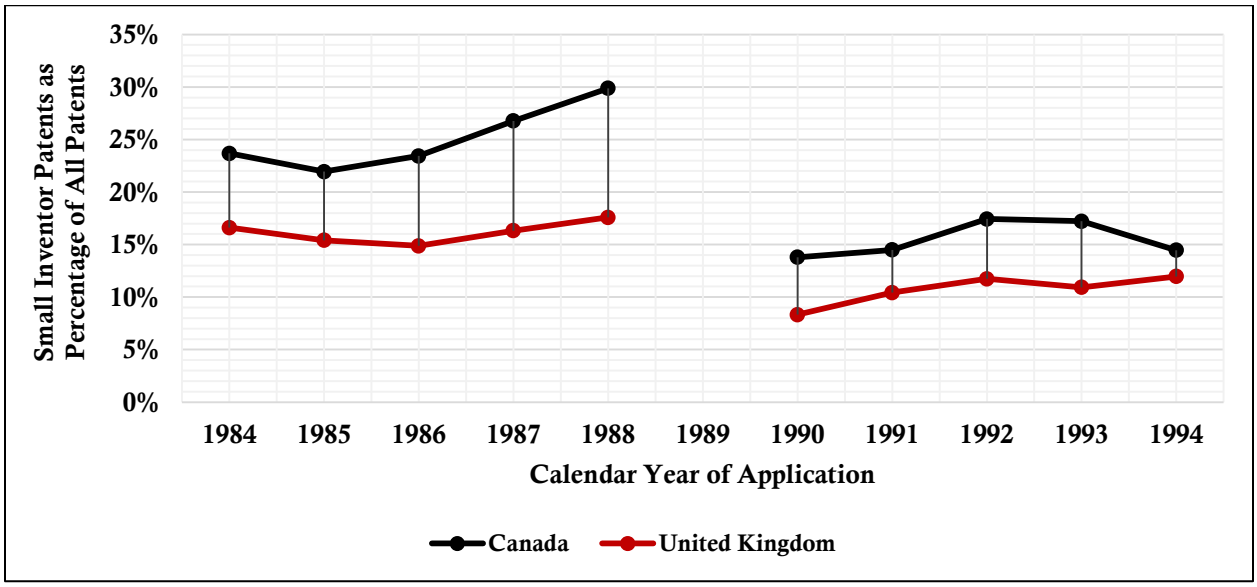
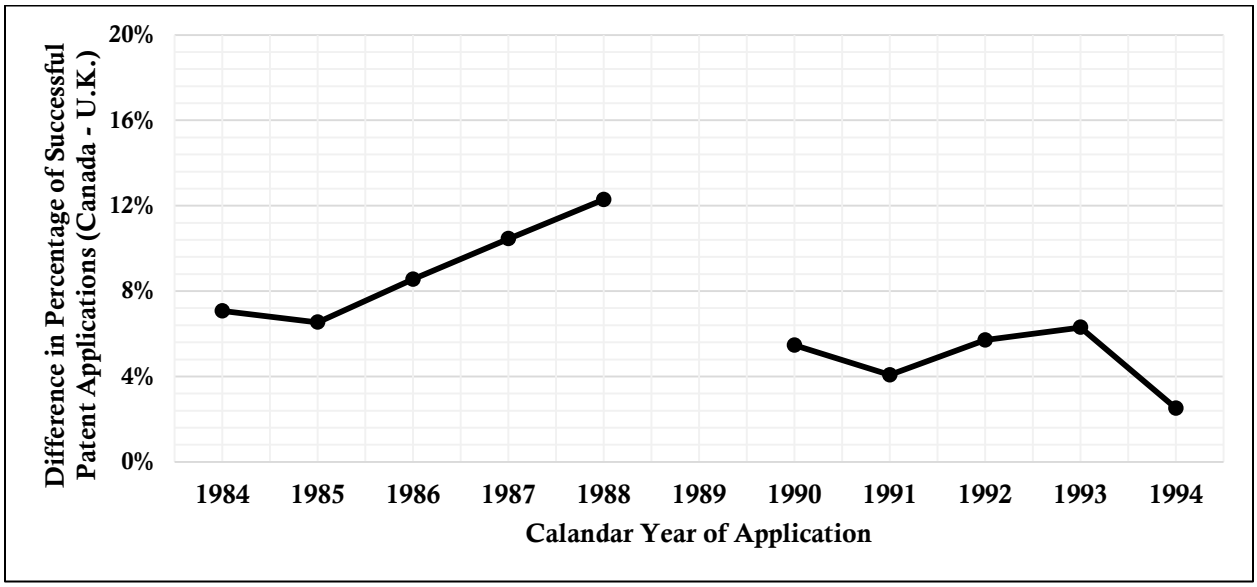


Exhibit 38: Difference (Canada-United Kingdom) in the Percentage of "Small Firm" Patents from Pre-Reform to Post-Reform

Note: "Patents" are defined as successful patent applications. "Small Firm" defined as those with one successful patent application in the pre-reform period.



We are more interested in seeing how the *difference* in the proportion of patents generated from our proxy for small firms changes in the pre-reform period relative to the post-reform period in Canada compared to the United Kingdom (i.e., black line minus red line in Exhibit 37). Exhibit 38 shows a substantial decline in the relative share of total patents from small inventors between the two countries.

B. Quantitative Analysis

B.1. Analysis of Proportional Change in Firms by Patent Frequency in Pre-Reform Period

Exhibit 39 breaks out the level of patenting activity by firms in the pre- and post-reform periods in several categories. We observe relatively little movement among the subset of "small firms" (i.e., those with one successful patent application in the pre-reform period), while we observe substantial movement among the subset of "large firms" (i.e., those with 6+ successful patent applications in the pre-reform period) in Canada relative to the United Kingdom.

Least Frequent Patenters (Group 1)

Among firms with one successful patent application in the pre-reform period — i.e., "small firms" — a roughly equal percentage of firms had no patents in the post-reform period (85.8 percent) in both Canada and the United Kingdom. Furthermore, among this same subset of firms in our sample, a roughly equal percentage (1.8 percent) had six or more patents in the post reform period.

Middle Group (Group 2)

Among firms with two to five successful patent applications in the pre-reform period, we find that a smaller proportion of firms in Canada had no patents in the post-reform period, relative to the United Kingdom (58.2 percent versus 64.5 percent). Moreover, a higher proportion of firms in Canada had six or more patents in the post-reform period (11.4 percent versus 6.4 percent).

Most Frequent Patenters (Group 3)

Among firms with six or more successful patent applications in the pre-reform period, we find that a higher proportion of firms in Canada (51.0 percent) had six or more patents in the post-reform period, relative to the United Kingdom (45.7 percent). Furthermore, a lower percentage of these firms in Canada had no patent activity in Canada (28.6 percent) relative to the United Kingdom (31.2 percent).

These statistics suggest that while the patenting behavior of the smallest firms changed minimally from pre-reform to post-reform in Canada relative to the United Kingdom, larger firms exhibited relatively higher patenting. As a result, it preliminarily appears that larger firms experienced a relative increase in patenting after the law change.

In the following section we statistically test these initial observations to help determine whether this change in behavior can be attributed to the reform.

Exhibit 39: Conditional on Pre-Reform Patent Activity, Percentage of Post-Reform Patent Activity Among Firm Groupings

Firm Groupings, by Number of Pre-Reform Patents (X)	Percentage of Post-Reform Patents Among All Firms (Y) (n=3780)											
	(I) Canada (percent)				(II) U.K. (percent)				(III) Difference (percent) (Canada – U.K.)			
	0	**1**	**2-5**	**6+**	**0**	**1**	**2-5**	**6+**	**0**	**1**	**2-5**	**6+**
1	**85.8**	7.4	5.1	**1.8**	**85.8**	7.1	5.2	**1.8**	**-0.1**	0.2	-0.1	-0.1
2-5	58.2	13.2	17.2	11.4	64.5	13.3	15.8	6.4	**-6.3**	-0.1	1.4	**5.0**
6+	**28.6**	6.1	14.3	51.0	**31.2**	6.0	17.1	45.7	-2.6	0.1	-2.8	**5.3**

Note: $\boldsymbol{Percentages} = \frac{\boldsymbol{Number\ of\ Firms\ with\ X\ Patents\ in\ the\ Pre-Reform\ Period\ and\ Y\ Patents\ in\ the\ Post-Reform\ period}}{\boldsymbol{Total\ Number\ of\ Firms\ with\ X\ Patents\ in\ the\ Pre-Reform\ Period}}$

B.2. Regression Analysis

We next run three regressions to examine the impact of the Canadian reforms on inventors of different sizes more closely. Each regression isolates the impact of the Canadian reforms by predicting the difference in the expected number of post-reform patents (relative to pre-reform patents) for inventors of different sizes in Canada relative to the United Kingdom.

OLS Regression

We first run the following OLS regression:

$$Patents\ Post\ Reform_{ij} = \alpha + \beta_1(Patents\ Pre\ Reform_i) + \beta_2(Canada_j) + \beta_3(Patents\ Pre\ Reform_i * Canada_j) + \varepsilon_{ij},$$

where "Patents Post Reform" is the number of successful patent applications that each company (*i*) received during all years post-reform (1990-1994), "Patents Pre Reform" is the number of successful patent applications prior to the reform (1984-1988), and "Canada" is a dummy variable equal to one if it is a Canadian firm and equal to zero if it is a U.K. firm. The coefficient β_3 on "Patents Pre Reform*Canada" is the coefficient of interest, as it shows patenting growth of more frequent versus less frequent patentees after the reform compared to before the reform in Canada relative to the United Kingdom. A positive interaction term would suggest that more frequent patentees in the pre-reform period were more likely to patent afterwards in Canada relative to the United Kingdom.

Our regression output is summarized in Exhibit 40. We find that the coefficient (β_3) of interest (bolded) is positive and significant at the 5 percent level, which suggests that Canadian firms that were frequent patentees in the pre-reform period were more likely to patent in the post-reform period in Canada relative to U.K. firms. Specifically, the coefficient implies that for every extra patent a Canadian firm had in the pre-reform period, the number of patents expected in the post-reform period was 0.04 higher than in the United Kingdom.

Exhibit 40: OLS Regression: Impact of the Canadian Reform Among Firms With At Least One Patent Pre-Reform on Post-Reform Patenting

Dependent Variable: Patents Post Reform	
Intercept ($\boldsymbol{\alpha}$)	-0.7858 (-4.73)**
Patents Pre Reform ($\boldsymbol{\beta_1}$)	0.8050 (93.13)**
Canada ($\boldsymbol{\beta_2}$)	0.4710 (1.65)
Patents Pre Reform*Canada ($\boldsymbol{\beta_3}$)	**0.0418** **(2.21)***

t stat noted in parenthesis
** indicates significance at p < 0.05*
*** indicates significance at p < 0.01*
n=3,780

Logarithmic Regression

We next run the logarithmic regression:

$$\ln(Patents\ Post\ Reform + 1)_i = \alpha + \beta_1(\ln(Patent\ Pre\ Reform_i + 1)) + \beta_2(Canada_j) + \beta_3(\ln(Patent\ Pre\ Reform_i + 1)) * Canada_j] + \varepsilon_i,$$

where "ln(Patents Post Reform+1)" is the natural logarithm one plus the expected number of successful patent applications that each company (*i*) received during all years 1990 to 1994, "ln(Patents Pre Reform+1)" is the natural logarithm of one plus the number of successful patent applications prior to the reform (1984-1988), and "Canada" is a dummy variable equal to one if it is a Canadian firm and equal to zero if it is a U.K. firm. The coefficient β_3 on "ln(Patents Pre Reform+1)*Country" is the coefficient of interest, as it shows patenting growth of more frequent versus less frequent patentees after the reform compared to before the reform in Canada relative to the United Kingdom.

Our regression is summarized in Exhibit 41. We again find that the coefficient (β_3) of interest is positive and significant at the 5 percent level, which suggests that more frequent patentees in the pre-reform period (relative to less frequent patentees) were more likely to patent in the post-reform period for Canadian firms relative to U.K. firms. Specifically, the coefficient implies that a 1 percent increase in successful patent applications for Canadian firms in the pre-reform period is associated with a roughly 0.075 percent relative increase in the number of patents expected in the post-reform period for Canada compared to the United Kingdom.

Exhibit 41: "Log-Log" OLS Regression: Impact of the Canadian Reform on Firms With At Least One Patent Pre-Reform on Post-Reform Patenting

Dependent Variable: ln(Patents Post Reform+1)	
Intercept ($\boldsymbol{\alpha}$)	-0.4125 (-16.53)**
Ln (Patents Pre Reform+1) ($\boldsymbol{\beta_1}$)	0.7592 (37.75)**
Canada ($\boldsymbol{\beta_2}$)	-0.0135 (-0.32)
Ln (Patents Pre Reform+1)*Canada ($\boldsymbol{\beta_3}$)	**0.0753** **(2.03)***

t stat noted in parenthesis
** indicates significance at p < 0.05*
*** indicates significance at p < 0.01*
n=3,780

Negative Binomial Distribution

As noted previously, the negative binomial regression best fits our data given its skewness and over-dispersion. We therefore run a negative binomial regression of the following form:

$$Patents\ Post\ Reform_{ij} = \alpha + \beta_1(Patents\ Pre\ Reform_i) + \beta_2(Canada_j) + \beta_3(Patents\ Pre\ Reform_i * Canada_j) + \varepsilon_{ij},$$

The regression output is summarized in Exhibit 42. The interaction term is positive and significant at the 1 percent level, which again suggests that patent frequency in the pre-reform period had more of an impact in Canada than in the United Kingdom.

Exhibit 42: Negative Binomial Regression: Impact of the Canadian Reform on Firms With At Least One Patent Pre-Reform on Post-Reform Patenting

Dependent Variable: Patents Post Reform	
Intercept ($\boldsymbol{\alpha}$)	-0.3098 (-4.08)**
Patents Pre Reform ($\boldsymbol{\beta_1}$)	0.0936 (8.81)**
Canada ($\boldsymbol{\beta_2}$)	-0.1656 (-1.26)
Patents Pre Reform*Canada ($\boldsymbol{\beta_3}$)	**0.0975** **(3.37)****

z stat noted in parenthesis
**** indicates significance at p < 0.05***
***** indicates significance at p < 0.01***
n=3,780

Note: Our negative binomial model has an alpha = 7.69 with an LR test p < 0.01.

Given that all three of our models had an interaction coefficient that was positive and significant at the 5 percent level (with the negative binomial regression significant at the 1 percent level), our data strongly suggests that more frequent patentees (i.e., our proxy for larger firms) in the pre-reform period either (a) were advantaged by the Canadian reform or (b) became less selective in their patenting decisions compared to infrequent patentees.

C. Extension 1: Allowing for Firms that Had Zero Patents in the Pre-Reform Period: Post-Reform Patent Activity

Our regressions thus far have only included the subset of firms in our sample that had a successful patent application in the pre-reform period. We now re-run the three regressions above to include firms without patenting activity prior to the reform, summarized in Exhibit 43.

Exhibit 43: OLS, "Log-Log" OLS, and Negative Binomial Regressions: Impact of Canadian Reform Among All Firms in Dataset on Post-Reform Patent Activity

Note: "All firms" include those with zero successful patent applications in the pre-reform period.

	(I) OLS	(II) "Log-Log" OLS	**(III) Negative Binomial**
Dependent Variable	Patents Post Reform	Ln (Patents Post Reform+1)	**Patents Post Reform**
Intercept	0.4235 (3.83)**	0.5232 (36.82)**	0.3127 (12.36)**
Patents Pre Reform	0.7938 (113.08)**		0.0531 (16.28)**
Ln (Patents Pre Reform+1)		0.1268 (8.38)**	
Canada	0.3305 (2.01)*	0.1249 (6.05)**	-0.0778 (-2.05)*
Patents Pre Reform*Canada	**0.0367 (2.40)***		**0.0427 (5.43)****
Ln (Patents Pre Reform+1)*Canada		**-0.1426 (-5.66)****	

t stat noted in parenthesis (Columns I and II)
z stat noted in parentheses (Column III)
* indicates significance at $p < 0.05$
** indicates significance at $p < 0.01$
n=7,270

The coefficients on the interaction term are positive and significant for the OLS and Negative Binomial models, and negative and significant for the "Log-Log" OLS model. The inclusion of firms with no patenting activity in the pre-reform period leaves the triple interaction coefficient relatively unchanged in the OLS and negative binomial regressions, but it flips the sign of the coefficient in the log-log transformation. Nonetheless, five of six models indicate that in the post-reform period the more frequent patentees (in the pre-reform period) filed more successful patent applications in Canada relative to the United Kingdom.

6.4.6. Results of Patent Citations Study

A. Qualitative Overview

Exhibit 44 provides a visual representation of changes in the difference in the mean number of patent citations from 1984 to 1994 among firms with one patent in the pre-reform period (1984-1988) relative to those with multiple patents in the pre-reform period.

We see an initial spike in the number of average citations per patent for Canadian firms in 1991, as the patents from those firms that only have one successful patent application in the pre-reform period have on average 2.03 more citations than those that had more than one successful patent application in the pre-reform period. The "small minus large" difference — which is the difference in the mean number of citations per patent among firms with one successful patent application (small) and firms with more than one successful patent application (large) in the pre-reform period — steadily declines, however, during the remainder of the sample period.

Exhibit 44: "Small Firm" Less "Large Firm" Citations Per Patent, Pre- and Post-Reform

Note: "Patent" defined as a successful patent application. We look at the mean number of citations per patent. "Small Firms" are those with one successful patent application in the pre-reform period. "Large Firms" are those with more than one successful patent application in the pre-reform period.

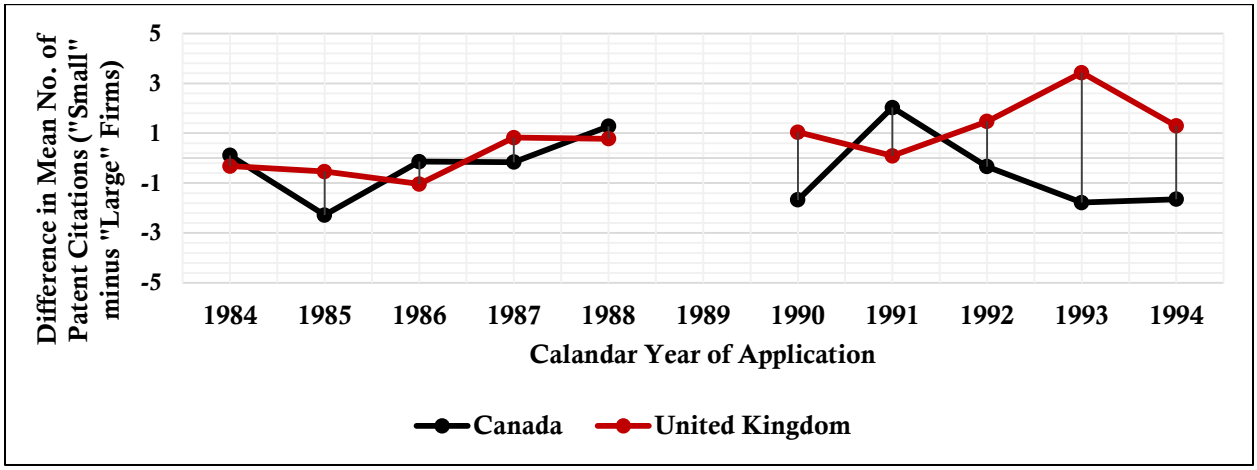
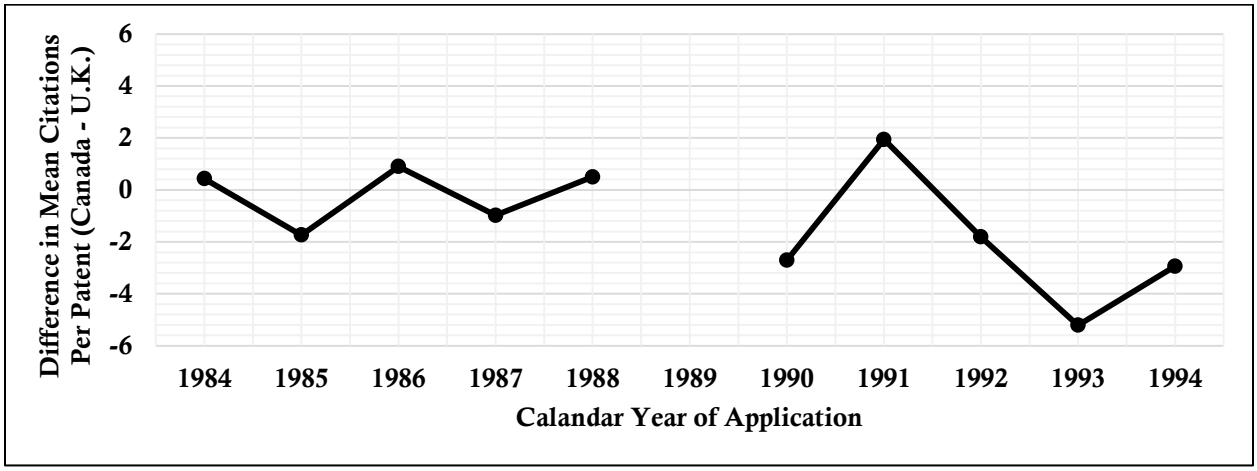


Exhibit 45 more explicitly displays the *difference* (i.e., black line minus red line in Exhibit 44) in mean citations per patent between our proxy for small and large firms in Canada relative to the United Kingdom. Exhibit 45 reveals a decline in the difference in "Canada minus U.K." mean citations per patent for firms with only one successful patent in the pre-reform period, relative to those with more than one successful patent in the pre-reform period. In other words, Exhibit 45

starts to contradict the suggestion that smaller firms in Canada started to patent higher quality patents in the post-reform period.

Exhibit 45: Difference in the Citations Per Patent from Small Firms Less Large Firms, Pre- and Post-Reform

Note: "Patent" defined as a successful patent application. We look at the mean number of citations per patent. "Small Firms" are those with one successful patent application in the pre-reform period. "Large Firms" are those with more than one successful patent application in the pre-reform period.



B. Quantitative Analysis

B.1. Analysis of Change in Mean Citations Per Patent in Firms by Patent Frequency in Pre-Reform Period

We begin our quantitative analysis by examining the mean number of citations per patent, based on patent frequency in the pre-reform period.

Exhibit 46 reports the mean number of citations per patent based on frequency of patenting in the pre-reform period for Canada and the United Kingdom, as well as the "differences in differences" between the two.

Column III reveals that for the subset of firms with one successful patent application in the pre-reform period, Canadian firms received 0.24 more citations per patent post-reform relative to the pre-reform period on average compared to their counterparts in the United Kingdom. The similar figure is 2.70 for firms with two to five patents in the pre-reform period, and 2.04 for firms with six or more patents in the pre-reform period.

Exhibit 46: Conditional on Pre-Reform Patent Activity, The Mean Number of Citations Per Patent

Firm Groupings, by Number of Pre-Reform Patents	(I) Canada		(II) United Kingdom		(III) Difference
	After	Before	After	Before	$(After_{Can.} - Before_{Can.}) - (After_{U.K.} - Before_{U.K.})$
1	10.96	10.79	8.89	8.96	**0.24**
2-5	11.20	10.75	7.43	9.67	**2.70**
6+	11.84	11.02	7.53	8.74	**2.04**

Exhibit 46 shows that while the average number of citations per patent increased in Canada relative to the United Kingdom, for those with just one patent in the pre-reform period the number increased *less* than that for those with more than one patent in the pre-reform period.

B.2. Regression Analysis

We again run three regressions to dig deeper and test the relationship between our proxy for firm size and patent activity in the post-reform period. Each regression isolates the impact of the Canadian reforms by looking at the difference in the expected number of patent citations a patent would receive given different levels of patent activity from the assignee in the pre-reform period, the country of the assignee, and whether or not the patent was filed in the post-reform period.

OLS Regression

We first run the following OLS regression:

$$Patent\ Citations_{ijt} =$$
$$\alpha + \beta_1(Patents\ Pre\ Reform_i) + \beta_2(Canada_j) + \beta_3(Patents\ Pre\ Reform_i * Canada_j) +$$
$$\beta_4(Canada_i * Post\ Reform\ Patent_t) +$$
$$\beta_5(Patents\ Pre\ Reform_i * Post\ Reform\ Patent_t) +$$
$$\beta_6(Canada_j * Patents\ Pre\ Reform_i * Post\ Reform\ Patent_t) + \sum \beta(Controls) \quad + \varepsilon_{ijt},$$

where “Patent Citations” is the number of citations a patent received from its issue date through 2006 (which is the last year in the NBER dataset), “Patents Pre Reform” is the number of successful patent applications the firm has prior to the reform (1984-1988), “Canada” is a

dummy equal to one for patents filed by a Canadian firm and equal to zero for patents filed by a U.K. firm. "Post Reform Patent" is a dummy equal to one if the application year was in the post-reform period (1990-1994), and controls represent dummies for each individual application year from 1985-88, 1990-94 (given that the patents filed in later years are likely to have less time to be cited) as well as U.S. patent classes (since different classes have different tendencies to be cited). The coefficient (β_6) on "Canada*Patents Pre Reform*Post Reform Patent" is therefore our DiDD estimator, as it shows, holding all else constant, the difference in the number of citations that more frequent patentees in the pre-reform period received in the post-reform period in Canada relative to the United Kingdom.

Our regression output is summarized in Exhibit 47. We find that the coefficient (β_6) of our triple interaction is positive and significant at the 1 percent level, which suggests that Canadian firms that patented more often in the pre-reform period patented more influential inventions in the post-reform period relative to U.K. firms. Specifically, the coefficient implies that, holding all else constant, one additional patent by a Canadian firm in the pre-reform period is associated with 0.014 more citations on average for post-reform period patents relative to U.K. firms.

Exhibit 47: OLS Regression: Impact of the Canadian Reform On Firms With At Least 1 Patent Pre-Reform on Post-Reform Citations Per Patent

Dependent Variable: Patent Citations	
Intercept ($\boldsymbol{\alpha}$)	11.71 (5.46)**
Patents Pre Reform ($\boldsymbol{\beta_1}$)	-0.0011 (-1.41)
Canada ($\boldsymbol{\beta_2}$)	1.77 (6.27)**
Patents Pre Reform*Canada ($\boldsymbol{\beta_3}$)	-0.0011 (-0.63)
Canada*Post Reform Patent ($\boldsymbol{\beta_4}$)	0.2595 (0.60)
Patents Pre Reform*Post Reform Patent ($\boldsymbol{\beta_5}$)	-0.0009 (-0.83)
Canada*Patents Pre Reform*Post Reform Patent ($\boldsymbol{\beta_6}$)	**0.0145 (5.86)****
Application Year Controls	Yes
Patent Classification Controls	Yes

t stat noted in parenthesis
* indicates significance at p < 0.05
** indicates significance at p < 0.01
n=21,579

Logarithmic Regression

We next run the logarithmic regression:

$$\ln(Patent\ Citations_{ijt} + 1) = \alpha + \beta_1(\ln(Patents\ Pre\ Reform_i + 1)) + \beta_2(Canada_j) + \beta_3(\ln(Patents\ Pre\ Reform_i + 1) * Canada_j) + \beta_4(Canada_i * Post\ Reform\ Patent_t) + \beta_5(\ln(Patents\ Pre\ Reform_i + 1) * Post\ Reform\ Patent_t) + \beta_6(Canada_j * ln(Patents\ Pre\ Reform_i + 1) * Post\ Reform\ Patent_t) + \sum \beta(Controls) + \varepsilon_{ijt},$$

where "ln (Patent Citations)" is the natural logarithm of one plus the number of expected citations a patent received from its issue date through 2006 (which is the last year accounted for in the NBER dataset), "ln (Patents Pre Reform+1)" is the natural logarithm of one plus the number of successful patent applications the firm has prior to the reform (1984-1988), "Canada" is a dummy equal to one for patents filed by a Canadian firm and equal to zero for patents filed by a U.K. firm, "Post Reform Patent" is a dummy equal to one if the application year was in the post-reform period (1990-1994), and controls represent dummies for each individual application year from 1985-88, 1990-94 (given that the patents filed in later years are likely to have less time to be cited) as well as all the different U.S. patent classes (since different classes have different tendencies to be cited).

Our regression output is summarized in Exhibit 48. As with the standard OLS regression, we find that the coefficient (β_6) for the triple interaction is positive and significant at the 1 percent level, further suggesting that Canadian firms that were more frequent patentees in the pre-reform period were more likely to patent more influential inventions in the post-reform period relative to U.K. firms. Specifically, the coefficient implies that a 1 percent increase in successful patent applications in the pre-reform period for Canadian firms is associated with a roughly 0.06 percent increase in the number of citations expected per patent in the post-reform period relative to the United Kingdom.

Exhibit 48: "Log-Log" OLS Regression: Impact of the Canadian Reform on Firms With At Least One Patent Pre-Reform on Post-Reform Citations Per Patent

Dependent Variable: ln(Patent Citations+1)	
Intercept ($\boldsymbol{\alpha}$)	2.30 (14.70)**
Ln (Patents Pre Reform+1) ($\boldsymbol{\beta_1}$)	-0.0146 (-2.65)**
Canada ($\boldsymbol{\beta_2}$)	0.1487 (4.67)**
Ln (Patents Pre Reform+1) *Canada ($\boldsymbol{\beta_3}$)	-0.0013 (-0.13)
Canada*Post Reform Patent ($\boldsymbol{\beta_4}$)	-0.0671 (-1.31)
Ln (Patents Pre Reform+1)*Post Reform Patent ($\boldsymbol{\beta_5}$)	-0.0095 (-1.15)
Canada*ln(Patents Pre Reform+1)*Post Reform Patent ($\boldsymbol{\beta_6}$)	**0.0574 (3.78)****
Application Year Controls	Yes
Patent Classification Controls	Yes

t stat noted in parenthesis
* indicates significance at p < 0.05
** indicates significance at p < 0.01
n=21,579

Negative Binomial Distribution

Because there are a substantial number of zero counts in the number of Patent Citations in the post-reform period, our citation dataset exhibits overdispersion and therefore a negative binomial regression can fit the data. Our negative binomial regression takes the following form:

$$
\begin{aligned}
&Patent\ Citations_{ijt} \\
&\quad = \alpha + \beta_1(Patents\ Pre\ Reform_i) + \beta_2\left(Canada_j\right) \\
&\quad + \beta_3\left(Patents\ Pre\ Reform_i * Canada_j\right) \\
&\quad + \beta_4\left(Canada_j * Post\ Reform\ Patent_t\right) \\
&\quad + \beta_5(Patents\ Pre\ Reform_i * Post\ Reform\ Patent_t) \\
&\quad + \beta_6\left(Canada_j * Patents\ Pre\ Reform_i * Post\ Reform\ Patent_t\right) \\
&\quad + \sum \beta(Controls)\ + \varepsilon_{ijt},
\end{aligned}
$$

where Patent Citations is the number of citations a patent received from its issue date through 2006 (which is the last year accounted for in the NBER dataset), "Patents Pre Reform" is the

number of successful patent applications the firm made prior to the reform (1984-1988), "Canada" is a dummy equal to one for patents filed by a Canadian firm and equal to zero for patents filed by a U.K. firm, "Post Reform Patent" is a dummy equal to one if the application year was in the post-reform period (1990-1994), and controls represent dummies for each individual application year from 1985-88, 1990-94 (given that the patents filed in later years are likely to have less time to be cited) as well as all different U.S. patent classes (since different classes have different tendencies to be cited).

The regression output is summarized in Exhibit 49.[179] The triple interaction is positive and statistically significant at the 1 percent level, giving additional evidence that larger firms in the pre-reform period generated more influential patents in the post-reform period relative to the United Kingdom. In other words, the difference in the number of citations in the post-reform period relative to the pre-reform period among larger versus smaller firms was more pronounced in favor of larger firms in Canada.

Exhibit 49: Negative Binomial Regression: Impact of the Canadian Reform on Firms With At Least One Patent Pre-Reform on Post-Reform Citations Per Patent

Dependent Variable: Patent Citations	
Intercept ($\boldsymbol{\alpha}$)	2.50 (14.73)**
Patents Pre Reform ($\boldsymbol{\beta_1}$)	-0.0001 (-1.95)
Canada ($\boldsymbol{\beta_2}$)	0.1612 (7.06)**
Patents Pre Reform*Canada ($\boldsymbol{\beta_3}$)	-0.0002 (-1.38)
Canada*Post Reform Patent ($\boldsymbol{\beta_4}$)	0.0254 (0.72)
Patents Pre Reform*Post Reform Patent ($\boldsymbol{\beta_5}$)	-0.0003 (-3.18)**
Canada*Patents Pre Reform*Post Reform Patent ($\boldsymbol{\beta_6}$)	**0.0013 (6.48)****
Application Year Controls	Yes
Patent Classification Controls	Yes

z stat noted in parenthesis
* *indicates significance at p < 0.05*
** *indicates significance at p < 0.01*
n=21,579

[179] Our negative binomial model has an alpha = 0.9022 with an LR test p < 0.01.

Our three models thus unanimously give evidence that counters the argument that less frequent inventors exhibited less of a boost in patent levels relative to more frequent inventors due to higher levels of selectivity. That is, larger firms are producing larger numbers of higher quality patents post-reform.

C. Extension 2: Allowing Firms that Had 0 Patents in the Pre-Reform Period

We include all those firms that had no patents in the pre-reform period to see if, by including such firms, the differential in patent citations for larger firms in the post-reform period relative to the pre-reform period changed in Canada compared to the United Kingdom.

We re-run the regressions above with the inclusion of firms without patenting activity prior to the reform, summarized in Exhibit 50.

The coefficient on the triple interaction in each case is positive and significant, which suggests the reduced patenting from our proxy for small firms (relative to large firms) in the post-reform period was *not* due to small firms being more selective.

D. Extension 3: "Group" Differences in Patent Influence: Citations Per Post-Reform Patent

We also look at differences in patent activity in the post-reform period among our three groups, namely, (a) those with one patent in the pre-reform period ("Group 1"), (b) those with two to five patents in the pre-reform period ("Group 2"), and (c) those with six or more patents in the pre-reform period ("Group 3"). We look at patent importance within Groups 2 and 3 relative to Group 1, rather than looking at patents in the pre-reform period as a continuous variable.

We are particularly interested in the triple interactions (i.e., Canada*Group 2 Pre Reform*Post Reform Patent and Canada*Group 3 Pre Reform*Post Reform Patent) which show the difference in citations per post-reform patent in Canada relative to the United Kingdom for firms in Group 2 or Group 3 relative to Group 1 (among the subset of firms with at least one patent in the pre-reform period).

The results are shown in Exhibit 51. While neither β_9 nor β_{10} is significant at the 5 percent level, β_{10} (i.e., the interaction term looking at the most frequent patentees in the pre-reform period) is significant at the 10 percent level (p=0.093).

Exhibit 50: OLS, "Log-Log" OLS, and Negative Binomial Regressions: Impact of Canadian Reform on All Firms on Post-Reform Citations Per Patent

Note: "All firms" includes those with zero successful patent applications in the pre-reform period.

	(I) OLS	**(II) "Log-Log" OLS**	**(III) Negative Binomial**
Dependent Variable	**Patent Citations**	**Ln (Patent Citations+1)**	**Patent Citations**
Intercept	11.00 (6.26)**	2.29 (18.77)**	2.44 (18.39)**
Patents Pre Reform	-0.0012 (-1.49)		-0.0001 (-2.16)*
Ln (Patents Pre Reform)		-0.0140 (-2.57)**	
Canada	1.81 (6.13)**	0.1557 (4.93)**	0.1642 (7.25)**
Patents Pre Reform*Canada	-0.0023 (-1.23)		-0.0003 (-2.15)*
Ln (Patents Pre Reform+1) * Canada		-0.0043 (-0.43)	
Canada*Post Reform Patent	0.0765 (0.20)	0.0374 (1.00)	0.0402 (1.38)
Patents Pre Reform*Post Reform Patent	-0.0016 (-1.50)		-0.0003 (-3.72)**
Ln (Patents Pre Reform+1)*Post Reform Patent		-0.0038 (-0.56)	
Canada*Patents Pre Reform*Post Reform Patent	**0.0140 (5.57)****		**0.0012 (6.15)****
Canada*Ln(Patents Pre Reform+1)*Post Reform patent		**0.0299 (2.40)***	
Application Year Controls	Yes		
Patent Classification Controls	Yes		

t stat noted in parenthesis (Columns I and II)
z stat noted in parenthesis (Column III)
** indicates significance at p < 0.05*
*** indicates significance at p < 0.01*
n=27,843

Exhibit 51: OLS Regression: Impact of the Canadian Reform Among Firm Groupings on Citations Per Patent – Groups 2 and 3, Relative to Group 1, Excluding Those Firms with No Successful Patent Applications in Pre-Reform Period

Dependent Variable: Patent Citations	
Intercept ($\boldsymbol{\alpha}$)	11.32 (5.22)**
Group 2 Pre Reform ($\boldsymbol{\beta_1}$)	0.7356 (1.61)
Group 3 Pre Reform ($\boldsymbol{\beta_2}$)	-0.1483 (-0.38)
Canada ($\boldsymbol{\beta_3}$)	2.06 (3.92)**
Canada*Group 2 Pre Reform ($\boldsymbol{\beta_4}$)	-0.6579 (-0.90)
Canada*Group 3 Pre Reform ($\boldsymbol{\beta_5}$)	-0.4421 (-0.71)
Canada*Post Reform Patent ($\boldsymbol{\beta_6}$)	-0.1201 (-0.12)
Group 2 Pre Reform*Post Reform Patent ($\boldsymbol{\beta_7}$)	-1.08 (-1.33)
Group 3 Pre Reform*Post Reform Patent ($\boldsymbol{\beta_8}$)	-0.8318 (-1.22)
Canada*Group 2 Pre Reform*Post Reform Patent ($\boldsymbol{\beta_9}$)	**1.75** **(1.39)**
Canada*Group 3 Pre Reform*Post Reform Patent ($\boldsymbol{\beta_{10}}$)	**1.82** **(1.68)**
Application Year Controls	Yes
Patent Classification Controls	Yes

t stat noted in parenthesis
** indicates significance at p < 0.05*
*** indicates significance at p < 0.01*
n=21,579

In unreported statistics, we also run regressions that include all firms and look at the citations per patent after the reform of Groups 1, 2, and 3, relative to Group 0 (i.e., those with no patents before the reform), and similarly find no statistically significant results at the 5 percent level, though Group 3 was again significant at the 10 percent level (p=0.080).

While grouping firms by patent activity in the pre-reform period into our three categories (i.e., one patent, two to five patents, and six or more patents) again generates results that are not statistically significant at the 5 percent level, the positive point estimates are consistent with our baseline regressions.

6.4.7. Conclusion

We find in our baseline results that Canadian firms with more successful patent applications in the pre-reform period exhibited more patenting activity in the post-reform period, compared to those with fewer patents in the pre-reform period, relative to the United Kingdom. In other words, Canadian inventors that patented inventions more frequently before the reform exhibited a boost after the reform relative to smaller firms compared to U.K. entities. This suggests that larger firms received greater benefits from the Canadian patent reform than did smaller entities.

Furthermore, we test the claim that perhaps small firms became more selective (relative to the United Kingdom) in what they patented in the post-reform period, but we find no empirical support for this claim. In fact, we find that, holding all else constant, firms with the more important patent applications in the pre-reform period filed more influential patents in the post-reform period relative to the United Kingdom.

7. Conclusion and Suggestions for Future Research

This report examines the impact that the America Invents Act has had on small businesses, and its potential future impact. Our literature review of articles written by patent lawyers, venture capitalists, government agencies, business owners, and academics illuminated the substantial debate regarding the impact of certain provisions on small businesses. While some championed the AIA as a set of reforms that would help smaller, patent-intensive businesses, others expected that it would severely stifle small business patenting capacities.

We conducted three empirical studies of the AIA's impact on small businesses. Whereas the public market event study and the VC financing study explore the impact of the AIA on businesses to date, our analysis of the impact of the similar Canadian patent reform that became effective in 1989 offers some insight on the potential longer-term impact of the AIA on small businesses. Although the results from the event study and the VC financing study both suggest minimal differential impact of the AIA on small companies vis-à-vis large ones, the Canadian study does suggest that the patenting of smaller companies declined relative to larger companies after Canada's switch to first-to-file became effective.

Because of the complexity of and ambiguities within the AIA, the impact of the legislation on small businesses is yet to be determined. Revisiting this topic would be appropriate after a larger number of applications filed under the FITF regime have been granted, court precedents have been established for the interpretation of currently ambiguous provisions, data on the effectiveness of the legislated improvements exist, and businesses and venture capitalists become accustomed to the reforms and learn to operate under the FITF regime.

While this assessment was mandated under the AIA legislation, we suggest that additional studies may help clarify the AIA's impact. We therefore suggest the following research be considered:

1. A series of interviews could be conducted with independent Canadian VC fund managers that operated both before and after the Canadian switch to FTF. This could be undertaken immediately and would offer an in-depth perspective on the responses of private investors to a similar, though not identical, patent reform.

2. Our study on VC financing in the United States could be updated in three to five years, to account for a potential lag in the VC community's reaction to the reform.
3. A study could examine changes in the patenting activity, in terms of both quantity and quality of patents, of small and large U.S. firms, using the same methodology as the Canadian study. Ideally, data would be obtained from the USPTO in roughly five years.

8. Appendix 1: Event Study Appendix

8.1. Sample of Firms used in Event Study Analysis, by Employee Count (A) and Market Cap (B)

A. Sample List of Firms with Full Return Data, by Employee Count

Rank	Name of Ultimate Parent Company	Name of Firm Listed by USPTO	Emp. of Ult. Parent Comp (2010)	Industry (SIC Code)
		Largest Four Companies		
1	International Business Machines Corporation	INTERNATIONAL BUSINESS MACHINES CORPORATION	426,751	Computer programming, data processing, and other computer related services (7370)
2	Siemens Aktiengesellschaft	SIEMENS AKTIENGESELLSCH FT	410,000	Conglomerates (9997)
3	Panasonic Corporation	PANASONIC CORPORATION	375,597	Electronic & Other Electric Equipment (No Computer Equip) (3600)
4	Hitachi Ltd.	HITACHI CABLE, LTD.	355,499	Drawing & Insulating Nonferrous Wire (3357)
		Middle Four Companies		
73	Taiwan Semiconductor Manufacturing Company Limited	TAIWAN SEMICONDUCTOR MANUFACTURING CO., LTD.	38,393	Semiconductors and Related Devices (3674)
74	Eli Lilly and Company	ELI LILLY AND COMPANY	38,350	Pharmaceutical Preparations (2834)
75	PPG Industries Inc.	PPG INDUSTRIES OHIO INC.	38,300	Paints, Varnishes, Lacquers, Enamels & Allied Prods (2851)
76	Autoliv, Inc.	AUTOLIV DEVELOPMENT AB	34,600	Testing Laboratories (8732)
		Smallest Ten Companies		
141	Silicon Laboratories Inc.	SILICON LABORATORIES INC.	908 (2011)	Semiconductors & Related Devices (3674)
142	O2Micro International Ltd.	O2 MICRO INTERNATIONAL LTD.	731	Semiconductors & Related Devices (3674)
143	FormFactor Inc.	FORM FACTOR, INC.	729	Instruments for Meas & Testing of Electricity & Electrical Signals (3825)
144	Power Integrations Inc.	POWER INTEGRATIONS, INC.	444	Semiconductors & Related Devices (3674)
145	Rambus Inc.	RAMBUS, INC.	390	Patent Owners & Lessors (6794)

Smallest Ten Companies (Cont.)				
146	InterDigital, Inc.	INTERDIGITAL TECHNOLOGY CORPORATION	300	Patent Owners & Lessors (6794)
147	Theravance Inc.	THERAVANCE, INC.	193	Pharmaceutical Preparations (2834)
148	NTN Buzztime Inc.	NTN CORPORATION	131	Television Broadcasting Stations (4833)
149	Digimarc Corporation	DIGIMARC CORPORATION	98	Electrical Components, NEC (3679)
150	Agree Realty Corp.[180]	ADC GMBH	11	Real Estate Investment Trusts (6798)

B. Sample List of Firms With Full Return Data, by Market Capitalization

Rank	Name of Ultimate Parent Company	Name of Firm Listed by USPTO	Mkt. Cap of Ult. Parent Company ($B, 2010)	Industry (SIC Code)
Largest Four Companies				
1	ExxonMobil Corporation	EXXONMOBIL RESEARCH AND ENGINEERING COMPANY	368.71	Commercial Physical and Biological Research (8731)
2	Apple Inc.	APPLE COMPUTER, INC.	295.89	Electronic Computers (3571)
3	Microsoft Corporation	MICROSOFT CORPORATION	238.78	Services-Prepackaged Software (7372)
4	Royal Dutch Shell plc	SHELL OIL COMPANY	204.44	Crude Petroleum & Natural Gas (1311)
Middle Four Companies				
97	Weatherford International plc	WEATHERFORD/LAMB, INC.	16.90	Oil and Gas Field Service (NEC) (1389)
98	Raytheon Co.	RAYTHEON COMPANY	16.89	Search, Detection, Navigation, Guidance, Aeronautical SYS (3812)
99	Xerox Corporation	PALO ALTO RESEARCH CENTER INCORPORATED	15.98	Commercial Physical and Biological Research (8731)
100	TE Connectivity Ltd.	ADC TELECOMMUNICATIONS, INC.	15.71	Telephone and Telegraph Apparatus (3661)
Smallest Ten Companies				
188	Cirrus Logic Inc.	CIRRUS LOGIC, INC.	1.10	Semiconductors & Related Devices (3674)
189	Unisys Corporation	UNISYS CORPORATION	1.10	Services-Computer Integrated Systems Design (7373)
190	Integrated Device Technology, Inc.	INTEGRATED DEVICE TECHNOLOGY, INC.	1.02	Semiconductors & Related Devices (3674)
191	Callaway Golf Co.	CALLAWAY GOLF COMPANY	0.52	Sporting & Athletic Goods, NEC (3949)

[180] Agree Realty Corp was incorrectly matched in Capital IQ with Berlin-based ADC GMBH, which is a subsidiary of TE Connectivity. TE Connectivity was, however, also included in the dataset.

Smallest Ten Companies (Cont.)				
192	FormFactor Inc.	FORM FACTOR, INC.	0.45	Instruments for Meas & Testing of Electricity & Electrical Signal (3825)
193	Himax Technologies, Inc.	Himax Technologies Limited	0.42	Semiconductors & Related Devices (3674)
194	Agree Realty Corp.[181]	ADC GMBH	0.25	Real Estate Investment Trusts (6798)
195	Digimarc Corporation	DIGIMARC CORPORATION	0.22	Electronic Components, NEC (3679)
196	O2Micro International Ltd.	O2 MICRO INTERNATIONAL LTD.	0.21	Semiconductors & Related Devices (3674)
197	NTN Buzztime Inc.	NTN CORPORATION	0.02	Television Broadcasting Stations (4833)

8.2. Additional Event Study Data

8.2.1. Qualitative Overview of Data by Employee Count

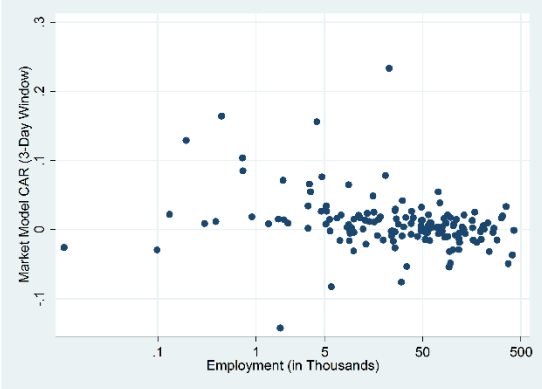
We generate scatterplots to qualitatively assess the data for any patterns in CARs for firms of different employment levels.[182] Exhibit 52 gives scatterplots of each firm's market model CAR for a three-day window around each key event. Any apparent patterns in the data would suggest some type of differential market response to the AIA.

The graphs of Events 1-3 show no clear indication of any real differences in the CAR of firms of different sizes, as the points appear to be scattered randomly. Event 4 shows a weak negative correlation, although the CARs for the small set of firms with under $1 billion in market capitalization do not stand out from the larger firms. While Event 5 suggests a moderate negative correlation, this pattern is driven by the small percentage of firms with CARs above 0.05. In addition, the small percentage of firms with fewer than 1,000 employees shows no clear difference in CARs from the larger firms. The pattern in the data switches, however, for Event 6, where a positive correlation emerges. The smallest firms appear to have returns on the lower end of the spectrum.

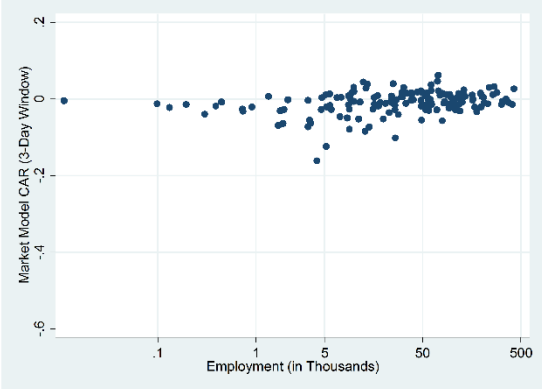
[181] Agree Realty Corp was incorrectly matched in Capital IQ with Berlin-based ADC GMBH, which is a subsidiary of TE Connectivity. TE Connectivity was, however, also included in the dataset.
[182] We use a logarithmic X axis to better represent the data since employee counts range widely.

Exhibit 52: Scatterplots of Market Model Returns for a Three-Day Window Around Each Key Event, by Employment

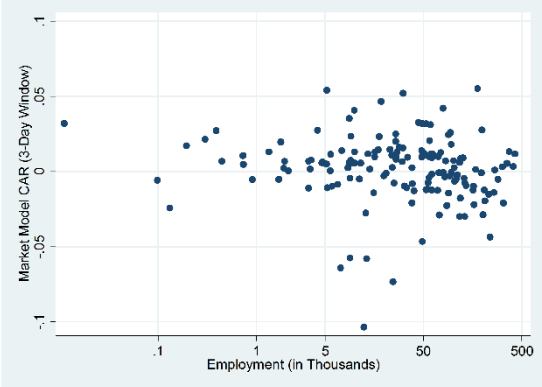
Market model CARs by employee count for 3-day window around Event 1



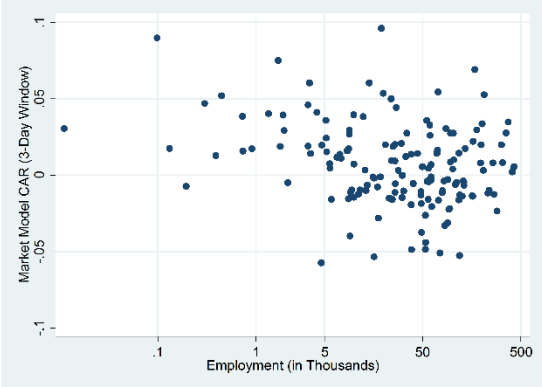
Market model CARs by employee count for 3-day window around Event 2



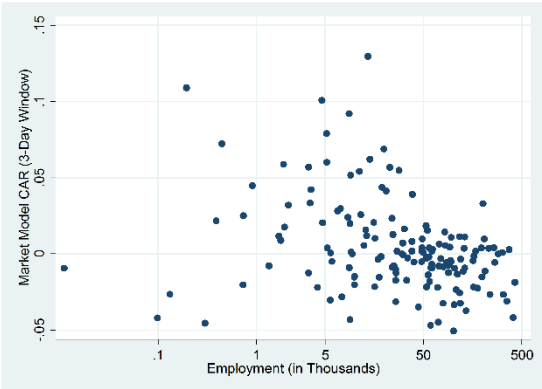
Market model CARs by employee count for 3-day window around Event 3



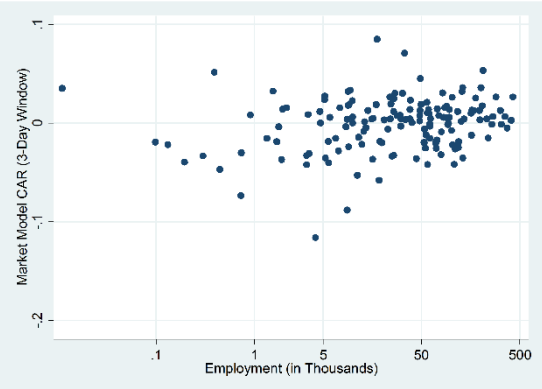
Market model CARs by employee count for 3-day window around Event 4



Market model CARs by employee count for 3-day window around Event 5



Market model CARs by employee count for 3-day window around Event 6



B.1. Qualitative Overview of Data by Market Capitalization

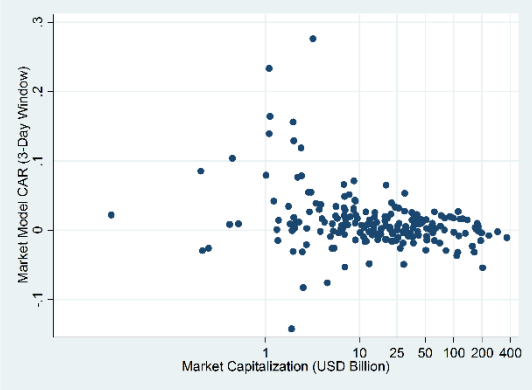
We also look at scatterplots to qualitatively assess the data for any apparent pattern in CARs for firms of different market capitalizations.[183] Exhibit 53 gives scatterplots using market model CARs for a three-day window around each key event.

The graphs collectively show minimal indication of a differential impact based on firm size. Each plot shows roughly random scatter, with smaller firm performance generally in line with larger firm performance. Event 4 does suggest a weak negative gradient. Overall, the smallest firms in our dataset, by market capitalization, appear to show abnormal returns in line with the larger firms.

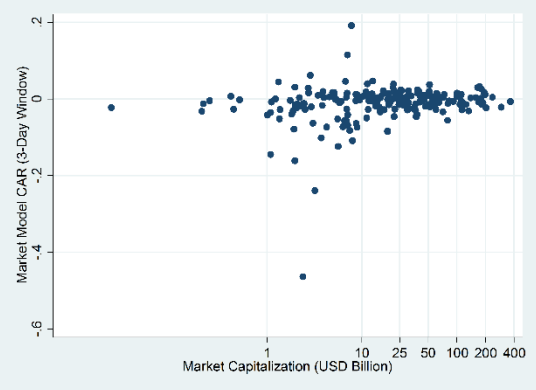
[183] We use a logarithmic x-axis to better represent the data since market capitalization ranges widely.

Exhibit 53: Scatterplots of market model returns for a three-day window around each key event, by market capitalization

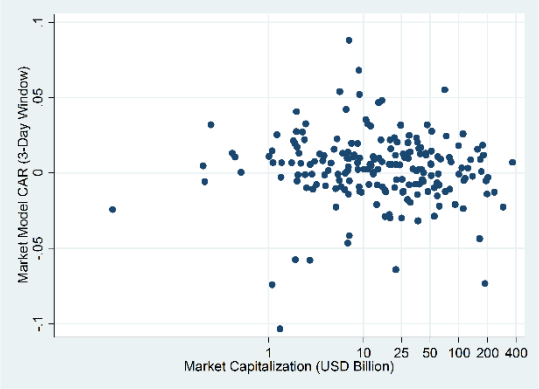
Market model CARs by market cap for 3-day window around Event 1



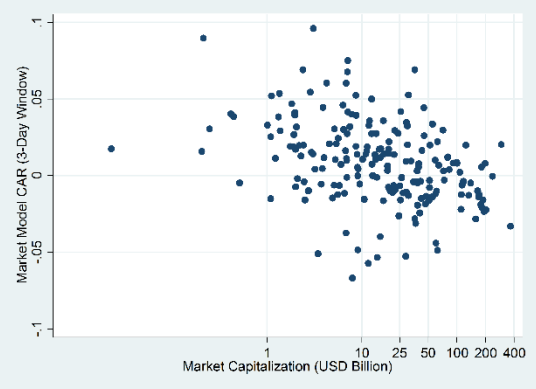
Market model CARs by market cap for 3-day window around Event 2



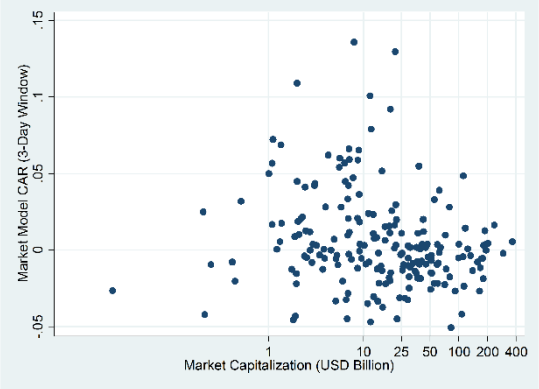
Market model CARs by market cap for 3-day window around Event 3



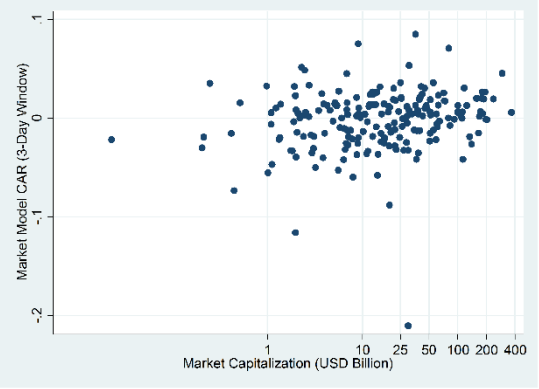
Market model CARs by market cap for 3-day window around Event 4



Market model CARs by market cap for 3-day window around Event 5



Market model CARs by market cap for 3-day window around Event 6



9. Appendix 2: Overview of Difference-in-Differences (DiD) and Difference-in-Differences-in-Differences (DiDD) Regressions

9.1. Overview of DiD and DiDD

Differences-in-Differences (DiD) and Difference-in-Differences-in-Differences (DiDD) are two types of econometric analyses used to identify the impact of policy changes. The underlying logic of both is that a simple comparison of some variable of interest (i.e., VC financing or patent activity) from before an intervention to after an intervention cannot truly isolate the impact of the intervention, as the results are likely to be distorted by other factors (for example, shifts in the macro-economy).

To address this problem, economists seek to identify a non-affected population that has historically followed a "parallel path" to the population exposed to the intervention. They then "net out" changes from this "control" population to determine how much change in the variable of interest can be attributed to the intervention. This gives a more accurate sense of the impact of a policy change than a simple "before and after" analysis.

9.2. Example of Difference-in-Differences (DiD)

DiD analyses generally take into account *two* time periods (i.e., before and after some policy change) and *two groups* – a treatment group (i.e., the group exposed to the policy change) and a control group (i.e., a group not exposed to the policy change but generally one that exhibits similar historical patterns of change with respect to the variable of interest).

A classic example of a DiD estimate comes from David Card and Alan Krueger's paper on the impact of New Jersey's increase in the minimum wage (from $4.25 to $5.05) in 1992 on low-wage employment levels. The authors surveyed fast-food restaurants in New Jersey and eastern Pennsylvania and measured employment before and after the law change. The authors explained that because fast-food stores in eastern Pennsylvania exhibited similar seasonal patterns to New Jersey, but did not experience any change in minimum wage, they could "net out" seasonal employment effects from the effects of the law change in New Jersey. They reported the following results (in the chart below), with the (counterintuitive) finding that New Jersey's fast-food restaurants experienced a relative gain in employment of 2.76 full-time-equivalent (FTE)

employees (13 percent). Numbers in parentheses are standard errors, which indicate the accuracy of the sample estimates.

Average Employment Per Store Before and After the Rise in New Jersey Minimum Wage[184]

Variable	Stores by State		
	Pennsylvania	**New Jersey**	**New Jersey – Pennsylvania**
FTE employment before	23.33 (1.35)	20.44 (0.51)	-2.89 (1.44)
FTE employment after	21.17 (0.94)	21.03 (0.52)	-0.14 (1.07)
Change in mean FTE employment	-2.16 (1.25)	0.59 (0.54)	**DiD: 2.76** *[-2.89 – (-0.14)] or [-2.16 – 0.59]* **(1.36)**

While the authors employ a number of different specifications and robustness tests, the above table illustrates the basic results of the DiD analysis. It is important to note that although the findings of Card and Krueger's paper have been subjected to significant criticism, the DiD methodology has become widespread in the analysis of policy changes.

Rather than representing the average employment per store by state in a two-by-two table, we can also run a regression analysis. This allows us to use additional controls for potential differences. In other words, DiD regressions offer a convenient way to consolidate and analyze a variety of statistical factors that allow a researcher to more precisely determine the reliability of results.

9.3. Example of Difference-in-Differences-in-Differences Analysis

A traditional DiDD analysis takes into account two types of entities (those exposed to the intervention and those immune to the intervention) in two geographies (one that was exposed to the intervention and one that was not exposed to the intervention). The analysis then looks at

[184] Section of Table 3, extracted from David Card and Alan B. Krueger, "Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania," *The American Economic Review* 84, no. 4, Sept. 1994, p. 780.

changes between the "treatment" group and "control" group in both areas exposed to the intervention and areas not exposed to the intervention. In other words, a DiDD analysis combines a look at changes in the variable of interest with respect to "treatment" and "control" groups within both the experimental region and the control region. Theoretically, this should help better control differences in time trends between the geographical areas, as well as between the types of entities (for example, firms of different sectors).

A classic example of this type of DiDD regression is found in Jonathan Gruber's paper on the change of wages after laws passed in the mid-1970s mandating comprehensive coverage for childbirth and health insurance policies. Gruber identifies a set of "experimental states" (i.e., those that passed such mandates) that impacted "a particular group of individuals" (i.e., broadly speaking, married women of child-bearing age (20-40)), as well as a control group (i.e., all individuals *not* of child-bearing age and single males age 20-40). Gruber is careful about matching control states of a similar nature to the treatment states, such that the control states could likely capture regional shocks. He reported his results in the table below.

Panel A looks at the average real wage *among those individuals most likely to be impacted by the mandate* in (a) the states exposed to the mandate and (b) states not exposed to the mandate. Panel B looks at the average real wage *among those individuals not likely to be impacted by the change* in (a) the states exposed to the mandate and (b) states not exposed to the mandate. By "netting out" the wage change among the control group from the change among treatment individuals, the calculation is theoretically able to remove the effect of non-related labor market shifts that took place in the experimental states. The DiDD estimate suggests a "5.4% fall in the *relative* wages of 20-40-year-old married women in the states that passed the laws, compared to the change in relative wages in the nonexperimental states."[185]

[185] Gruber, "Mandated Maternity Benefits," p. 630.

DiDD Estimates of the Impact of State Mandates on Hourly Wages[186]

Location/year	Before law change	After law change	Time difference for location
Panel A: Treatment Individuals: Married Women, 20-40 Years Old:			
Experimental states	1.547 (0.012)	1.513 (0.012)	-0.034 (0.017)
Nonexperimental states	1.369 (0.010)	1.397 (0.010)	0.028 (0.014)
			DiD: -0.062 **(0.022)**
Panel B: Control Group: Over 40 and Single Males 20-40:			
Experimental states	1.759 (0.007)	1.748 (0.007)	-0.011 (0.010)
Nonexperimental states	1.630 (0.007)	1.627 (0.007)	-0.003 (0.010)
			DiD: -0.008 **(0.014)**
			DiDD: -0.054 **[-0.062 – (-0.008)]** **(0.026)**

Note: Cells contain mean log hourly wage for the group identified. Standard errors are given in parentheses.

For comparison purposes, we note that in our VC financing study, we look at:

- Firms operating in the United States (the "experimental state") versus firms operating in Europe (the "nonexperimental State");
- VC financing in patent-intensive industries versus VC financing in non-patent-intensive industries.

Our DiDD estimator is therefore:

[186] Table 3, extracted from Gruber, "Mandated Maternity Benefits," p. 632.

$$DiDD = [DiD\ for\ Average\ VC\ Activity\ among\ Patent\ Intensive\ Industries] - [DiD\ for\ Average\ VC\ Activity\ among\ Patent\ Light\ Industries].$$

In other words, how much relative change do we see in VC activity in patent-intensive industries before versus after the reform in the United States and Europe, net of relative changes in VC activity among patent-light industries? Consider a case where patent-intensive industries receive proportionally less VC financing in the United States relative to Europe from before versus after the intervention. Meanwhile, imagine patent-light industries see no change in VC financing. The DiDD estimator would then be negative, implying that the financing of innovative patent-intensive industries was hurt by the reform.

In our Canadian study, we observe *two groups* (i.e., Canadian firms and U.K. firms) in *two periods*, i.e., the five years before and the five years after the reform), and we look at the *difference* within smaller firms versus larger firms. Specifically, our Canadian patenting study looks at:

- Firms operating in Canada (the "experimental state") versus firms operating in the United Kingdom (the "nonexperimental state");
- Patent activity from smaller firms versus patent activity from larger firms, based on the number of patents a firm had in the pre-reform period.

Our DiDD estimator is therefore:

$$DiDD = [DiD\ for\ Average\ Patent\ Activity\ among\ Firms\ with\ X\ patents\ in\ the\ PreReform\ Period] - [DiD\ for\ Average\ Patent\ Activity\ among\ Firms\ with\ Y\ Patents\ in\ the\ PreReform\ Period]$$

In other words, how much relative change do we see in patent activity among firms with more patents in the pre-reform period versus the post-reform period in Canada and the United Kingdom, net of relative changes in patent activity among firms with fewer patents in the pre-reform period?

As with the DiD analysis, we may view the DiDD estimators in regression form.

9.4. General Criticisms of DiD Analyses

DiD and DiDD analyses have been subject to substantial criticisms, such as (a) the possibility that policy changes are not truly "random" but are rather the result of certain economic conditions that are independently changing the variable of interest (i.e., an "endogeneity problem"),[187] (b) the difficulty in finding truly independent control groups to limit biases in results,[188] and (c) several data challenges of DiD analyses.[189]

[187] Timothy Besley and Anne Case, "Unnatural Experiments? Estimating the Incidence of Endogenous Policies," *The Economic Journal* 110, Nov. 2000.
[188] Besley and Case, "Endogenous Policies." See also, Alberto Abadie, "Semiparametric Difference-in-Differences Estimators," *Review of Economic Studies* 72, 2005.
[189] Marianne Bertrand, Esther Duflo, and Sendhil Mullainathan, "How Much Should We Trust Differences-In-Differences Estimates?," *Quarterly Journal of Economics* 119, no. 1, Feb. 2004.

10. Appendix 3: VC Financing Study

10.1. VC Financing Study Dataset

Exhibit 54: Frequency of Patent Grants Among U.S. Industries, 2006-2010

NAICS Industry (Code)	Percent of Total Patent Grants to U.S. Corporations[a]	Classification
Computer and peripheral equipment (3341)	18.36	Super heavy
Semiconductors and other electronic components (3344)	12.76	Super heavy
Navigational, measuring, electromedical, and control instruments (3345)	11.48	Super heavy
Communications equipment (3342)	11.19	Super heavy
Machinery (333)	9.29	Super heavy
Electrical equipment, appliances, and components (335)	6.16	Heavy
Pharmaceutical and medicines (3254)	3.85	Heavy
Other miscellaneous (339, except 3391)	3.75	Heavy
Basic chemicals (3251)	3.47	Heavy
Fabricated metal products (332)	3.29	Heavy
Medical equipment and supplies (3391)	2.94	Heavy
Other chemical product and preparation (3253, 3255, 3256, 3259)[b]	2.79	Heavy
Motor vehicles, trailers and parts (3361-3363)	2.14	Heavy
Other computer and electronic products (3343, 3346)	2.03	Light
Plastics and rubber products (326)	1.95	Light
Nonmetallic mineral products (327)	0.88	Light
Aerospace product and parts (3364)	0.72	Light
Textiles, apparel and leather (313-316)	0.67	Light
Resin, synthetic rubber, and artificial and synthetic fibers and filaments (3252)	0.65	Light
Other transportation equipment (3365, 3366, 3369)	0.41	Light

Exhibit 54: Frequency of Patent Grants Among U.S. Industries, 2006-2010 (Continued)

NAICS Industry (Code)	Percent of Total Patent Grants to U.S. Corporations[a]	Classification
Furniture and related products (337)	0.27	Light
Primary metal (331)	0.26	Light
Food (311)	0.18	Light
Wood products (321)	0.12	Light
Beverage and tobacco products (312)	0.06	Light

Source: http://www.uspto.gov/web/offices/ac/ido/oeip/taf/naics/naics_own_fgall/naics_own_fg.htm, accessed July 15, 2014.

a. Each percentage is the "pooled" percentage of patent grants issued from 2006-2010, as a proportion of total patent grants issued from this period. For example, the percentage of patent grants from "Computer and Peripheral Equipment" (18.4 percent) is calculated by dividing the 71,972 patents classified within this industry by the 391,937 patent grants issued to all industries during this period.

b. SIC Code 3259 was inadvertently omitted from this analysis among the "Other chemical product and preparation" group. This SIC code, however, composed a small percentage of deals/equity invested overall and changed minimally from the pre-AIA to post-AIA period. Specifically, we find that SIC Code 3259 composed roughly 2.1 percent of heavy deals on average pre-AIA and 2.9 percent of heavy deals on average post AIA in the United States. In Europe, the figures were 2.6 percent pre AIA and 2.7 percent post AIA. With respect to equity invested, SIC Code 3259 composed on average 2.4 percent of equity invested pre-AIA and 2.7 percent post-AIA on average. The figures were similarly small in Europe, with 0.2 percent pre-AIA and 0.5 percent post-AIA on average. Thus, this has no material impact on the results.

10.2. Additional Sample Statistics

Exhibit 55: Percentage of Deals and Equity Invested in Sample in Patent Intensive (Patent-Super-Heavy and Patent-Heavy) and Patent-Light Industries

	Patent Intensive	Patent-light
Percentage of U.S. Deals		
Q1 2004 - Q2 2014	89	11
Subset: Q1 2008 - Q2 2014	*91*	*9*
Percentage of Euro Deals		
Q1 2004 - Q2 2014	81	19
Subset: Q1 2008 - Q2 2014	*82*	*18*
Percentage of U.S. Equity Invested		
Q1 2004 - Q2 2014	93	7
Subset: Q1 2008 - Q2 2014	*94*	*6*
Percentage of Euro Equity Invested		
Q1 2004 - Q2 2014	82	18
Subset: Q1 2008 - Q2 2014	*86*	*14*

10.3. Examining Parallel Paths Assumption

We look at the two elements of the parallel path assumption below:

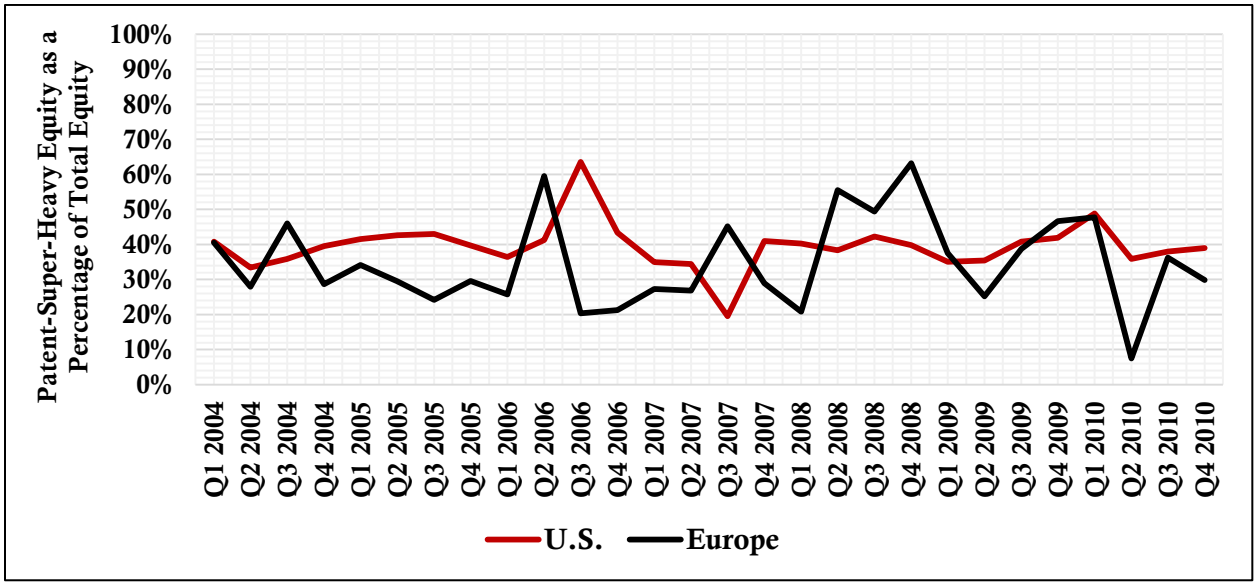
Pre-AIA Paths

Europe is likely to be the best control given similarities with the United States in terms of the macro economy that typically drives VC financing. Examining the "pre-AIA" period from Q1 2004 to Q4 2010, we find that whatever time period we selected, the proportion of equity dollars being invested among the patent-intensive industry groups in Europe and the United States does *not* show a consistent trend.

A time series of the relative proportion of equity invested in patent-super-heavy industries since 2004 is shown in Exhibit 56.

Exhibit 56: Paths of Equity Invested in Patent-Super-Heavy Industries in the United States and Europe, Q1 2004 – Q4 2010

Note: Data represent the percentage of "patent-super-heavy" equity invested to total VC equity invested.

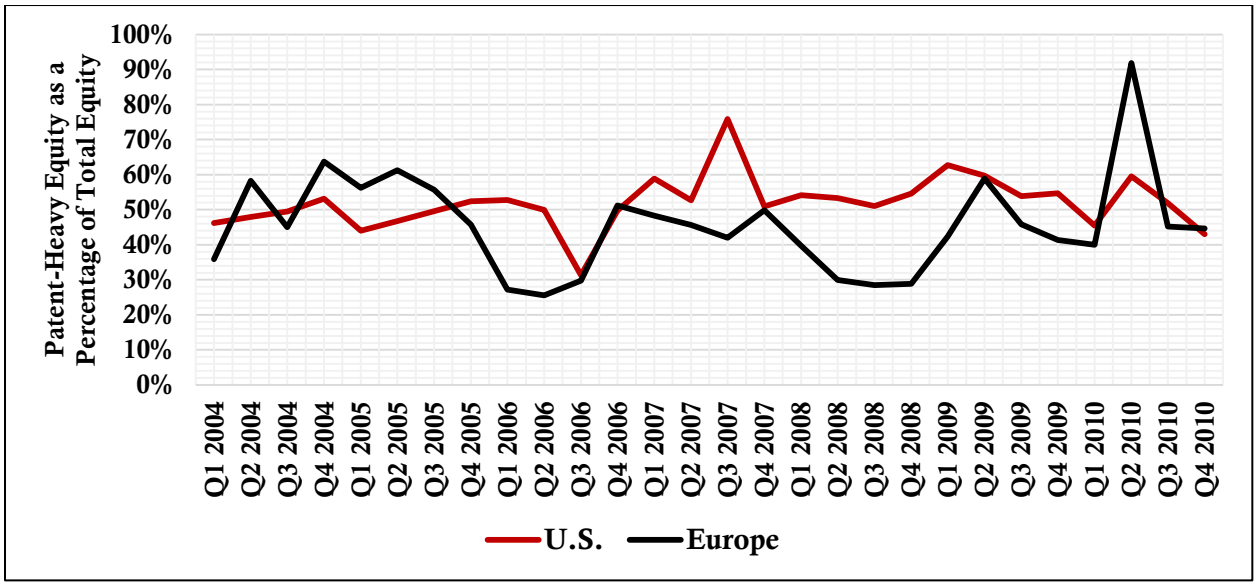


Source: VentureXpert, accessed July 16, 2014.

Exhibit 57 shows the relative proportion of equity dollars in patent-heavy industries since 2004.

Exhibit 57: Paths of Equity Invested in Patent-Heavy Industries in the United States and Europe, Q1 2004 - Q4 2010

Note: Data represent percentage of "patent-heavy" equity invested to total VC equity invested.



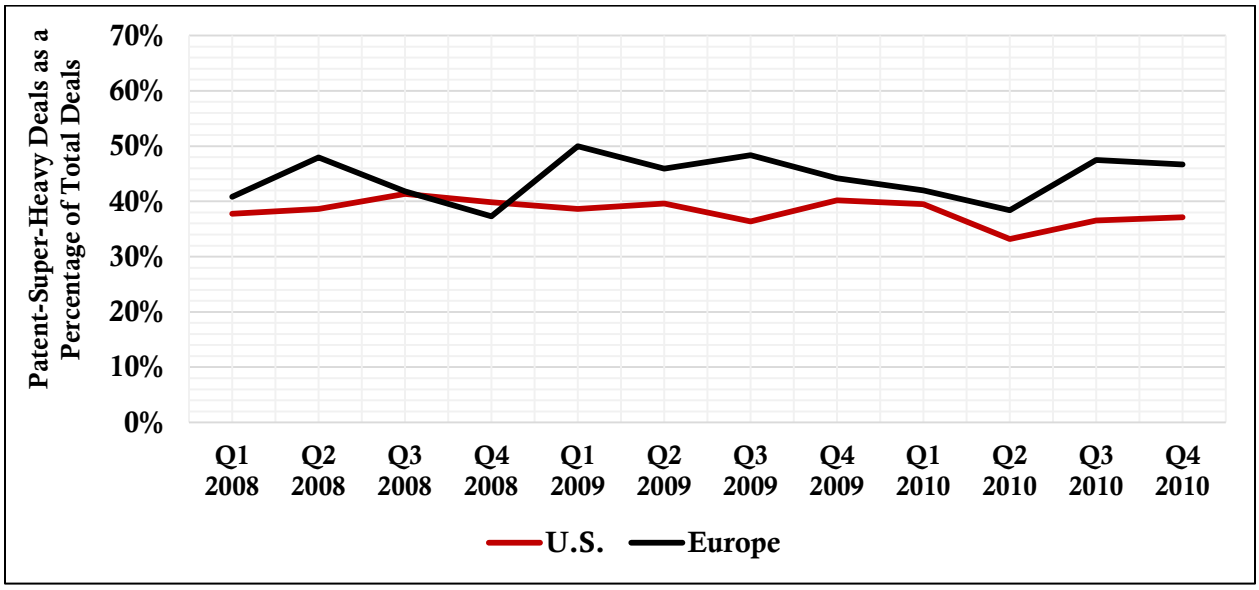
Source: VentureXpert, accessed July 16, 2014.

The graphs reveal greater fluctuations in the European time series, no doubt reflecting the relatively small number of venture financings taking place there. There is no clear time trend in the United States or Europe. The lack of a clear time trend before the reform will allow a DiD analysis to spot a general shift in activity post-AIA.

In addition, the relative proportion of VC deals for each of the three industry groups has exhibited a roughly parallel trend from 2008 through 2010. Exhibit 58 and Exhibit 59 show that in spite of clear quarterly fluctuations in the difference between the United States and Europe, a substantial change in the proportions post-AIA would certainly be noticeable.

Exhibit 58: Paths of VC Deal Counts in Patent-Super-Heavy Industries in the United States and Europe, Q1 2008 - Q4 2010

Note: Data represent the proportion of "patent-super-heavy" deals to total VC deals.

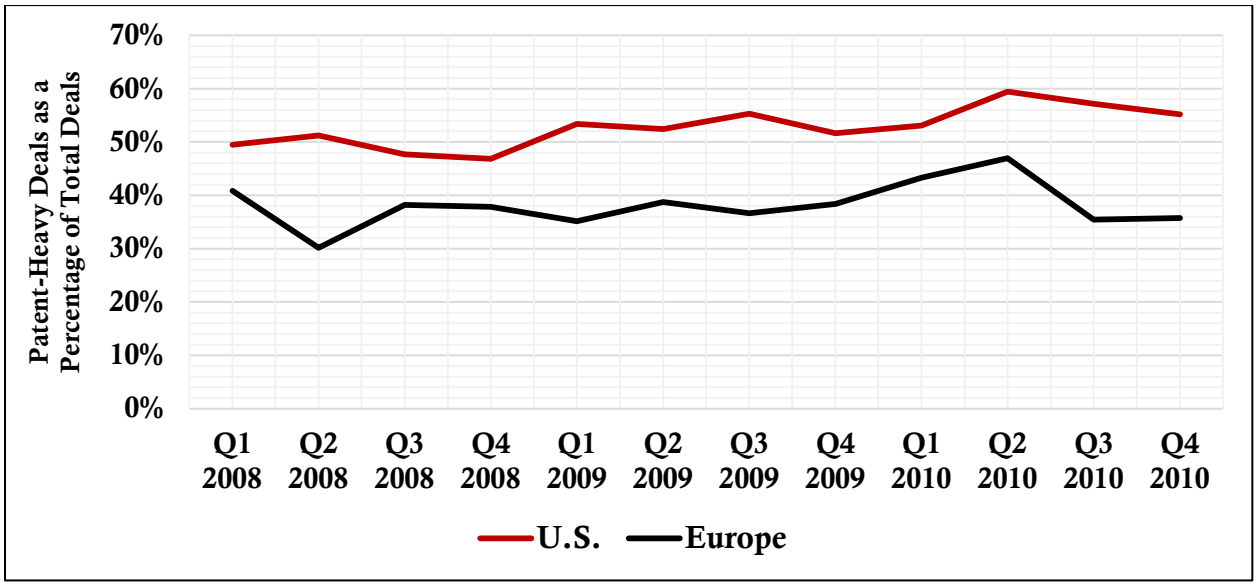


Source: VentureXpert, accessed July 16, 2014.

The relative proportions in patent-heavy industries show a roughly parallel trend since 2008 (Exhibit 59).

Exhibit 59: Paths of VC Deal Counts in Patent-Heavy Industries in the United States and Europe, Q1 2008 - Q2 2010

Note: Data represent percentage of "patent-heavy" deals to total VC deals.



Source: VentureXpert, accessed July 16, 2014.

Post-AIA Paths

Other major changes post-AIA may have affected the relative disbursement of venture financing. It is important to emphasize that even if the total number of deals or equity dollars was substantially affected post-AIA, this would not imply a shift in the proportion of deals among each industry group.

With respect to confounding legal reforms, Europe had no major patent reform during the sample period that would put patent-reliant small businesses at a disadvantage. While European firms also patent in the United States, because most small businesses will typically first patent in Europe—which already had a FTF system—the shift in the United States would be unlikely to have a substantial impact on European VC financing. Although some claim that the development of unitary patents in Europe (i.e., a European patent granted by the EPO that would give uniform protection and equal effect in all participating Member States of the European Union) could potentially harm[190] or help[191] the patenting prospects of small businesses once it takes effect in 2015/2016, we find it unlikely that it would materially impact VC financing of small businesses during our sample period.

Without significant legal reforms that could distort the proportion of VC funding aimed at our different industries, we proceed with a DiD analysis.

[190] Gail Edmondson, "Europe's Unitary Patent to Launch in 2015 – But Will Companies Embrace It?," *Science Business,* Oct. 16, 2013.
[191] Dugie Standeford, "European Unitary Patent and Court Becomes Reality," *International Property Watch,* Dec. 11, 2012.

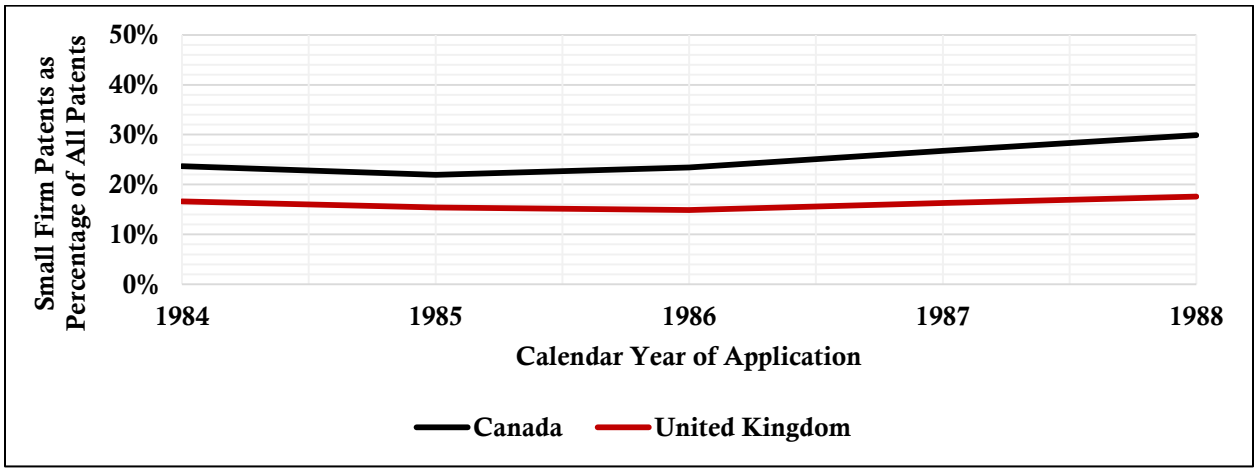
11. Appendix 4: Canadian Study

11.1. Examining Parallel Paths Assumption

Pre-Reform Paths

A time series of the relative proportion of patents from infrequent patentees as a proportion of total patents is shown in Exhibit 60 for Canada and the United Kingdom.

Exhibit 60: Paths of Patent Counts: Proportion of Successful Patent Applications from Firms with One Successful Patent (i.e., "Small Firms") as a Percentage of Total Patents, 1984-1988

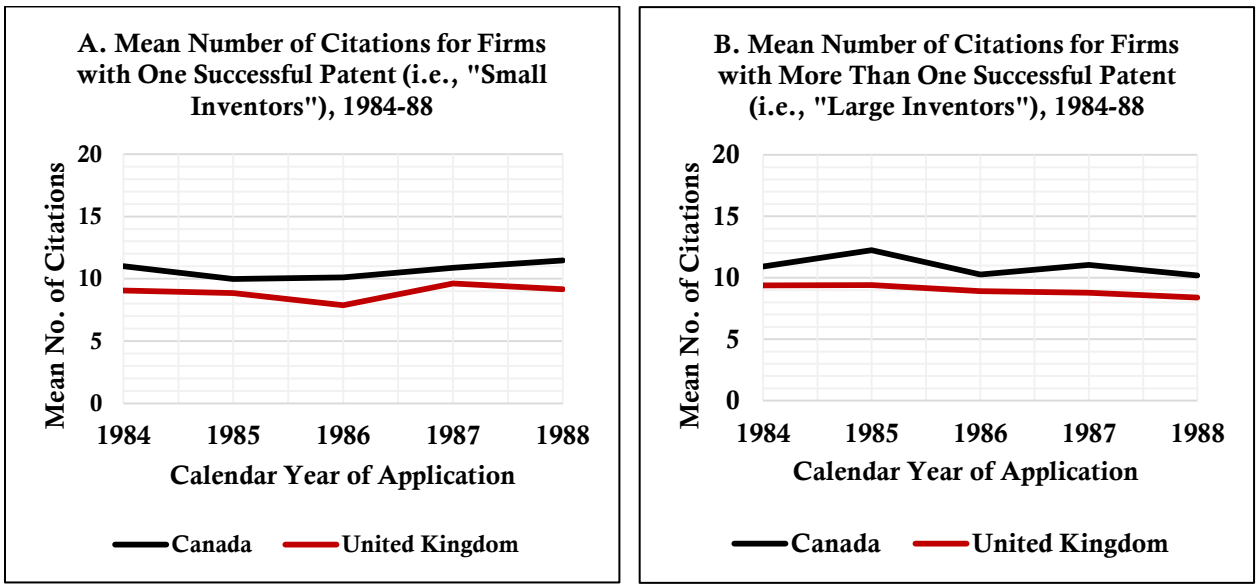


Although the difference in the proportion of patents from infrequent patentees in Canada and the United Kingdom gradually spreads, the differences are modest.

We also test how the mean number of citations for our proxies for small and large firms trended in the pre-reform period, as shown in Exhibit 61. Again, the differences are limited in scale.

Exhibit 61: Paths in Citations Among Smaller and Larger Inventors, 1984-1988

Note: Mean Number of Citations for Firms with (A) One Successful Patent Application (i.e., "Small Inventors") and (B) Firms with More than One Successful Patent Application (i.e., "Large Inventors")



Confounding Events

One concern is the presence of potentially confounding events. With respect to other legal reforms, we note that in November 1988 the United Kingdom enacted the Copyright, Designs and Patents Act 1988 with several amendments to the Patents Act 1977. The main amendments pertaining to patent law (most of which became effective in 1989) dealt with (a) de-monopolizing the patent advisory industry, (b) introducing lower-cost patent county courts, and (c) removing the "license of right" provision for certain pharmaceutical patents, which previously required pharmaceutical companies to license patents in the final four years of the 20-year patent term.[192] Although the boost in competition among patent agents as well as lower-cost domestic patent courts were aimed at helping more resource-constrained patentees domestically, it is not clear that the law materially changed U.S. patenting of small firms relative to large firms in the United Kingdom.[193]

[192] Gerald Dworkin and Richard D. Taylor, *Blackstone's Guide to the Copyright, Designs, & Patents Act 1988*, (Oxford: Oxford University Press, 1989), pp. 203-209.

[193] For example, Gerald Dworkin and Richard D. Taylor note in their book, with respect to lower-cost patent courts, that "[t]hese enabling provisions provide little more than a framework for a new patent court" and that the question of "[h]ow flexible and innovative it will turn out to be [would] depend to a large extent upon the detailed procedural rules which [had] yet to be made and the manner in which they [would be] operated by the judge." Dworkin and Taylor, *Blackstone's Guide to the Patents Act 1988*, p. 206.

In addition, there are several other provisions in the Canadian reform, such as a change in patent term, the introduction of annual maintenance fees, deferred examination, and the newly patentable status of pharmaceuticals. We suggest, however, that no major external variables in one country make isolation of the priority change implausible.

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