

DOES AGENCY FUNDING AFFECT DECISIONMAKING?: AN EMPIRICAL ASSESSMENT OF THE PTO'S GRANTING PATTERNS

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This Article undertakes the first attempt to causally investigate the influence of the PTO's funding on the agency's decision-making. More specifically, this Article studies the influence of the PTO's budgetary structure on the most important decision made by the agency: whether or not to grant a patent. It begins by setting forth a theoretical model predicting that certain elements of the PTO's fee schedule, such as issuance and maintenance fees, which are only collected in the event that patents issue, create incentives for the PTO to grant additional patents. Using a rich database of previously-unavailable patent grant rates, we then empirically test the predictions of the theoretical model by comparing the agency's granting patterns before and after 1991, the period at which the agency became almost exclusively funded by user fees.

Our findings suggest that the agency's fee structure biases the PTO towards granting patents. For instance, with respect to those types of patents for which the PTO is likely to profit the most from granting, we estimate a relatively stronger sensitivity to the PTO's funding structure. More specifically, our findings suggest the PTO is preferentially granting patents on technologies with high renewal rates and patents filed by large entities, as the PTO stands to earn the most revenue by granting additional patents of these types. Furthermore, we also find that these distortions are more likely to occur when markers indicative of an underfunded PTO are present. As such, our results are relevant to the ongoing debate regarding the nature of bureaucrats or government employees. Our findings contradict the idea that bureaucrats seek to maximize their budgets while lending support to the notion that when agencies seek enlarged budgets they do so as a result of being mission minded but financially constrained.

From a social welfare perspective, our results are discouraging, as they suggest that the PTO's financial incentives, and not solely the merits of the invention, may be, in part, driving patentability decisions. While patents attempt to push society towards a socially optimal level of innovation by providing

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inventors with a mechanism to recoup their research and development expenses, they do so only at a cost—consumers pay higher prices and have less access to the patented invention. A PTO that is applying the patentability standards in a patent-protective manner is likely to be routinely granting patents on inventions that were either already known or represent only a trivial advancement over the existing scientific knowledge. As a result, a grant-biased PTO is likely to systematically issue patents that end up imposing significant costs on society without bestowing the commensurate benefits of innovation.

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INTRODUCTION

In 1991, Congress changed the mechanism by which the United States Patent and Trademark Office (“PTO”) was funded. The result being that the agency, whose principal task is to determine whether an invention merits the reward of a patent, became almost entirely funded through user-fees.³ Since 1991, the PTO’s budget has largely been derived from patent examination and post-allowance fees.⁴ While patent processing comprises the majority of the agency’s operational expenses, patent examination fees cover less than one-third of the examination costs.⁵ As a result, the agency is heavily dependent on post-allowance fees—fees the PTO only collects when it grants a patent—to fund its operations. This Congressional-set fee structure creates a possible financial incentive for the PTO to grant patents, although the extent to which the agency will act on this incentive depends both on the PTO’s objectives and its needs. Thus, the 1991 variation in the law affords the opportunity to explore an important issue

³ Omnibus Budget Reconciliation Act of 1990, Pub. L. No. 101-508, § 10101, 104 Stat. 1388, 1388–91 (1990).

⁴ See, e.g., U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT, FISCAL YEAR 2010, at 55 (2010) [hereinafter 2010 PERFORMANCE AND ACCOUNTABILITY REPORT], available at <http://www.uspto.gov/about/stratplan/ar/2010/USPTOFY2010PAR.pdf> (stating that approximately 85% of total patent income comes from maintenance fees, initial application for filing, search, and examination and issue fees).

⁵ See *id.* at 55, 57 (showing that although filing, search, and examination fees amount to only 28.7% of patent revenue, the “USPTO directs maximum resources to the priority functions of patent and trademark examination . . .”).

in administrative law—the relationship between agency funding and agency decision-making—and an important issue in patent law—is the PTO biased towards issuing patents.

To the best of our knowledge, this Article undertakes the first attempt to causally investigate the influence of the PTO's funding on the agency's decision-making (i.e., causal in the sense of statistically ruling out other potentially confounding factors).⁶ Through this causal investigation, it also builds upon those studies that have attempted—albeit, more indirectly than the present study—to challenge the hypothesis that the PTO's granting decisions are solely guided by the non-biased application of patentability standards.⁷ To this extent, we set forth a theoretical model that predicts that, under certain agency objectives, particular elements of the PTO's fee structure create incentives for the PTO to grant additional patents. Using a rich database of previously unavailable patent data, we then empirically test the predictions of this model by comparing the agency's granting patterns before and after the period the PTO became fully user-fee funded.⁸

Our results suggest that the agency's fee schedule biases the PTO towards granting patents. For instance, with respect to those types of patents for which the PTO is likely to profit the most from granting, we estimate a relatively stronger sensitivity to the PTO's funding structure. More specifically, our findings suggest the PTO is preferentially granting patents on technologies with high renewal rates and patents filed by large entities, as the PTO stands to earn the most revenue by granting additional patents of these types. Furthermore, we also find that these distortions are more likely to occur when markers indicative of an underfunded PTO are present. As such, a more general implication of this analysis is that the PTO does not appear to seek a universal expansion of its budget. Rather, the evidence is more consistent with a view that distortions in the PTO granting patterns are more likely to occur when the agency is financially constrained.

⁶ One study by Deepak Hegde has theorized that the PTO's appropriation process (but not the fee schedule) affects patent backlog and patent pendency. However, unlike our analysis, Hegde's analysis, which relies upon graphical time series evidence, was not designed to statistically identify (i.e., isolate) the actual relationship between the agency's funding and outcome of interest. Moreover, Hegde did not explore how the PTO's fee schedule affects patent outcomes nor did he explore how the PTO's appropriation process affects the agency's decision to grant a patent. Deepak Hegde, *Funding and Performance at the US Patent and Trademark Office*, 30 NATURE BIOTECHNOLOGY 148 (2012).

⁷ A number of scholars have set forth evidence that indirectly (non-causally) bears on the question of whether the U.S. PTO is biased in its decision-making. For instance, scholars have compared the growth of patent families, patents that are directed to the same underlying inventions that are filed in multiple countries, that originated in the United States with successful applications in the United States by U.S. inventors and found the latter to have grown over twice as much as the former. They have reasoned that this difference supports declining standards of the U.S. PTO, conceivably as a result of internal biases within the PTO. See, e.g., ADAM B. JAFFE & JOSH LERNER, INNOVATION AND ITS DISCONTENTS 136–38, 142–43 (2004). Other scholars have put forth indirect evidence of a PTO bias by suggesting that the decisions of a certain group of examiners may be driven, in part, by considerations other than patentability standards. See generally Mark Lemley & Bhaven Sampat, *Examiner Characteristics and the Patent Office Outcomes*, 94 REV. OF ECONOMICS & STATISTICS 817 (2012) (finding that more experienced examiners cite less prior art and are more likely to grant patents). While these studies provide valuable information, they have not been designed to causally identify a PTO bias, as we attempt to do in this Article. For instance, the Jaffe and Lerner analysis, while indeed suggestive of a number of possible biases, is not designed to statistically identify any particular bias as being responsible for the observed decline in patentability standards within the US.

⁸ Details on the database are provided in Part III.

Our findings have broad implications for both policy and theory. Regarding social welfare policy, our results are discouraging, as they suggest that the PTO's financial incentives, and not solely the merits of the invention, may in part be driving patentability decisions. Standard economic theory predicts that distortions in the PTO's granting behavior may result in substantial harm to society. While patents attempt to push society towards an optimal level of innovation by providing inventors with a mechanism to recoup their research and development expenses, they do so only at a cost—consumers pay higher prices and have less access to the patented invention.⁹ A PTO that is applying the patentability standards in a patent-protective manner is likely to be routinely granting patents on inventions that were either already known or represent only a trivial advancement over the existing scientific knowledge.¹⁰ As a result, a grant-biased PTO is likely to systematically issue patents that end up imposing significant costs on society without bestowing the commensurate benefits of innovation.¹¹

Our results are also relevant to the ongoing policy debate in Congress and elsewhere on how best to fix the “broken” patent system.¹² Criticism of the patent system has largely coalesced around one charge: The PTO permits too many invalid patents to issue which unnecessarily drain consumer welfare.¹³ Both the Supreme Court's renewed interest in substantive patent law and the enactment of the America Invents Act, which represents the first major overhaul of the patent system in over sixty years, were driven in part by this concern.¹⁴ Yet our findings suggest this charge is under-inclusive, as they provide evidence that the PTO is not only likely biased towards issuing patents but also that the agency is likely biased towards issuing particular types of patents—those with a high probability of being renewed or

⁹ See WILLIAM D. NORDHAUS, *INVENTION, GROWTH, AND WELFARE: A THEORETICAL TREATMENT OF TECHNOLOGICAL CHANGE* 76 (1969) (explaining the need for finding the optimal patent length, for the longer a patent lasts, the greater the social cost due to inefficiencies caused by monopoly of information); Ian Ayres & Gideon Parchomovsky, *Tradable Patent Rights*, 60 *STAN. L. REV.* 863, 867 (2000) (discussing the costs of “patent thickets”); Keith Leffler and Christofer Leffler, *Efficiency Trade-offs in Patent Litigation Settlements: Analysis Gone Astray?*, 39 *U.S.F. L. REV.* 33, 33 (2004) (stating that the “static inefficiency” caused by valuable patents causes consumer welfare to suffer due to high prices).

¹⁰ Not surprisingly, the patentability standards reflect a careful balance between encouraging innovation and drains on consumer welfare. In order for an invention to be patent eligible, it must be both new and represent a non-trivial advancement over current scientific understanding. 35 U.S.C. § 103 (2010). If an invention was obvious to the person of ordinary skill in the art or was already in the public domain, the invention would have likely arisen without the patent incentive. In contrast, an invention that represents a significant advancement in the art may not have arisen but for the patent inducement.

¹¹ Mark A. Lemley & Carl Shapiro, *Probabilistic Patents*, 19 *J. ECON. PERSPECTIVES* 77 (2005)

¹² See generally DAN L. BURK & MARK A. LEMLEY, *THE PATENT CRISIS AND HOW THE COURTS CAN SOLVE IT* (2009); JAMES BESSEN & MICHAEL J. MEURER, *PATENT FAILURE: HOW JUDGES, BUREAUCRATS, AND LAWYERS PUT INNOVATORS AT RISK* (2008); JAFFE & LERNER, *supra* note 7.

¹³ See, e.g., Mark A. Lemley, *Rational Ignorance at the Patent Office*, 95 *Nw. U. L. REV.* 1495, 1495 n.1 (2001) (citing a litany of sources critical of the PTO for issuing invalid patents); Dough Lichtman & Mark A. Lemley, *Rethinking Patent Law's Presumption of Validity*, 60 *STAN. L. REV.* 45, 47 n.5 (2007) (citing a number of sources calling for reform of the patent system because the PTO is issuing a large number of undeserving patents); FED. TRADE COMM'N, *TO PROMOTE INNOVATION: THE PROPER BALANCE OF COMPETITION AND PATENT LAW AND POLICY* (2003), available at <http://www.ftc.gov/os/2003/10/innovationrpt.pdf> (discussing how poor quality patents harm innovation); John R. Thomas, *Collusion and Collective Action in the Patent System: A Proposal for Patent Bounties* 2001 *U. ILL. L. REV.* 305, 320–22 (2001) (demarcating the social costs associated with improvidently issued patents); Mark A. Lemley & Bhaven Sampat, *Is the Patent Office a Rubber Stamp?*, 58 *EMORY L.J.* 181, 185 (2008) (noting the widespread consensus that the PTO is routinely issuing invalid patents that impose costs upon the public).

¹⁴ Lemley & Sampat, *supra* note 13, at 185.

those that are filed by large entities. Of course, eliminating the agency's over-granting tendencies requires not only an understanding of the extent of its bias but also the mechanisms that create pressure on the agency to issue patents. Unfortunately, up to this point, there has been a failure on both counts.¹⁵ As a result, recent patent reform efforts are unlikely to eliminate the granting pressure identified in this Article.¹⁶

From a policy perspective, our results also suggest that Congressional action intended to promote innovation with respect to entrepreneurs and small firms may have the exact opposite effect. Largely in recognition that individuals and small entities both constitute a significant source of innovative activity and rely more heavily on the patent system than larger enterprises, Congress provided a 50% reduction in patent fees to these entities.¹⁷ Yet we find evidence that this reduction in patent fees has the unintended consequence of likely biasing the PTO towards granting patents associated with large enterprises. Thus, it is possible that the alleged benefits small entities obtain by paying reduced patent fees are outweighed by the harms they experience in the marketplace because the PTO is extending preferential treatment towards large entities.

On a theoretical level, our modeling of the various ways in which the PTO may distort its practices in light of its funding structure, builds on, and fills various gaps in, a literature that has attributed the PTO's perceived bias towards issuing patents to a number of causes.¹⁸ To the extent scholars have posited that the PTO's user fee income may bias the agency towards issuing patents, they have done so chiefly under the simple premise that funding the PTO through fees paid by patent applicants may lead it to make decisions that favor applicants (i.e., grant patents) at the expense of the public (i.e., apply the patentability standards in a non-biased fashion).¹⁹ One of us has previously argued that by ignoring the

¹⁵ See *infra* notes 18–20 and accompanying text.

¹⁶ See *infra* Part V.

¹⁷ 35 U.S.C. § 41(h)(1).

¹⁸ For example, scholars have argued that the PTO is underfunded and hence hamstrung from spending sufficient time examining patent applications to reject patents, see, e.g., JAFFE & LERNER, *supra* note 7, at 130–33 (describing the PTO's budgetary woes); Lemley, *supra* note 13, at 1500 (noting that examiners spend on average only 18 hours reviewing a patent application), that the patent examiners compensation system favors allowances, see, e.g., THOMAS H. STANTON ET AL., NAT'L ACAD. OF PUBLIC ADMIN., U.S. PATENT & TRADEMARK OFFICE: TRANSFORMING TO MEET THE CHALLENGES OF THE 21ST CENTURY 102 (2005), available at http://www2.aipla.org/Content/ContentGroups/Issues_and_Advocacy/Comments2/Patent_and_Trademark_Office/20055/NAPAFullReport.pdf (paraphrasing one patent examiner's statement saying that the productivity schedule is "highly biased toward early allowances"); Clarisa Long, *The PTO and the Market for Influence in Patent Law*, 157 U. PA. L. REV. 1965, 1991 (2009) ("Internal PTO practices create a bias in favor of granting patents."); Merges, *supra* note 13, at 607 ("Consequently, the only way to earn bonus points with confidence is to allow a patent application."); Thomas, *supra* note 13, at 324–25 (discussing the PTO's employee shortage and employee compensation structure contribute to disproportionate amounts of patent allowances), that the asymmetric review of the agency's decisions bias it towards expanding substantive patent law, Melissa F. Wasserman, *The PTO's Asymmetric Incentives: Pressure to Expand Substantive Patent Law*, 72 OHIO ST. L.J. 379, 401–406 (2011), and that the burden of proof is on the examiner to show that a patent should not issue, Thomas, *supra* note 13, at 325 ("Long-established practice places the burden of persuasion and initial burden of production upon examiners to generate rejections.").

¹⁹ See, e.g., Stuart Minor Benjamin & Arti K. Rai, *Who's Afraid of the APA? What the Patent System Can Learn from Administrative Law*, 95 GEO. L.J. 269, 314 (2007) ("[PTO] is favorably disposed to patent holders . . . [in part because] the agency as a whole is funded by applicant fees."); Jeanne C. Fromer, *Patent Disclosure*, 94 IOWA L. REV. 539, 579 n.178 (2009) ("A pro-patent bias also arises because the PTO is wholly funded by patent-applicant

structure of user-fees, legal scholarship has overlooked the import that the more fine-grained, structural components of agency financing may play in influencing agency decision-making.²⁰ This Article builds on this previous work by exploring how various PTO objectives would interact with both the agency's fee structure and the nuances of the PTO's budgetary process and, of course, empirically testing the hypotheses that result from this exploration.

Despite a general perception in the literature that the PTO is routinely granting bad patents,²¹ it is important that scholars turn to an empirical analysis of PTO decision-making, as we endeavor to do in this Article, in order to understand whether the PTO is, in fact, deviating from otherwise optimal practices. After all, there are at least three reasons to doubt that the agency's funding mechanism would bias the PTO towards issuing patents. First, as administrative law scholars have long debated, the nature or objectives of high-level agency administrators are unclear.²² Do bureaucrats seek larger budgets for self-interested reasons or solely to better accomplish the agency's mission? Second, Congress has never given the PTO the authority to spend all of the fees it collects, potentially blunting any incentives of the PTO to grant additional patents in an attempt to expand its budget.²³ Third, emphasizing the

fees."); Long, *supra* note 18, at 1994 ("[T]he PTO's budgetary structure . . . creates the incentive for the PTO to favor patentees (who pay fees to the PTO) over nonpatentees (who do not)."); Meurer, *supra* note 24, at 699 ("The PTO has endorsed a 'customer service' orientation that stresses the importance of meeting the needs of patent applicants. This orientation may be motivated in part by the dependence of the agency on fees to fund its operation.").

²⁰ While at least two scholars have noted the current fee structure may bias the agency to grant patents, they have not begun to explore how the PTO may have a differential bias across patent type. Compare Arti K. Rai, *Growing Pains in the Administrative State: The Patent Office's Troubled Quest for Managerial Control*, 157 U. PA. L. REV. 2051, 2062 (2009) ("[T]he current fee structure also sets up an obvious financial incentive for the PTO to grant patents."); Long, *supra* note 18, at 1994 ("[T]he PTO's budgetary structure creates a bias in favor of granting patents and encouraging inventors to apply for patents), with Wasserman, *supra* note 18, at 407–414 (asserting that the PTO's budgetary structure favors granting patents that are likely to earn the most revenue—i.e., patents directed towards technologies with high renewal rates and patents issued to large entities).

This gap in the literature is all the more puzzling in consideration of the substantial literature regarding the incentives created by various fee structures and compensation structures in other decision-making contexts. To provide one example, scholars in health economics, law, and policy have long acknowledged the expansionary distortions in physician decision-making that may follow from a "fee-for-service" payment system that more generously compensates physicians for providing their patients with a greater quantity of medical services, such as office visits, procedures and tests. See, e.g., THOMAS G. MCGUIRE, PHYSICIAN AGENCY, in HANDBOOK OF HEALTH ECONOMICS at 517-19 (A.J. Culyer & J.P. Newhouse Eds., 2000).

²¹ See sources cited *supra* note 13.

²² Compare WILLIAM A. NISKANEN, JR., BUREAUCRACY AND REPRESENTATIVE GOVERNMENT 38–42 (1971) (arguing bureaucrats seek enlarged budgets because they are positively correlated with other goods the bureaucrat values such as power, prestige, and salary), and THE BUDGET-MAXIMIZING BUREAUCRAT: APPRAISAL AND EVIDENCE (Andre Blais & Stephane Dion Eds., 1991) (aggregating a number of essays and studies that support the assertion that bureaucrats seek enlarged budgets), with JAMES Q. WILSON, BUREAUCRACY: WHAT GOVERNMENT AGENCIES DO AND WHY THEY DO IT 182 (1989) ("The view that all bureaus want larger budgets ignores the fact that there is often a tradeoff between bigger budgets on the one hand and the complexity of tasks, the number of rivals, and the multiplicity of constraints on the other."), and Daryl J. Levinson, *Empire-Building Government in Constitutional Law*, 118 HARV. L. REV. 915 (2005) (arguing that empire-building of agencies is overstated because bureaucrats do not have the same motives as corporate leaders), and Michael A. Livermore, *Cause or Cure? Cost-Benefit Analysis and Regulatory Gridlock*, 17 N.Y.U. ENVTL. L.J. 107, 120 (2008) (challenging the notion that bureaucrats will always seek to increase budgets).

²³ See *infra* notes 27- 28 and accompanying text.

autonomous nature of individual patent examiners and the difficulties involved in supervising examiners,²⁴ the current literature has questioned the ability of the PTO to enact top-down directives, such as pressure to grant more patents (especially in targeted areas).²⁵

Finally, our findings also shed light on some of the above-mentioned ambiguities surrounding agency responsiveness to financial incentives. Our results contradict the idea that bureaucrats seek to maximize their budgets for self-interested reasons—i.e., in an effort to increase their own salaries, prestige, or advancement. Instead, our findings suggest that, to the extent bureaucrats seek enlarged budgets, they do so as a result of being mission minded but resource constrained.

The rest of the Article is organized as follows. Part I delineates the PTO's possible financial incentives to grant patents and begins to explore the extent to which the PTO will act on this incentive by introducing two competing models of agency behavior: self-interested PTO and benevolent PTO. Part II further refines these models of agency behavior by examining how the PTO's financial incentives likely vary across patent types. Part II also introduces the predictions of these models which serve as the hypotheses that will guide our empirical analysis. Part III describes the data set and methodology utilized. The results of our empirical analysis are presented in Part IV. Part V begins to explore the implications of our results and also assesses potential methods to reduce the PTO's financial tendency towards issuing patents. This Part also concludes that the recently enacted America Invents Act which grants the PTO fee-setting authority is unlikely to extinguish the PTO's financial predisposition to grant patents.

I. PTO'S FINANCIAL INCENTIVES AND ITS OBJECTIVES

This section describes how the PTO's current budgetary process, including its fee schedule, sets up possible financial incentives to grant patents.²⁶ It next turns to examining when and if the PTO is likely to act on those financial incentives by exploring two competing models of agency behavior: the self-interested PTO who desires to maximize its budget and the benevolent-but-resource-constrained PTO who seeks additional funding in order to match its revenue with its expenses.

²⁴ See, e.g., Michael Abramowicz & John F. Duffy, *Ending the Patenting Monopoly*, 157 U. PA. L. REV. 1541 at 1544, 1551, 1559–60 (2009) (noting PTO difficulties in controlling patent examiner's output); Michael J. Meurer, *Patent Examination Priorities*, 51 WM. & MARY L. REV. 675, 700 (2009) (detailing difficulties with implementing reforms affecting patent examiners).

Several scholars have found that patent examiner characteristics have an effect on patent outcomes. Iain M. Cockburn et al., *Are All Patent Examiners Equal? Examiners, Patent Characteristics, and Litigation Outcomes*, in PATENTS IN THE KNOWLEDGE BASED ECONOMY 19 (Wesley M. Cohen & Stephen A. Merrill eds., Nat'l Acads. Press 2003) (finding that differences in examiners explain a significant percentage of the variation in the characteristics of issued patents, and that some examiners are more likely than others to have their patents upheld in court); Douglas Lichtman, *Rethinking Prosecution History Estoppel*, 71 U. CHI. L. REV. 151 (2004) (finding that certain examiners more systematically required applicants to narrow the scope of their patents); Lemley & Sampat, *supra* note 7 (finding that more experienced examiners cite less prior art and are more likely to grant patents).

²⁵ See, e.g., Abramowicz & Duffy, *supra* note 24 at 1559–60, 1563–64 (discussing the difficulty the PTO has controlling examiner conduct through strict rules and oversight).

²⁶ We use the term patents in this Article to refer to "utility" patents. Utility patent protects the way an article is used and works. 35 U.S.C. § 101.

A. PTO's Budget Process and Its Possible Financial Incentive to Grant Patents

Historically, the PTO has been funded largely by taxpayer revenues. In 1991, the agency was made to essentially fund its entire operations through user-fees.²⁷ The PTO, however, was not given fee-setting authority—Congress chose to remain the sole arbitrator of patent fee levels.²⁸ Importantly, Congress also did not give the agency the right to automatically spend its fee collections; instead the PTO must receive Congressional approval through annual appropriations to utilize its fee revenue.²⁹

Prior to 2004, Congress routinely set the agency's budget to a level that was essentially below both its estimated and actual fee collections.³⁰ Since 2004, the agency's spending authority has been capped at its projected revenue stream which has resulted in the PTO's budget being larger than its fee collections

²⁷ Omnibus Budget Reconciliation Act of 1990, Pub. L. No. 101-508, § 10101, 104 Stat. 1388, 1388-391 (1990). The PTO's budget in 1991 was over 370 million dollars, of which 3 million were from general revenue funds. U.S. PATENT & TRADEMARK OFFICE, 1991 ANNUAL REPORT 1 (1991) [hereinafter 1991 ANNUAL REPORT].

²⁸ The PTO only recently obtained fee-setting. Leahy-Smith America Invents Act, Pub. L. No. 112-29, § 10(a), 125 Stat. 284, 316 (2011). Prior to 2011, the PTO lacked fee-setting authority and any significant change in the filing fees, issuance fees, and maintenance fees required congressional action. See 35 U.S.C. § 41(d) (2006) (amended 2011) (limiting the PTO's discretion in setting fees to minor issues such as "processing, services, or materials").

²⁹ The PTO is funded through discretionary spending, which means that Congress evaluates the agencies and their funding needs annually during the appropriations cycle. See Elizabeth Garrett, *Rethinking the Structures of Decisionmaking in the Federal Budget Process*, 35 HARV. J. ON LEGIS. 387, 398-400 (1998) (describing discretionary spending and budget process generally).

³⁰ In 1991, when Congress made the agency essentially user fee funded it concomitantly enacted a 69% surcharge on certain patent fees. Omnibus Budget Reconciliation Act of 1990 § 10101(a), 35 U.S.C. 41 (2006). From the fiscal years of 1991 to 1998, fees collected from users were fully available to the PTO; however, surcharge revenue was not. Starting in the fiscal year of 1992, Congress limited the agency's ability to spend surcharge fees, using the fees to fund other government programs. Consolidated Appropriations Act, 2004, Pub. L. No. 108-199, Div.B, Tit. II, 118 Stat. 3, 69.

In 1999 the surcharge fees expired. From 1999 to 2003, Congress made certain dollar amount of fees unavailable for PTO use each year and then, in differing amounts over the years, allowed the agency to use some, but not all prior year fees. The result, however, was that for the fiscal years of 1999 to 2003, the agency's budget was essentially set to below its estimated fee collections. U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2003 54 (2003), available at <http://www.uspto.gov/about/stratplan/ar/2003/2003annualreport.pdf>; U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2010 54 (2002), available at <http://www.uspto.gov/web/offices/com/annual/2002/1-58.pdf>; U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2001 58 (2001), available at <http://www.uspto.gov/web/offices/com/annual/2001/01performreport.pdf>; U.S. PATENT & TRADEMARK OFFICE, ANNUAL REPORT, FISCAL YEAR 2000 49 (2000), available at <http://www.uspto.gov/about/stratplan/ar/2000/00findisc.pdf>; U.S. PATENT & TRADEMARK OFFICE, ANNUAL REPORT, FISCAL YEAR 1999 28 (1999), available at <http://www.uspto.gov/about/stratplan/ar/1999/99mssgchief.pdf>. For example, in the fiscal year of 2002 the PTO estimated its fee collections would total 1,346 million dollars. OFFICE OF MGMT. AND BUDGET, BUDGET OF THE U.S. GOVERNMENT FISCAL YEAR 2002, APPENDIX, DEPARTMENT OF COMMERCE 227 (2002) available at <http://www.gpo.gov/fdsys/pkg/BUDGET-2002-APP/pdf/BUDGET-2002-APP-1-6.pdf>. That year, Congress chose to set the office's budgetary resources for spending to 1,146.7 million dollars, of which 282.3 million was from fees collected in fiscal years 2000 and 2001. Congress also appropriated 843.7 million dollars from fees collected during fiscal year 2002; however, 304.1 million dollars from fees collected during fiscal year 2002 was not available for spending. U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2002 54 (2002) available at <http://www.uspto.gov/web/offices/com/annual/2002/1-58.pdf>.

at times.³¹ When the PTO's fee collections fall below its appropriated budget, the agency will experience a budgetary shortfall, as Congress does not provide the agency with the difference.³² In contrast, if the PTO's fee collections surpass its spending authority, the excess fees are not immediately available to the PTO.³³ On occasion, the PTO has obtained supplemental appropriations from Congress enabling the agency to use all or a portion of these excess fees.³⁴ More typically, the excess fees are utilized by Congress to fund other government operations.³⁵ This practice, known as fee-diversion, first occurred in 1992 and appears to have peaked in the late 1990s to the early 2000s.³⁶ We revisit the

³¹ U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2004 60 (2004) *available at* <http://www.uspto.gov/about/stratplan/ar/2004/2004annualreport.pdf>; U.S. PATENT & TRADEMARK OFFICE, ANNUAL REPORT, FISCAL YEAR 2005 PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2005 80 (2005), *available at* <http://www.uspto.gov/about/stratplan/ar/2005/2005annualreport.pdf>; U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2006 83 (2006), *available at* <http://www.uspto.gov/about/stratplan/ar/2006/2006annualreport.pdf>; U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2007 53 (2007), *available at* <http://www.uspto.gov/about/stratplan/ar/2007/2007annualreport.pdf>.

³² This occurred in the fiscal years of 2005, 2006, 2008, 2009. U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2005 80 (2005) (PTO was appropriated up to 1.554 million but only collected 1.497 in fees); U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2006, 83 (2006) (PTO was appropriated up to 1.683 million but only collected 1.554 million in fees); U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2008 54 (2008), *available at* <http://www.uspto.gov/about/stratplan/ar/2008/2008annualreport.pdf> (PTO was appropriated up to 1.915 million but only collected 1.879 million in fees); U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2009 47 (2009), *available at* <http://www.uspto.gov/about/stratplan/ar/2009/2009annualreport.pdf> (PTO was appropriated up to 2.010 million but only collected 1.874 million in fees).

³³ This occurred in the fiscal years of 1992-2004, 2007, 2010, and 2011. U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2003 47 (2003) (stating that PTO fee collections exceeded spending authority); U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2004 80 (2004); U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2007 53 (2007); 2010 PERFORMANCE AND ACCOUNTABILITY REPORT, *supra* note 4, at 99; U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2011 67 (2011), *available at* <http://www.uspto.gov/about/stratplan/ar/2011/USPTOFY2011PAR.pdf> [hereinafter 2011 PERFORMANCE AND ACCOUNTABILITY REPORT].

³⁴ *See, e.g.*, Pub. L. No. 111-224 (2010) (designating a supplemental appropriation in fiscal year of 2010 enabling the PTO to spend an additional 129 million dollars in fee collections, bringing the PTO's spending authority up to 2.016 billion in fee collections).

³⁵ In theory these surplus fees may become available to the agency in future years—the PTO still has these fees on their books as “temporarily unavailable.” *See, e.g.*, 2011 PERFORMANCE AND ACCOUNTABILITY REPORT, *supra* note 33, at 67. However, it is widely believed that the PTO is unlikely to ever receive the authority to spend these fees, at least not any significant portion of them. INTELLECTUAL PROPERTY OWNERS ASSOCIATION, UNDERSTANDING PATENT FEE DIVERSION AND HOW IT IS AFFECTED BY CURRENT SENATE AND HOUSE PATENT REFORM BILLS (2011), *available at* <http://www.ipo.org/AM/Template.cfm?Section=Home&ContentID=30761&Template=/CM/ContentDisplay.cfm> (“No one expects that these fees will ever be made available to the USPTO.”).

³⁶ Intellectual Prop. Owners Ass'n, User Fees Diverted from the U.S. Patent and Trademark Office (USPTO) 1991-2005, http://www.ipo.org/AM/Template.cfm?Section=Search§ion=USPTO_Fees_and_Funding&template=/CM/ContentDisplay.cfm&ContentFileID=2294 (last modified Dec. 16, 2004). Importantly, the America Invents Act does not conclusively end the practice of fee diversion, although it arguably diminishes the chances it will occur. H.R. 1249, 112th Cong. § 22 (2011). The America Invents Act creates a new account, known as the “reserve fund,” wherein fees the PTO collects above its appropriated budget are deposited, but does not guarantee the PTO access to these

nuances of this quasi-appropriations process when discussing the incentives posed by the practice of fee diversion in Section IV below. To illustrate the incentives posed by the agency's fee structure, however, we proceed by simply viewing the PTO as operating off of the user fees that it collects.

Since the PTO became essentially fully user fee funded, roughly 85% of its patent operating budget is garnered through three types of fees: (1) filing, search, and examination fees (collectively referred to as examination fees), (2) issuance fees, and (3) maintenance or renewal fees.³⁷ Examination fees are paid at the time the application is filed, issue fees are paid at the time a patent application is granted, and maintenance fees are paid periodically over the lifetime of an issued patent so that the patent can remain enforceable.

While examination fees account for approximately 30% of the PTO budget, these fees fail to cover the actual cost incurred by the PTO to examine applications.³⁸ Consider, for example, that in the fiscal year of 2011 the PTO estimated that the average cost of examining a patent application was approximately \$3,600.³⁹ Yet, during the fiscal year of 2011 the examination fee was set at \$1,090 for large for-profit corporations and half that amount for individuals, small firms, non-profit corporations, or other enterprises that qualify for "small entity" status.⁴⁰ Therefore, the level of examination fees covered less than one third of the actual examination costs for large corporations and less than one sixth of actual costs for small entities.

The PTO is heavily dependent on issuance fees and maintenance fees, which account for over 50% of the PTO's patent budget, to fund its operations.⁴¹ These post-allowance fees are typically larger than the examination fees. In the fiscal year of 2011, the issuance fee was set at \$1,510, and the maintenance fees which are due at 3 ½, 7 ½, and 11 ½ years from the date the patent issues were \$980, \$2,480, and \$4,110 respectively.⁴² Again, small entities pay half these amounts. The result is that the vast majority of the PTO's budget is gained through fees that the agency collects *only if a patent is granted*. Further, the majority of the agency's operational costs are incurred by processing patents;⁴³ the expenses

fees. *Id.* The language of the Act defers to future appropriations bills as to this matter; therefore, it appears to leave open the possibility that fee-diversion may occur in the future. *Id.*

³⁷ 2010 PERFORMANCE AND ACCOUNTABILITY REPORT, *supra* note 4, at 55 (stating that approximately 84% of total patent income comes from maintenance fees, initial application for filing, search, and examination and issue fees), available at <http://www.uspto.gov/about/stratplan/ar/2010/USPTOFY2010PAR.pdf>; U.S. PAT. & TRADEMARK OFFICE, ANNUAL REPORT, FISCAL YEAR 1994, at 59 (1995) (stating that approximately 83% of total patent income comes from maintenance fees, filing fees, and issue fees).

³⁸ 2009 PERFORMANCE AND ACCOUNTABILITY REPORT, *supra* note 32, at 49 (stating 31.3% of total patent income comes from filing, search, and examination fees).

³⁹ 2011 PERFORMANCE AND ACCOUNTABILITY REPORT, *supra* note 33, at 17 (stating that in 2011 that the average patent cost the \$3,597 to examine).

⁴⁰ See 37 C.F.R. § 1.16(a)(1) (2011) (basic filing fee is \$330 and \$165 for small entity); 37 C.F.R. § 1.16(k) (2011) (utility search fee is \$540 and \$270 for small entity); 37 C.F.R. § 1.16(o) (2011) (utility examination fee is \$220 and \$110 for small entity). Entities defined by the PTO as "small" include individuals, nonprofit corporations, or corporations which qualify as small businesses under the Small Business Act. 37 C.F.R. § 1.27(a)(1)-(3) (2011).

⁴¹ See 2010 PERFORMANCE AND ACCOUNTABILITY REPORT, *supra* note 4, at 56 (noting that "renewals [fees] recoup costs incurred during the initial patent process").

⁴² 37 C.F.R. § 1.18(a) (2011) (utility fee); C.F.R. § 1.20(e-g) (2011) (maintenance fees).

⁴³ 1991 ANNUAL REPORT, *supra* note 27, at 3 (noting that "patent processing constituted 51% of the PTO's total obligations").

associated with issuing and maintaining a patent are minimal.⁴⁴ Thus, these post-allowance fees are almost exclusively used to fund other agency activity. The back-end fee structure and the inadequacies of the examination fees both provide a possible incentive for the PTO to grant rather than deny patents. The extent to which the PTO would act on either of these inducements depends, in part, on the objectives of the agency and its needs.

B. The PTO's Objectives

The decisions of agencies, like many other entities, are influenced by a variety of factors. The purpose of this Subpart is not to elucidate every factor that may affect agency decision-making but instead to establish that under certain situations monetary concerns are likely to influence the decision-making process of the PTO. To this effect, this Subpart outlines two competing models of agency behavior. The first model assumes a self-interested bureaucrat who desires to maximize the agency's budget. For this bureaucrat the existence of post-allowance fees will bias the PTO towards allowing patents. The second model supposes a benevolent bureaucrat that is resource constrained. Unlike the self-interested bureaucrat, the benevolent bureaucrat's bias towards granting patents may stem solely from the PTO's examination fees failing to cover the agency's examination expenses. However, even if examination fees were adequate, a benevolent bureaucrat may apply the patentability standards in a patent-protective direction if the agency's overall fees collections fail to cover its operational expenses.

1. Self-Interested Bureaucrat

To begin, we envision a state of the world in which the PTO resembles the imperialistic maximizing bureaucrat theorized by William Niskanen.⁴⁵ Niskanen posits that bureaucrats seek to maximize agency budgets because budgets are positively correlated with other goods that a bureaucrat values, such as their compensation, prestige, power, and prospects for advancement.⁴⁶ In other words, Niskanen contemplates a self-interested bureaucrat that puts their own interests above that of the public.⁴⁷ Under Niskanen's view, it is the existence of informational asymmetries that enables high-level administrators to extract ever increasing budgets from Congress.⁴⁸

The universal nature of the maximizing bureaucratic, however, has been questioned.⁴⁹ One line of challenge focuses on the extent to which high-level administrators actually profit from enlarged budgets. Even if bureaucrats were primarily self-interested there is little empirical evidence that high-

⁴⁴ U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-97-113, FEES ARE NOT ALWAYS COMMENSURATE WITH THE COSTS OF SERVICES 26 (1997) (noting that "only 8.6 percent of the costs associated with an individual patent were attributable to the actual issue of the patent and 0.1 percent were attributable to its maintenance").

⁴⁵ See generally THE BUDGET-MAXIMIZING BUREAUCRAT: APPRAISAL AND EVIDENCE 3-11 (Andre Blais & Stephane Dion eds., 1991); WILLIAM A. NISKANEN, JR., BUREAUCRACY AND REPRESENTATIVE GOVERNMENT 38 (1971).

⁴⁶ THE BUDGET-MAXIMIZING BUREAUCRAT, *supra* note 46, at 33 (citing NISKANEN, *supra* note 46, at 38).

⁴⁷ NISKANEN, *supra* note 46, at 38.

⁴⁸ *Id.* at 36-42.

⁴⁹ See JAMES Q. WILSON, BUREAUCRACY: WHAT GOVERNMENT AGENCIES DO AND WHY THEY DO IT 182 (1989) ("The view that all bureaus want larger budgets ignores the fact that there is often a tradeoff between bigger budgets on the one hand and the complexity of tasks, the number of rivals, and the multiplicity of constraints on the other."); Daryl J. Levinson, *Empire-Building Government in Constitutional Law*, 118 HARV. L. REV. 915, 916 (2005) (arguing that empire-building of agencies is overstated because bureaucrats do not have the same motives as corporate leaders).

level administrators accrue larger salaries when a bureau's budget grows.⁵⁰ Of course, there is still the possibility that such administrators seek larger budgets for intangible benefits such as power and prestige.⁵¹ However, to date, there is little empirical evidence that supports or refutes this latter hypothesis.⁵² Another line of inquiry has challenged Niskanen's view that Congress is easily duped into providing agencies with inflated budgets.⁵³ By delineating the multitude of ways in which the legislator and the executive exert considerable influence over administrative agencies, scholars have largely refuted Niskanen's assumption that Congress is submissive in setting agencies' budgets.⁵⁴ Of course, Niskanen's views may continue to hold some relevance in that it remains possible, even likely, that both Congress and bureaucrats play influential roles in the budgetary process.⁵⁵ Accordingly, we consider the manner in which a self-interested PTO of the Niskanen variety would seek to expand its budget.

While the PTO's budgetary process provides the agency with multiple pathways to satisfy its maximizing proclivities,⁵⁶ arguably the easiest way for the agency to increase its budget is to grant more patents. In

⁵⁰ See Levinson, *supra* note 22, at 932 (noting "the relationship between a larger agency budget and higher salaries or cushier working conditions is empirically tenuous"); Robert A. Young, *Budget Size and Bureaucratic Careers*, in *THE BUDGET-MAXIMIZING BUREAUCRAT: APPRAISAL AND EVIDENCE* 37-43 (Andre Blais & Stephane Dion eds., 1991) (concluding that studies on the relationship between budget growth and financial benefits to bureaucrats "are unanimous in offering little support, even to the weak proposition that bureaucrats become relatively better-off when the budget of their bureau grows disproportionately"). Research shows that it is seniority, not the size of the agency budgets, which explains a substantial portion of salary increases. Ronald N. Johnson and Gary D. Libecap, *Agency Growth, Salaries and the Protected Bureaucrat*, 27 *ECON. INQUIRY* 431-51 (1989).

⁵¹ *THE BUDGET-MAXIMIZING BUREAUCRAT: APPRAISAL AND EVIDENCE* 357 (Andre Blais & Stephane Dion Eds., 1991).

⁵² *Id.*

⁵³ See Mathew D. McCubbins et al., *Administrative Procedures as Instruments of Political Control*, 3 *J.L. ECON. & ORG.* 243 (1987); Mathew D. McCubbins et al., *Structure and Process, Politics and Policy: Administrative Arrangements and the Political Control of Agencies*, 75 *VA. L. REV.* 431, 443 (1989) (describing the appropriations process as a "low cost route" politicians use to prevent agency deviations from congressional goals); Mathew D. McCubbins & Thomas Schwartz, *Congressional Oversight Overlook: Police Patrols Versus Fire Alarms*, 28 *AM. J. POL. SCI.* 165, 170 (1984) (noting that "subcommittees controlling authorizations and appropriations may be in a better position to do oversight than so-called oversight committees"); cf. Barry R. Weingast & Mark J. Moran, *Bureaucratic Discretion or Congressional Control? Regulatory Policymaking by the Federal Trade Commission*, 91 *J. POL. ECON.* 765, 789 (1983) (finding congressional preferences over agency action to be a statistically significant factor).

⁵⁴ *Id.*

⁵⁵ There is empirical evidence that suggests bureaucrats have a substantial impact on budgetary outcomes and that this impact usually results in larger budgets. Jean-Michel Cousineau and Anne-Marie Girard, *Public Sector Unions, Government Expenditures, and the Bureaucratic Model*, in *THE BUDGET-MAXIMIZING BUREAUCRAT: APPRAISAL AND EVIDENCE* 259 (Andre Blais & Stephane Dion Eds., 1991) (finding that the presence of a public sector union in a municipality tends to increase government expenditures by about 6 percent).

⁵⁶ Of course, the PTO could seek to increase its budget by lobbying Congress for fee increases. In this scenario, the PTO could leverage its informational monopoly on the true cost of examining patent applications to extract temporary or long-term fee increases from Congress. Because the agency's budget is generally set to its estimated fee collections, any increase in fee levels will automatically translate into a larger budget. Niskanen's model predicts that the PTO would repeatedly and routinely ask for needless fee increases. The agency has enjoyed some success in lobbying for larger fees, but its success has been far from universal. See *infra* note 59.

The agency could also lobby for enhanced fee-setting authority. To the extent that the PTO could control of its fee levels, the PTO could increase its fees in an effort to enlarge its own budget. Arguably, biasing the agency towards granting patents is the easiest pathway to increase the PTO's budget, as this requires the least Congressional action.

this scenario, the PTO exploits its informational monopoly on the socially optimal grant rate to artificially inflate its fee collections (and hence the budget that it requests reflecting those inflated fee collections). At the extreme, a self-interested PTO would grant every patent, as the existence of back-end fees means the agency can maximize its fee collections by maximizing its patent grants (this is true whether or not the agency's examination fees covered the full operational expenses of the PTO). However, there are a number of reasons why the agency would not adopt such an excessive practice, including the fact that Congress is unlikely to believe that a hundred percent grant rate is optimal. Nonetheless, a self-interested PTO can still increase its budget by biasing the agency towards granting patents, as long as its distortionary bias remains under the threshold of Congressional detection.

2. *Benevolent but Resource Constrained Bureaucrat*

The PTO bureaucrat, however, does not need to be self-interested in order to seek a larger budget. High-level administrators may also seek more abundant budgets because of their values; there is ample evidence that many civil servants are mission minded.⁵⁷ The "benevolent bureaucrat" is a high-level administrator which attempts to increase agency funding solely for the purpose that the agency can better accomplish its mission.

While the benevolent PTO's preferred method of augmenting the agency's budget is to lobby Congress for increased fee levels,⁵⁸ this approach is unlikely to yield routine success.⁵⁹ Thus, in certain situations even an administrator that is only attempting to better accomplish the PTO's mission, may bias the agency towards issuing patents in an effort to augment the agency's budget.

Congress has stipulated that the PTO funds its entire operations through fee revenue.⁶⁰ Yet, at the same time, Congress set the agency's fee structure so that examination fees fail to cover two-thirds of the agency's costs to examine patent applications. The inadequacy of the examination fees necessitates the agency's dependence on post-allowance fees to subsidize the examination process. More generally, the fact that half of the agency's budget stems from these back-end fees suggests the PTO is heavily

⁵⁷ See Laurence E. Lynn, Jr., *The Budget-Maximizing Bureaucrat: Is there a Case?* in THE BUDGET-MAXIMIZING BUREAUCRAT: APPRAISALS AND EVIDENCE 66 (Andre Blais & Stephane Dion eds., 1991) (discussing case studies that indicate many civil servants are mission minded); KENNETH A. SHEPSLE & MARK S. BONCHECK, ANALYZING POLITICS: RATIONALITY, BEHAVIOR, AND INSTITUTIONS 347–48 (1997).

⁵⁸ This course of action would allow the PTO to increase its budget without distorting its own granting behavior.

⁵⁹ While there is general agreement that the PTO's present budget is insufficient for the agency to carry out its expected responsibilities, FED. TRADE COMM'N, To Promote Innovation: The Proper Balance of Competition and Patent Law and Policy 10 (2003) ("Hearings participants unanimously held the view that the PTO does not receive sufficient funding for its responsibilities."), Congress has on a number of occasions refused to increase fee levels. Fees changes appear to be harder to enact when they are not supported by patent applicants. For example, a 1990 and 1991 campaign to end small entity status and a 2002 campaign to increase fee levels and restructure fees were largely unsuccessfully because patent applicants did not support these increases. See Traci Watson, *Patent Office Drops Plan to Raise Fees*, 356 NATURE 645, 645 (1992) (noting that after "failing twice to convince Congress that small-scale inventors do not deserve a price break, the US Patent and Trademark Office (PTO) has dropped its opposition to such a discount" and that "small inventors convinced Congress that a higher maintenance fees would weaken the US economy").

⁶⁰ It was Congressional intent that the fees the agency collects cover the full operating needs of the agency. See WENDY H. SCHACHT, CONG. RESEARCH SERV., RS20906, U.S. PATENT AND TRADEMARK OFFICE APPROPRIATIONS PROCESS: A BRIEF EXPLANATION 1 (2011) (reviewing the Patent and Trademark Office's funding as a result of the Omnibus Reconciliation Act).

dependent on these fees to cover its operational expenses. Accordingly, the PTO must grant patents at a sufficiently high rate to recoup these costs.

It is of course possible that the agency's non-biased grant rate—i.e., the rate at which it would grant patents if it were solely applying the patentability standards in a non-biased fashion—is at a rate such that the PTO would indeed be able to cover its operational costs. In this instance, a benevolent PTO would not be bound by any resource constraints and would thus feel no need to distort its granting practices in an effort to generate additional fees. However, if this otherwise non-biased grant rate is as such that its current stream of fee collections based on these granting patterns are insufficient to cover the agency's operational expenses—i.e., the agency's grant rate is below a sustainability threshold rate—then the agency will need to raise additional revenues in order to achieve financial sustainability. In this instance, the PTO may find itself inclined to increase its granting tendencies in order to cover this shortfall.

A number of time-varying factors may disrupt the equilibrium reached between the agency's back-end fees and front-end and other operational costs and thus induce a bias towards granting. The PTO is more likely to trigger its sustainability constraint and encounter an imbalance between its back-end fees and examination or other operational costs under two broad scenarios: (1) when its non-biased grant rate drops below the threshold rate required to break even, taking as given all of those factors that shape the break-even threshold (discussed below) or (2) when that threshold rate itself rises, taking as given the PTO's non-biased rate of granting. This first scenario may arise if the quality of the stream of incoming patents deteriorates, leaving the PTO otherwise inclined to grant less frequently. The second scenario (i.e., an increase in the threshold sustainability rate) may materialize upon the occurrence, among others, of the following developments: (1) patentees elect to pay their maintenance fees at a lower rate, (2) aggregate examination costs rise due to a shift in patent applications towards more complex technology classes (to which the PTO allocates more examination hours), (3) the aggregate incidence of small-entity applicants rises, and (4) patent examinations demanded of the PTO increase (relative to the existing stock of patents from which the PTO may collect post-allowance fees).⁶¹ In each such instance, the indicated development will decrease the ratio between the back-end fees to be collected by the PTO and the obligatory operational costs of the PTO and thus, all else equal, increase the rate at which the agency must grant patents so that its fees will be able to cover the agency's expenses.

In the event that any of the above developments do indeed challenge the ability of the agency to finance its operational costs through the fees generated by its non-biased patent grants, the benevolent PTO may find that it is left with no other choice than to increase its grant rate in order to break even.⁶²

⁶¹ The PTO is dependent on renewal fees from patents that were issued 3.5, 7.5, and 11.5 years ago to sustain its processing of patent applications today. However, the PTO is processing many more applications today than it was even four, eight, or twelve years ago. As the ratio of the PTO's fee levels has not dramatically changed over time, it is unlikely that they were set to allow for such a dramatic growth in the volume of processed patent applications. Thus, the PTO's financial sustainability may be threatened solely by the fact that the agency, which is under continued pressure to expand its capacity to examine patent applications in order to decrease its growing backlog, must fund its expansion in processing capacity based on previously issued patents.

⁶² David S. Kim & Glenn M. Kubota, *Behind the Scenes at the USPTO: Accounting for the Supervisory Patent Examiner*, MORRISON & FOERSTER Q. NEWS, Summer 2011, at 2, 3 (“One former examiner recalled that allowances were being encouraged at the same time that USPTO fee revenues were reported as being low.”). In an effort to reestablish financial equilibrium, the PTO could attempt to cut costs, such as enacting a hiring freeze. However,

II. THE DIFFERENTIAL IMPACT OF THE AGENCY'S FINANCIAL INCENTIVES

The previous section established that the PTO can increase its fee collections and hence likely its budget by granting additional patents, and, in order to better understand when high-level administrators would bias the PTO towards granting patents, introduced two different models of agency behavior: the self-interested bureaucrat who desires to maximize the agency's budget and a resource constrained benevolent bureaucrat who desires to generate additional funds in order to maintain financial sustainability. This section further refines these models by considering an additional nuance in agency decision-making: the PTO's monetary incentives likely vary across patent types. Although the agency's basic fee structure preferences patent grants over denials, not all patents grants generate equal revenue.⁶³ As a result, the PTO may find that it will best achieve the goals of self-interest or benevolence by granting more patents with respect to some types of patents relative to others. This Article examines two characteristics that bear on the PTO's ability to earn increased revenue by issuing additional patents of that type: (1) the rate of renewal or maintenance among patents of that type and (2) the entity size (large vs. small) of the relevant patent applicant.⁶⁴

The latter characteristic, entity size, is immediately discernible to the PTO upon the filing of a patent application. Patent examiners, who are charged with reviewing applications and making a decision on the patentability of the invention, know the entity size of the patent applicant.⁶⁵ Because small entities pay half the examination, issue, and maintenance fees as large entities, entity size has a significant impact on the magnitude of the agency's fee stream. In contrast, maintenance rates are not readily apparent to the agency upon the filing of a patent application. However, the PTO may assess the likelihood that a given patent will ultimately pay renewal fees by using relevant historical data on maintenance rates associated with patents within the same technology category of the application. The PTO may assign these categorical likelihoods using a relatively coarse classification of technology types (e.g., chemical applications, electrical device applications, etc.) or, perhaps, using the more fine-grained, internal classification system that the PTO uses to instruct its examination search process.⁶⁶ Finally, it should be noted that unlike entity size, the maintenance fees paid by patent applicants do not vary by patent class or by technology.

any such efforts would only leave the PTO less able to process the substantial (and likely growing) examinations demanded of the agency to which the agency is *obligated* to respond.

⁶³ See Wasserman, *supra* note 18, at 412-14 & n.129 (noting that the PTO stands to earn more money by granting patents in technologies with high renewal rates and patents associated with large entities).

⁶⁴ See *id.* at 412 n.129 (noting that because small entities pay half the amount of issue and renewal fees as large entities the PTO stands to make twice as much fee revenue by granting a patent to a large relative to a small entity); *id.* at 412-14 (noting that because patentees in certain technological sectors are more likely to renew their patents than other technological sectors the PTO stands to earn more fee revenue by granting a patent associated with a technology that has high renewal rate relative to a patent associated with a technology that has a low renewal rate).

⁶⁵ This information is included in the patent application documents provided to patent examiners. Patent applications are not sorted by large and small entities. Applications for the most part are randomly assigned to patent examiners that have that technological expertise to examine the application. See Lemley & Sampat, *supra* note 24, at 818.

⁶⁶ Every patent application that is filed before the PTO is assigned a classification before it enters examination. The agency utilizes classifications to funnel patent applications to examiners with the prerequisite scientific knowledge to review the application.

While this study is not designed to explore the mechanism by which additional patents are granted, we believe there are at least two different channels for favoring certain patent types.⁶⁷ The first is a top-down channel, wherein senior-level officials that are responsive to the post-allowance fee differential instruct examiners to preferentially grant patents filed by large entities and high renewal rate technologies relative to others. The PTO's ability to extend such categorical or technology-specific instructions to examiners is facilitated by the agency's organizational structure, which is itself largely based on technological divisions.⁶⁸ The second is an examiner-focused channel, whereby patent examiners themselves, without prompting from supervisors, respond to the profitability implications of varying renewal rates and entity size.⁶⁹ Patent examiners, especially senior examiners, may internalize the negative impact of budgetary shortfalls to the agency.⁷⁰ Thus, patent examiners may possess sufficient motivation by themselves to preferentially grant patents filed by large entities and high renewal rate technologies relative to others when the PTO's fee collections are low.

The rest of this section proceeds by considering the manner in which each of the two above-mentioned characteristics (i.e., renewal rates and entity size) bears on the profitability of the PTO's marginal granting decisions. We then set forth various testable hypotheses regarding how the agency will alter its granting decisions in response to these marginal incentives.⁷¹

⁶⁷ In future work we plan to explore this mechanism in more depth.

⁶⁸ Once a patent application has been assigned a technology classification it is then, based on its class number, routed to an Art Unit, where it will be eventually examined by a patent examiner. Lemley & Sampat, *supra* note 7, at 818. Art Units may be assigned patent applications from one class, a portion of a class, or from several classes involving closely related technology. U.S. PAT. & TRADEMARK OFFICE, Patent Classification: Classes Arranged by Art Unit, *available at* <http://www.uspto.gov/patents/resources/classification/art/index.jsp>. Art Units are likewise aggregated into larger parcels that contain anywhere from five to fifteen Art Units and are eventually aggregated into one of nine technology centers. *Patent Technology Centers*, U.S. PATENT & TRADEMARK OFFICE, http://www.uspto.gov/about/contacts/phone_directory/pat_tech/index.jsp (last modified Feb. 17, 2010) (listing the nine patent technology centers within the U.S. Patent and Trademark Office). This hierarchical structure creates a situation in which patents of a particular PTO class are consistently examined by a targeted population of examiners (i.e., applications within a particular class are not randomly assigned among a large number of Art Units; rather, they are assigned to one or a few Art Units). This consistency makes it easier for top-level officials within the agency to coordinate with and direct examiners to grant more patents in one technology category (for example, one with a higher renewal rate) relative to another category (for example, one with a lower renewal rate).

⁶⁹ Patent examiners may be consciously or unconsciously responding to profit variations of patents.

⁷⁰ Alternatively, patent examiners may be responding to low fee collections by favoring certain types of patents over others because they recognize the negative impact of budgetary shortfalls to their daily life—i.e., such as an elimination of overtime. Examiners will most likely respond to the differential in fee collections when fees are low, as overtime is most likely to be eliminated when the PTO financial health is in jeopardy. If this is the dominate mechanism, then low-level officials would be acting in a self-interested manner but the aggregate result would mimic a benevolent but resource constrained agency.

⁷¹ Importantly, besides the harms associated with a bias towards granting patents, any distortions in the PTO granting patterns across technological fields and entity size may likewise distort the allocation of innovation resources in society.

A. Renewal Rates

Once a patent is issued it does not automatically remain in force for the duration of its twenty year patent term.⁷² The patentee must take the affirmative step of paying renewal or maintenance fees at 3 ½, 7 ½, and 11 ½ years from the date at which the patent issued to assure the patent's enforceability (referred to as 4-year, 8-year and 12-year maintenance fees in the empirical analysis discussed below). If a patentee fails to pay any of these fees, the invention enters the public domain.⁷³ Renewal fees currently account for nearly 30% of the PTO's patent budget, while the cost to the agency to maintain a patent is negligible. Thus, such fees are almost exclusively utilized to subsidize other agency activity.

However, not every patent grant generates equal renewal fee revenue. While maintenance fees do not vary across technology classifications, patentees elect to pay these fees at dramatically different rates across such classifications.⁷⁴ Accordingly, the PTO stands to gain more financially by granting patents in technologies that are likely to be renewed at a higher rate relative to those likely to be renewed a lower rate.⁷⁵ Of course, just because the PTO has this financial incentive does not necessarily mean the agency will act on it. The latter depends, in part, on the agency's primary objectives and its needs. The rest of this subsection proposes that both a self-interested and a benevolent-but-resource-constrained PTO will grant more patents in technology categories with high renewal rates relative to patents in categories with low renewal rates, albeit for different reasons.

1. *Self-Interested Budget Maximizing PTO*

Given that the PTO is seeking to maximize its budget, how will this differential renewal fee incentive affect its granting behavior? At first glance it might not affect it at all. A budget-maximizing PTO will instruct examiners to grant every patent, as the agency stands to profit on each marginal grant from the possibility of the ensuing maintenance fees, whether the probability of collecting such fees is low or high.⁷⁶ Of course, a self-interested PTO may not adopt such a drastic practice for several reasons, including fear of Congressional retribution.⁷⁷ To the extent the PTO believes it can skirt detection, and

⁷² This is true only for patents that mature from patent applications filed on or after December 12, 1980. 35 U.S.C. § 41(b) (2006) (listing the duration of a patent's effectiveness and the corresponding fees that the Director may charge "for maintaining in force all patents based on applications filed on or after December 12, 1980"). This date introduced renewal or maintenance fees to the U.S. patent system. Thus, patent applications filed before December 12, 1980 were automatically enforceable until the end of their patent term. 35 U.S.C. § 41(b).

⁷³ The late payment of any maintenance fee may be accepted if the delay in payment is shown to have been "unavoidable." 35 U.S.C. § 41(c)(1) (2006).

⁷⁴ Renewal rate differentials hold across technologies both when categorizing technology in terms of the PTO's own classification system and when using more coarsely-defined systems. *See supra* notes 66-68 and accompanying text.

⁷⁵ Wasserman, *supra* note 18, at 412.

⁷⁶ Examination costs are irrelevant for this marginal profitability assessment given that the PTO must examine those applications that are filed and that such examination costs will have already been incurred at the time the PTO makes its granting decision.

⁷⁷ Administrative law scholars have long noted that Congress exerts substantial influence over agencies that are funded through discretionary spending, meaning that Congress evaluates their budgetary needs annually during the appropriations cycle. *See, e.g.*, RICHARD F. FENNO, JR., *THE POWER OF THE PURSE: APPROPRIATIONS POLITICS IN CONGRESS* 291 (1966) ("Once the [Appropriations] Committee's ability to hurt it is recognized, the most obvious way for the agency to ensure a favorable kind of relationship with the Committee is simply to do . . . what the Committee tells it to do."); Bruce Yandle, *Regulators, Legislators and Budget Manipulation*, 56 *PUB. CHOICE* 167, 178 (1988) ("Budget manipulation is the most effective sanction available to Congress.").

hence punishment, by adopting a less extreme bias towards allowing patents, then even a self-interested PTO may distort its granting behavior in response to the differential in profits arising from technology-wide variations in renewal rates. A self-interested agency can maximize the fees it stands to collect for a given distortionary bias by focusing this over patenting tendency on technology categories where it stands to profit the most by granting additional patents—technology categories with high renewal rates.

Hypothesis 1: Following the adoption of a near fully user-fee funded system, a self-interested PTO will grant patents at an incrementally higher rate for patents within technology categories that generally have high maintenance rates relative to patents within categories that generally have low maintenance rates.

2. Benevolent-but-Resourced-Constrained PTO

As discussed in the previous section, even a benevolent PTO may bias examiners towards granting patents in an effort to reestablish financial sustainability. However, rather than increase patenting across the board, a benevolent PTO in need of additional funds may also generally instruct examiners to grant relatively more patents in technologies with high renewal rates than patents in technologies with low renewal rates.⁷⁸ Under the assumption of benevolence, the PTO will likely wish to limit the degree to which it distorts its granting decisions away from what is otherwise optimal policy. As a result, a benevolent-but-resource-constrained PTO that is attempting to reach a revenue goal would prefer to satisfy this target by granting a few extra patents in technology categories with respect to which it will profit the most – i.e., those with high maintenance rates—rather than a larger number of extra patents in technology categories with respect to which it will profit the least—i.e., those with low maintenance rates.⁷⁹

Hypothesis 2: Following the adoption of a near fully user-fee funded system and during times at which a benevolent PTO is resource constrained, the PTO will grant patents at an incrementally higher rate for patents within technology categories that generally have high maintenance rates relative to patents within categories that generally have low maintenance rates.

⁷⁸ This analysis, of course, assumes that the PTO knows it will take at least 3 ½ years to generate any of these additional revenues. Accordingly, the agency must anticipate that its resource constraints will likely be binding over at least a moderately long period of time. Moreover, this analysis also assumes that the current PTO management structure is sufficiently forward thinking, even in light of the limited tenure of PTO Directors. The Director of the PTO is nominated by the President and approved by the Senate, and thus The Director of the PTO changes when the administration in the White House changes. Nonetheless, other high-level administrators offer significant continuity to the agency, as these bureaucrats tend to have long tenures at the agency. 35 U.S.C. § 3 (2006). For example, Commissioner Stoll, who was Commissioner for Patents, retired from the PTO at the end of 2011 after 29 years of service to the agency. Commissioner for Patents Robert Stoll to Retire from Government Service After 29 Years at the United States Patent and Trademark Office, Press Release 11-62 (Nov. 2, 2011).

⁷⁹ Assume that a benevolent PTO is seeking to generate an additional \$6800 in fee revenue at a future date. In order to accomplish this goal, the agency is considering granting additional patents either a class which has a 90% renewal rate or a class which has a 10% renewal rate. The maintenance fee income generated, on average, from granting an additional patent in each of these classes is \$6813 in the former and only \$757 in the latter. Thus, in order to meet its revenue target, the PTO can either grant one additional patent in the 90% renewal patent class or nine additional patents in the 10% renewal rate class. This calculation assumes the same renewal rate across all three stages of renewal fees. 37 C.F.R. § 1.20(e-g) (2011) (the renewal fees at 3 ½, 7 ½, and 11 ½ years from the date the patent issues were \$980, \$2,480, and \$4,110 respectively).

B. Entity Size

Small entity status allows independent inventors, small businesses, and nonprofit organizations to pay 50% reduced patent fees.⁸⁰ As a result, the PTO stands to earn twice the amount of post-allowance fees (i.e., issuance and renewal fees) by granting a patent filed by a large entity than by granting a patent filed by a small entity.⁸¹ Of course, the manner in which the PTO responds to this marginal incentive will likely depend on its baseline objectives. The rest of this subsection outlines the reasons for why both a self-interested and a benevolent-but-resource-constrained PTO are likely to grant more patents with large entity designations relative to patents with small entity designations.

1. *Self-Interested Budget Maximizing PTO*

Similar to the maintenance rate factor, a self-interested PTO will be incentivized to always grant. Although the agency stands to earn half as much fee revenue by granting a small entity patent versus a large entity patent, the PTO will still collect some fee revenue by granting the former. As discussed above, the agency is unlikely to adopt such an extreme practice. However, if a self-interested PTO believes it can avert detection and hence punishment by adopting a less extreme bias towards allowing patents, then the agency will likely focus this expansionary pressure where it stands to earn the biggest returns—large entities. As a result, a self-interested PTO will grant relatively more patents filed by large relative to small entities.

Hypothesis 3: Following the adoption of a near fully user-fee funded system, a self-interested PTO will grant patents at an incrementally higher rate to patent applicants with large entity status, relative to those with small entity status.

2. *Benevolent-but-Resourced-Constrained PTO*

A benevolent PTO that is resource constrained will grant more patents in an effort to increase revenue. However, desiring to minimize deviations from optimal patent policy, the PTO is likely to focus its granting bias on those patents where it stands to profit the most by issuing an additional patent. Accordingly, when a benevolent PTO is bound by financial constraints, it will grant more patents with large entity status, relative to those with small entity status.

Hypothesis 4: Following the adoption of a near fully user-fee funded system and during times at which a benevolent PTO is resource constrained, the PTO will grant patents at an incrementally higher rate to patent applicants with large entity status, relative to those with small entity status.

III. DATA AND METHODOLOGY

A. Data Sources and Key Variables

In order to investigate the manner in which the PTO responds to the incentives posed by its fee structure, it is necessary to acquire data on PTO granting patterns covering a sufficiently long period of time and covering a broad array of patent types. For these purposes, we filed Freedom of Information Act requests to the PTO and obtained a previously-unavailable, comprehensive annual data set on PTO patent processing outcomes for every utility patent application that was received at the PTO over the

⁸⁰ 35 U.S.C. § 41(h) (2006). An entity is defined by the PTO as “small” individuals, nonprofit corporations, or corporations who qualify as small businesses under the Small Business Act. 37 C.F.R. § 1.27(a)(1)-(3) (2012).

⁸¹ Wasserman, *supra* note 18, at 412 n.129.

sample period.⁸² More specifically, the patent processing data contains annual patent filings, allowances, and disposals, disaggregated by patent class and entity size.⁸³ The sample collected spans the time period from 1983 to 2010. On average over our sample period, 258,883 patent applications were filed each year, 132,181 patents were allowed each year, and 189,660 patent applications were disposed of each year. Previous investigations on the PTO's granting patterns have utilized an alternate source that allows for the calculation of PTO grant rates across patent types from only 2001 onwards.⁸⁴ Our data allows for the calculation of annual PTO grant rates across patent types spanning the period of 1983 to the present, which in turn makes possible the exploration of the influence of the 1991 fee reform on the PTO's granting behavior.

More specifically, we use these data to calculate patent grant rates specific to given technology-year combinations (e.g., for genetic patents in 1995) and specific to given technology-year-entity-size combinations. Consistent with the PTO's own representation of its granting practices, we calculate grant rates as the number of patents granted by the PTO divided by the number of patent applications disposed of by the PTO.⁸⁵ We categorize technology groups in various ways throughout this analysis. In our primary specifications, we utilize the technological sub-categories (delineating 37 different

⁸² For the purposes of this empirical analysis, we focus only on utility patents, especially considering that maintenance fees do not apply to design or plant patents. 37 C.F.R. § 1.20 (2012).

⁸³ In the data received by the PTO, disposals include patent applications that have been allowed and abandoned. Abandoned patent applications include patent applications that have been rejected and patent applications that have been abandoned for business reasons. Curiously, a patent applicant can elect to "restart" the patent examination process of an application that has been rejected by filing a request for continued examination (RCE) or by filing a continuation application. By restarting the patent examination process, a "finally rejected" patent application receives continued examination by the PTO. The PTO includes a finally rejected patent application which then an applicant subsequently files a continuation application in its disposals. In contrast, the agency does not include a finally rejected patent application which then an applicant subsequently files a RCE in its disposals. Most likely, this difference in accounting results from the fact that a patent applicant who files a continuation application files an entirely new application where as a patent applicant who files an RCE is requesting continued prosecution of the existing application. Mark A. Lemley & Kimberly A. Moore, *Ending Abuse of Patent Continuations*, 84 B.U. L. REV. 63, 68 n.14 (2004). As a result, we control for RCE filings to alleviate concerns that some patent types are better able to secure ultimate allowances through greater usage of RCEs. See *infra* Section IV.E and Appendix B.

In addition, the PTO appears to have little to no financial incentive to encourage the filing of continuations. The fees for examining an RCE are set below the examining fees for a new application and the fees for examining a continuation application are the same as a new application. 37 C.F.R. § 1.17(e) (2012) (showing that in the fiscal year of 2010 the examination fees for a RCE were \$ 810 for a large entity and \$ 405 for a small entity). While the PTO acknowledges that the cost of examining a continuing application are, on average, less than the costs of examining an original application, the savings do not reach the amount required to align fees with costs. See PTO, DETAILED APPENDICES: PATENT FEE PROPOSAL 1, 61 (February 7, 2012), *available at* http://www.uspto.gov/aia_implementation/fee_setting_-_ppac_hearing_appendices_7feb12.pdf (showing PTO estimates the historical cost of examining RCE is approximately \$1700). See also Wasserman *supra* note 18, at 409-10 (noting that "the mismatch in examination fees and examination costs for a patent application are likely to increase with each iteration through the examination system").

⁸⁴ See, e.g., Lemley & Sampat, *supra* note 13, at 187-89.

⁸⁵ See, e.g., EUROPEAN PATENT OFFICE, JAPANESE PATENT OFFICE, KOREAN INTELLECTUAL PROPERTY OFFICE & UNITED STATES PATENT OFFICE, 2010, FOUR OFFICE STATISTICS REPORT, *available at* <http://www.trilateral.net/statistics/tsr/fosr2010/annex2.pdf>. Table A2 of Appendix B demonstrates the robustness of the empirical results to the use of alternative grant-rate constructions. See also *supra*, note 83 (describing the data received by the PTO).

technology groups) specified by Bronwyn Hall, Adam Jaffe and Manuel Trajtenberg and developed for the Patent Data Project of the National Bureau of Economic Research.⁸⁶

We then merge these data on grant rates with data on technology-specific maintenance rates, which capture the likelihoods that patents issuing within the relevant category will be renewed by the patentee at the respective 4-year, 8-year and 12-year marks following their issuance.⁸⁷ The primary empirical specifications estimated below focus on differentiating across technology categories based on the likelihood of renewing patents at the 4-year mark; however the empirical results are robust to alternative approaches that focus on 8-year or 12-year rates or on some combination of the three rates, as demonstrated by Table A2 in Appendix B. Appendix A provides further details on the construction of the estimation sample and of the relevant variables employed in the empirical analysis.

Table 1 presents descriptive statistics for the key variables used in the regression analysis. The PTO has granted or allowed roughly 70% of the total patents that it has disposed of over the sample period.⁸⁸ Applications from inventors with small entity status represent roughly 29% of the total number of application filings. Roughly 85% of those patents eligible for renewal at the 4-year mark, in fact, renewed their patents. In Appendix A, we provide a breakdown of the maintenance rates and incidence of small entities for each technology category. This breakdown evidences meaningful variation in renewal rates across categories, providing support not only for the methodological framework discussed below, which relies upon this variation, but also in the predicted sensitivity of PTO grant rates to its fee structure.⁸⁹

⁸⁶ Bronwyn H. Hall et al., *The NBER Patent-Citations Data File: Lessons, Insights, and Methodological Tools*, in PATENTS, CITATIONS, & INNOVATIONS: A WINDOW ON THE KNOWLEDGE ECONOMY 403, 434-37 (Adam B. Jaffe & Manuel Trajtenberg eds., 2002). The PTO classifies patents into nearly 500 different technology classes. This classification scheme, however, changes somewhat over time as new classes are added or as others are divided. These compositional changes (particularly divisions) potentially complicate an empirical analysis that tracks within-category changes in PTO behavior over time. For these reasons (and to facilitate a more manageable regression framework), in our preferred specifications, we group patents into the relatively coarser technology classification system set forth by Hall, Jaffe and Trajtenberg. As demonstrated by Table A2 of Appendix B, however, the results are nearly identical when using regression specifications based on the PTO classifications themselves. In any event, this approach may constitute a more appropriate specification to the extent that the PTO elects to differentiate its granting practices (as hypothesized) at a relatively coarser level. Moreover, if the PTO does indeed differentiate all the way at the PTO classification level, any such differential response should still be observable at the more aggregated level assuming some amount of correlation of profitability characteristics (e.g., maintenance rates) across PTO classes within NBER sub-categories, as is borne out by the data.

⁸⁷ For each patent issued following September, 1, 1981, the PTO collects detailed log data on all maintenance events for the relevant patent, including, for example, the payment of its 4-year renewal fee or the termination of the patent for the failure to pay its due 4-year renewal fee. See Downloads, U.S. PAT. & TRADEMARK Office, <https://eipweb.uspto.gov/MaintFeeEvents> (providing publically available data).

⁸⁸ As the data received by the PTO includes a finally rejected patent application which then an applicant subsequently files a continuation application as a disposal, our grant rates do not represent the chances that an originally filed application will issue. Importantly, our analysis does not depend on this calculation as we are interested in studying the influence of the PTO's fee-structure on its granting behavior not the chances an originally filed application will be allowed.

⁸⁹ See *infra* Table A1 in Appendix A (demonstrating the average maintenance rates across each of the 37 technological categories considered in this empirical analysis. Averaging over the entire sample period, four-year maintenance rates, for instance, span from roughly 69.5% at the lowest to 93.4% at the highest).

TABLE 1: MEANS AND STANDARD DEVIATIONS OF SELECTED VARIABLES

	(1)
Panel A. Averaged across Patent Category/Year Combinations	
Patent Grant Rate (% Allowances / Disposals)	70.21 (13.71)
Patent Allowances (1,000's)	6.75 (5.09)
4-Year Maintenance Rate (%)	84.74 (5.09)
8-Year Maintenance Rate (%)	63.48 (8.82)
12-Year Maintenance Rate (%)	43.70 (8.94)
Small-Entity Status Rate (% Small Entity Applications / Total Applications)	28.52 (15.28)
Panel B. Aggregate PTO Measures, Averaged across Years	
Fee Diversion Policy (% Incidence)	50.00 (50.92)
Sustainability Score	0.40 (0.11)

Standard deviations are in parentheses. Descriptive statistics are from a sample of 1058 technology category / year cells from 1983 to 2010 in Panel A and from a sample of 28 years in Panel B. The statistics presented in Panel A are weighted by the relevant number of patent disposals associated with each category-year cell, while those in Panel B are unweighted. The definition of each variable is set forth in greater detail in Appendix A.

Likewise, grant rates demonstrate a meaningful level of variation across technology categories and across years, with a standard deviation of 13.7 relative to its mean of 70.2 (with over 30% of this variation reflecting changes in grant rates within patent categories over time).⁹⁰ How much of this variation can be explained by the imposition of the PTO's current fee structure and by variations in the PTO's financial strength? We now turn to an explanation of the methodological approach undertaken to investigate these questions.

B. Methodology

⁹⁰ It is technically this within-class variation over time in grant rates that is the target of our regression analysis. By including what are called category "fixed effects" we allow for there to be completely fixed differences in grant rates over time across the categories. We ask whether grant rates increase following the 1991 reform *within* our treatment categories, subtracting out the corresponding *within-category* changes in grant rates for the control categories (e.g., low maintenance rate categories) in order to isolate the effect of the fee reform.

1. *Difference-in-Difference Analysis*

In order to statistically tease out the relationship between the PTO's fee structure and its grant rates, we embrace the existence of a "natural experiment" made possible by the Omnibus Reconciliation Act of 1990, which became effective in 1991. This reform resulted in a roughly 70% increase in the fees assessed by the PTO and, for the first time, left the PTO essentially fully funded by user fees.⁹¹ By observing the PTO's granting practices before and after a reform that put into place its current funding structure, we may hope to gain an understanding of how this structure affects the foremost decision with which the agency is tasked: whether or not to grant a patent.

Of course, simply observing the change in overall PTO grant rates before and after this reform in an effort to explore the impact of the reform would be highly problematic. Grant rates are almost certain to change over time for reasons unrelated to the financial incentives facing the PTO—e.g., changes in the quality of underlying applications. Indeed, the predictions set forth in Part II do not dictate that the PTO's grant rates will, in an absolute sense, clearly increase subsequent to the fee reform and during times of strongly binding financial constraints. Rather, the theory predicts that the PTO's grant rates will be *higher than they otherwise would be* absent the presence of the fee reform and/or the financial constraints.⁹² The possibility that other factors may drive grant rates leaves it difficult statistically to disentangle the marginal influence of the fee-structure reform from the impact of changes in these other factors over time (absent observable data on all such other factors). To surmount this problem, we utilize a "difference-in-difference" estimation approach (implemented via regression analysis) that is commonly employed by policy evaluation studies in the economics and law and economics literatures.

The essential premise behind the difference-in-difference approach is to observe how grant rates change before and after the 1991 reform for a set of patents with respect to which the PTO is not likely to exhibit an expansionary responsiveness between grant rates and fee structure (e.g., those with low maintenance rates). To the extent that the grant rates associated with patents of this latter type are likewise impacted by those unobservable drivers of PTO behavior, one can view this set of patents as a "control" group. As such, one can effectively use the change in grant rates around the 1991 fee reform for this control group as an estimate for the influence of the change over time in these unobservable drivers. Thereafter, one can subtract this estimate from the corresponding estimate of the change in grant rates before and after the 1991 reform on the set of patents for which one would expect a responsiveness between grant rates and fee structure—i.e., the treatment group. This calculation should provide us with the desired disentangling of factors and thus leave us with an unbiased estimate of the true impact of the reform itself on PTO granting practices.

To execute this empirical approach and to form the necessary treatment and control groups, we draw on the theoretical predictions from Part II regarding which types of patents are associated with grant rates that are more or less likely to be sensitive to fee structure. Embracing each of the predictions set

⁹¹ Prior to this time, the PTO met roughly half of its obligations through the collection of user fees. U.S. PATENT & TRADEMARK OFFICE, ANNUAL REPORT, FISCAL YEAR 1992, 53 tbl.2 (1992).

⁹² For instance, if other, unrelated factors are driving a downward trend in PTO grant rates, the theory predicts that the influence of fees and/or financial constraints may cause that trend to be less severe than it would otherwise would be. Moreover, even if, in absolute terms, grant rates are not rising over time, it may still be the case that the marginal increase in patent grant rates that otherwise does ensue from these fee influences could be detrimental to innovation policy. After all, such influences could be disrupting what is otherwise a rational and optimal downward trend in granting policies. The concern with this paper is on that marginal, fee-related distortion itself.

forth in Part II, we test for various differential responses to the 1991 reform across different types of patents—e.g., across large and small entities. Under the fundamental assumption that, absent the reform, each patent type would have continued along the same trajectory (not necessarily at the same level, though), this exercise allows us to evaluate the general motivating question of this Article: does the PTO distort its granting practices in an expansionary manner in response to its fee-based incentives?

It is worth emphasizing that this approach accounts for the possibility of completely fixed differences in grant rates across patent types—i.e., inherent differences across types that are present across all sample years. After all, to use entity size as an example, our analysis is not simply comparing large and small entity grant rates. Rather, we are comparing how the change in large entity grant rates before and after 1991 compares to the corresponding change in small entity grant rates before and after 1991. As such, by focusing on this difference-in-difference calculation, we allow for the possibility that there is something fundamentally unique about the granting likelihoods facing large entities relative to small entities (i.e., the possibility that large entities garner a higher grant rate than small entities because the latter has access to higher quality attorneys or because the latter has better internal screening mechanisms regarding the patentability of their inventions). It is also worth emphasizing that this empirical exercise does not rule out the possibility of other agency-level and examiner-level biases in behavior (e.g., examiner biases ensuing from their compensation structure). Rather, the design is simply meant to isolate the particular bias stemming from the agency’s fee structure.

In reality, the empirical specifications that we estimate below are a bit richer than the simple difference-in-difference description set forth above, though that description does capture its key intuitions. In Appendix A we provide more details regarding the precise empirical specifications that we estimate. For instance, rather than forming one treatment group and one control group, many of our empirical approaches consider a continuum of patent types (e.g., differentiating technology categories based on a measure of their 4-year maintenance rates) and then observe how the PTO’s practices respond to the 1991 reform as we move along this continuum.⁹³

Of course, while the difference-in-difference approach holds the promise of isolating the marginal effect of the PTO’s fee structure on its grant rates, it does rely on various assumptions and thus carries various caveats. For instance, if those separate patent types that are predicted to be responsive and non-responsive, respectively, to the patent fee structure already happen to be on divergent trends in their granting patterns prior to the fee reform, then the basic difference-in-difference results may be picking up the influence of these pre-existing trends, as opposed to the influence of the reform itself. Fortunately, we will be able to look for various markers of this potentially confounding story, as will be discussed in the results section below. More generally, in a series of so-called “specification checks,” we challenge the various assumptions underlying the baseline empirical approaches and demonstrate the flexibility and the robustness of the findings to a range of alternative approaches.

⁹³ While numerous examples abound, the primary empirical precedent that we follow in this Article is Amy Finkelstein and Daron Acemoglu’s investigation into the differential change in the capital-labor ratio of hospitals following the national adoption of the Medicare Prospective Payment System (PPS) in 1984, where hospitals are differentiated (and theorized to respond differently to the adoption of PPS) based on their pre-reform share of Medicare patient days. Amy Finkelstein & Daron Acemoglu, *Input and Technology Choices in Regulated Industries: Evidence from the Health Care Sector*, 116 J. POL. ECON. 5, 837-80 (2008).

2. Financial Sustainability Analysis

Our regression analysis exploits sources of variations beyond that of mere time (before and after 1991) and patent type (e.g., large vs. small entity). Integral to our empirical analysis is also the consideration of variations over time in the degree to which the PTO is bound by its financial constraints and likely to be in need of additional sources of revenue. As predicted in Part I, under the assumption of benevolence, the PTO may only be expected to respond to fee incentives by granting differentially across patent types during times in which such constraints are binding. In order to test this prediction, we modify the basic regression approach discussed above and effectively explore whether the primary difference-in-difference finding is itself likely to emerge to a stronger degree during times in which markers indicative of PTO-revenue-need are more prevalent. For these purposes, we draw upon the theory set forth in Part I, whereby we predicted that the PTO would be more likely to trigger its sustainability constraint upon a change in various factors, including an increase in its backlog, a decrease in its annual renewal fee collections, an increase in the average complexity of its examinations and a decrease in the proportion of large-entity patentees. Each such development would disrupt any financial balance reached and decrease the proportion of incoming fees to outgoing costs.

In Table A8 of Appendix B, we estimate regressions that explore how fluctuations over time in each of these separate factors are associated with a differential grant rate across the delineated patent types. Of course, in any given year, all of these factors are changing at the same time, even though the PTO is only subject to a single sustainability constraint. In other words, in a given year, the PTO may experience an X% increase in its backlog, which will leave it more likely to face break-even concerns, along with a Y% increase in aggregate renewal rates, which will leave it less likely to face such concerns. These separate regressions alone leave us unable to determine how to weigh the respective influences of each such development upon the PTO's aggregate financial strength and thus upon its ultimate decision-making. Therefore, in our primary approach to testing this sustainability prediction, which we undertake in Section IV below, we combine these factors into a composite sustainability measure. This "sustainability score" is constructed so as to capture the impact of these factors on the PTO's financial balance in a manner consistent with the empirically relevant influence of each such factor. To this end, we use actual data on the annual fluctuations in the above factors (e.g., annual maintenance rates, backlog levels, etc.), along with information on the parameters of the PTO's fee schedule, to simulate an annual measure equal to the ratio between (1) the issuance and post-issuance fees generated by the existing stock of patents at a given point in time and (2) the net costs associated with the examinations demanded of the PTO at that time.⁹⁴ Appendix A provides further specifics regarding this calculation. A higher simulated sustainability score is suggestive of fewer financial pressures facing the PTO and thus less need of additional funds.

In calculating this sustainability metric, we proxy the examination demand facing the PTO in a given year by the PTO's backlog of patent examinations at that time.⁹⁵ Of course, the PTO does not need to

⁹⁴ This calculation also draws upon information on the history of patent issuances over time, which bears, for instance, on the number of patents up for renewal during the given year. In rough terms, multiplying these numbers by the annual renewal rates and by the associated renewal fees allows us to estimate the amount of issuance and post-issuance fees that were made available to the PTO during the given year. *See infra* Appendix A.

⁹⁵ Using annual disposal counts to proxy for this demand is less preferred considering that disposals are under the PTO's control and could be seen as a reflection of the PTO's response to the demands it faces, as opposed to a reflection of the underlying, external cost pressures being placed upon the PTO. In rough terms, we estimate the net costs associated with all of the examinations demanded upon the PTO for a given year by multiplying the backlog by the average costs of examination for that year, where this average is influenced by the

examine its entire backlog each year. Nonetheless, it might be reasonable to assume, especially considering the PTO's own rhetoric,⁹⁶ that the agency is nonetheless motivated by its mission to increase disposals in the face of a large and growing backlog. As such, the calculated sustainability score may provide a sense of the ease by which the PTO may use its stream of incoming funds to satisfy the substantial costs associated with all of those examinations presently awaiting the PTO.

This exercise of exploring whether the PTO's distortionary practices are more pronounced during times of greater financial need allows for an appropriate specification of the PTO's predicted behavior under the benevolent model. At the same time, this approach also allows us to shed light on an ongoing debate in administrative law regarding the nature of government employees: are PTO bureaucrats acting in self-interest to universally expand the agency's budget or are PTO bureaucrats acting with optimal innovation policy in mind, though occasionally bound to distort the agency's behavior in pursuit of required resources?

IV. RESULTS

The regression results presented in Table 2 illuminate and test the key hypotheses presented in Section II above. Generally, these hypotheses set forth that the PTO's fee structure causes it to increase the rate at which it grants patent types that generate higher back-end fees relative to the rate at which it grants patent types that generate lower back-end fees. This differential analysis sheds light on the broader and more fundamental question motivating this paper: does the PTO's fee structure create a bias towards granting patents. We begin in Panel A of Table 2 with an analysis of the PTO's differential response to its fee structure across technology categories with varying renewal rates.⁹⁷

A. Difference-in-Difference Results: Renewal Rate Specifications

To recap, in Section II, we set forth the following testable hypotheses:

Hypothesis 1: *Following the adoption of a near fully user-fee funded system, a self-interested PTO will grant patents at an incrementally higher rate for patents within technology categories that generally*

distribution of applications across the various examination complexity levels for that year (that is, certain technologies are allocated more hours of examination and thus carry greater examination costs, in which event average examination costs for a given year depend upon the distribution of applications across technologies for that year). See *infra* Appendix A (offering more detail). The sustainability score is not meant to reflect the actual profits accruing to the PTO in a given year. Rather, it is meant to simulate how variations in the above-mentioned factors (keeping all other factors fixed) affect its general profitability. That is, it provides a meaningful and empirically relevant way of assessing the relative contributions to the PTO's financial position—that is, its balance of incoming fees to outgoing costs—of each of these factors. If the backlog happens to grow by 40% over a given year, while annual renewal rates increase by 5% over that year, this calculation allows for an appropriately greater emphasis to be placed upon the backlog growth in assessing the PTO's need for funds.

⁹⁶ PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2011, *supra* note 33 at 112 (stating that the Inspector General's top management challenges facing the PTO include "reducing the patent application backlog"); PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2010, *supra* note 4 at 3 ("The Agency continues to face operational challenges including . . . a large backlog.").

⁹⁷ As discussed in Section III above, we classify patents into the 37 technological sub-categories set forth by Hall, Jaffe & Trajtenberg, *supra* note 86. As demonstrated in Table A2 of Appendix B, however, the pattern of results presented in Table 2 remain virtually unchanged when we use alternative classification schemes, including the more fine-grained PTO Classification System and the broader 6-category-level system likewise introduced by Hall, Jaffe & Trajtenberg.

have high maintenance rates relative to patents within categories that generally have low maintenance rates.

Hypothesis 2: Following the adoption of a near fully user-fee funded system and during times at which a benevolent PTO is resource constrained, the PTO will grant patents at an incrementally higher rate for patents within technology categories that generally have high maintenance rates relative to patents within categories that generally have low maintenance rates.

1. Primary Difference-in-Difference Results

The results presented in Panel A of Table 2 are, consistent with the general prediction that the PTO would, following the adoption of a fully-user fee funded system, grant at an incrementally higher rate to patents within high-maintenance-rate categories relative to those within lower-maintenance-rate categories. The coefficient estimate presented in Column 1 of Panel A captures the relationship between the PTO's grant rate and the interaction between being in the post-reform period ("REFORM") and being in a high-maintenance rate category ("MAINTAIN"). More specifically, the estimated figure of 58.96 suggests that the impact of the 1991 reform on the PTO grant rate is 59 percentage points higher (or roughly 84% higher) for a patent category with a maintenance rate of 100% than it is for a category with a 0% maintenance rate and likewise, 5.9 percentage points higher for a category with a maintenance rate of $X\%$ relative to one with a rate of $X-10\%$.⁹⁸

This latter interpretation—i.e., the 5.9 percentage point differential—is perhaps a more meaningful description of the findings considering that technology categories simply do not differ by 100 percentage points in their maintenance rates.⁹⁹ The standard deviation in 4-year maintenance rates across technology categories (unweighted) is roughly 6 percentage points, with a low maintenance rate of roughly 62% (amusement devices) and a high of roughly 94% (semiconductors).¹⁰⁰ The underlying regression estimated in Panel A explores the differential response to the 1991 reform along a linear continuum of maintenance rates (by interacting the binary reform variable with a continuous maintenance-rate measure). In Table A4 of Appendix B, we relax the assumption of linearity and estimate a less parametric specification that assigns technology categories dichotomous (0/1) variables for being in different quartiles (e.g., top 25%, bottom 25%, etc.) of maintenance rates. We find a roughly 6.8 percentage-point differential grant-rate response to the 1991 reform between technologies in the top and bottom quartiles of maintenance rates.

⁹⁸ Considering that maintenance fees originated with patents issuing at least after September 1981, and considering the late payment period generally authorized by the PTO, we do not begin the sample period used in the maintenance-rate regressions until 1987. By that time frame, the PTO will have had the experience of evaluating the first cohort of 4-year maintenance rate payments.

⁹⁹ Panel A simply interprets the findings along such drastic extremes considering that the MAINTAIN variable is defined in fractional terms (thus ranging from 0 to 1 in value) and that coefficients of regressors are typically interpreted as the change in the dependent variable associated with a 1-point change in the regressor.

¹⁰⁰ This range is based on the preferred specification of the 4-year maintenance rates, which are determined according to the average rates experienced across technology categories up to 1990. See *infra* Appendix A. As such, this range differs slightly from that reported in Table A1 (see *infra* Appendix A), which reports average maintenance rates experienced over all sample years.

TABLE 2. THE IMPACT OF PTO FEE REFORMS ON GRANT RATES: PRIMARY DIFFERENCE-IN-DIFFERENCE REGRESSION COEFFICIENTS

	(1)	(2)	(3)	(4)
Panel A. Differential Impact of Fee Reform across Patent Categories with Varying Maintenance Rates (unit of observation: Category / Year; dependent variable: category-year-specific grant rate)				
REFORM * MAINTAIN _i	58.96*** (19.16)	170.41*** (47.16)	104.50*** (28.63)	125.78*** (45.67)
REFORM * MAINTAIN _i * SUSTAINABILITY	-	-290.18*** (92.37)	-	-77.68 (126.20)
REFORM * MAINTAIN _i * DIVERSION	-	-	-70.29*** (18.38)	-57.09** (23.83)
Number of observations	887	887	887	887
Panel B. Differential Impact of Fee Reform between Patents with Large and Small Entity Status (unit of observation: Category / Year / Entity Size; dependent variable: category-year-entity-size-specific grant rate)				
REFORM * LARGE	6.44*** (1.61)	21.92*** (4.36)	12.20*** (2.37)	17.39*** (4.33)
REFORM * LARGE _i * SUSTAINABILITY	-	-40.82*** (8.44)	-	-19.24** (9.46)
REFORM * LARGE _i * DIVERSION	-	-	-9.27*** (1.77)	-5.88*** (1.87)
Number of observations	1843	1843	1843	1843

* significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are reported in parentheses and are clustered to correct for autocorrelation within patent categories over time (Panel A) and for autocorrelation within patent-category / entity size combinations over time (Panel B). All regressions include patent-category fixed effects and year fixed effects to control for fixed differences in grant rates across patent categories and across years, respectively. Regressions in Panel B include entity-size fixed effects as well. Regressions are weighted by the number of disposals used to form each observation's grant rate. Data on patent processing statistics and maintenance rates were obtained from the PTO.

Under an assumption that the PTO's granting patterns for high-maintenance-rate categories would otherwise have trended in the same manner as for low-maintenance-rate categories absent the reform (though still allowing for inherently fixed differences in grant rates across technologies), the estimated difference-in-difference findings can be interpreted as an expansionary *effect* of the fee-reform itself and thus of the user-fee funded fee structure imposed by the reform. In other words, the above estimate can be treated as causal in nature under an assumption that there are no unobservable "shocks" to the PTO's granting practices that are specific to high-maintenance-rate categories in the post-1991 period. We relax, and further explore the validity of, this assumption in various ways in Part D and Appendix B below. For instance, among others things, we demonstrate that the PTO had not already begun these differential granting patterns during the period of time prior to the reform, a finding which would have otherwise raised concerns that some unobservable factor other than the reform is responsible for the findings.

Of course, observing the differential response to the fee reform across technologies with different renewal rates does more than simply allow us to tell a potentially causal story (under the above assumptions). This differential response represents an immediate policy concerns in its own right. That

is, by possibly inducing the PTO to extend preferential treatment to some technologies over others, the PTO's fee structure may be undesirably distorting the allocation of resources across different sectors of the economy.

2. Sustainability Interaction Results

According to the theory set forth in Sections I and II, a self-interested PTO aiming to either maximize its budget or its profits would always be expected to act upon the incentives created by its fee structure. On the other hand, our model suggests that a benevolent PTO would only elect to grant additional patents in an effort to earn extra revenues during periods of time in which it is likely to be resource constrained. As such, to more completely test the predictions of the benevolent PTO model, we modify the empirical specifications estimated in Column 1 to interact the primary difference-in-difference variable with a metric (i.e., the sustainability score described in Section III) capturing the likelihood that the PTO is on strong financial ground.

The coefficient on this interaction variable—*i.e.*, in Panel A of Table 2, the REFORM * MAINTAIN * SUSTAINABILITY variable—provides us with an indication of whether the differential grant-rate response to the 1991 reform between high- and low-maintenance-rate categories is itself likely to be greater during periods of time in which the PTO is subject to heightened financial sustainability concerns. A greater differential response of this nature would be identified by the estimation of a negative coefficient on this interaction variable considering that the sustainability score is defined such that a higher score entails a stronger financial position of the PTO. Consistent with this prediction, we estimate that as the sustainability score increases by 0.1 (or roughly a 25% improvement in the financial position of the PTO), the differential response to the 1991 reform between a 100% maintenance rate category and a 0% rate category is itself expected to fall by roughly 29 percentage points.

While Column 2 explores whether the differential response to the fee reform is stronger during times of more financial stress, we also estimate empirical specifications that de-emphasize the 1991 reform and that directly specify a difference-in-difference analysis based only on variations over time in the PTO's financial sustainability score, *focusing only on the post-1991-reform period*. That is, we also estimate specifications that test whether the PTO begins to grant patents at an incrementally higher rate to high-maintenance-rate technologies relative to low-maintenance-rate technologies as the PTO experiences a change in conditions that leaves it more likely to face sustainability concerns. One, of course, needs some variation in the PTO's fee structure to statistically tease out the impact of that structure. This alternative conceptualization of the basic difference-in-difference design is premised on the idea that we may gain a better understanding of the impact of the PTO's fee structure by exploring variations in the conditions under which the PTO would even be sensitive to that structure in the first place.

We present results of this alternative specification of the primary difference-in-difference approach in Table A6 of Appendix B. The findings completely match those of Column 2 in suggesting that the PTO is more likely to distort its behavior when it is greater need of funds. For instance, we estimate that, as the sustainability score *decreases* by 0.1 (representing a 25% decline in the PTO's financial sustainability position), the PTO begins to grant patents at a 29.2 percentage point higher rate for patents within a technology category with a maintenance rate of 100% relative to patents within a category with a 0% maintenance rate. This finding can likewise be interpreted as an *effect* ensuing from the PTO's fee structure under an assumption that there are no unobservable shocks to the PTO's grant rates for high maintenance-rate technologies that coincide with declines in the PTO's financial health.

All told, it appears that the PTO is not universally seeking to expand its revenues in response to the incentives created by its user-fee funded structure. Rather, it may tend to use its granting practices as a revenue-generating tool only when necessary to sustain itself. We demonstrate this finding more clearly and on a year-to-year basis in Part D below in discussing the results of a dynamic difference-in-difference regression. In addition to confirming the predictions of the benevolent-but-constrained PTO model, these findings likewise shed light on the initial and more fundamental question of whether the PTO is indeed self-interested or benevolent in motivation, arguably providing support for those theories that have challenged the Niskanen model.¹⁰¹

Accordingly, the findings presented in Panel A of Table 2 do not lend support to *Hypothesis 1*, in so far as they are generally inconsistent with the characterization of the PTO as being a self-interested budget-maximizing agency. However, the findings are consistent with *Hypothesis 2* in suggesting the PTO's fee structure induces the agency to grant at an incrementally higher rate to high renewal rate technologies.

B. Difference-in-Difference Results: Entity-Size Specifications

To recap, in Section II, we set forth the following testable hypotheses:

Hypothesis 3: Following the adoption of a near fully user-fee funded system, a self-interested PTO will grant patents at an incrementally higher rate to patent applicants with large entity status, relative to those with small entity status.

Hypothesis 4: Following the adoption of a near fully user-fee funded system and during times at which a benevolent PTO is resource constrained, the PTO will grant patents at an incrementally higher rate to patent applicants with large entity status, relative to those with small entity status.

1. Primary Difference-in-Difference Results

Similar to the maintenance-rate results discussed above, the results presented in Panel B of Table 2 are consistent with the prediction that the PTO would respond to the adoption of a fully-user fee funded system by granting at an incrementally higher rate to patent applicants with large entity status, relative to those with small entity status.¹⁰² The coefficient estimate reported in Column 1 of Panel B suggests that the 1991 fee reform is associated with a 6.4 percentage-point higher grant rate for large entities relative to small entities. Considering a mean grant rate of 70% over the sample period, this corresponds to a roughly 9% higher grant rate for large entities.¹⁰³ As above, under an assumption that

¹⁰¹ See *supra* Section I.B.1.

¹⁰² While this underlying regression considers differences in grant rates over time (before and after 1991) and across entity sizes (large and small), it also includes technology-specific fixed effects. See *infra* Appendix A (providing further discussion). By accounting for fixed and inherent differences across technologies (and knowing grant rates at a level specific to given years, entity sizes and technologies), we can alleviate concerns that the estimated findings are attributable to a scenario in which the incidence of large entity patentees increases over time within technology categories that happen to experience higher grant rates historically.

In late 1982, Congress, for the first time, set differential fees based on small versus large entity size distinctions. Act of August 27, 1982, Pub. L. No. 97-247, § 1, 1982 U.S.C.A.N. (96 Stat.) 317, 317. This discount for small entities was eventually made permanent. Act of Nov. 6, 1986, Pub. L. No. 99-607, § 1(b)(2), 1986 U.S.C.A.N. (100 Stat.) 3470, 3470 (codified as amended at 35 U.S.C. § 41(h) (2000)). Accordingly, we set 1986 as the beginning of the sample period for the small-entity regressions; however, the results remain virtually unchanged when we begin the estimation sample in 1983.

¹⁰³ See also *infra* Table A2 of Appendix B (finding virtually identical results for this entity-size interaction coefficient when we include controls for maintenance rates specific at the entity-size-category-specific level,

large and small entities would have otherwise followed a similar trend over time absent the reform (though, still allowing for completely fixed differences in granting patterns between large and small entities), this finding is suggestive of an *effect* of the reform itself and thus of a bias towards granting additional patents induced by the agency's fee structure.

In finding that the 1991 reform is associated with a preferential grant rate for large entities, which pay double the fees of small entities, we provide general support for the contention that the PTO's fee structure induces a bias towards granting patents. As with the maintenance rate results, this differential response also raises policy concerns of its own and suggests that the effect of extending lower fees to small entities may be to undermine the very purpose of that fee differential in the first instance—i.e., to foster innovation among small firms and individual entrepreneurs.¹⁰⁴

2. Sustainability Interaction Results

Consistent with the maintenance-rate results, we likewise find that as the sustainability score increases (representing an improvement in the PTO's financial status), the differential response to the 1991 reform between large and small entities falls, as evidenced by the negative estimate of the coefficient of the REFORM*LARGE*SUSTAINABILITY interaction term presented in Column 2 of Panel B. Again, this suggests that the PTO may not be universally increasing its grant rates in order to maximize fee revenues. Rather, it appears that the PTO distorts its behavior so as to increase grant rates to large entities (which generate higher fees) to a greater degree during times in which the PTO is greater need of funds.¹⁰⁵

Accordingly, as with the maintenance rate findings, the results presented in Panel B of Table 2 do not lend support to Hypothesis 3, in so far as they are generally inconsistent with the characterization of the PTO as being a self-interested budget-maximizing agency. However, the findings are consistent with Hypothesis 4 in suggesting the PTO's fee structure induces the agency to grant at an incrementally higher rate to high renewal rate technologies.

C. Interactions with Fee Diversion Policy.

As indicated in Section I above, between the years of 1991 and 2003, the PTO was subject to policies that effectively forced it to share a portion of its anticipated fee collections with Congress, an event that is often labeled as "fee diversion." The practice of fee diversion and the consequent division of anticipated collections with Congress may blunt the incentives of the PTO to increase its grant rates in an effort to generate greater revenues. Consider the year 2002, for instance. While the PTO projected it would collect roughly \$1.35 billion over that year, Congress only authorized a budget of \$1.05 billion.¹⁰⁶ Accordingly, Congress's inclinations to limit the PTO's funding availability in 2002, in turn, may have

confirming that the estimated differential granting trend between large and small entities following the 1991 reform is likely a result of the higher (i.e., double) fees ensuing from the large entity status and not a result of the possibility that large entities also happen to maintain their patents at higher rates).

¹⁰⁴ See *supra* note 17 and accompanying text.

¹⁰⁵ See also *infra* Table A6 in Appendix B (estimating an alternative difference-in-difference specification that focuses only on the post-1991 period and simply explores whether the PTO increases its grant rate to large entities relative to small entities during times in which the PTO faces greater financial pressures – i.e., during times in which its sustainability score falls. Again, the estimates of this exercise match those of the results presented in Column 2 of Panel B, which interact the fee-reform-based difference-in-difference variable with the sustainability score).

¹⁰⁶ See *supra* note 30.

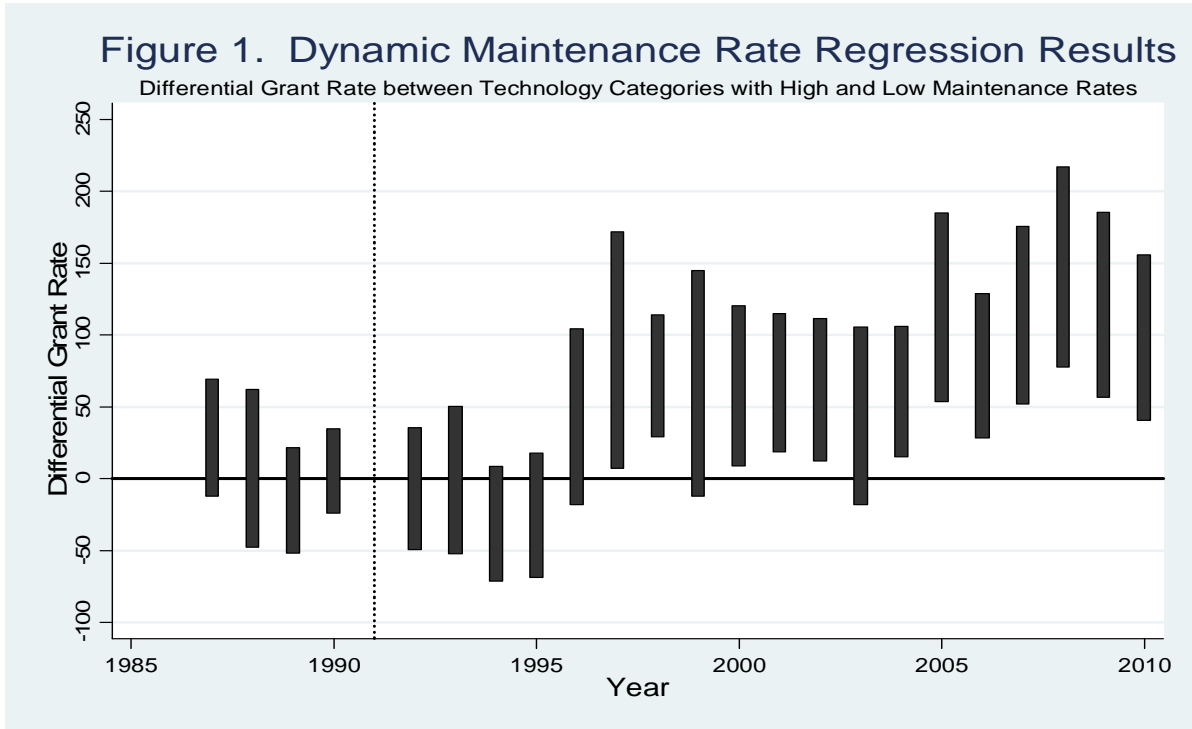
likely left the PTO less inclined to push Congress for an even higher budget that year and thus less inclined to seek an expansion in its grant rates to justify a higher budget.

Following 2004, on the other hand, Congress neither automatically diverted a percentage of the fees collected (as it did between 1991 and 1998) nor capped the PTO's budget at an amount less than its anticipated collections (as it did between 1999 and 2003). Rather, the PTO's spending authority was capped at its projected revenue stream, thereby maintaining a possible incentive of the PTO to seek an expanded grant rate during those years and a correspondingly higher anticipated revenue amount. We test these predictions in Column 3 of Table 2. Similar to the sustainability-interaction specifications, we explore whether the differential response to the 1991 reform across different patent types is, in turn, weaker during those years (i.e., 1991-2003) in which a stronger fee diversion policy was in place. Consistent with these expectations, the results presented in Column 3 suggest that during periods of a strong fee diversion policy relative to a weak one, there will be a smaller fee-induced divergence in PTO grant rates across varying maintenance-rate categories and between large and small entities.¹⁰⁷ While the practice of fee diversion may be undesirable from a number of policy perspectives, it may nonetheless blunt the grant-related distortions that arise from the PTO's user-fee funded structure.

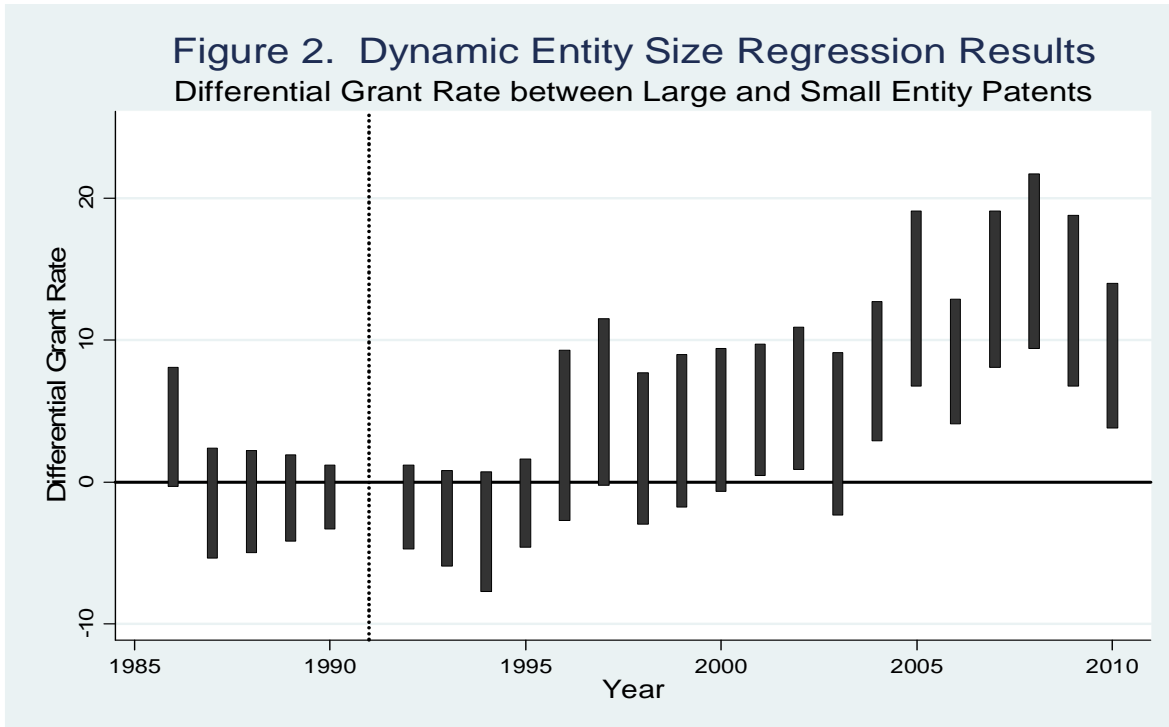
D. Dynamic Difference-in-Difference Regression Results

Our empirical specifications allow for completely fixed differences in grant rates across years and patent categories (in Panels A and B) and likewise across entity size specifications (in Panel B). However, a concern arises that the primary difference-in-difference result is merely reflective of a pre-existing differential granting trend between, for instance, large and small entities, as opposed to being attributable to an actual effect of the fee reform itself. To help rule out this possibility, we estimate dynamic difference-in-difference regressions, which modify the approaches taken thus far to now interact the categorical distinctions in patent types with a set of dichotomous variables representing each year in the sample (as opposed to simply a dichotomous variable for being in the post-1991 period). We present the results of these dynamic regressions in Figures 1-2. For each year of the sample, we report the 95% confidence bands of the coefficient of the interaction between that year and the differential grant rate of interest (e.g., between large and small entities in Figure 2). The coefficient values are interpreted with reference to 1991, where the differential grant rate across patent types is normalized to 0 in 1991. More simply, the results of this dynamic exercise can be interpreted as the time trend in the differential grant rates across technology categories with high and low maintenance rates (Figure 1) and between large and small entities (Figure 2), where these differential rates are scaled such that they equal 0 in 1991.

¹⁰⁷ In Column 4 of Table 2, we attempt to disentangle the fee diversion and sustainability stories by including both sets of interactions in the same regression, an exercise complicated by the significant collinearity between these two factors. While the estimated coefficients of the interaction terms fall in magnitude and precision, the findings remain suggestive that the differential granting patterns induced across patent types by the 1991 reform are themselves likely to vary both as a result of fee diversion and as a result of the PTO's actual need for additional funds.



Note: the bars represent 95% confidence intervals for the estimated coefficients of a dynamic difference-in-difference regression specification that interacts the category-specific maintenance rate variable with indicator variables representing each year in the 1987-2010 period. This collection of estimated dynamic coefficients can be interpreted as a time trend in the differential granting periods between patent categories with high maintenance rates relative to low maintenance rates. This differential is normalized at 0 in 1991, representing the reference year. Each regression includes category and year fixed effects. Patent processing and maintenance data are from the PTO.



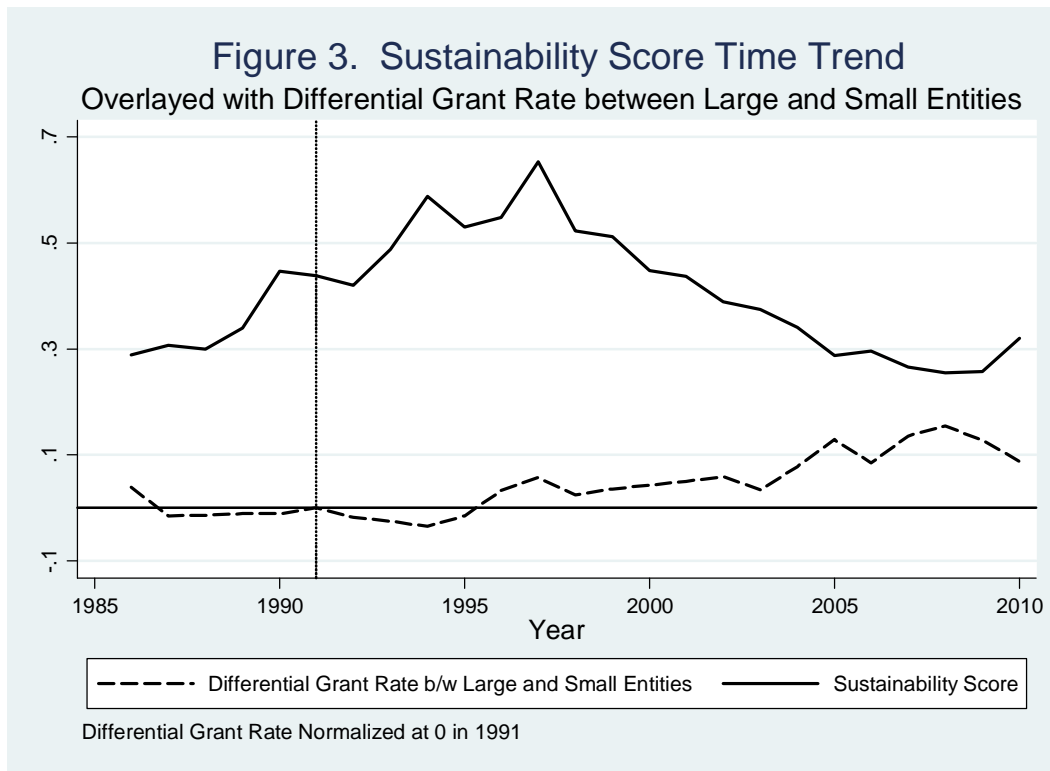
Note: the bars represent 95% confidence intervals for the estimated coefficients of a dynamic difference-in-difference regression specification (with a unit of observation at the category-year-entity-size level) that interacts the large-entity-size status indicator with indicator variables representing each year in the 1986-2010 period. This collection of estimated dynamic coefficients can be interpreted as a time trend in the differential granting periods between large and small entities. This differential is normalized at 0 in the 1991, representing the reference year. Each regression includes category and year fixed effects. Patent processing and maintenance data are from the PTO.

This dynamic approach allows us to explore the evolution over time in the relevant differential granting patterns. As can be observed in each of Figures 1 and 2, there appears to be no discernible trend in the direction of the expected reform effect in the pre-1991 period, easing any concerns that the main results in Table 2 are reflective of pre-existing differential trends likely attributable to factors other than the reform.

Of course, there remains a concern that unobservable factors emerging in the post-1991 period are responsible for the observed patterns—e.g., there are unobserved “shocks” in the grant rates of high-maintenance-rate categories in the post-1991 period. We appease these concerns in various ways in Appendix B. For instance, in Table A3, we demonstrate the robustness of our results to the inclusion of various observable control variables (which are only available in the pre-2005 period—e.g., forward-looking citation counts). We also estimate a so-called “triple-differences” regression that explores whether the differential maintenance-rate result is itself stronger with respect to large entities within those high-maintenance rate categories (under an assumption that a benevolent PTO wishing to minimize its distortionary practices as much as possible would focus its distortionary efforts on the highest fee-generators—i.e., large entity patents within high maintenance-rate classes). As explained in further detail in Appendix A, this “triple-differences” specification allows us to rule out the confounding influence of a larger range of unobservable factors, including those that are specific to given technology-year combinations and to given entity-size-year combinations. Accordingly, this specification addresses

concerns over unobservable “shocks” in the grant rates of large entities and high-maintenance-rate categories in the post-1991 period. Indeed, as demonstrated by Table A5 of Appendix B, we find evidence suggesting that the divergent grant rates between high- and low-maintenance-rate categories is itself more concentrated in large entities within those categories than small entities, providing general support to the findings presented in Table 2.

To complement these dynamic figures, in Figures 3, we plot the time trend in the PTO’s sustainability score, overlaid with the trend in the differential grant rates between large and small entities (reporting the means of the coefficients displayed in Figure 2, represented in fractions). As demonstrated by this figure, consistent with the interaction results of Table 2, the degree to which the PTO elects to grant at a relatively higher rate to large entities (presumably to earn higher revenues) appears to be highly correlated with a deterioration in the agency’s financial position—represented by a reduction in the PTO’s sustainability score—during the period of time following the imposition of the fully user-fee funded system (while not shown, a similar correlation becomes apparent with the differential grant rates across technologies with high and low maintenance rates). This correlation is apparent over the long horizon and even with respect to several of the short-term spikes and dips in the sustainability score (e.g., 1994, 2005, 2006, and 2009). The graph also evidences an apparent correlation between the distortionary granting practices and a relaxation of the relevant fee-diversion policies in the post-2003 period.



As evidenced by Figures 1 and 2, the divergent responses to the 1991 reform emerge with a several year lag following 1991. This lag may be reasonable under an assumption that it takes the PTO some time to adjust its granting practices under the new fee regime. More likely, perhaps, this lag may be attributable to the fact that markers indicative of financial sustainability are particularly strong during the 1992 to

1995 period, as demonstrated by Figures 3. The PTO may have experienced a financial boost over this short time period considering that it began to collect the substantial 12-year maintenance fees for the first time during these years.¹⁰⁸ Ultimately, the results from these dynamic exercises lend further support to hypotheses 2 and 4.

E. Robustness / Specification Checks

There is a potential concern that selection effects due to changes in the filing behavior among small and large entities following the 1991 fee reform may be responsible for the observed differential trends in the PTO's granting behavior. Two selection-effect scenarios in particular could potentially explain the observed differential trends in grant rates. First, large entities or patent applicants in high renewal groups may file relatively fewer patent applications post-1991 than pre-1991. This response could implicate a possible concern that a selected sample of higher quality applications remained resulting in the PTO granting more patents with respect to large entities and high maintenance rates categories. Because the 1991 reform which modified the funding structure at the agency level also carried a substantial increase in the fees charged to applicants, it is possible that applicants responded to this increase by reducing their filings¹⁰⁹ (potentially to a higher degree among large entities and among those in high maintenance rate categories considering the higher expected fees).

Second, small entities or patent applicants in low renewal groups may file relatively more patent applications after the 1991 reform than before. This response would also implicate a concern that a selected sample of applications are driving our results, however, this selected sample would be of lower not higher quality. Both the post-1991 enactment of programs at the PTO to assist small entities¹¹⁰ and the rise of the "patent troll" or the non-practicing entity,¹¹¹ could possibly result in small entities increasing their filings. We appease both of these concerns in Table A7 of Appendix B and demonstrate that the 1991 reform did not lead to either a reduced (and possibly more-selective) large entity or high renewal rate applicant pool or an increased (and possible less-selective) small entity or low renewal rate applicant pool in the post-1991 period. More specifically, if anything, it appears that the 1991 reform is associated with an incrementally higher rate of filing for large entities relative to small entities and for high maintenance technologies relative to low maintenance rate technologies.¹¹²

¹⁰⁸ U.S. PAT. & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT, FISCAL YEAR 1994, at 29 ("In the fiscal year 1994, the PTO was just beginning to receive the full effects of the third stage renewal."). The PTO saw a substantial jump in renewal fee income in the fiscal year 1994. *Compare id.* at 59 (noting that 32% of patent fee collections resulted from maintenance fees), with U.S. PAT. & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT, FISCAL YEAR 1993, at 29 & fig.9 (noting that 26% of patent fee collections resulted from maintenance fees).

¹⁰⁹ There is some support for a modest sensitivity of patent demand to fees. See generally de Rassenfosse G. and B. van Pottelsberghe de la Potterie, *On the price elasticity of demand for patents*, 74 OXFORD BULLETIN OF ECON. AND STATISTICS 58, 58-77 (2011).

¹¹⁰ For example, the PTO began hosting an annual Independent Inventor Conference in 1995. Press Release, Press Release, U.S. PAT. & TRADEMARK OFFICE, Fifth Annual Independent Inventors Conference, (Sept. 26, 2000) available at <http://www.uspto.gov/news/pr/2000/00-55.jsp>.

¹¹¹ See, e.g., Mark A. Lemley, *Are Universities Patent Trolls?*, 18 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 611, 630 (2008) (describing generally the rise of the patent troll).

¹¹² Furthermore, a decrease in sustainability score (and thus an increased need of funds) is associated with an incrementally higher rate of filing for high maintenance technologies relative to low maintenance rate technologies. Finally, there is no significant evidence to suggest that a decrease in sustainability score is associated with an incrementally higher filing rate for small relative to large entities which could pose troubling selection

A potential concern likewise arises that certain developments in substantive patent law may be responsible for the observed differential trends in the PTO's granting behavior. For instance, this may occur if the law expands what constitutes patentable subject matter within technologies that happen to have high maintenance rates or high concentrations of large entity applicants. Patent scholars have noted that patent eligible technology has expanded largely to include inventions in the field of biotechnology, software, and business methods.¹¹³ However, most of the legal developments of this potentially expansionary nature with respect to biotechnology occurred in the early to mid 1980's prior to the estimation sample frame.¹¹⁴ While the mid to late 1990's likewise experienced expansions in patentable subject matter that likely targeted software and business method patents,¹¹⁵ the above results are not a reflection of these developments, as demonstrated by Table A2 in Appendix B. The estimates remain virtually unchanged when we remove those technology categories implicated by the relevant legal developments.

Another possible concern arises that the divergent grant rates across the various patent types are a response to the passage of the Trade-Related Aspects of Intellectual Property Rights ("TRIPS") agreement in 1995. Considering the variation in category-specific examination times, one of the effects of TRIPS (which modified the patent term from 17 years from issuance to 20 years from application) was to increase the effective patent length for some technology categories relative to others.¹¹⁶ One might argue that TRIPS induced those patents in the larger-expansion categories to file higher quality applications in the post-1995 period, resulting in a higher grant rate. To the extent that such categories are correlated with those that also maintain their patents at high rates or that have strong large-entity representations, the possibility of this TRIPS story may confound the above analysis. In Table A2 of Appendix B, we address these concerns by demonstrating that the regression results presented above are robust to the inclusion of control variables capturing a differential response to being in the post-1991 period (or, in the alternative, in the post-1995 period) across technology categories with different examination prosecution times (i.e., with different patent-duration increases expected under TRIPS).¹¹⁷

concerns. *See also infra* Appendix B (generally discussing the robustness of the above findings to the possibility of compositional changes in applicants among the delineated patent types).

¹¹³ *See, e.g.,* Wasserman, *supra* note 18, at 381 (describing the "dramatic expansion of the scope of patentable subject matter").

¹¹⁴ *See* *Diamond v. Chakrabarty*, 447 U.S. 303, 305 (1980) (holding that "human-made, generically engineering bacterium" is patentable subject matter); *see also* Policy Statement on the Patentability of Animals, 1077 Off. Gaz. Pat. & Trademark Office 24 (Apr. 21, 1987), *reprinted in* DONALD S. CHISUM, 9 CHISUM ON PATENTS app. 24-1 (2005) ("[T]he Patent and Trademark Office now considers nonnaturally occurring, non-human multicellular living organisms, including animals, to be patentable subject matter.").

¹¹⁵ *See, e.g.,* Proposed Examination Guidelines for Computer-Implemented Inventions, 60 Fed. Reg. 28,778, 28,778 (proposed June 2, 1995); *State St. Bank & Trust v. Signature Fin. Grp.*, 149 F.3d 1368, 1373 (Fed. Cir. 1998) (enlarging patent subject matter to include anything that provides a "useful, concrete, and tangible result"), *abrogated by in re Bilski*, 545 F.3d 943 (2008) .

¹¹⁶ David S. Abrams, *Did TRIPS Spur Innovation? An Analysis of Patent Duration and Incentives to Innovate*, 157 U. PA. L. REV. 1613, 1615 (2009).

¹¹⁷ Likewise, we also estimate the main difference-in-difference specifications for two different sets of patent categories: (1) within the top 25% of patent categories based on the expected duration increase associated with TRIPS and (2) within the bottom 25% of patent categories based on the expected TRIPS-related patent duration increase. We actually find a stronger divergent response to the 1991 fee reform for patents within the latter set of patent categories, suggesting that the overall findings are not likely driven by TRIPS as opposed to the fee reform.

In Appendix B (primarily in Table A2), we further demonstrate the robustness of the findings reported in Table 2 and in Figures 1-3 to an additional range of specification checks. These exercises largely demonstrate the flexibility of the above results to the use of various alternative approaches in either specifying the key analytical variables or in specifying the empirical model itself. More specifically, we discuss the robustness of the findings to:

- the inclusion of control variables capturing the intensity of usage of requests for continued examinations (RCE's) and their predecessors (i.e., continuing prosecution applications, or CPA's), to alleviate concerns that some patent types are better able to secure ultimate allowances through greater usage of these mechanisms;
- the systematic, one-by-one exclusion of each technology category from the regression specification (along with the exclusion of each patent class and broad (6-level) category) to demonstrate that no single technology (broadly or narrowly defined) is driving the results.
- alternative constructions of the PTO grant rate (and the use of natural logs of all such rates),
- the inclusion of various category-year-specific control variables,
- the simultaneous (as opposed to separate) treatment of maintenance rate, entity-size and examination cost stories,
- the specification of the 1991 reform variable as a post-reform linear trend variable,¹¹⁸ along with the subsequent inclusion of technology category-specific linear time trends,
- the classification of technology categories based on (1) the PTO Classification System and (2) the broad 6-category classification scheme alternatively introduced by Hall, Jaffe and Trajtenberg,¹¹⁹
- the estimation of a "triple-differences" empirical specification that explores whether the divergence in patent grant rates across high- and low-maintenance-rate categories is itself stronger for large (relative to small) entities within those categories,
- the use of a more flexible randomization-inference approach to the determination of the statistical significance of the estimates,
- the specification of the fee reform based on the percentage of the agency's funding attributable to user fees, and
- less parametric specifications of those factors, such as category-specific maintenance rates, that are treated linearly in the main regressions.

F. Results Summary and Implications

Collectively, the above findings provide consistent and robust evidence of:

- an association between the 1991 reform and a divergence in granting patterns between patent application filed by large versus small entities
- an association between the 1991 reform and a divergence in granting patterns between patent applications associated with high versus low renewal rate categories;
- a stronger association of the above nature during times when the PTO is more likely to be bound by financial sustainability constraints; and
- a stronger association of the above nature during times in which the PTO is subject to a less stringent fee-diversion policy.

¹¹⁸ See Acemoglu and Finkelstein, *supra* note 94, at 855-56.

¹¹⁹ See *supra* note 86.

As discussed above, our results have a number of implications for both policy and theory.¹²⁰ First, from a social welfare perspective our results are discouraging. Under the assumption that the PTO's grant rates would otherwise reflect the optimal balance between dynamic innovation-stimulation incentives and static consumer welfare costs, any marginal increase in patent granting attributable solely to the agency's funding structure may implicate potentially substantial social welfare costs.¹²¹ From a policy perspective, our results also suggest that the 50% reduction in patent fees to small entities may have the inadvertent effect of biasing the PTO towards granting patents associated with large enterprises. As a result, it is possible that the PTO's response to the fee-differential may end up leaving small-entities worse off than before this special status was created. On a theoretical level, our results are also relevant to the ongoing debate in administrative law regarding the nature of governmental employees. Our findings that the PTO granting distortions are more likely to occur when markers indicative of an underfunded PTO are present contradict the idea that bureaucrats are budget maximizers while lending support to the notion that when agencies seek enlarged budgets they do so as a result of being mission minded but resource constrained.

V. IMPLICATIONS AND REDUCING THE PTO'S FINANCIAL INCENTIVE TO GRANT PATENTS

Beyond the implications already discussed, our results are also relevant to the recently passed America Invents Act. This section begins by exploring the implications of our findings to the America Invents Act and then turns to sketch two possible mechanisms for reducing PTO bias towards granting patents: eliminating the agency's self-financing requirement and changing the fee structure of the agency.

A. Implications of the America Invents Act

The results presented in this Article have implications for at least two changes brought forth to the patent system by the America Invents Act (the Act), which represents the most significant modification to the patent system since 1952. Similar to small entities, our findings cast doubt on whether the provisions of the Act that create a new status of micro entity and provide this entity with reduced patent fees will fulfill their legislative intent of nurturing innovation by individual inventors.¹²² Our results suggest that under the historic fee schedule, the fee-reduction provided to micro-entities will likely have the undesirable effect of biasing the PTO towards granting patents filed by large entities. Just as with small entities, it is possible that the alleged benefits that micro-entities obtain by paying reduced patent fees may be outweighed by the harms they experience in the marketplace because the PTO is extending preferential treatment towards large enterprises.

Second, our results should help to allay some of the concerns voiced by those who opposed the sections of the Act that granted the agency fee-setting authority. Several groups objected to giving the PTO the ability to set its fees out of fear that the agency would act in a self-interested and imperialistic manner—dramatically increase its fees and decrease its productivity.¹²³ Our findings that the PTO's behavior is

¹²⁰ See *supra* Part I.

¹²¹ See *supra* notes 9-11 and accompanying text.

¹²² America Invents Act, Pub. L. No. 112-29, 125 Stat 284 (2011) (codified at 35 USC § 123) (requiring micro entities to have not filed more than 4 previously filed patent applications at the PTO and to have a gross income that does not exceed 3 times the medium household income as reported by the Bureau of the Census); see also H.R. REP. NO. 112-98, pt. 1, at 50 (2011) (describing Congress's intent to spur innovation among independent inventors).

¹²³ See, e.g., Letter from Douglas Norman, President, Intellectual Prop. Owners Ass'n, to John Conyers & Lamar Smith, U.S. Congressmen (May 17, 2010), *available at*

more consistent with the model of benevolence rather than self-interestedness suggest that the PTO is more likely to restructure its fees to recover its aggregate costs while continuing or expanding its current productivity rather than set its fees in a manner to clandestinely maximize its budget.¹²⁴

B. Reducing the PTO's Financial Incentives to Grant Patents

Currently, our findings suggest that the inadequacies of the examination fees and the existence of post-allowance fees may bias even a benevolent PTO towards granting patents. Our results also suggest that this bias is most likely to manifest with respect to patent grants that the PTO stands the most to profit from—patents with a high likelihood of being renewed and patents associated with large entities. The PTO's granting distortions could be eliminated by removing the agency's ability to use post-allowance fees as a mechanism to raise revenue. We explore two different approaches to this end: funding the agency, at least partially, from direct appropriations and restructuring the PTO's fee schedule.

The PTO's financial incentive to grant patents may be decreased and possibly eliminated by financing the agency, at least partially, from tax revenue. If the agency's funding does not scale directly with its revenue collection, the PTO's financial incentive to grant patents could be substantially curtailed. Our findings that the PTO's granting bias is dampened during fee-diversion support this contention. However, we are concerned that Congress may fail to adequately fund the agency. Mounting concern regarding deficit containment as well as Congress's past track record of utilizing PTO fees to fund other governmental activity (even when the agency's financial sustainability was in question) suggest that serious consideration should be given to eliminating the PTO's granting bias by restructuring the agency's fee schedule.

The PTO has very recently been given the ability to set its fees to recoup its aggregate costs by rulemaking,¹²⁵ as a result modifying the agency's fee schedule may be easier today than before the agency had such authority. Importantly, any fee schedule adopted must take into account not only the PTO's needs for financial sustainability but also the incentives and social welfare of patent applicants and society. More research is needed on how both the PTO and patent applicants would respond to fee changes and thus it is beyond the scope of this Article to propose an optimal fee structure of the PTO.¹²⁶ Nonetheless, we believe it is helpful to begin to explore fee structures that are likely to eliminate or dampen the PTO's pro-patentee tendencies identified in this Article.

<http://www.ipo.org/AM/Template.cfm?Section=Home&TEMPLATE=/CM/ContentDisplay.cfm&CONTENTID=25867> (“[W]e are concerned that placing fee-setting authority with the USPTO will lead to large declines in productivity and large increases in fees in the longer term.”).

¹²⁴ See *supra* Section IV.B (suggesting that the PTO's behavior reflects an attempt to increase grant rates in an effort to raise additional revenue is strongest when the agency is financially constrained not in an effort to maximize budget more generally).

¹²⁵ America Invents Act § 10.

¹²⁶ Recent studies have shown that, at least with respect to low patent fees, patent demand is relatively inelastic. See Gaetan de Rassenfosse & Bruno van Pottelsberghe de la Potterie, *On the Price Elasticity of Demand for Patents*, 74 OX. BULL. OF ECON. AND STAT. 58, 71-72 (2012) (finding that the demand for patents is responsive to price, but relatively inelastic); Timothy K. Wilson, *Patent Demand – A Simple Path to Patent Reform*, 2 INT'L IN-HOUSE COUNS. J. 806, 810-12 (2008) (arguing that filing fees need to be raised significantly in order to reach the elastic portion of the demand curve).

To begin, the PTO cannot choose to eliminate the fee reductions for small and micro-entities, as this is beyond the scope of its rule-making authority.¹²⁷ Thus, one way to reduce the PTO's incentives towards granting patents to large entities may be to adopt a fee schedule that curtails the agency's incentives towards allowing patents in general.

The PTO could dampen its incentives to grant patents by adopting a fee schedule that will align its examination fees with examination costs and/or enact other pre-allowance fees—i.e., restructure its fee schedule so that it garners a greater percentage of its budget through pre-allowance fees. Because the PTO is required to set its fee collections to match its operational expenses, an increase in the level of examination fees will likely necessitate a decrease in the level of post-allowance fees. This fee schedule will likely reduce the agency's tendency to grant patents because the PTO will be less likely to be constrained by financial sustainability—i.e., the agency will be less sensitive to dips in the non-biased grant rate or aggregate renewal fee collections. However, when the agency's sustainability is triggered the distortionary bias to grant patents will likely be larger. The PTO will have to grant more patents to meet a revenue target than it would have under its traditional fee structure because the agency stands to make less money per patent grant than it did under the traditional fee schedule.

Additionally, as long as the agency is dependent on back-end fees, its pro-patentee tendencies will not be eliminated. The PTO will still have to grant a certain percentage of patents in order for its fee collections to match its operational expenses and a number of factors will continue to possibly disrupt the agency's financial equilibrium.¹²⁸ Of course, the fact that the agency has recently been granted fee-setting authority means the PTO can attempt to reestablish financial equilibrium by changing its fee-structure, rather than granting additional patents. However, there are several reasons why the agency may struggle with utilizing rulemaking to routinely tweak its fee schedule.¹²⁹ First, legislative challenges and procedural requirements associated with rulemaking may increase the cost of the process to a level that the agency will not be able to frequently utilize it so as to change its fee structure.¹³⁰ Second, to the

¹²⁷ It also seems unlikely that Congress will extinguish these fee reductions, as the America Invents Act just created the micro entity status.

¹²⁸ See *supra* Section I.B.2 (describing factors that may produce imbalance in the ratio of post-allowance fees and operational expenses).

¹²⁹ Although it is likely that the PTO will be able to use rulemaking to occasionally change its fee structure.

¹³⁰ See, e.g., JERRY L. MASHAW ET AL., *ADMINISTRATIVE LAW, THE AMERICAN PUBLIC LAW SYSTEM: CASES AND MATERIALS* 617-20 (6th ed. 2009) (describing institutional impediments to rulemaking).

The PTO, like many other agencies, has struggled with using rulemaking to implement changes. For example, in 2007 the PTO utilized rulemaking to limit the number of continuation applications as well as the number of claims that could be included within each application, however, the agency ultimately rescinded the regulations amidst court challenges. See *Changes to Practice for Continued Examination Filings, Patent Applications Containing Patentably Indistinct Claims, and Examination of Claims in Patent Applications*, 72 Fed. Reg. 46,716, 46,716–46,843 (Aug. 21, 2007) (to be codified at 37 C.F.R. pt. 1) (revising patent rules regarding continuing applications); *Tafas v. Dudas*, 511 F. Supp. 2d 652, 671 (E.D. Va. 2007) (granting a preliminary injunction preventing the PTO from implementing changes to the continuation practice on the eve of their implementation); *Tafas v. Dudas*, 541 F. Supp. 2d 805, 817 (E.D. Va. 2008) (granting summary judgment against the PTO); *Tafas v. Doll*, 559 F.3d 1345, 1349 (Fed. Cir. 2009), *vacated*, 328 Fed. Appx. 658, 658 (Fed. Cir. 2009) (holding that both the claim and continuation rules were procedural in nature and within the agency's rulemaking authority but that the continuations rule was inconsistent with patent law); *Tafas v. Doll*, 328 Fed. Appx. 658, 658–59 (Fed. Cir. 2009) (granting petition to rehear the case en banc, vacating the panel opinion); Press Release, U.S. Pat. & Trademark Office, *USPTO Rescinds Controversial Patent Regulations Package Proposed by Previous Administration* (Oct. 8,

extent the agency is facing an impending financial crisis, the PTO may not be able to enact fee increases fast enough to boost its revenue, as the rulemaking process can take years to complete.¹³¹ Thus, a PTO that is both dependent on back-end fees and facing immediate financial pressures may still turn to granting additional patents in an effort to augment its fee collections.

Perhaps the only way to eliminate a self sufficient PTO's bias towards granting patents is to abolish post-allowance fees altogether. Under this approach the agency's examination fees would need to be dramatically increased and possibly other pre-allowance fees would need to be enacted in order for the PTO's fee collections to cover its operational expenses. As the agency's entire fee stream would derive from pre-allowance activity, the agency would no longer have a financial incentive to grant patents because the agency no longer stands to gain any additional fee revenue from patent grants. While this fee structure would eliminate the pro-patentee tendencies identified in this Article it is not clear that it would enhance consumer welfare overall. The elimination of maintenance fees would effectively mean that all patents would last their entire term of twenty years, which may substantially increase the static costs of patents to society. Furthermore, depending on how patent applicants would respond to increase fees, patent applications may fall to a level below ideal.¹³² The former concern could be addressed, however, by preserving renewal fees but restricting the amount of renewal fees the PTO can retain. The restricted fees could be utilized to pay a portion or all of the small entity and micro entity subsidy. This funding structure would likely result in dampening the agency's bias towards issuing patents that are likely to be renewed or that were filed by large entities. Most likely, Congress would need to enact additional changes to the PTO funding structure in order to achieve this result, but these changes would be minor.

Conclusion

This Article presents the first empirical study of the influence of the PTO's funding on the agency's decision on whether or not to grant a patent. Our findings suggest that the PTO's current fee schedule likely biases the agency to grant patents. Moreover, we find the agency's bias is more likely to manifest with respect to patents that it stands to profit the most from granting—patents that are likely to be renewed or patents filed by large entities. Furthermore, we also find that these distortions are more likely to occur when markers indicative of an underfunded PTO are present.

In addition to their theoretical implications, our findings also speak to policy issues concerning patent law. Prior to our study, commentators failed to recognize the extent to which the PTO's fee schedule biased the agency towards issuing patents. As a result, recent patent reform, which was enacted in part to address the harms associated with the PTO issuing too many invalid patents, may not eliminate the granting pressure identified in this Article. Moreover, our results have a number of implications to the

2009), available at http://www.uspto.gov/news/09_21.jsp (reporting on PTO's Final Rule rescinding regulations, providing background on the rules, and reviewing related litigation history).

¹³¹ Several agencies have abandoned rulemaking altogether, largely in part of frustration with the slow pace at which the process proceeds. ROBERTA S. KARMEI, REGULATION BY PROSECUTION: THE SECURITIES AND EXCHANGE COMMISSION VS. CORPORATE AMERICA 16 (1982) (describing the Securities and Exchange Commission's evolution toward adjudication).

¹³² See *supra* note 126 (citing sources that illustrate relative inelasticity of patent demand at least with respect to low patent fees). A simple decrease in patent filings does not necessarily have negative social welfare implications. Patent applicants may respond to the increased fees by performing better sorting of patent applications—i.e., filing applications that are more likely to meet the standards of patentability. Companies and individuals may also utilize alternative mechanisms to protect their ideas, such as trade secrecy.

recently enacted America Invents Act, including the creation of micro-entity status wherein eligible patent applicants pay 75% reduced patent fees. Our findings suggest that the fee reductions for micro-entities are likely to have the unintended consequence of further biasing the PTO to granting patents to large entities.

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Appendix A: Methodology

Maintenance-rate specifications. In exploring whether the 1991 fee reform is associated with a distortion in the PTO's granting patterns across technology categories with varying maintenance-rate levels, we estimate the following specification (with a unit of observation at the technology category-year level):¹

$$GR_{c,t} = \alpha + \gamma_c + \lambda_t + \beta_1 (POST_t * m_c) + \beta_2 X_{c,t} + \varepsilon_{c,t} \quad (1)$$

where $GR_{c,t}$ is the grant rate for technology category c (based on the NBER patent sub-categories) in year t (grant rates are calculated as specified below). Category fixed effects and year fixed effects are specified by γ_c and λ_t , accounting for fixed differences in grant rates across technologies and years. $POST_t$ represents an indicator variable for being in the post-reform (i.e., post-1991) period. Maintenance rates specific at the technology category level are represented by m_c (calculated as specified below). $X_{c,t}$ includes certain time-varying covariates specific to technology categories, including the average number of patent claims, the average number of citations to the relevant patents, and the percentage of patentees representing various inventor types (e.g., individual, corporate, government, etc.).²

The coefficient of interest is represented by β_1 , capturing the degree to which the passage of the 1991 fee reform is associated with a differential grant rate across technology categories with varying maintenance rates. A positive coefficient suggests that the PTO may respond to the adoption of a user-fee funded system by granting relatively more within those categories that generally garner higher maintenance fees. This coefficient can be interpreted as an effect of the reform under an assumption of conditional mean independence ($E[\varepsilon | POST * m, X, \gamma, \lambda, \alpha] = E[\varepsilon | X, \gamma, \lambda, \alpha]$) – that is, under an assumption that there are no unobservable shocks in granting patterns that are correlated with being in a high-maintenance category in the post-reform period.

Entity size specifications. In exploring whether the 1991 fee reform is associated with a distortion in the PTO's granting patterns between large and small entity patent applicants, we estimate the following specification (with a unit of observation at the entity size-technology category-year level):

$$GR_{e,c,t} = \alpha + \gamma_c + \lambda_t + LARGE + \beta_1 (POST_t * LARGE) + \beta_2 X_{c,t} + \beta_3 m_{e,c} + \varepsilon_{e,c,t} \quad (2)$$

¹ This specification is modeled after the approach taken by Daron Acemoglu and Amy Finkelstein in their investigation into the differential response across hospitals with varying levels of Medicare representation to the imposition of Medicare's Prospective Payment System. *Input and Technology Choices in Regulated Industries: Evidence from the Health Care Sector*, 116 J. POL. ECON. 5, 837-80 (2008).

² Data on claims, assignee types and citations by technology category were obtained from the National Bureau of Economic Research Patent Data Project, available at: <https://sites.google.com/site/patentdataprotect/Home>.

where $GR_{c,t}$, γ_c , λ_t , $POST_t$ and $X_{c,t}$ are defined as above. $LARGE$ represents an indicator for patents with large entity status, while e indicates a given entity size classification. A positive coefficient for β_1 suggests that the PTO may respond to the adoption of a user-fee funded system by granting relatively more to patentees with large entity status. This coefficient can likewise be interpreted as an effect of the reform under a similar assumption of conditional mean independence ($E[\varepsilon | POST * LARGE, X, \gamma, \lambda, LARGE, \alpha] = E[\varepsilon | X, \gamma, \lambda, LARGE, \alpha]$) – that is, under an assumption that there are no unobservable shocks in granting patterns that are correlated with being a large entity in the post-reform period.

To the extent that large entities also happen to carry higher maintenance rates (even after controlling for technology effects), it may be difficult to isolate whether the PTO's preferential granting towards large entities arises from the possibility of higher maintenance fees or from the large-entity component itself within the fee structure. To help separate these influences, in some specifications, we include controls for the maintenance rates specific to entity sizes and technologies (as represented by $m_{e,c}$ above.)

While focusing on entity size, the above specification includes technology-specific fixed effects. By accounting for fixed and inherent differences across technologies, we can alleviate concerns that the estimated findings are attributable to a scenario in which the incidence of large entity patentees increases over time within technology categories that happen to experience higher grant rates historically.

Post-reform trends. The results presented in Section IV demonstrate an increasing impact of the imposition of a user-fee-funded system over time. Whether this is attributable to a worsening financial position of the PTO or a lag and evolving alteration of PTO practices, this dynamic suggests that a more proper parameterization of the post-reform period may be a trend variable, as opposed to a single indicator variable.³ Accordingly, we also estimate specifications that modify the above specification to interact the category-specific maintenance rates (or the indicator for large entity status) with a trend variable that equals 0 prior to 1991 and that linearly increases from a value of 1 beginning in 1991. In yet other specifications, we also consider the addition of category-specific linear time trends to account for the possibility of slowly moving trends in grant rates within technologies over time.⁴

Triple differences. Finally, we explore a richer specification premised on the assumption that the PTO will target their distortionary granting practices even more intensely on large entity patents within high maintenance-rate technologies (in a sense beyond just the additive effect resulting from the fact that the PTO may prefer both large entities and high maintenance rate classes independently). Consider a low maintenance-rate technology. Within that category, the PTO may extend a preferential grant rate to large entities following the 1991 reform as a result of the higher large entity fees. What this

³ Acemoglu and Finkelstein *supra* note 1 at 856.

⁴ It may not be the case, of course, that unobserved technology-specific factors follow a linear trend, in which case the imposition of such a trend could confound the estimates. We also consider the imposition of technology-specific quadratic trends to account for a nonlinear unobservable trends within technologies over time, though this approach runs the risk of having these trends consume the very effect we are trying to identify.

assumption presumes is that this large-entity grant-rate bump is even higher with respect to large entities within high maintenance-rate technologies.⁵ Why? Perhaps, because the PTO is trying to limit its distortionary practices to only those few areas where it can really earn the highest funds (consistent with a benevolent PTO's intentions to distort as little as possible or with a self-interested PTO's desire to reduce its likelihood of detection).

Accordingly, to test the hypothesis that the PTO extends even higher grant rates following the 1991 reform to large entities within high maintenance-rate categories, even after accounting for across-the-board preferential responses to the reform for large entities and high maintenance-rate technologies independently, we estimate the following difference-in-difference-in-difference specification:⁶

$$GR_{e,c,t} = \alpha + \gamma_c + \lambda_t + \partial_{c,t} + \delta_{e,t} + LARGE + \beta_1(POST_t * LARGE) + \beta_2(POST_t * m_c) + \beta_3(LARGE * m_c) + \beta_4(POST_t * LARGE * m_c) + \varepsilon_{e,c,t} \quad (3)$$

The coefficient of interest is captured by β_4 , capturing the degree to which the PTO extends preferential treatment following the 1991 reform to this interaction of being a large entity within a high maintenance rate category. A positive coefficient confirms this more targeted granting story, while at the same time lending general support to the independent stories in which the PTO's fee structure induces it to grant more to large entities and to high maintenance-rate technologies, thereby also lending support to the most general claim that the PTO's fee structure biases it towards granting. A key benefit of this approach is that it also allows us to account for (i.e., rule out the potentially confounding influence of) unobservable factors that are specific to (1) given years and entity-size categories and (2) given years and technology categories. That is, the above approach will allow us to capture the effect of the fee reform on differential granting patterns while even controlling for the possibility, for instance, that grant rates would rise after 1991 within a particular technology that generally carries a high maintenance rate. What is required is an assumption that grant rates do not happen to spike following 1991 specifically for those large entity patents within high maintenance-rate technologies.

Variables.

Grant rates. In the preferred specifications, patent grant rates for each technology category-year cell are calculated as the number of patent allowances within the relevant cell divided by the number of patent disposals within that cell. Patent disposals, in turn, equal the number of patents allowed plus the number of patents abandoned.⁷

⁵ Likewise consider small entity patents. We may assume that within the set of small entities, that the PTO would extend preferential treatment to high maintenance rate technologies considering the possibility of higher renewal fees in the future. What this assumption presumes is that the grant-rate bump for high maintenance technologies will be even higher among large entity patents.

⁶ The general triple-differences methodology is motivated by Gruber. Jonathan H. Gruber, *The Incidence of Mandated Maternity Benefits*, 84 AM. ECON. REV. 622, 627 (1994).

⁷ The data received from the PTO does not treat requests for continued examinations as abandonments.

Alternative grant rates: allowance percentages. For the purposes of a robustness check, we follow Quillen and Webster⁸ and calculate an allowance rate for each technology category-year cell as the number of patent allowances for that cell divided by the number of original patent applications filed within that cell.

Maintenance rates:

1990 maintenance rate. In the preferred specification, following the relevant difference-in-difference precedent (based on a differential response to a national reform across institutional types),⁹ we assign maintenance rates to technology categories according to the maintenance rates observed in the year prior to the reform—i.e., 1990.¹⁰ The 4-year maintenance rate as of 1990 is determined as the percentage of all patents issued after September 1, 1981¹¹ and due for their 4-year renewal payment by 1990 that in fact paid their 4-year renewal fee.¹² We calculate a similar rate for 8-year renewals.

Time-invariant, all years. In alternative specifications, we assign maintenance rates to technology categories according to the mean renewal rates observed in the respective category over the full sample period—i.e., the rate by which all patents issuing after September 1, 1981 and prior to January 1, 2007 renewed their patents at the 4-year post-issuance mark. We calculate a similar rate for 8- and 12-year renewals.

In differentiating across technology categories based on renewal rates, we follow the relevant difference-in-difference literature in applying consistency in how we categorize each technology group's renewal proclivities. In other words, in our preferred regression specifications, we specify the category-specific maintenance rates as time-invariant measures, allowing us to focus on how grant rates change in response to variations in fee policies and in the PTO's need for revenues (i.e., sustainability score). A concern would arise, of course, if maintenance rates varied considerably within technology categories over time. In such an instance, it would be difficult to interpret a change over time in the grant rates of those categories labeled "high maintenance" as actually being reflective of any higher maintenance rate. This concern is perhaps slightly less relevant in the period of time following the reform considering that

⁸ *Continuing Patent Applications and Performance of the U.S. Patent and Trademark Office*, 15 FED. CIR. BAR J. 4, 635-77 (2006).

⁹ See, e.g., Acemoglu and Finkelstein, *supra* note 1; see also David S. Abrams, *Did TRIPS Spur Innovation? An Analysis of Patent Duration and Incentives to Innovate*, 157 U. PA. L. REV. 1613, 1615 (2009).

¹⁰ This creates stability in the classification throughout the difference-in-difference specification in an attempt to isolate the reform impact as opposed to any compositional impact in high maintenance categories. This concern is of relatively little significance, however, as maintenance rates remain relatively stable within classes and technology categories over time. Moreover, the difference-in-difference results remain virtually unchanged when we use maintenance rates that are time-varying in nature or that represent an average over the entire period.

¹¹ The PTO began collecting data on renewal events after this date.

¹² This preferred approach assumes that the PTO would assess a technology's renewal likelihood using all information on that technology to date. The same results are achieved when we specify a 1990 maintenance rate according to just the renewal percentage of those applications due for their 4-year payments in 1990 itself.

some amount of within-category change in renewal rates may be attributable to the PTO's differential treatment of that category.

Overall, the data implicate little concern over the possibility of substantial within-technology variation in renewal rates over time. Rather, they demonstrate relative stability within categories in the percentage of patents due for renewal in a given year that actually renew. In the pre-1991 period, for instance, only 10% of the overall category-year variation in maintenance rates can be attributable to variations within-categories over time. Moreover, the composition of categories in the various quartiles of annual maintenance rates remain nearly unchanged in that time period.

In any event, in Appendix B below, we discuss dynamic regression results based on a difference-in-difference approach that nonetheless interacts an indicator variable for being in the post-1991 period with a time-varying and technology-specific maintenance rate (where, for instance, the 4-year maintenance rate in 1992 is calculated as the percentage of patents issuing in 1988 that, in fact, renewed in 1992 as due). This alternative approach also identifies the relationship between fees and differential granting behavior across technologies using changes in technology-specific renewal rates.

Sustainability score. In Section 1, we predicted that the PTO would be more likely to trigger its sustainability (i.e., break-even) constraint as the ratio between its incoming post-allowance fee collections to outgoing examination expenditures fell. We predicted that this would be more likely to occur upon the following developments: an increase in the PTO's backlog, a decrease in its annual maintenance fee collections, an increase in its average examination complexity (i.e., the average number of hours allocated to each examination disposed of in a given year) and a decrease in the percentage of patentees that are large entities. While we consider regressions that interact each of these factors separately with the 1991-reform indicator, we also estimate regressions that aggregate each of these factors into one sustainability measure so that we can determine whether the PTO, on net, faces sustainability concerns. For instance, if over time, backlog grows considerably while annual maintenance rates actually increase somewhat (which characterizes much of the sample period), how can we determine whether the PTO is in fact experiencing changes in its financial outlook? For these purposes we construct the follow sustainability measure, which captures the impact of each measure on the PTO's financial balance in a manner that facilitates across-factor comparisons in such impacts.

Broadly, the sustainability score in a given year equals the amount of incoming post-allowance fees for that year divided by the net examination costs associated with all of the patent applications awaiting examination at that time. More specifically:

$$SUST_t = \frac{MAINT_FEE_COLLECTIONS_t + ISSUANCE_FEE_COLLECTIONS_t}{DEMAND(LE)_t * NET_COST(LE)_t + DEMAND(SE)_t * NET_COST(SE)_t}$$

where

$$\begin{aligned}
MAINT_FEE_COLLECTIONS_t &= (ISSUANCES(LE)_{t-12} * MAINT_RATE(12yr)_t * \\
&MAINT_FEE(12yr)) + \\
&\left(ISSUANCES(SE)_{t-12} * MAINT_RATE(12yr)_t * \frac{1}{2} * MAINT_FEE(12yr) \right) + \\
&(ISSUANCES(LE)_{t-8} * MAINT_RATE(8yr)_t * MAINT_FEE(8yr)) + \\
&\left(ISSUANCES(SE)_{t-8} * MAINT_RATE(8yr)_t * \frac{1}{2} * MAINT_FEE(8yr) \right) + \\
&(ISSUANCES(LE)_{t-4} * MAINT_RATE(4yr)_t * MAINT_FEE(4yr)) + \\
&\left(ISSUANCES(SE)_{t-4} * MAINT_RATE(4yr)_t * \frac{1}{2} * MAINT_FEE(4yr) \right);
\end{aligned}$$

where

$$ISSUANCE_FEE_COLLECTIONS_t = ISSUANCES(LE)_t * ISSUE_FEE + ISSUANCES(SE)_t * ISSUE_FEE * 1/2 ;$$

where

$$NET_COST(LE)_t = AVG_EXAM_COST \left(\frac{COMPLEXITY_t}{COMPLEXITY(REFERENCE)} \right) - EXAM_FEE;$$

where

$$\begin{aligned}
NET_COST(SE)_t \\
= AVG_EXAM_COST \left(\frac{COMPLEXITY_t}{COMPLEXITY(REFERENCE)} \right) - 1/2 * EXAM_FEE;
\end{aligned}$$

where

$$DEMAND(LE)_t = BACKLOG_t * LARGE_ENTITY_FILING_RATE_t;$$

and where

$$DEMAND(SE)_t = BACKLOG_t * SMALL_ENTITY_FILING_RATE_t.$$

The above score is not meant to reflect the actual profits accruing to the PTO in a given year. Rather, it is meant to simulate how variations in the above-mentioned factors (keeping all other factors fixed) affect its general profitability. That is, it provides a meaningful and empirically relevant way of assessing the relative contributions to the PTO's financial position of each of these factors. Also, while an actual annual profitability measure may consider the costs associated with those applications disposed of during a given year, this measure considers the costs associated with all of those applications awaiting examination at that time—i.e., the backlog. As discussed in Section III, the costs associated with examining the backlog represent a better sense of the external pressures being placed upon the PTO (as

opposed to the costs associated with those patents the PTO elected to dispose of during the year, which would be, in part, a reflection of the PTO's own response to its financial pressures). Our goal is then to evaluate how these external pressures to the agency's financial position induce it to take certain actions.

The sustainability score keeps fixed over time the fee amounts themselves (based on the 2011 amounts), again focusing only on variations in the above-mentioned factors. Though, our preliminary extensions of this score based on our current understanding of fee amendments suggest that the regression results persist under this extension. Likewise, in calculating the average cost per examination, the only factor changing over time is the average complexity of the patents disposed of during that year. To calculate net costs, we multiply the average examination cost in 2010 by the ratio of the average examination complexity for the given year (based on the distribution of patents disposed of during the year) to the average examination complexity of 2010, the reference year.

Examination hours / complexity of the art. Examination complexity is based on the hours of examination allocated to each patent application. Examination hour schedules are set at the PTO classification level (and remain unchanged over the sample period). To form examination hours at the coarser technology category, we calculate the average hours over the classes within those categories, weighted by disposals per class. Data on examination complexity schedules by PTO class was likewise obtained from the PTO.

TABLE A1. PATENT CHARACTERISTICS BY TECHNOLOGY CATEGORY

Technology Category	(1) 4-Year Maint. Rate (%)	(2) 8-Year Maint. Rate (%)	(3) 12-Year Maint. Rate (%)	(4) Examination Hours	(5) % Small Entity Applicants
Agriculture, Food, Textiles	77.5	50.4	31.1	19.3	16.6
Coating	85.4	63.2	43.4	20.9	22.0
Gas	84.1	58.6	36.3	21.7	29.6
Organic Compounds	83.6	59.5	38.0	18.8	12.8
Resins	87.1	65.7	44.6	19.3	11.1
Miscellaneous Chemical	85.0	62.0	41.6	18.8	22.4
Communications	89.5	71.9	51.9	18.9	15.9
Computer Hardware & Software	91.4	74.9	55.5	23.4	15.9
Computer Peripherals	93.0	77.2	59.2	21.9	10.1
Information Storage	92.6	76.7	57.3	14.2	10.3
Electronic business methods and software	90.7	77.0	58.1	27.4	25.8
Drugs	84.9	63.2	42.3	17.2	34.2
Surgical and Medical Instruments	86.7	68.2	50.2	15.3	43.2
Genetics	91.9	80.4	64.9	24.8	27.2
Miscellaneous Drugs and Medical	84.4	62.3	42.2	18.8	47.9
Electrical Devices	87.2	66.7	47.1	17.8	16.8
Electrical Lighting	83.2	60.1	40.3	18.7	27.4
Measuring & Testing	85.2	61.4	40.5	17.9	24.5
Nuclear & X-rays	87.3	64.4	44.1	19.8	20.8
Power Systems	87.0	65.9	44.5	18.7	19.0
Semiconductor Devices	93.4	78.6	60.8	20.6	6.9
Miscellaneous Electrical	89.4	70.8	50.9	17.6	16.4
Mat. Proc & Handling	81.9	57.6	37.5	19.1	32.8
Metal Working	84.2	60.6	40.2	19.2	21.3
Motors & Engines & Parts	84.5	61.4	41.1	18.4	20.2
Optics	88.2	67.5	46.5	17.1	15.9
Transportation	78.1	51.5	31.3	16.9	39.5
Miscellaneous Mechanical	78.8	54.2	35.0	17.9	42.1
Agriculture, Husbandry and Food	76.2	50.9	32.5	18.5	52.0
Amusement Devices	69.6	40.9	22.1	17.2	59.0
Apparel & Textile	74.6	47.4	28.9	17.3	53.8
Earth Working & Wells	82.3	56.4	35.3	17.6	35.2
Furniture, House Fixtures	71.1	43.2	25.2	16.6	63.8
Heating	79.6	52.9	32.8	13.8	36.7
Pipes & Joints	82.8	60.0	41.1	16.6	33.5
Receptacles	74.6	49.1	31.6	15.3	53.1
Miscellaneous Other	80.1	55.8	36.5	18.4	42.9

Maintenance rates are calculated as the percentage of all patents filed after September 1, 1981 that renewed their patents at the respective 4-year, 8-year, and 12-year mark (excluding patents filed within the last 4, 8 and 12 years respectively). Examination hour schedules are set at the PTO classification level (and remain unchanged over the sample period). To form examination hours at the coarser technology category, we calculate the average hours over the classes within those categories, weighted by disposals per class. Note that the indicated maintenance rates average over available sample years, while the preferred regression specification, as indicated above, sets 4-year maintenance rates according to their average level as of 1990.

Appendix B: Robustness Analysis / Specification Checks

In this Appendix, we demonstrate and discuss the robustness of the findings presented in Table 2 and in Figures 1-4 to a range of specification checks and other robustness exercises. Generally, the results of this exercise demonstrate the flexibility of the findings to a number of alternative approaches and demonstrate the robustness of the conclusions to the consideration of various potentially confounding stories.

TABLE A2. VARIOUS SPECIFICATION CHECKS

	(1)	(2)
Difference-in-difference coefficient estimate under the following alterations to baseline specification:	Maintenance Rate Specification (frame of reference: Column 1 of Panel A, Table 2)	Entity Size Specification (frame of reference: Column 1 of Panel B, Table 2)
1) Replace grant rate level with its natural log	94.66*** (30.76)	11.82*** (2.94)
2) Define grant rate as allowances / total original filings (i.e., excluding continuation filings)	79.33** (34.15)	4.67* (2.46)
3) Include control for RCE/CPA filing count (at technology-year level or technology-year-entity-size level, respectively)	53.35*** (18.94)	4.83*** (1.61)
4) Include control for RCE/CPA filing count and its square (at technology-year level or technology-year-entity-size level, respectively)	56.13*** (20.04)	4.38*** (1.60)
5) Include control for rate of RCE/CPA filings relative to total filings (at technology-year level or technology-year-entity-size level, respectively)	59.40*** (19.46)	5.26*** (1.72)
6) Specification of maintenance rates as % maintained within category over entire sample period (as opposed to just prior to 1991)	59.76*** (13.91)	-
7) Use of 8-year maintenance rate (as opposed to 4-year maintenance rate)	34.21*** (8.81)	-
8) Use of 12-year maintenance rate (as opposed to 4-year maintenance rate)	32.44*** (9.22)	-
9) Use of average of 4-, 8- and 12-year maintenance rates (as opposed to 4-year maintenance rate)	39.78*** (10.19)	-
10) Specification of 1991 fee reform variable as post-reform linear trend (as opposed to single dummy for post-1991 period)	6.45*** (1.70)	0.74*** (0.14)
11) Specification of 1991 fee reform variable as post-reform linear trend, with addition of category specific linear time trends	29.95*** (6.44)	0.53*** (0.09)
12) Specification of 1991 fee reform variable as post-reform linear trend, with addition of category specific linear and quadratic time trends	33.39*** (8.33)	0.53*** (0.10)
13) Specification of 1991 fee reform variable as post-reform linear trend, with addition of entity-size specific linear time trends	-	2.15*** (0.64)
14) Categorizing technologies according to PTO classes (as opposed to the NBER sub-categories)	31.94*** (8.68)	3.33* (1.83)
15) Categorizing technologies according to NBER 6-level categories (as opposed to the NBER sub-categories)	88.38** (22.22)	7.05** (2.22)
16) Maint. rate regression: include category-year controls for % of small-entity filings (reported coefficient of MAINTAIN*POST)	63.08** (23.8)	-

17) Maint. rate regression: include interaction between fee reform and category-specific % of small-entity filings and examination hours (reported coefficient of MAINTAIN*POST)	25.8 (40.7)	-
18) Entity-size regression: include control for technology-entity-size maintenance rate (reported coefficient of LARGE*POST)	-	6.74*** (1.42)
19) Specification of fee reform based on % of agency's funding attributable to user fees (as opposed to single dummy variable for post-1991 period)	153.33*** (48.68)	15.90*** (3.97)
20) Dropping technology categories covering software patents and business methods patents.	54.62*** (19.80)	5.36** (1.59)
21) Include interaction between post-fee-reform period and expected patent duration increase for the relevant category associated with TRIPS.	52.03** (21.05)	6.14*** (1.54)
22) Include interaction between post-1995 period and expected patent duration increase for the relevant category associated with TRIPS.	43.83** (20.41)	5.90*** (1.68)

* significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are reported in parentheses and are clustered to correct for autocorrelation within patent categories over time (Column 1) and for autocorrelation within patent-category / entity size combinations over time (Column 2). All regressions include patent-category fixed effects and year fixed effects to control for fixed differences in grant rates across patent categories and across years, respectively. Regressions in Column 2 include entity size fixed effects as well. Regressions are weighted by the number of disposals used to form each observation's grant rate. Data on patent processing statistics and maintenance rates were obtained from the PTO.

Sensitivity to dropping technologies. In addition (not shown), the primary difference-in-difference coefficients for the entity-size and maintenance-rate regressions persist (in terms of sign, magnitude and statistical significance) when we estimate a series of regressions that systematically, one-by-one drop each technology category from the sample, confirming that no single category is responsible for the observed results. The same holds true when we specify technologies according to PTO classifications and to the broader 6-level NBER categories.¹³

Control variables and dynamic regression results. Columns 1 and 4 of Table A3 present detailed results for the coefficients graphed in Figures 1 and 2. In Columns 2 and 5 we demonstrate the effect of adding the following category-year covariates: average number of claims in the relevant patents, average number of citations to the relevant patents and the percentage of the relevant patents attributable to various inventor types (e.g., individual, government, corporation, etc.). Data on covariates is only available prior to 2005. For those years in which such variables are available, the table demonstrates the robustness of the baseline specifications to their inclusion. Finally, in Columns 3 and 6, we demonstrate the effect of adding controls for the usage of requests for continued examination (RCE) filings (including RCE filing counts and their squares).¹⁴

¹³ Only with respect to the dropping of one broad 6-level NBER category (signifying "other" technologies) does the estimate lose statistical significance. However, even in that one instance the estimated coefficient itself remains positive and similar in magnitude.

¹⁴ The findings remain virtually unchanged under alternative specifications of the intensity of usage of RCE's, including controls for the level of RCE filings and for the rate of usage of RCE's (as a percentage of total filings). Considering that successive RCE utilization may increase an applicant's chances of allowance (by effectively buying a longer prosecution time), these controls address concerns that the proliferation of usage of RCE's following their initiation in 2000, to a potentially varying degree across patent types, is responsible for the observed successes (in terms of allowance percentages) among high maintenance-rate technologies and large entities. One could conceivably address this concern as well by building RCE's into the denominator of the grant rate (i.e., including

Randomization inference. Standard errors may be inaccurately estimated in difference-in-difference specifications when there are a limited number of overall analytical or treatment groups.¹⁵ In the case of the basic entity-size specification, there may be little that one can do to address this concern. With respect to the maintenance-rate regressions, this concern is less pronounced considering that (with 37 technology categories each with different maintenance rates) there are effectively a larger number of treatment groups. In any event, we also perform hypothesis tests on the estimated coefficient of the *MAINTAIN*POST* variable in the maintenance-rate regressions using a randomization inference approach,¹⁶ which allows for an estimation of the distribution of the treatment effect that is valid under any number of groups. For these purposes, we run 5,000 simulations, where, with each simulation, we randomly assign each technology category a different maintenance rate (based on the distribution of maintenance rates actually observed).¹⁷ We find that the estimated difference-in-difference coefficient reported in Column 1 of Panel A of Table 2 falls within the 1st percentile of the empirical distribution of the 5000 estimated coefficients from the simulations, consistent with a p-value of less than 0.01.

each RCE filing as a rejection and abandonment). Any such calculation, however, would attenuate the calculated grant rate towards 0 considering the non-independence of each RCE filing within a given initial patent application effort. Consider, for instance, an applicant that unsuccessfully abandons its applications after having filed several RCE's. If all RCE's were included as separate abandonments in a grant rate denominator, this one single application would be responsible for at least several 0's in the grant rate calculation, even though there was likely some high level of persistence in the granting decision across each such RCE filing. That is, it is inaccurate to treat each such filing as an independent evaluation of the PTO's granting tendencies by which we can capture a metric of the PTO's inclinations to grant, especially considering that the filing of an RCE is evaluated by the same examiner without returning to the beginning of the examination queue. Accordingly, considering that this non-independence concern attenuates the grant rate calculation in the direction of 0, simply including RCE's in the denominator of the grant rate would also attenuate towards 0 any estimated differential grant rate between a high-fee patent type (e.g., large entities) that may use RCE filings to a greater degree than a low-fee type. With this mathematical concern in mind, we elect to account for the potentially confounding influence of RCE filings by asking whether their differential utilization across patent types can explain any observed differences in the rates of ultimate allowances (i.e., to include this measure as a covariate).

¹⁵ See, e.g., Conley, Timothy G., and Christopher R. Taber. *Inference with 'Difference-in-Differences' with a Small Number of Policy Changes*. 93 REV. ECON. STAT. 1, 113-25 (2011).

¹⁶ See, e.g., Duflo, Esther, Rachel Glennerster, and Michael Kremer. *Using Randomization in Development Economics: A Toolkit*." In *Handbook of Development Economics*, ed. T. Paul Schultz, and John Strauss, North Holland: Elsevier Science Ltd., 3895-62 (2007).

¹⁷ See Gruber, Jonathan, and Daniel M. Hungerman. *Church versus the Mall: What Happens When Religion Faces Increased Secular Competition*. 123 Q. J. Econ. 2, 831-62 (2008).

TABLE A3. DYNAMIC REGRESSION RESULTS, WITH CATEGORY-YEAR COVARIATES

	(1)	(2)	(3)	(4)	(5)	(6)
	Maint. Rate (TYPE = MAINTAIN)			Entity-Size (TYPE = LARGE)		
d(1986) * TYPE	-	-	-	3.92*	3.24	3.90*
				(2.11)	(2.03)	(2.09)
d(1987) * TYPE	28.52	42.18**	28.08	-1.49	-1.66	-1.51
	(20.17)	(19.53)	(20.20)	(1.95)	(1.74)	(1.93)
d(1988) * TYPE	7.21	24.36	6.99	-1.44	-1.44	-1.46
	(27.06)	(29.52)	(27.15)	(1.81)	(1.75)	(1.79)
d(1989) * TYPE	-15.45	-7.61	-15.59	-1.14	-1.28	-1.12
	(18.22)	(18.60)	(18.28)	(1.52)	(1.44)	(1.52)
d(1990) * TYPE	5.32	2.78	5.33	-1.08	-1.21	-1.09
	(14.53)	(16.04)	(14.55)	(1.12)	(1.17)	(1.12)
d(1991) * TYPE (REFERENCE YEAR)	-	-	-	-	-	-
d(1992) * TYPE	-6.78	-6.64	-6.70	-1.77	-2.04	-1.77
	(20.95)	(22.82)	(20.91)	(1.47)	(1.59)	(1.48)
d(1993) * TYPE	-1.30	-4.66	-1.37	-2.54	-2.91*	-2.53
	(25.36)	(20.99)	(25.15)	(1.68)	(1.70)	(1.67)
d(1994) * TYPE	-31.59	-52.57**	-31.92	-3.48	-4.30*	-3.46
	(19.75)	(22.97)	(19.88)	(2.11)	(2.22)	(2.09)
d(1995) * TYPE	-25.40	-39.88	-24.94	-1.51	-2.11	-1.54
	(21.37)	(24.41)	(21.46)	(1.55)	(1.55)	(1.54)
d(1996) * TYPE	42.95	16.42	43.70	3.26	2.36	3.23
	(30.28)	(27.52)	(30.59)	(3.01)	(2.68)	(3.00)
d(1997) * TYPE	89.51**	73.53**	90.05**	5.66*	4.68*	5.62*
	(40.64)	(32.41)	(40.58)	(2.95)	(2.59)	(2.96)
d(1998) * TYPE	71.64***	58.11**	75.41***	2.36	1.39	2.11
	(20.91)	(22.79)	(21.45)	(2.70)	(2.41)	(2.77)
d(1999) * TYPE	66.11*	50.29	70.80*	3.56	2.42	3.26
	(38.82)	(38.12)	(39.66)	(2.71)	(2.49)	(2.71)
d(2000) * TYPE	64.63**	58.01**	70.73**	4.33*	3.29	3.94
	(27.57)	(27.66)	(28.56)	(2.54)	(2.31)	(2.58)
d(2001) * TYPE	66.75***	70.40**	72.66***	5.03**	3.88*	4.61*
	(23.77)	(31.32)	(25.21)	(2.33)	(1.95)	(2.51)
d(2002) * TYPE	61.73**	74.80***	68.15**	5.89**	4.87**	5.38**
	(24.50)	(24.45)	(25.64)	(2.52)	(2.35)	(2.61)
d(2003) * TYPE	43.69	62.14*	51.81	3.39	2.22	2.75
	(30.50)	(32.77)	(31.74)	(2.88)	(2.62)	(2.92)
d(2004) * TYPE	60.46**	96.35***	70.85***	7.84***	7.00***	7.10***
	(22.36)	(28.10)	(25.03)	(2.46)	(2.18)	(2.57)
d(2005) * TYPE	119.07***	-	131.73***	12.87***	-	11.87***
	(32.37)		(36.85)	(3.11)		(3.19)
d(2006) * TYPE	75.56***	-	92.95***	8.50***	-	7.16***
	(24.83)		(30.41)	(2.22)		(2.69)
d(2007) * TYPE	113.70***	-	127.02***	13.62***	-	11.91***
	(30.56)		(35.59)	(2.74)		(3.18)
d(2008) * TYPE	147.45***	-	159.44***	15.53***	-	13.34***
	(34.34)		(39.08)	(3.10)		(3.57)
d(2009) * TYPE	120.98***	-	126.91***	12.76***	-	9.91***
	(31.71)		(34.54)	(3.03)		(3.72)
d(2010) * TYPE	98.00***	-	98.09***	8.86***	-	5.60*
	(28.45)		(30.15)	(2.56)		(3.23)
Category-year covariates?	NO	YES	NO	NO	YES	NO
Include RCE controls?	NO	NO	YES	NO	NO	YES

* significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are reported in parentheses and are clustered to correct for autocorrelation within patent categories over time (Columns 1-3) and for autocorrelation within patent-category / entity size combinations over time (Columns 4-6). All regressions include patent-category fixed effects and year fixed effects. Regressions in Column 4-6 include entity size fixed effects as well. Regressions are weighted by the number of disposals used to form each observation's grant rate. Reported coefficient values represent the differential grant rate between patent types (high vs. low-maintenance or large vs. small entity) for the given year. Values are to be interpreted with reference to 1991, whose differential grant rate between types is normalized to 0. Data on patent processing statistics and maintenance rates were obtained from the PTO.

Non-parametric treatment of maintenance rates. The primary results explore the interaction between the fee reform and maintenance rates using a linear treatment of category-specific maintenance rates. In the following table, we allocate technology categories into one of four groups, based on their maintenance-rate percentile: (1) bottom 25th percent, (2) 25th-50th percent, (3) 50th – 75th percent and (4) top 25th percent. We assign each technology category 4 dummy variables indicating whether or not the respective category falls into the relevant percentile group. We then interact each such dummy variable with the post-1991 dummy variable. We include each interaction in a single regression, leaving out the dummy representing the bottom 25th percent, which will serve as the reference group. The results suggest a greater degree of differentiation in granting tendencies on the part of the PTO as we move into higher and higher maintenance rate categories.

TABLE A4. NON-PARAMETRIC TREATMENT OF MAINTENANCE RATES

	(1)
(Reference group: 0-25 th Percentile)	
POST * (25 th -50 th Percentile)	3.34 (2.54)
POST * (50 th -75 th Percentile)	6.47** (2.61)
POST * (75 th -100 th Percentile)	6.81** (2.70)

* significant at 10%; ** significant at 5%; *** significant at 1%.
Standard errors are reported in parentheses and are clustered to correct for autocorrelation within patent categories over time. All regressions include patent-category fixed effects and year fixed effects.
Regressions are weighted by the number of disposals used to form each observation's grant rate. Data on patent processing statistics and maintenance rates were obtained from the PTO.

Triple differences estimation. In the table below, we modify the entity-size regressions to include a term in which we interact the category-specific maintenance rate with a dummy variable for being in the post-reform period and with another dummy variable representing large entity status.¹⁸ The estimated positive coefficient suggests the grant-rate response to the 1991 reform for large entities within high maintenance rate technologies does not just represent an additive effect reflective of the independent entity-size and maintenance-rate stories. Rather, it suggests that the PTO may be targeting its distortionary practices within that particular group, consistent with a story, for instance, in which a benevolent PTO would want to target its distortionary practices in that area where it stands to generate the most revenues. As demonstrated by Columns 2 and 3, this exercise is robust to inclusion of technology-year and entity size-year fixed effects and thus accounts for the possibility that there may be unobservable shocks in the grant rates of particular technologies (e.g., to account for the possibility that some unobserved factor may drive up the grant rates for genetics-related patents over the 1991-2010 period), in addition to unobservable shocks to the grant rates of large entity in this post-reform period.

¹⁸ This regression also includes the pieces of this three-level interaction –e.g., the interaction between large entity status and post-1991.

TABLE A5. DIFFERENCE-IN-DIFFERENCE-IN-DIFFERENCE RESULTS

	(1)	(2)	(3)
POST * MAINTAIN * LARGE	42.79*** (17.92)	48.29* (26.23)	40.41** (19.14)
Include technology-year fixed effects?	NO	YES	YES
Include entity-size-year fixed effects?	NO	NO	YES

* significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are reported in parentheses and are clustered to correct for autocorrelation within patent-category / entity size combinations over time. All regressions include patent-category fixed effects, year fixed effects and entity-size fixed effects. Regressions are weighted by the number of disposals used to form each observation's grant rate. Data on patent processing statistics and maintenance rates were obtained from the PTO.

Alternative Difference-in-Difference Formulation. We also estimate difference-in-difference specifications that focus only on the post-1990 period and that, instead of relying upon the 1991 fee reform, identify the relationship between the PTO's fee structure and its granting practices using variations over time in the PTO's sustainability score – that is, variations over time in its need of funds. Consistent with the interaction results presented in Table 2 of this Article, the results presented in Table A6 (as evidenced by the negative coefficient estimates) suggest that the PTO is more likely to grant at an incrementally higher rate to high-fee patent types (i.e., large entities and high maintenance-rate technologies) during periods of time in which it has greater difficulties covering the examination costs demanded of it by its incoming crop of maintenance fees (as proxied by a lower sustainability score).

TABLE A6. SUSTAINABILITY DIFFERENCE-IN-DIFFERENCE RESULTS (POST-1990 PERIOD)

	(1)	(2)
SUSTAINABILITY * MAINTAIN	-291.78*** (93.02)	-
SUSTAINABILITY * LARGE	-	-38.28*** (8.00)

* significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are reported in parentheses and are clustered to correct for autocorrelation within patent categories over time (Column 1) and for autocorrelation within patent-category / entity size combinations over time (Column 2). All regressions include patent-category fixed effects and year fixed effects. Regressions in Column 2 include entity size fixed effects as well. Regressions are weighted by the number of disposals used to form each observation's grant rate. Data on patent processing statistics and maintenance rates were obtained from the PTO.

More selected filings following fee reform? As discussed in Section IV, a concern arises that perhaps the observed differential responses to the fee reform (and to changes in sustainability measures) are a reflection of selection concerns – i.e., to the changing composition of patents within the delineated patent types. Primarily, if large entity applicants or applicants within high maintenance rate technologies begin to file at a lower rate following 1991 (or following declines in the PTO’s financial balance), one may be concerned that the observed increases in grant rates for these types are a reflection of the more selective (and potentially higher quality) applicant pools remaining. Appeasing these concerns, as demonstrated by Table A7 below, if anything, we find that the 1991 reform was associated with an increase in the rate of filings for large entities and for high maintenance rate technologies relative to small entities and low maintenance rate technologies. Likewise, the negative coefficients estimated in the sustainability difference-in-difference specifications (Rows 2 and 4) suggest that, if anything, we find an increase (as opposed to a potentially concerning decrease) in the rate of filings for large entities and for high maintenance rate technologies relative to small entities and low maintenance rate technologies as the PTO experiences a decrease in its sustainability score.

TABLE A7. EFFECT OF FEE-REFORM AND SUSTAINABILITY FLUCTUATIONS ON RELATIVE FILING RATES ACROSS PATENT TYPES

	(1)	(2)	(3)	(4)
Panel A: Maintenance Rate Specifications. Dependent variable: natural log of initial filings count (filings – total continuation filings)				
REFORM*MAINTAIN	8.81* (4.82)	-	-	-
SUSTAINABILITY*MAINTAIN (post-1990)	-	-10.57*** (5.02)	-	-
Panel B: Entity Size Specifications. Dependent variable: natural log of initial filings count (filings – total continuation filings)				
REFORM*LARGE	-	-	0.11 (0.28)	-
SUSTAINABILITY*LARGE (post-1990)	-	-	-	-0.13 (0.37)

* significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are reported in parentheses and are clustered to correct for autocorrelation within patent categories over time (Panel A) and for autocorrelation within patent-category / entity size combinations over time (Panel B). All regressions include patent-category fixed effects and year fixed effects. Regressions in Panel B include entity size fixed effects as well. Regressions are weighted by the number of disposals used to form each observation’s grant rate. Data on patent processing statistics and maintenance rates were obtained from the PTO.

Components of Sustainability Score. Rather than simply exploring how the differential grant rate across patent types changes in connection with fluctuations in the composite sustainability score measure, we also estimate regressions that break out the key components to that score and estimate how the differential grant rate across patent types changes in connection with fluctuations within each of these components, independently. For the purposes of this illustration, we break out the following factors:

- (1) The PTO's backlog of pending examinations for the given year normalized by the stock of patents available to generate post-allowance fees that year – i.e., the sum of the patents issued that year, 4 years previously, 8 years previously and 12 years previously (an increase in this backlog ratio would suggest a weakening in the PTO's financial balance, in connection with one would presume to observe an increase in granting),
- (2) the average maintenance rate for patents eligible for renewal that year, averaging the 4-year, 8-year and 12-year rates for ease of presentation (a decrease in this rate would suggest a weakening in the PTO's financial balance, in connection with one would presume to observe an increase in granting),
- (3) the average examination complexity (i.e., average examination hours) of the patents disposed of that year (an increase in this average complexity would suggest a weakening in the PTO's financial balance, in connection with one would presume to observe an increase in granting), and
- (4) the percentage of the patent stock available to generate post-allowance fees that year (e.g., the patents issued that year and each of 4-, 8- and 12-years previously) that are large entities (a decrease in this rate would suggest a weakening in the PTO's financial balance, in connection with one would presume to observe an increase in granting).

The sign of the estimated coefficients for the backlog, exam complexity and entity-size percentage specifications are consistent with the above predictions; however, only the backlog finding is statistically distinguishable from 0. It is worth noting that the backlog factor varied to the greatest degree over the sample period out of the 4 factors. These findings suggest that the growing examination demand facing the PTO, relative to the existing stock of patents by which the PTO may generate post-allowance fees, is primarily responsible for the observed sustainability-score findings.

TABLE A8. EFFECT OF KEY COMPONENTS OF SUSTAINABILITY SCORE ON DIFFERENTIAL GRANT RATE ACROSS PATENT TYPES

	(1)	(2)
	TYPE = MAINTAIN	TYPE = LARGE
TYPE * BACKLOG RATIO	61.27*** (20.81)	9.91*** (2.26)
TYPE * AVG RENEWAL RATE	257.90 (243.05)	14.08 (18.30)
TYPE * AVG EXAM COMPLEXITY	9.63 (67.38)	1.64 (5.32)
TYPE * LARGE ENTITY %	-405.70 (449.08)	-52.29 (40.36)

* significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are reported in parentheses and are clustered to correct for autocorrelation within patent categories over time (Column 1) and for autocorrelation within patent-category / entity size combinations over time (Column 2). All regressions include patent-category fixed effects and year fixed effects. Regressions in Column 2 include entity size fixed effects as well. Regressions are weighted by the number of disposals used to form each observation's grant rate. Data on patent processing statistics and maintenance rates were obtained from the PTO.