Prioritized Examination and its Impact on Commercialization of Patents*

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Abstract

Patents play an important role in facilitating transfers of knowledge, and enable commercialization of innovative ideas by reducing information asymmetry between potential buyers and sellers on the market for technology. The crucial question, however, is how quickly innovative ideas can be patented. Previous research has shown that the probability of commercialization for pending applications peaks immediately after the patent allowance event (Gans, Hsu & Stern, 2008). But does the length of pendency of an application at a patent office also affect the overall saleability of a technology and create some frictions on the market for technology? In this paper, we exploit the introduction of the USPTO's Prioritized Examination (Track One) Program to capture the impact of shortened pendency on the likelihood that a pending or granted patent will be commercialized via the transfer of property rights. Using the difference-in-differences approach, we compare the average saleability of patents, which we assign into three groups according to their predicted propensity for prioritization before and after the program start date. We find that introduction of the Track One program has significantly increased the probability of commercial reassignment of applications that were more likely to be prioritized. Our results suggest that the policy implemented by the USPTO and shortened pendency of applications, in general, may reduce frictions on the market for technology and facilitate commercialization of innovations.

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1 Introduction

Patents play an important role in facilitating the transfer of knowledge and enabling commercialization of innovative ideas via the market for technology. There are many well-known cases in which patent sales have been accompanied by multi-billion dollar deals between technology giants, such as the $12.5 billion purchase of Motorola Mobility and its 20,000 patents by Google Inc. in 2011. Anecdotal evidence has shown that even small startups and individual inventors may turn their patents into salable commodities in rather short periods. On April 27, 2015, Google Inc. announced its Patent Purchase Promotion, offering to buy patented technology for the price set by the patent owner. The time during which sale offers could be submitted was limited to several weeks. This short-term experimental marketplace was just the beginning of a series of such events[1] supported by many other large companies across different industries. This has proven how quickly patents owned by small startups and individual inventors may be converted into cash flow. The crucial question that remains is how quickly innovative ideas can be patented.

In practice, an inventor cannot immediately obtain patent protection for her invention, since the patent system requires time to process applications before the patent office grants formal property rights to the invention claimed by the applicant. The total time to patent, which is also known as the pendency time, is not strictly determined. It may vary substantially from one case to another and its length depends on many different factors that have been examined in the literature (Harhoff & Wagner, 2009, Mejer & Potterie, 2011, Liegsalz & Wagner, 2013, Tong *et al.*, 2018). Currently, the total pendency time averages 2-4 years across the largest patent offices[2]. Although the length of pendency is largely determined by the time of certain actions taken by the patent office and the applicant, more than half of the total pendency may be spent waiting in a queue of unprocessed applications (Figure 1).

As the demand for patents increases, the patent backlog also increases, due to the numbers of applications waiting for examination by the patent offices (Mitra & Kahn,

[1] IP3 Program (https://www.ast.com/ip3/).

[2] The range corresponds to the total pendency time averages at the USPTO, EPO, JPO and SIPO.

2013). This trend has attracted increasing public concern over the last decade and is commonly referred to as "global patent warming" (Mejer & Potterie, 2011). One of the negative externalities arising from this trend is a large volume of idle inventions that may be associated with substantial social costs of the delayed benefits from a technological change. According to London Economics, the estimated[3] overall harm to the global economy caused by an additional year of pendency for all current applications at the three largest patent offices, the European Patent Office (EPO), the Japan Patent Office (JPO) and the United States Patent and Trademark Office (USPTO), is as large as $9 billion per annum (London Economics, 2010).

While some applicants may intentionally postpone the outcome of the examination process (Henkel & Jell, 2010) and applicants' preferences related to the length of pendency time are, in general, ambiguous (Rassenfosse & Zaby, 2015), patent offices are generally willing to redistribute their limited examination capacity in favor of welfare generating inventions and examine these patent applications as a matter of priority. Therefore, the so-called 'accelerated examination' is commonly used by patent offices to promote green technologies[4], cancer research, e.g. the "Patents 4 Patients" pilot program at the USPTO and earthquake disaster recovery support-related innovations (at the JPO) by issuing patent grant decisions for these inventions on an accelerated basis.

The privilege of faster examination may be granted only for certain groups of patent applications selected by patent offices, as in the cases above. Such policies, however, do not directly address the issue of patent backlogs, and many other inventions with potentially high value that do not belong to the selected groups may remain idle in pendency. To cope with the patent backlog more generally, as a part of the America Invents Act (AIA) enacted in September 2011, the USPTO introduced Track One Prioritized Examination – an option for applicants to obtain priority in the list of pending applications and, thus, expedite the examination process, for an extra fee. This intervention was partly motivated by the need to promote innovations produced primarily by small firms in technology

[3]The cost of lost innovation estimated from the average patent values in the PATVAL survey (Gambardella *et al.*, 2006) and the assumption that the value of a patent is proportionally spread over its lifetime.

[4]See Lu (2013) for an overview of existing policy practices to expedite examination of green patents in different countries.

sectors with short product life cycles[5].

There are many potential benefits that wider access to faster examination at the USPTO may have brought to the market for technology, including private benefits for start-up firms willing to obtain a competitive advantage in the R&D race on markets with short product life cycles or which seek financing in sectors with scarce funding sources (Fischer & Ringler, 2014). The Track One option has also been widely promoted by patent attorneys around the U.S. encouraging applicants to take advantage of the faster examination at the USPTO. Nevertheless, to our knowledge, the introduction of the USPTO Track One Prioritized Examination and its consequences for the market for technology have not yet been studied in the literature.

In this paper, we raise two empirical questions about the prioritized examination of patent applications. First, we summarize the main statistics related to the participation of applicants in the USPTO Track One program and ask whether the program's target group – start-up firms – was effectively reached during the first year of the program. Second, we ask whether participation in the program brought pecuniary benefits to start-ups. More specifically, we verify whether prioritizing an innovation in a queue of pending applications increases its saleability in the market for technology. Hence, we shed some light on frictions of the market for technology potentially created by the pendency time of patent applications.

Our empirical strategy aims to address three main challenges related to the questions posed above: (1) how to measure the saleability of both pending and granted patents; (2) how to avoid confounding due to the fact that, under the limited time coverage of the data, prioritized applications are observed longer after a patent is granted than regular applications (3) how to disentangle the effect of participation in prioritized examination on saleability of a patent, which may be confounded by other observable and unobservable characteristics of patents.

First, the extensive coverage of the dataset released by the Office of the Chief Economist of the USPTO, which contains patent assignments recorded by the USPTO (Marco *et al.*, 2015), allows us to track the history of the reassignment of property rights

[5] https://www.uspto.gov/

for regular patent applications, and for those that have undergone the prioritized examination. We closely follow the refinement procedure employed in Serrano (2010)[6] to select reassignment records that most likely correspond to the sales transactions from the start-up firms to larger corporate entities. The most important feature of the USPTO Patent Assignment Dataset is that it contains virtually all records of both pending and granted patent sales, as it is legally required that patent sale transactions are filed with the USPTO and, thus publicly recorded, to be legally binding (Dykeman & Kopko, 2004; Serrano, 2011).

Second, in measuring the saleability of patents, we take into account the fact that the limited time coverage of the Patent Assignment Dataset restricts the length of the forward-looking time window starting from the application filing date during which we can track the reassignment history of a pending or granted patent and, thus, conclude whether it was sold by the start-up firm or not. We also take into account the empirical observation first documented in Gans, Hsu and Stern (2008) and recently confirmed in Gaessler (2016) that the distribution of the timing of patent commercialization agreements (licensing and reassignment) peaks immediately after the patent allowance date. Therefore, granted patents which underwent the prioritized examination would be observed longer during the post-allowance period than granted patents that underwent a regular, longer examination process. In view of this, we first verify whether the limited time window causes underestimation of the saleability of patents in the regular, longer system.

Third, to eliminate a potential bias driven by omitted characteristics of patents correlated both with the probability of application for prioritized examination and the probability of commercial reassignment, we compare patent applications filed before and after the Track One inception date with high predicted propensity for prioritization implied from their observable characteristics. Thus, if there are any confounding patent characteristics strongly correlated with the probability of prioritization, they would be equally distributed among the two groups of applications filed before and after the program start date. This conjecture relies on the assumption that there was no evidence of manipulation

[6] Described in detail in Serrano (2008) – the working paper version of the referenced study.

of the filing date in anticipation of the announced Track One program. As we find strong evidence of strategical filing immediately after the program start date, we eliminate its impact on the main results by excluding applications filed closely around this date. We also eliminate the effect of other factors that may have affected all applications, including those less likely to be prioritized, by estimating a standard difference-in-differences model. Finally, we control for differential non-linear time trends of applications with high and low propensity for prioritization to eliminate the effect of potential pre-program changes in saleability of patents that persisted after the Track One inception date.

We find that shortening the examination time for participants in the Track One program is associated with at least a 1.6 percentage point increase in the probability of commercial reassignment, which is in fact 60% of the average reassignment rate of patent applications filed by the start-ups. Our finding suggests that the USPTO Track One Prioritized Examination, additionally to its obvious advantage of providing an earlier disposition of patent applications, may have brought private pecuniary benefits to applicants who opted for prioritization, and that a large overall benefit to the market for technology remains unrealized due to low participation in the program.

This study contributes to the literature on the commercialization of innovations via the market for technology in two respects. First, in the data on transfers of formal property rights across firm boundaries, we find evidence for the sales of patents, in line with Serrano (2008, 2011), Galasso *et al.* (2013) and Gaessler (2016). Second, we find that, other things being equal, patent applications that undergo prioritized examination are significantly more likely to be commercialized via the market for technology. This finding suggests that longer pendency time of applications at patent offices may not only lead to a welfare loss due to the deferred commercialization of innovations (Gans, Hsu & Stern, 2008), but also create frictions on the market for technology that reduce the overall saleability of granted and pending patents. We thus contribute to other studies (Galasso *et al.*, 2013, Harhoff & Stoll, 2015, Hegde & Luo, 2018) that provide evidence of frictions in the market for technology and analyze different sources of those frictions.

2 Institutional Context and Hypotheses

2.1 America Invents Act and Track One Prioritized Examination

At the USPTO, patent examination – the process that precedes the issuance of a patent – typically takes about two years. A final disposition – allowance or final rejection – for a patent application is reached, on average, in 24 months from the filing date. About two-thirds of that time is spent awaiting a first office action – the start of communication between the patent office and the applicant on the merits of an application (Figure 1). Thus, a major part of pendency time at the USPTO is spent waiting in a line of other filed applications that remain to be examined.

While earlier approval of a patent application may hasten commercialization of innovation via the market for technology (Gans, Hsu & Stern, 2008; Gaessler, 2016), it is not common for all applicants to seek a shorter examination time. Some inventors, for example, may need more time to secure investment or generate revenue needed to convert the invention into a marketable product, and therefore they tolerate or prefer a deferred patent grant. Moreover, owners of pending patent applications may be able to realize up to three-forths of the returns that would be generated under full patent protection by strategically creating uncertainty for competitors about the patentability of an innovation and the risk of infringement of a future patent (Harhoff, Rudyk & Stoll, 2016).

To allow inventors to shorten waiting times and release the potential value of innovations trapped in a backlog of pending applications, the USPTO introduced the Track One Prioritized Examination program as a part of the America Invents Act (AIA) enacted in September 2011. Under this program, up to 10,000 nonprovisional utility patent applications filed each year on and after September 26, 2011 can obtain prioritized status in the examination process. This option is offered for a fee that ranges from $1,000 for a micro-entity to $4,000 for a large entity, which compares to the minimal overall cost of all stages from an application filing to an issued patent[7] ranging from $715 to $2,860 depending on the applicant's status.

[7] A sum of filing, search, examination and issue fees.

In exchange for the prioritization fee, applicants in the Track One Prioritized Examination are effectively allowed to obtain a final disposition for their applications in about half the time of the regular examination (Figure 1). Since the usual 20-years term of the patent starts from the filing date of a application, earlier final disposition and a patent grant imply a longer enforcement time, during which a patent can be enforced by its owner against potential infringers. Moreover, in some cases, a pending application may severely delay product market entry when legal protection of the technology is crucial for a producer to secure itself against unauthorized infringement. In many other cases, such an aggressive R&D race between large corporations or participation in limited-time marketplaces for innovations, such as the Patent Purchase Promotion[8], a faster examination of patent applications may create a substantial competitive advantage for innovators. Shorter pendency time may also reduce transaction costs faced by start-up innovators commercializing their technologies via licensing contracts (Gans, Hsu & Stern, 2008). Also, start-up firms seeking external funding with a lack of tangible assets to secure the loan may benefit from earlier issue of a patent, since the patent can be immediately provided to a lender as an alternative form of collateral (Fischer & Ringler, 2014).

Introduction of the Track One program was motivated by the USPTO as a promotion mechanism for innovations produced in the first place by small firms in technology sectors with short lifecycles and high speed R&D races[9]. Since the program's inception, the advantages of faster examination at the USPTO have been widely promoted by patent attorneys around the U.S. (Whitt, 2015; Kuo, 2017; Murty, 2017; O'Brien, 2017). Surprisingly low demand, however, for the fast examination track at the USPTO is evidenced by the fact that the limit of 10,000 prioritization requests per fiscal year has never been achieved (Merchant, 2015). The overall participation rate in Track One Prioritized Examination during the first year of its action averaged only 1.2% of all eligible utility patent applications filed at the USPTO. We find that the participation rate was notably higher among the VC-backed start-ups, averaging 4.8% and peaking in the following technology sectors: Computer Hardware & Software, Communications, Surgery & Medical Instruments and Drugs, with the shares of prioritized applications ranging between 6-8% (Figure

[8] IP3 Program (https://www.ast.com/ip3/)
[9] http://www.uspto.gov/

2). To see how the group of innovators targeted by the USPTO and characterized by more active participation was affected by the Track One program, we focus on the applications initially owned by the VC-backed start-up firms.

2.2 Empirical hypothesis

In our empirical analysis, we study the implications of faster examination for the commercialization of innovations made by VC-backed start-up firms via the market for technology. We ask how probability of commercial reassignment from a VC-backed start-up to a large corporation of a granted or pending patent is affected by the length of pendency time at the patent office.

There are several potential ways prioritized status of a patent application can affect its saleability on the market for technology. First, in sectors characterized by a short product life cycle and incremental innovations, new technologies developed by innovative start-ups may quickly become obsolete and lose demand from potential buyers – practicing firms willing to acquire patents for productive or strategic use. Thus, other things being equal, faster examination would naturally increase the probability of commercial reassignment of a given patent. Second, when the marketplace for technology is limited in time[8], the possibility to expedite examination of a pending application may become a deciding factor in a competition among sellers. Last but not least, the innovator may convey an informative signal about the intrinsic value of a pending or granted patent to its potential buyers by filing a prioritized application (Harhoff & Stoll, 2015).

Thus, we claim that introduction of the prioritized examination track at the USPTO may have affected the market for technology by reducing frictions between buyers – start-up innovators – and sellers – large corporations – and by increasing the saleability of patents undergoing prioritized examination. We exploit a variation in the length of patent examination generated by the introduction of the USPTO Track One Prioritized Examination to test the hypothesis of the existence of a difference in the saleability of granted and pending patents that undergo regular versus prioritized examination.

3 Data

For the purpose of our empirical analysis, we consider patent applications filed at the USPTO within one year before and after the effective inception date of the Track One program, that is between September 26, 2010, and September 26, 2012. These are 803,621 applications filed within a time window. We merge several data sources to find the necessary details about the application characteristics, their prosecution, and their reassignment history. First, we use the USPTO Patent Examination Research Dataset (PatEx), including such application characteristics as technology class, number of inventors, small entity status of the applicant and a detailed transactions history between the applicant and the patent office, including the filing date, notice of allowance date, and the date of grant of the prioritized status. Second, we use the USPTO Patent Assignment Dataset to track the reassignment history of each patent application in a sample and identify its initial owner and the first assignee involved in a commercial transaction with the initial owner. Third, we retrieve the names of VC-backed firms and dates of their funding rounds from the VentureXpert database to match them with the names of the initial owners of the patent applications, and finally obtain the subset of 15,458 applications filed within one year before and after the program inception date and initially owned by the VC-backed start-ups; that is, VC-backed firms that had their first round of funding no later than five years before September 26, 2010 – the beginning of the time window. Additionally, we use the OECD Triadic Patent Families database and the PATSTAT data to get the application characteristics that are not available in the PatEx database, including patent family size and the triadic status of the patent.

To construct the outcome variable – saleability of patent applications – measured by the probability of commercial reassignment, we use the Patent Assignment Dataset[10] released by the Office of the Chief Economist of the USPTO. This dataset contains patent assignments – transactions in patents executed by an interested party prior to or after a patent is granted and recorded by the USPTO (Marco *et al.*, 2015). Though, in general, the disclosure of patent assignments to the USPTO is not mandatory, it is required for patent sale transactions to be filed with the USPTO and publicly recorded,

[10] http://www.uspto.gov/economics

to be legally binding. The latter condition implies a no or negligibly small selection issue in a subsequent empirical analysis (Dykeman & Kopko, 2004; Serrano, 2011). Most of the recorded transactions, however, may not be associated with a genuine transfer of property rights across firm boundaries and, thus, the sale of a patent (Serrano, 2008, 2010; Galasso et al., 2013; Gaessler, 2016). There are several types of records, including individual inventor assignments, security agreement assignments, name change records, patent assignments associated with mergers and acquisitions, and transactions between subsidiaries and patent companies, that are usually disregarded in analyses of commercial reassignments. We closely follow the refinement procedure employed in Serrano (2010)[11] to filter out non-relevant transactions and to select reassignment records that most likely correspond to the sales transactions between the VC-backed start-up firms and the large corporations. We construct a dichotomous variable which is equal to one if a given patent application is reassigned from its initial owner – a VC-backed start-up firm – to another corporate entity. A more detailed description of the data construction and refinement procedures is presented in Appendices C, D, and E.

When identifying whether a given patent application is reassigned or not, we take into account the fact that the time coverage of the Patent Assignment Dataset is limited by its most recent update, and applications with earlier filing dates in a sample are observed in the Assignment Dataset for a longer time than applications with more recent filing dates. We thus consider a fixed five-year forward-looking time window starting from the application filing date, during which we track the reassignment history of all applications in a sample.

We also take into account the fact that the probability of commercial reassignment is not evenly distributed along a patent's life and peaks right after its allowance date (Figure 3; Gans, Hsu & Stern, 2008; Gaessler, 2016). Therefore, given a limited five-year forward-looking time window, patents that undergo prioritized examination and are, on average, allowed within twelve months from the filing date, would be exposed longer to a higher probability of reassignment than the non-prioritized patents that are allowed within twenty-four months on average. To verify whether a five-year time window

[11] Described in detail in Serrano (2008) – the working paper version of the referenced study.

causes underestimation of the reassignment rates of regular versus prioritized patents, we calculate reassignment rates of patents filed in 2006 and granted within twelve months of the filing date, considering a restricted five-year time window and a counterfactual time window of a maximum of ten years. The former reassignment rate is 36% lower than the latter due to the truncated distribution of timing of reassignments. It turns out, however, that this discrepancy is not much different for patents filed in the same year and granted within twelve months of the filing date. For the latter patents, reassignment rates within the five-year time window is 38% lower than the time window of a maximum of ten years. We thus conclude that the restricted time window does not cause any implicit differences in the reassignment rates of regular and prioritized applications.

4 Empirical results

4.1 Treated vs untreated applications

Only applications filed on, or after September 26, 2011 – the effective date of the policy change – were eligible for a prioritized examination request. However, since the requests were initiated by the applicants, not all applications filed after the policy change were actually treated. In fact, fewer than 5% of all eligible applications[12] had prioritized status (Table 1). Thus, it is not possible to directly utilize a discontinuity in the length of examination time around the policy change to estimate the effect of shortened examination time on commercialization of patent applications.

Another way of assessing the degree of association between a shortened examination time on the saleability of patent applications – a simple comparison of means (Tables 1 and 2) – shows that applications that were filed after the program inception date which underwent the prioritized examination had a 1.8 p.p. higher reassignment rate, thus, were on average 54% more frequently reassigned from their initial owners – VC-backed start-ups – to other corporate entities than applications that underwent the regular examination. It is, however, also evident from the summary statistics (Table 1) that the

[12] We assume that only the filing date of an application is a relevant eligibility criterium. Even though other eligibility criteria were set by the USPTO, such as the maximum total number of claims and the maximum number of independent claims, those were satisfied by more than 80% of all applications in our sample.

two groups of applications – prioritized and non-prioritized – differ in terms of their observable characteristics. If a clustering of some of these characteristics in either group affected both the probability of treatment and commercial reassignment, they could not be directly compared in terms of their average saleability, and the estimate in a simple comparison of means presented in Table 2 may be biased.

To address non-random assignment of applications into the treated (prioritized) or untreated (non-prioritized) group, we consider a comparison of applications in two groups that have similar observable characteristics. Particularly, we compare applications filed before and after the policy change, that have a high predicted propensity for prioritization; that is, to possess certain characteristics that are more clustered within the treated group (Table 1, column 5) compared to the untreated counterpart (Table 1, column 4). Thus, if there are any confounding patent characteristics strongly correlated with the probability of prioritization, they would be equally distributed among the two groups of applications filed before and after the program start date. We also seek to eliminate the effect of other factors that may have affected all applications, including those that were less likely to be prioritized, by estimating a standard difference-in-differences model.

4.2 Difference-in-differences framework

In this setup, we do not distinguish patent applications based on their actual treatment status. Instead, we define several levels of treatment intensity inferred from the observable applicant and application characteristics. Using the difference-in-differences framework, we compare the difference in the probability of commercial reassignment before and after the policy change for applications with the highest, the lowest and medium propensity for prioritization.

Under the null hypothesis of no effect of prioritized examination, the difference in reassignment probability between high, medium and low propensity groups would be the same around the policy change date. Alternatively, if the difference in probability of reassignment between high and low groups increased after the implementation of Track One Prioritized Examination, this may suggest the presence of an effect of a prioritized examination on the probability of commercial reassignment.

4.2.1 Propensity for prioritization

To predict the propensity for prioritization of applications filed before and after the policy change, we start with the linear probability model of the form:

$$TrackOne = Z\beta + \varepsilon \tag{1}$$

where $TrackOne$ is a binary outcome variable that takes value one if an application was examined on the prioritized track and Z denotes the matrix of observable applicant and application characteristics listed in Table 1. Based on the subset of 8,285 patent applications filed after the policy change, we estimate equation (1). Coefficient estimates, their standard errors, and significance levels are reported in the first column of Table 3.

Most characteristics are significant predictors of prioritization status. Notably, if the application is prosecuted by a top-tier patent attorney, its probability of prioritization increases by 2.17 p.p. Filing an application at multiple jurisdictions in different countries, thus increasing its family size and broadening the market scope (Harhoff et al., 2003), increases the probability of prioritization. However, applications that are part of a triadic patent family undergo prioritized examination less frequently. Applications authored by larger teams of inventors are more likely to be prioritized. Small entity status increases the probability of prioritization by 1.28 p.p. We also find that prioritization of applications is requested more frequently by small and younger firms, though the magnitude of the relationship is not statistically different from zero.

To find similar applications in terms of their propensity for prioritization filed before and after the policy change date, we estimate model (1) using Logit[13]. We use estimates reported in the second column of Table 3 to make an out-of-sample prediction of the prioritization status of all 15,458 applications filed within one year around September 26, 2011, and initially owned by the VC-backed start-ups based on the applicant and application observable characteristics. Outliers in the top and bottom 1% of the overall distribution of predicted values were excluded resulting in 15,150 observations used in the subsequent analysis (Figure 4).

[13]We run a robustness check with the Penalized maximum likelihood model (Firth, 1993), to account for potential bias arising from the rare-event nature of the prioritization, which gave similar results.

Based on the predicted values of propensity for prioritization, we assign applications into three groups with different levels of the treatment intensity. Applications in the upper quarter of a distribution of the predicted propensity correspond to the high level, applications in the lower quarter correspond to the low level, and applications between the 25^{th} and 75^{th} percentiles correspond to the medium level of treatment intensity[14].

4.2.2 Assumptions

Our empirical strategy of performing a difference-in-differences comparison of applications with similarly high or low predicted propensity for commercialization relies on several assumptions. We state them and discuss their validity in this section.

First, we assume that applications filed before the policy change with relatively higher predicted propensity for prioritization would have been exposed to the policy change to a larger extent if it had been implemented earlier. The validity of this assumption relies on the choice of predictors used to predict the propensity for prioritization. We test for this assumption by running a simple OLS of actual treatment status (prioritized vs. non-prioritized) of 8,151 applications filed after the policy change on their predicted propensity for prioritization (Table 4). In fact, 10.5% – the highest participation rate – corresponds to applications with the highest predicted propensity and is significantly larger than in the case of applications with the lowest predicted propensity.

Second, we implicitly assume that observed characteristics used to predict the propensity for prioritization are confounding, to a certain extent, the effect of a prioritized examination on reassignment probability. Thus, we expect significant discrepancies between the reassignment rates at different levels of the treatment intensity, if our assumption is valid. We test for the presence of the latter discrepancies by running a simple OLS of the reassignment probability on $Medium$ and $High$ group dummies along with an intercept corresponding to the base group, using all 15,150 observations in the sample (Table 5). The average reassignment rate in the medium and high groups are in fact significantly higher than in the base group, and at the same time, the high treatment intensity group exhibits a higher reassignment rate than its medium counterpart.

[14] We ran the robustness checks with $20^{th}/80^{th}$ and $10^{th}/90^{th}$ percentile thresholds, which gave similar results.

Third, we assume that confounding patent characteristics strongly correlated with the probability of prioritization are equally distributed among applications around the program start date, making applications that were filed before the inception date comparable counterfactuals of those that were filed after. To explore evidence of a manipulation – strategical postponement – of the filing date by the applicants in anticipation of the announced Track One program, we test for discontinuity in a distribution of filing dates of applications with a high propensity for prioritization at the program start date. The "manipulation test" (McCrary, 2008) clearly rejects the null hypothesis of no discontinuity at a 99% significance level (Figure 5). To avoid a potential impact of this filing pattern on our results, we exclude from our sample applications filed closely around the program start date. The result of the test confirms the absence of any statistically significant evidence of manipulation after excluding applications filed within one week before and after the program start date (Figure 6).

Last but not least, we assume that changes in the reassignment probability in high, medium and low groups over time before the policy change followed parallel paths and were on the same increasing, decreasing or constant trajectories at the time of the policy change. We test for the validity of the latter assumption by estimating a more flexible difference-in-differences model with individual group-specific time trends.

4.2.3 Results

We start with a comparison of means of an outcome variable – reassignment probability – across six cells constructed on the interaction of three treatment intensity groups – high, medium and low – and two time intervals relative to the policy change date – before and after. The results (Figure 7) suggest that the high treatment intensity group exhibiting about the average level of reassignment probability (within one year) before the policy change, experienced a significant increase in the outcome (within one year) after the policy change, whereas other groups seem unaffected by the introduction of Track One Prioritized Examination. We formally test for the latter finding by estimating a difference-in-differences model of the form:

$$Reassign = \beta_0 + \beta_1 After + \beta_2 Medium + \beta_3 High + \\ + \beta_4 After \times Medium + \beta_5 After \times High + \varepsilon \quad (2)$$

where *Reassign* is a binary outcome variable that takes value one if an application was reassigned from its first assignee (VC-backed startup) to a corporate entity within five years of its filing date, *After* dummy takes value one if the filing date is on or after September 26, 2011, and *Medium* and *High* dummies correspond to the treatment intensity groups defined above. The coefficient of the interaction term, β_5, is a DID estimator and constitutes the focus of interest in our analysis.

The results (Table 6) suggest that the introduction of the Track One Prioritized Examination by the USPTO on September 26, 2011, did not change the saleability of patent applications with low and medium propensity for prioritization. At the same time, compared to the change in the probability of commercial reassignment of patent applications with low propensity for prioritization before and after the policy change, patent applications that were more likely to be prioritized were also, by 1.79 p.p. (57% of the mean reassignment rate), more frequently reassigned once the Track One Prioritized Examination was introduced.

To test the assumption of parallel paths implicitly made in the model (1), we allow for differential changes over time in pre- and post-treatment periods for each treatment intensity group. Thus, we consider the linear model with time fixed effects and interactions between *Medium* and *High* treatment intensity group dummies with time period dummies:

$$Reassign = \sum_t \beta_{H,t} T_t \times High + \sum_t \beta_{M,t} T_t \times Medium + \sum_t \beta_t T_t + \varepsilon \quad (3)$$

where *Medium* and *High* dummies correspond to the treatment intensity groups, T_t are time period dummies corresponding to four 90-day lags preceding the policy change indexed as $-4, -3, -2, -1$ and four 90-day leads following the policy change indexed as $1, 2, 3, 4$.

Estimates of the coefficients and their significance levels are reported in Table 7. In Figure 8, we plot values of the coefficients $\beta_{H,t}$ which correspond to the departures of the outcomes of high-propensity group from the base – low-propensity group in each period. Coefficients $\beta_{H,t}$ in the pre-treatment periods were not significantly different from zero, which confirms the validity of our assumption about the parallel trends posed in the previous section. At the same time, coefficients $\beta_{H,t}$ in the post-treatment periods show that the probability of commercial reassignment of the high-propensity group with the largest share of actually prioritized applications visibly increased and remained significantly higher than the probability of commercial reassignment of the low-propensity group, which was unlikely to be exposed to the effect of the Track One Prioritized Examination.

Finally, our extended difference-in-differences model suggests that applications which underwent prioritized examination may have about 1.8 p.p. (the difference between averages of the $\beta_{H,t}$ coefficients in the pre- and post-treatment periods) higher reassignment rates, that is 60% of the average reassignment rate of applications filed by the VC-backed start-up firms.

5 Conclusion

Previous research has shown that timely granting of patents plays a crucial role in the commercialization of innovations via the market for technology (Gans, Hsu & Stern, 2008). Even though in some cases innovators may choose to strategically postpone the outcome of a patent office examination, it is widely claimed that longer application pendency has a detrimental impact on the social value of innovations. Therefore, patent offices around the world have been implementing various policy programs targeted at accelerating the examination process of innovations with the highest social value.

Starting September 26, 2011, the USPTO offered its applicants filing for nonprovisional utility patents the option to choose a faster examination track – Track One. As evidenced from the data, the Track One examination allows applicants to obtain a final disposition in half the usual time. Several empirical observations made in this study concern the participation activity of applicants in the Track One program. First, we find that the group of applicants – small start-ups – which were primarily targeted by the USPTO indeed participated in this program much more actively than others. Second, we find that dissemination of information about the benefits of the Track One program by the patent attorneys may have had a persuasive impact on innovators' decisions to apply for the prioritized examination. Third, despite the overall low demand for the prioritized examination documented by the USPTO, we find evidence of bunching of strategically postponed filings right after the program start date, suggesting possible anticipation of some benefits made available by participation in the program.

Using the difference-in-differences approach, we compare the average saleability of granted and pending patents, which we assign into three groups according to their predicted propensity for participate in the Track One program before and after the program start date. We find that shorted examination time or a decision to apply for prioritized status have a positive impact on the probability of commercialization of a patent via the market for technology. We suggest that this empirical finding may have important policy implications for patent offices willing to minimize the social costs of pending innovations and reduce the frictions on the market for technology. Our findings may also be relevant in the context of innovation management within start-up firms seeking formal protection for their intellectual property rights and commercialization of ideas via the market for technology.

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Appendix

A Tables

Table 1: Summary statistics

	Means (SD)				
	Whole sample	Period		Track One status	
		before Sep 26	after Sep 26	untreated	treated
	(1)	(2)	(3)	(4)	(5)
Outcome variables					
Reassignment rate	0.031 (0.175)	0.032 (0.175)	0.031 (0.174)	0.031 (0.172)	0.048 (0.215)
Track One rate	–	–	0.047 (0.213)	–	–
Applicant characteristics					
Small entity status	0.44 (0.50)	0.44 (0.50)	0.44 (0.50)	0.43 (0.50)	0.53 (0.50)
Age of the firm	1.78 (2.31)	1.81 (2.26)	1.75 (2.34)	1.78 (2.34)	1.22 (2.39)
Application characteristics					
Top-tier law firm	0.21 (0.41)	0.21 (0.41)	0.21 (0.41)	0.21 (0.41)	0.31 (0.46)
Triadic status	0.12 (0.32)	0.13 (0.33)	0.12 (0.32)	0.12 (0.32)	0.09 (0.29)
Patent family size	4.81 (8.39)	5.06 (8.37)	4.59 (8.40)	4.45 (8.22)	7.39 (11.05)
Number of inventors	2.92 (1.86)	2.92 (1.93)	2.93 (1.79)	2.92 (1.77)	3.22 (2.06)
Allowance lag (months)	26.4 (12.05)	28.53 (12.9)	24.59 (10.96)	25.13 (10.66)	14.57 (11.53)
Allowance rate	0.68 (0.47)	0.68 (0.47)	0.69 (0.46)	0.68 (0.47)	0.75 (0.43)

Notes: This table reports the summary statistics (means and standard deviations – in parentheses) of the outcome variable in the difference-in-differences model and predictor variables used for predicting the treatment status, separately for untreated applications filed before the Track One program start date, and treated and untreated applications filed after the program start date.

Table 2: Difference in means: treated vs. untreated

	Reassignment ($mean = 0.031$)
$Intercept$	0.0309***
	(0.0020)
$TrackOne$	0.0181**
	(0.0091)
Observations	8,151
F-statistic	3.916

Notes: Simple comparison of means of the outcome variable computed for the treated and untreated patent applications filed after the Track One program start date suggests a higher reassignment probability of prioritized applications as compared to the applications that underwent a regular examination process.

Standard errors are in parentheses; $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 3: Propensity for prioritization

	Track One status ($mean = 0.047$)	
	LPM	Logit
Applicant characteristics		
Small entity status	0.0128**	0.0114*
	(0.0062)	(0.0060)
Age of the firm	−0.0011	−0.0016
	(0.0016)	(0.0016)
Small × Age of the firm	−0.0024	−0.0015
	(0.0021)	(0.0021)
Application characteristics		
Top-tier law firm	0.0217***	0.0195***
	(0.0058)	(0.0052)
Triadic status	−0.0254***	−0.0254***
	(0.0077)	(0.0087)
Patent family size	0.0019***	0.0009***
	(0.0003)	(0.0002)
Number of inventors	0.0034**	0.0032***
	(0.0013)	(0.0012)
Technological sector dummies	Yes	Yes
Observations	8,285	8,285
R^2/Pseudo R^2	0.042	0.107

Notes: This table reports the estimated coefficients (LPM) and average marginal effects (Logit) of the variables predicting the treatment – prioritized status of applications filed after the Track One program start date.

Standard errors are in parentheses; $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 4: Participation rates across treatment intensity groups

	Track One ($mean = 0.047$)
Intercept	0.0039
	(0.0046)
Medium	0.0337***
	(0.0057)
High	0.1052***
	(0.0065)
Observations	8,151
R-squared	139.4

Notes: We regress the treatment variable – prioritization dummy – on a set of dummies for the treatment intensity levels. The results reported in this table show that actual prioritization rate is significantly higher in the group of applications with high (above the 75^{th} percentile) as opposed to low (below the 25^{th} percentile) predicted propensity for prioritization.

Standard errors are in parentheses; $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 5: Reassignment rates across treatment intensity groups

	Reassignment ($mean = 0.031$)
Intercept	0.0240***
	(0.0028)
Medium	0.0059*
	(0.0035)
High	0.0180***
	(0.0040)
Observations	15,150
F-statistic	10.59

Notes: We regress the outcome variable – reassignment probability – on a set of dummies for the treatment intensity levels. The results reported in this table show that, in the absence of treatment, higher predicted propensity for prioritization is associated with higher reassignment probability. Thus, the effect of prioritization on the outcome variable may be confounded by other characteristics of patent applications that are associated both with the treatment and outcome variables.

Standard errors are in parentheses; $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 6: Difference-in-differences (baseline results)

	Reassignment ($mean = 0.031$)
$After$	-0.0073
	(0.0057)
$Medium$	0.0017
	(0.0051)
$High$	0.0084
	(0.0060)
$After \times Medium$	0.0071
	(0.0070)
$After \times High$	0.0179**
	(0.0081)
Observations	15,150
F-statistic	5.272

Notes: Our baseline results of a standard difference-in-differences model are reported in this table. We compare applications with medium and high propensity for prioritization with the base group – low-propensity applications – before and after the Track One program start date. A significantly higher reassignment rate after the policy change is observed only among applications with high propensity for prioritization.

Standard errors are in parentheses; $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

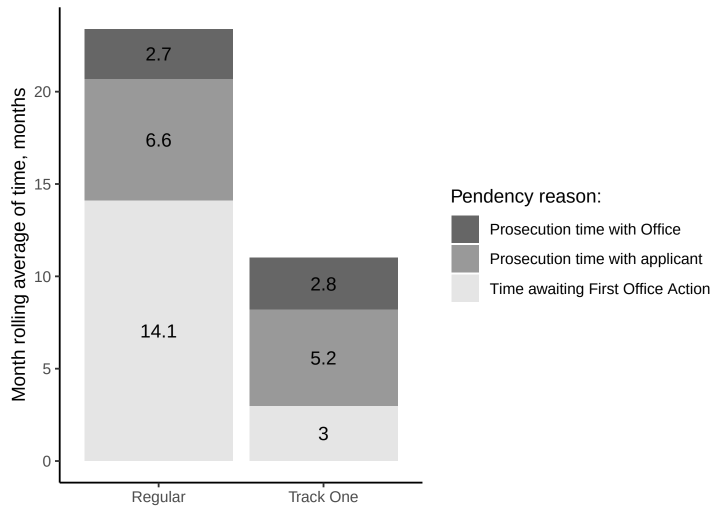
Table 7: Difference-in-differences (flexible model)

	Reassignment ($mean = 0.031$)		
$High_{-4}$	0.0200	$Medium_{-4}$	0.0124
	(0.0126)		(0.0108)
$High_{-3}$	0.0041	$Medium_{-3}$	−0.0030
	(0.0123)		(0.0105)
$High_{-2}$	0.0093	$Medium_{-2}$	−0.0051
	(0.0116)		(0.0101)
$High_{-1}$	0.0015	$Medium_{-1}$	0.0032
	(0.0112)		(0.0096)
$High_{1}$	0.0167	$Medium_{1}$	0.0101
	(0.0112)		(0.0096)
$High_{2}$	0.0411***	$Medium_{2}$	0.0249**
	(0.0113)		(0.0099)
$High_{3}$	0.0290***	$Medium_{3}$	−0.004
	(0.0106)		(0.0093)
$High_{4}$	0.0190*	$Medium_{4}$	0.0057
	(0.0107)		(0.0094)
Observations	15,150		
F-statistic	22.24		

Notes: This table reports the estimation results of the extended version of the baseline difference-in-differences model that allows for a flexible specification of the time trends.

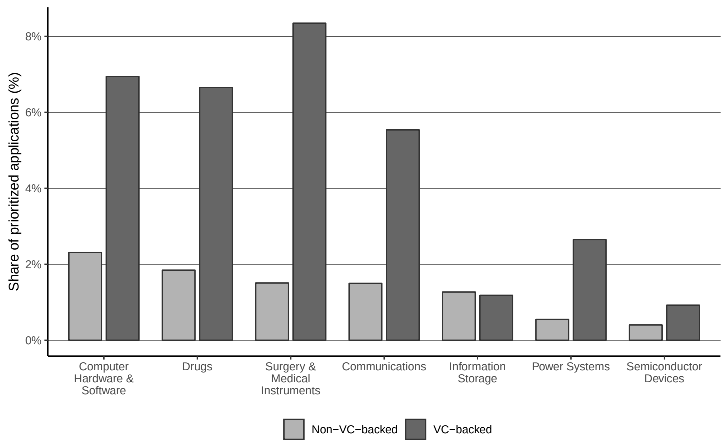
Standard errors are in parentheses; $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

B Figures



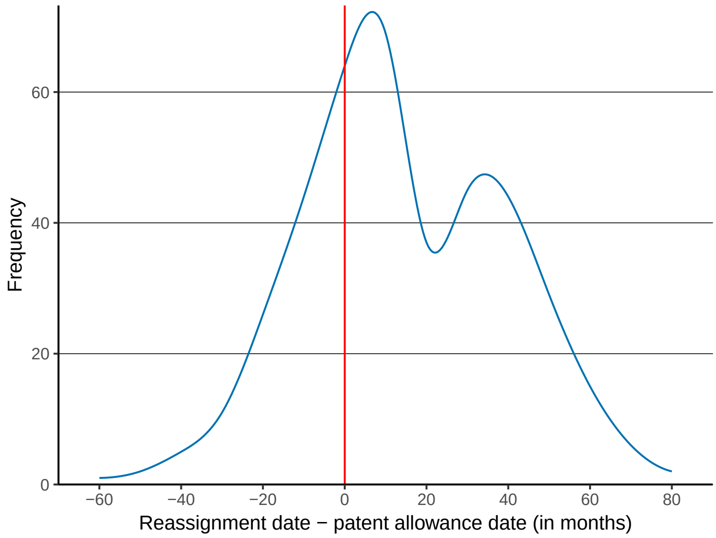
Source: Data Visualization Center of the USPTO.
Notes: This figure compares the average total pendency time and its determinants for applications under regular and prioritized examinations. Numbers correspond to the most recent statistics as of January 2019.

Figure 1: Total Pendency Time



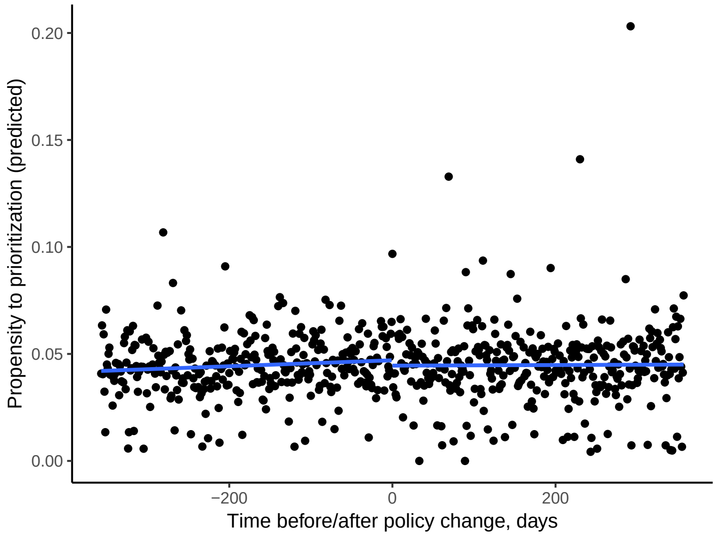
Notes: This figure compares the shares of applications in our sample that were prioritized, across technology sectors defined in Hall, Jaffe & Trajtenberg (2001) and between two groups of applicants: VC-backed start-ups and all others.

Figure 2: Track One Participation Rates



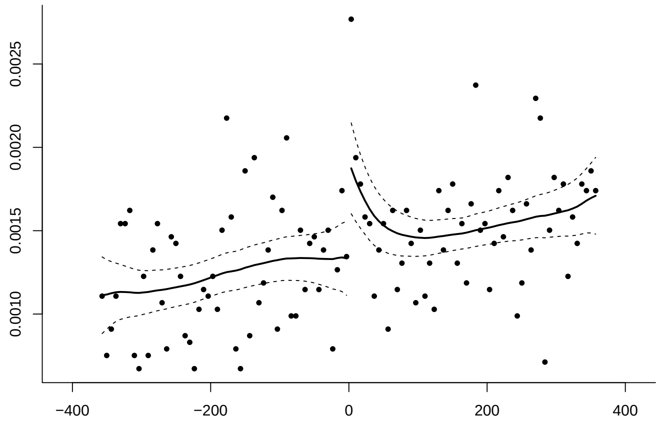
Notes: We plot the distribution of the reassignment lag (the difference between the reassignment and patent allowance dates) to confirm that the probability of commercialization (conditional on patent allowance) peaks right after the date of patent allowance, which was previously documented in Gans, Hsu and Stern (2008) and Gaessler (2016).

Figure 3: Distribution of Difference Between Reassignment and Patent Allowance Dates



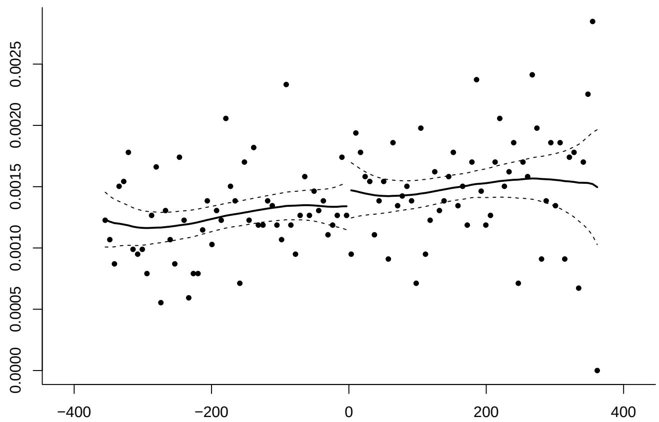
Notes: This figure plots the predicted propensity for prioritization over time. Each dot corresponds to the average propensity score of applications filed within a one-week interval.

Figure 4: Predicted Propensity for Prioritization



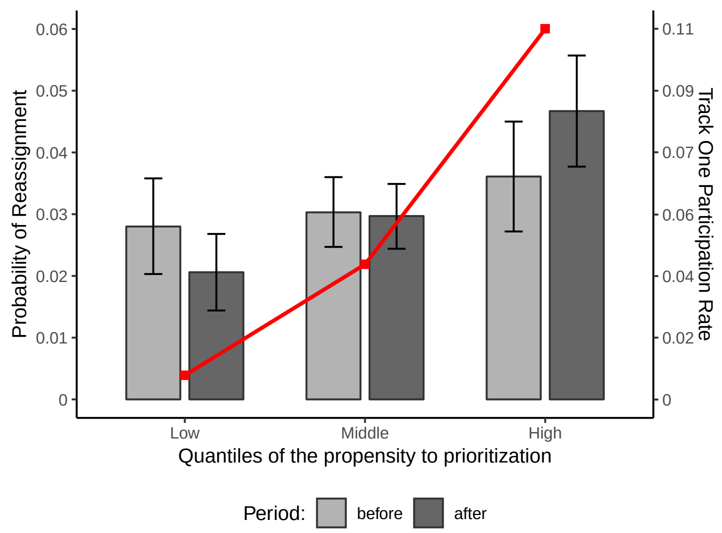
Notes: This figure plots the distribution of filings with high propensity for prioritization around the Track One program start date. "Manipulation test" rejects the null of no discontinuity at the program start date.

Figure 5: Distribution of filings in a high treatment intensity group



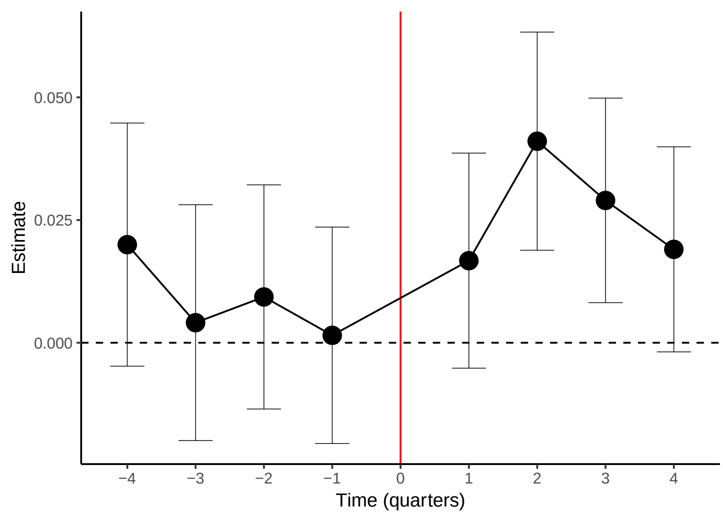
Notes: Excluding applications filed within one week around the Track One program start date mitigates the issue of manipulation of filing date in anticipation of the policy change. A repeated "manipulation test" does not reject the null of no discontinuity in a distribution of filings at the program start date.

Figure 6: Excluding one week around the program start date



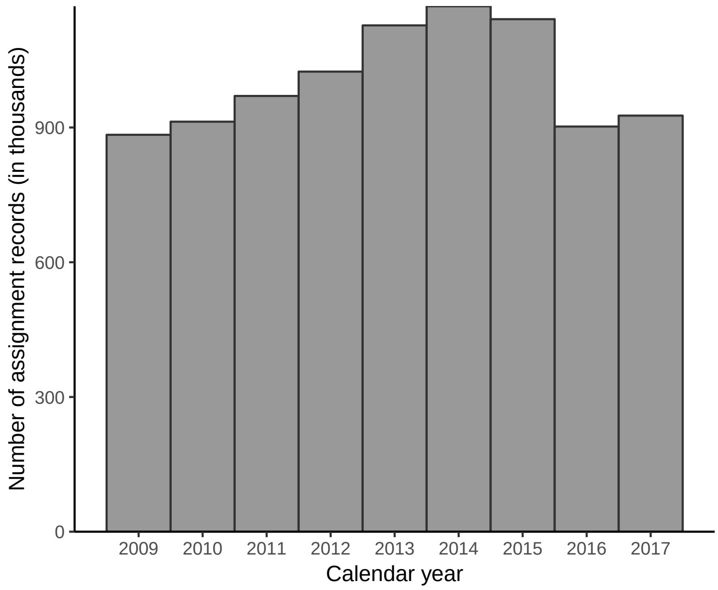
Notes: This figure plots the average probability of reassignment (bars, left vertical axis) and the shares of prioritized applications (line, right vertical axis) in each treatment intensity group. The results suggest that a higher participation rate is associated with a larger positive difference in the reassignment probability before and after the policy change.

Figure 7: Comparison before and after



Notes: This figure depicts the statistical significance of the upward trend in the high-propensity group after the Track One program start date. Error bars correspond to the 95% CI.

Figure 8: Difference-in-differences (flexible model)



Notes: We track the reassignment history of the applications starting from the filing date. This figure plots the number of assignment records available in the original Patent Assignment Dataset and additional data retrieved from the online Patent Assignment Database of the USPTO.

Figure 9: Availability of Assignment Data

C Data Refinement: Applications of the VC-backed start-ups

To construct a sample of patent applications initially owned by the VC-backed start-ups we implement the following refinement procedure:

1. **Subset applications filed within one year around the program start date:** We started with a set of 803,621 applications filed between September 26, 2010 and September 26, 2012 retrieved from the USPTO Patent Examination Research Dataset (PatEx). 578,963 of them had at least one assignment record in the USPTO Patent Assignment Dataset.

2. **Identify the first assignee of a patent application:** for 572,986 applications that were assigned by inventor(s) at least once it was possible to identify a unique assignee (employer) in 541,088 cases; in the other 6,732 cases it was possible to identify a unique non-academic employer (some inventors may assign their patent applications to multiple employers – academic and business entities). Out of the 5,977 applications that were never assigned by the inventor(s), in 2,961 cases there was just one assignment of the assignor's interest, and assignors of such applications were treated as the first assignees. In total, for 28,182 applications (less than 5%) with at least one assignment record, it was not possible to identify a unique first assignee.

3. **Match the names of assignees with the names of VC-backed firms:** before identifying VC-backed firms among the first assignees of patent applications, we unified both names of assignees and known VC-backed firms by simplifying and deduplicating them. Specifically, both groups of names were cleaned of special characters and numbers, names containing such strings as "also known as" and "formerly known as" were split into separate names of the same company, all resulting names were deduplicated using the Rosette API[15] and assigned unique identifiers that allowed matching the names of first assignees with the list of names of VC-backed firms and dates of their funding rounds retrieved from the VentureXpert database.

4. **Subset patent applications owned by the VC-backed start-ups:** out of

[15] https://developer.rosette.com/features-and-functions

550,781 applications for which first assignees could be identified, 45,190 applications had names of their first assignees that matched names of VC-backed firms. 15,458 were owned by the VC-backed firms that had their first round of funding no later than five years before September 26, 2010 and, thus, were further considered in our analysis as applications owned by the VC-backed start-ups.

D Data Refinement: Commercial reassignments

To construct an outcome variable – probability of commercial reassignment – we implement the following refinement procedure:

1. **Assignments from the VC-backed start-ups:** Out of 57,349 assignment records associated with a set of patent applications defined above, 2,789 transactions originated from the VC-backed first assignees.

2. **Assignments of assignor's interest:** 1,136 of 2,789 records were of the "assignment of assignor's interest" type identified based on the conveyance text, and those records were considered to be commercial reassignment candidates. 291, however, were excluded as their execution dates were prior to the filing dates of reassigned applications. Another 81 records were excluded as their assignors' and assignees' names were identified as the same names, 26 records where applications were assigned to entities that later reassigned the same applications back to the first VC-backed assignees were also excluded and, finally, 18 records that duplicated earlier records with the same assignor-assignee-application combination were excluded from the sample. As a result, 720 assignment records associated with 712 patent applications remained.

3. **Probability of commercial reassignment:** in our analysis, we treat a patent application as commercially reassigned if the execution date of commercial reassignment is within the five years after the filing date. The length of the time window is dictated by availability of the data on assignments (Figure 9) recorded up to 2016 in the original Patent Assignment Dataset and additional data on assignments recorded in 2017 that were retrieved via the API interface of the web-based Patent

Assignment Database[16]. The length of the forward-looking time window is, thus, set to five years based on the maximum possible value for the most recent applications in our sample. Out of 712 commercially reassigned applications in our sample, 606 were reassigned within five years of the filing date, thus implying 3.1% average commercialization rate.

E Data Construction: Applicant and application characteristics

1. **Track One status:** indicator variable constructed from the Transaction History Data, part of the PatEx dataset, that takes value 1 if there is a specific type of transaction coded as "Mail Track 1 Request Granted" in the transaction history of the patent application. Available only on and after September 26, 2011, when the USPTO began to accept requests for prioritized examination.

2. **Small entity status:** indicator variable retrieved from the PatEx dataset that takes value 1 if the applicant is either an individual inventor, a collaboration of individual inventors, a nonprofit organization, or a company with fewer than 500 employees[17].

3. **Age of the firm:** numerical variable indicating the difference between September 26, 2010 (start of the sample time frame) and the date of first funding round of the VC-backed firm – first assignee of the patent application – constructed from the VentureXpert data.

4. **Top-tier patent attorney:** indicator variable constructed from the information on the attorneys' and patent agents' names who have been granted power of attorney with regard to the corresponding subject applications, that takes value 1 if the name of a patent agent appears in the list of 123 "Best Law Firms for Patent Law" compiled by the U.S. News & World Report[18].

5. **Triadic status:** indicator variable retrieved from the OECD Triadic Patent Fam-

[16] https://assignment.uspto.gov/,https://assignment-api.uspto.gov/documentation-patent/
[17] https://www.uspto.gov/web/offices/pac/mpep/s2550.html
[18] https://www.usnews.com/rankings

ilies database, February 2015, that takes value 1 if the patent application is a part of a patent family formed by patents filed at the European Patent Office (EPO), the Japan Patent Office (JPO) or the United States Patent and Trademark Office (USPTO).

6. **Patent family size:** numerical variable retrieved from the PATSTAT database indicating the number of patents that cover exactly the same technical content as a focal patent application.

7. **Number of inventors:** numerical variable constructed from the PatEx dataset indicating the number of individual inventors listed in a patent application.

8. **Technological sector:** categorical variable indicating 36 two-digit technological sectors aggregated from 457 classes of the U.S. Patent Classification (USPC) System based on the mapping constructed by Hall, Jaffe & Trajtenberg (2001).