DO PATENTS COME TOO EASY?

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I. INTRODUCTION

Recently, the detailed workings of the U.S. patent system have emerged from obscurity to become a highly debated public policy issue. Much of the current debate focuses on access to AIDS drugs in Africa. Other topics being debated include access of developing countries to patented, plant-based technologies and public sector access to research materials. Underlying this debate is the doubling of U.S. patent applications from 1980-1995 (See Figure 1 in Appendix). Surely something dramatic is happening to propel such an increase.

Under current U.S. law, by some interpretations, the novelty and nonobviousness standards for obtaining a U.S. patent are too low, which creates too many minor patents.1 Minor patents are narrow patents that do not confer a large monopoly to the patent holder.2 According to some, “there is no economic value in conferring a patent monopoly except for an invention that will have a significant impact.”3 The Human Development Report states, “consensus is emerging that intellectual property rights can go too far, hampering rather than encouraging innovation . . . .”4 Supporting the assertion of low patentability standards, approximately two thirds of all U.S. patent applications mature into patents.5 Yet, substantiating the general statement that patentability standards are too low is difficult, partly because relatively high and low patentability standards create different incentives and outcomes for inventors. Indeed, it has

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2 Id.
3 Id.
5 See infra pt. B (discussing success of certain types of patent applications).
been argued the real purpose of a patent system is not to stimulate basic research for major products, but rather to encourage the production of mundane but practical products for which a monetary inducement is essential.\(^6\)

A. Objectives

This paper analyzes the issue of patent breadth indirectly by examining changes in patentability standards over time through the examination of the success ratio of patent grants.\(^7\) If patentability standards have declined, then the recent proliferation of minor patents is evidence supporting the beliefs of Barton\(^8\) and UNDP.\(^9\) However, if patentability standards are largely unchanged, then the rise in grants and applications can be attributed to changes external to the U.S. Patent and Trademark Office (USPTO). The generally stable success ratio in recent decades can be interpreted as suggesting no major changes have occurred in patentability standards. Yet, if standards had declined and inventors responded by increasing the number of applications in the same proportion, the results would be as seen in Figure 3.

B. Success Ratio

The success ratio is a somewhat complex variable to interpret. The USPTO publishes several figures annually: total (foreign and domestic) application numbers, total grants in year t, and total grants from applications made in year t.\(^10\) Yet, certain USPTO practices may lead to an under count of the true success ratio. An alternative determination of the success ratio, known as the Grant Rate, has been developed.\(^11\) In contrast to the reported USPTO

\(^6\) "[I]t is certainly unwarranted to assume that the small [inventions] need less stimulus than the great ones; rather the contrary, for minds of the first order are more apt to express themselves without other inducements than the work itself." 117F.2d at 364, 48 USPQ 446.

\(^7\) The success ratio is the proportion of applications in a given year that eventually leads to a patent grant.

\(^8\) Barton, supra n. 1, at 1933.

\(^9\) U.N. Dev. Program, supra n. 4.

\(^10\) U.S. Patent and Trademark Office <http://www.uspto.gov> (accessed April 5, 2004), except total grants from applications made in year t is available by request only.

success ratio averaging about two-thirds during 1993-1998 (Figure 3), the Grant Rate was computed up to 97 percent.\footnote{Id. at 3.}

At issue are allowances under U.S. patent law which permit amendments to patents undergoing examination, leading to a new application number but the same priority date.\footnote{In a recalculation by the USPTO, the Grant Rate for 1996-2000 was computed at 75%.
Robert a. Clark, U.S. Continuity law and its Impact on the Comparative Patenting Rates of the US, Japan and the European Patent Office, 85 J. Pat. Trademark Off. Socy. 335, 337 (2003).} If Quillen is correct that the newly numbered applications are essentially identical to the earlier ones, then the actual success ratio is higher than reported by the USPTO.\footnote{35 U.S.C. § 120 (2000).} Since we are attempting to explain changes in the reported success ratio, this is potentially significant for our analysis.

The aspects of the Patent Act at issue are:

Continuation Applications:\footnote{Quillen, supra n. 11, at 6-7.} Once an examiner has filed a final rejection, the applicant may either accept any approved claims, leading to a narrowed patent, or file for continuation.\footnote{35 U.S.C. § 120.} In a continuation, claim amendments are permitted, but new matter cannot be added to the description. Because new matter is not claimed, the only prior art reviewed during a continued examination is the prior art existing at the time of the original application.\footnote{Philip W. Grubb, Patents for Chemicals, Pharmaceuticals and Biotechnology ch. 6, 104-05 (Clarendon Press 1999). The applicant also has a third option; appeal the decision by the examiner. Id. at 105.}

Continuation-in-Part Applications:\footnote{Id. at 106.} The continuation-in-part application is similar to the continuation application except that new matter may be added, increasing the scope of the original application. Unlike continuation applications, intervening prior art must be considered for all added matter.\footnote{35 U.S.C. § 120; See William B Slate, The Real Security of Continuation-in-Part Applications, 83 J. Pat. Trademark Off. Socy. 551 (2001) (discussing the merits and misconceptions of continuation-in-part applications).}

Divisional Applications:\footnote{Grubb, supra n. 17, at 106-07.} If the original application includes more than one distinct invention, the examiner will require the applicant to file separate
applications for each invention leading to two or more "divisions". If a divisional application is filed, one division may retain the filing date of the original (subsequently abandoned) application, but with a new application number.

The accuracy of the reported success ratio hinges on whether revised applications represent the same application merely with a new number, or whether the original and revised applications are distinct inventions. We argue that continuation-in-part applications are indeed new inventions due to the addition of new matter.

Consider that, as an alternative approach to a continuation-in-part application, an applicant could have an original application issue and then file an improvement application on matter that could have been the basis for a continuation-in-part application. This example emphasizes how the two inventions are distinct under USPTO practice.

Divisional applications can create double counting of applications to the extent revised applications carry forward essentially unchanged the description and claims of the parent application. Figures provided by Quillen and Webster indicate divisional applications represent 11 percent of all applications from 1993-1998. This means divisional applications represent, at most, a 5.5 percent double counting of applications (the number of partial parent applications resubmitted with a new patent number) and less if a parent application leads to more than two divisions.

Adding to the calculation confusion is whether continuation applications (at sixteen percent, the largest class of applications identified by Quellen over 1993-1998), contain new, distinct inventions when submitted. A continuation application may be submitted with claims to a new invention, or may be submitted as a means of delaying the issuance of a (ultimately narrowed) patent. When the patent term was seventeen years from the issue date, there was a benefit to delaying issuance in some cases. That benefit evaporated in 1995 when the patent term was changed to be measured from the

22 Id.
23 Id.
24 Quillen, supra n. 11, at 4.
25 Quillen, supra n. 11, at 16 tbl.1.
26 Id.
27 Patents subject to an extended examination period, during which time the PTO treats them as confidential, are known as submarine patents. Grubb, supra n. 17, at 111. Such patents can cause havoc among competitors using the now-patented products or processes when they emerge years later. Id.

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application date, not issuing date. Under the amended law, delaying the patent issuance only reduces the ultimate life/value of the granted patent.

If continuation applications were primarily intended to delay issuance, one would expect to see the number of continuation applications decline after 1995. However, the number of continuation applications submitted in 1996 and 1997 are nearly identical to the amount submitted in 1993 and 1994. The number of applications submitted in 1995 is higher than any other year from 1993-1998. This one year increase is likely due to applicants taking advantage of the last opportunity to use continuing applications for delay purposes.

However, the increase is minimal when compared to the total number of applications submitted. Moreover, the number of continuation applications is fairly stable from 1993-1998. Since our approach analyzes annual changes, not absolute levels, the variation is trivial; therefore, we conclude the success ratio figures reported by the USPTO largely represent Patent Office actions on distinct inventions.

C. Approach

Our methodology, described in detail below, recognizes that the patent examination process is a highly systemized one. The approximately 2,000 current examiners are coordinated by adherence to the USPTO Manual of Patent Examining Procedures (MPEP) with its detailed procedures and definitions. Changes in procedures may be initiated by the Patent Office, by the courts, or by the legislature, and practiced through the MPEP. Failures to follow those practices are assessed through the examination processes. Thus, when in the Human Development Report the statement is made that “the criteria of non-obviousness and industrial utility are being interpreted too loosely,” those changes should be associated with a specific internal USPTO policy or external court decisions and legislative acts. That is, changes in examination practices are judged to be neither random nor incremental.

29 Quillen, supra n. 11, at 16 tbl. 1.
30 Id. In 1995 39,448 were submitted, versus 28,975 and 32,563 submitted in 1996 and 1997 respectively. Id.
31 See id. (citing approximately 10,000 range in continuations patents from a low of 28,339 to a 1995 high of 39,448 in 1995, or 5.5 percent of the average of 180,000 annual patents for 1993-94.
34 U.N. Dev. Program, supra n. 4, at 103.
Here, we analyze aggregate patent application and grant data from 1965 through 1997. The aggregated analysis is necessitated by the USPTO practice of releasing annually only total application numbers; no data on applications by patent classification/technology categories are available.\footnote{In April 2001, the USPTO began to publish most applications within 18 months of the initial filing date, which represents a far too recent data set for our analytical purposes here.} Overall, after examining the effects of six major changes in USPTO practice in the 1980-1993 period, we find there is no evidence of declining (or, indeed, increasing) patentability standards. Changes in procedures and practices, while notable in some regards, did not affect the system overall.

II. LITERATURE REVIEW

Zvi Griliches conducted an expansive literature review and hypothesized that a patent application is submitted when the expected value exceeds the application costs.\footnote{Zvi Griliches, Patents: Recent Trends and Puzzles, in Brookings Papers on Economic Activity: Microeconomics, 291-319 (Martin Neil Baily & Clifford Winston eds., 1989).} (Firms also incur a liability associated with the possible need to protect a patent against infringement). Expected value is the market value of the property rights times the probability of the patent issuing, minus the potential negative effects of disclosure. Hence, any change in USPTO practice which alters the probability of receiving a patent or affects the scope of the patent rights granted influences the number of applications as well as the success rate, the proportion of applications leading to patent grants.

More formally, let $A_t$ be application numbers in year $t$ defined as,

$$A_t = \sum_j \sum_i 1\{E[\pi_{ijt}] - \text{ApplicationCost}, > 0\}$$ \hspace{1cm} (1)$$

where

$$1\{E[\pi_{ijt}] - \text{ApplicationCost}, > 0\} = \begin{cases} 1 & \text{if } (E[\pi_{ijt}] - \text{ApplicationCost}) > 0 \\ 0 & \text{otherwise} \end{cases}$$

and $E[\pi_{ijt}]$ is the expected value of invention $i$ in sector $j$ during year $t$. Without loss of generality, $E[\pi_{ijt}]$ can be set at $\overline{\pi}_{jt}$, the average value of an
invention in sector j year t, times the expected probability of a patent issuing (EPr(G_t)), adjusted for enforcement costs.\(^{37}\) Substituting yields,

\[
A_t = \sum_j 1\{\bar{\pi}_{jt} \cdot EPr(G_t) - ApplicationCost_t - EnforcementCosts_t > 0\} (2)
\]

where, \(\frac{dA_t}{d\bar{\pi}_{jt}} > 0\) (i.e., increasing the expected value of a patent increases application numbers), and \(\frac{dA_t}{dEPr(G_t)} > 0\) (i.e., increasing the probability of a grant increases application numbers).

Now, consider the patent granting function. A close statistical correlation between applications and examiner numbers was found in an analysis explaining application numbers for the 1925-1987 period.\(^{38}\) On average, the patent pendency period has been 18 – 24 months, but at times longer due to examiner shortages stemming from inadequate budget allocations and other factors.\(^{39}\) Delays in grants generally reduce the economic value of an application and hence application numbers. The resultant lags have contributed to the fluctuations in the annual success ratios, particularly in the 1970’s. The quality of an application (Q_a) and the granting standards also affect grants.

If \(G_t =\) total patent grants for applications filed in year \(t\), and \(E_t =\) examiner numbers in year \(t,\)

\(^{37}\) We recognize that in practice average values of patents are not informative. However, our use of these average values is purely for expository simplicity. Because of data limitations that prevent the calculation of sector-specific granting probabilities, we assume that the probability of a patent issuing is constant across sectors. We also assume that application costs and enforcement costs are constant across sectors, though we recognize that this simplifying assumption conceals sectoral variation.

\(^{38}\) Griliches, supra n. 36, at 296 tbl. 2.

\(^{39}\) There is a non-systematic lag between examiner demand (applications) and examiner numbers because funds for examiners must be justified to and appropriated by the Congress. This remains true today despite the fact that the USPTO generates about a ten percent surplus of fees over costs. H.W Hoglund, Patent Fee Diversion Crosses Constitutional Boundary, 83 J. Pat. & Trademark Off. Socy., 725, 735 (2001).
\[ G_t = \sum_i 1\{Q_{it} \geq S \tan \text{darts}_i \left| \sum_{m=0}^{2} E_{t+m} \right\} \]  

(3)

where \(1\{\cdot\}\) is an index function that yields 1 if application \(i\) meets or exceeds patenting standards in year \(t\) given examination capacity and 0 otherwise. This formulation says standards (and hence \(G_t\)) are affected at the margin by examiner numbers, \(E_t\). The relationship can best be understood by considering what happens when \(E_t\) is inadequate and a backlog of applications develops. In the short term, examiners can reduce the backlog only by accepting or rejecting a higher proportion of applications. Either is possible; we leave the determination as an empirical question. The relevant information here is that \(G_t\) is affected by \(E_t\). Examination capacity for an application in year \(t\) is measured as the sum of number of examiners in years \(t, t+1,\) and \(t+2\) since the examination process extends across multiple years.

Given equation (3) we assume that \(\frac{d G_t}{d Q_{it}} > 0, \frac{d G_t}{d E_{t+m}} > 0 (m = 0,1,2),\) and

\[ \frac{d G_t}{d S \tan \text{darts}_i} < 0. \]  Thus, as application 'quality' (in the sense of fulfilling the patentability criteria) and examiner numbers increase, grants rise, while a rise in patentability standards causes grant numbers to fall.

Finally, combining (2) and (3) yields the success ratio, \(S_t\), defined as:

\[ S_t = \frac{\sum_i 1\{Q_{it} \geq S \tan \text{darts}_i \left| \sum_{m=0}^{2} E_{t+m} \right\}}{A_t} = \frac{\sum_i 1\{\pi_{ij} \cdot \Pr(G_i) - \text{ApplicationCost}_i - \text{EnforcementCosts}_i > 0\}}{A_t} \]

(4)

We are particularly concerned with the effects of changes in USPTO practices on standards, application quality, and application numbers. Note, while by definition \(S_t = \Pr(G_t)\), this does not necessarily apply to \(E\Pr(G_t)\) due to differences in expectations and actual outcomes.

From the perspective of the 1980's, when the issue was the decline in the propensity to patent per dollar of R&D expenditure, Griliches was also concerned with explaining patenting trends. Changes in industrial composition were found to be unrelated to patenting propensities. Statistical analysis indicated an annual decline in the propensity to patent in the one to two

\[ \text{Griliches, supra n. 36, at 299-312.} \]

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percent range, of which about a third was explained by changing defense expenditures. Yet, rising industrial R&D as well as public sector research expenditures (part of which are industry-sourced), left an unexplained decline in patenting over the study period, the reduced propensity-to-patent. Here, we are concerned with an unexplained change as well, but an increase rather than a decrease in the propensity to patent.

Kortum and Lerner focus directly on the issue of interest here; namely, what explains the rise in patent applications since about 1980. In particular, they analyze one of the factors we consider as well, the creation of the so-called ‘friendly court’ scenario in 1982. The establishment of the Court of Appeals for the Federal Circuit (CAFC) concentrated patent-related cases in a single court, widely considered to be pro-patent. This was in contrast to the prior gamesmanship of forum shopping among 12 regional appeals courts based on perceived differences in attitudes, resulting in varied and generally less support for the patent system and individual patents. More favorable and consistent treatment would raise the value of patents and patent application numbers.

Kortum and Lerner’s null hypothesis is that technological change increased the opportunity to develop commercial products, leading to the observed post-1980 trend of a rising patenting propensity. Clearly, distinguishing between effects of court policy and technological change is of critical importance for public welfare and USPTO policy.

The empirical test used by Kortum and Learner is structured around the hypothesis that a friendly court would raise patent values for all applicants, both foreign and domestic. Hence, application rates should rise in concert, with domestic applications rising far faster that those of foreigners. Moreover, higher application numbers should lead to lower quality applications under Griliches’ theory, and hence a declining success ratio following the creation of the CAFC. None of the expected outcomes described above occurred. Rejecting the effect of the existence of the CAFC, “a more plausible

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42 *Id.* at 4-6.
43 *Id.* at 2-3.
44 *Id.* at 6.
45 The Kortum and Lerner approach fails to account for the combination of multiple foreign applications and other differences between US and EU and Japanese patent office practice. See Clark, *supra* n. 13.
46 Griliches, *supra* n. 36 at 292.
47 Kortum and Lerner, *supra* n. 41, at 11.
explanation for the rise in patenting is that either technological opportunities or the process of doing research has improved."

They rejected the technological opportunity explanation by noting that patent numbers were distributed across technologies in an unchanging pattern. New opportunities, in contrast, would likely skew grants toward certain technologies at variable points in time when such technologies became available and affordable. The explanation of improvement in the research process then emerges by default as the favored explanation. Of course, a change in corporate policy favoring greater patenting would lead to the same outcome, something Rivette and Kline have observed. We examine the friendly court hypothesis in section III, along with five additional policy explanations for changes in the application numbers and success ratio. Our approach, however, uses different methodology not dependent on distinguishing between domestic and foreign applicants.

III. METHODOLOGY

A. Changes in Policies and Practices Since 1980

As noted briefly above, our analysis is based on the presumption that any changes in patent granting practices by the USPTO can be traced to specific policy or legal changes. In this sub-section, we identify six such major policies in the post-1980 period and their effects on the application and granting process. Only changes which could affect applications and grants in all technology areas can be used on the aggregated applications data available from the USPTO. We select the year 1980 as the starting point because it approximately identifies when application numbers began a sharp increase (Figure 1). We did not test policy changes following 1993, largely because insufficient ex post observations to conduct the analysis were available.

Identification of the effects of the six analyzed policy/practice changes is based on Equation (4), repeated here for convenience:

43 Kortum and Lerner, supra n. 41, at 13.
49 Id. at 12-14.
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\[
S_t = \frac{G_t}{A_t} = \frac{\sum \mathbb{1}\{Q_{it} \geq \text{Standards}_t \mid \sum_{m=0}^{2} E_{t+m}\}}{\sum \mathbb{1}\{\bar{\pi}_{jt} \cdot \text{EPr}(G_i) - \text{ApplicationCost}_t - \text{EnforcementCosts}_t > 0\}}
\]

(4)

where,

- \(S_t\) – success rate year \(t\),
- \(G_t\) – total grants from applications made in year \(t\),
- \(A_t\) – applications in year \(t\),
- \(Q_{it}\) – quality (in the sense of fulfilling novelty, utility and nonobviousness standards) of the application for invention \(i\) in year \(t\),
- \(E_t\) – examiner numbers in year \(t\),
- \(\text{Standards}_t\) – USPTO examination standards, year \(t\),
- \(\bar{\pi}_{jt}\) – average (expected) profitability of patent granted in sector \(j\) and year \(t\),
- \(\text{EPr}(G_i)\) – expected probability of receiving a patent from an application filed in year \(t\),
- \(\text{Application Cost}_t\) – cost of patent application in year \(t\), and
- \(\text{Enforcement Costs}_t\) – expected cost of enforcing a patent based on an application made in year \(t\).

We considered the following policy changes:

1. **1980.** In *Diamond v. Chakrabarty*, the Supreme Court noted the Committee Reports related to the 1952 recodification of the patent laws indicate that Congress considered “everything under the sun that is made by man” to be patentable subject matter.\(^{31}\)

   Implications: Technically, *Chakrabarty* applies only to microorganisms and biotechnology. Nonetheless, the Court’s expansionist position in the ‘everything under the sun’ statement however could, under our reasoning, signal the potential of new technological areas of patentable subject matter, boosting application numbers.

   In terms of equation (4), \(A_t\) would rise, but the effect on patent quality \((Q_{it})\) (and hence probability of a grant, \(\text{EPr}(G_i)\)) as well as expected profitability \((\bar{\pi}_{jt})\) are all ambiguous, so that no prediction can be made regarding changes in the success rate.

\(^{31}\) 447 U.S. 303, 309 (1980).
2. 1982. The CAFC is created, concentrating judicial interpretation and infringement actions in a single, “friendly” court and ending forum selection.\footnote{Kortum and Lemer, supra n. 41, at 12.}

Implications: From equation (4), more consistent and favorable treatment of patent cases should raise the expected value of a patent in all sectors ($\bar{\alpha}_p$) and application numbers ($A_i$). However, because applications which would not previously have been filed now are being filed, average patent quality ($Q_i$) declines, holding down the number of grants ($G_i$), leading overall to a reduced equilibrium success rate.

3. 1984. The CAFC ruled prior publication obviates novelty only when a single publication reveals all aspects of an invention.\footnote{Studiengesellschaft Kohle v. Dart Indus. Inc., 726 F.2d 724, at 726-17. (Fed. Cir. 1984).}

Implications: A reduction in the novelty requirement is a form of decline in standards (Standards, ) so that grants ($G_i$) will rise. Similarly, the expected probability of a grant will increase (EPr($G_i$)), leading to increases in application numbers. These two offsetting effects are expected to lead to no change in the equilibrium success rate. A short term (non-equilibrium) effect also results. In the period immediately following the change but before more applications can be filed, grants ($G_i$) rise but applications ($A_i$) are unaffected, leading to a temporary rise in the success rate ($S_i$).\footnote{Recall that $G_i$ is the number of patents granted for which applications were filed in year $t$.} This is referred to as the short term effect.

4. 1987. The CAFC re-interprets the definition of a patentable invention from ‘reduced to practice’ to ‘substantially complete.’\footnote{UMC Elecs. Co. v. U.S., 816 F.2d 647, 656 (Fed. Cir. 1987).}

Implications: As above in #3, with no expected change in the equilibrium success rate. The short term effect is as in #3.


Implications: As noted above in policy change #3, no change in the equilibrium success rate is expected, due to offsetting effects. The short term effect is also described in policy change #3 as noted above.

6. 1993. The Patent and Trademark Office Center for Quality Services (the Center) was established, making a commitment to customer services and surveys.\footnote{R. Corcoran, Quality Review and Control in the PTO: the Historical Evolution, 81 J. of the Pat. & Trademark Off. Socy. 7 (1999).}
Implications: The existence of the Center would likely signal the commitment of the Patent Office to assisting applicants, reducing costs (Application Cost,) and/or granting uncertainty (EPr(Gi)) and hence raising application numbers. However, as in #2, because applications are filed which would not have been, average patent quality (Qn) declines, leading to a reduced equilibrium success rate overall. For the short run, if part of the commitment is the more rapid hiring of examiners as needed (to the degree the USPTO controls that timing), then grants will rise as well, leading to an ambiguous short term success rate.

Table 1 summarizes these changes and expected associated effects on applications and success rates. As can be seen, the effect of all the identified changes is to raise application numbers, in line with observed behavior. The predicted short- and long-term changes in the success rate, however, provide a means for determining if the rise in application numbers is due to policy changes or factors external to the USPTO.

B. Analytical Approach

In this sub-section we analyze empirically the changes specified in Table 1 beginning by considering changes in applications following a policy or procedural change. The following econometric model of patent applications is based on Griliches:58

\[
\ln(A_t) = \beta_0 + \beta_1 \cdot TIME + \sum_{i=2}^{3} \beta_i \ln(RD_{t-i}) + \beta_4 \ln(GDP_t) + \varepsilon_t, \quad (5)
\]

where TIME is an annual time trend, RD, aggregate R&D expenditures, and GDP, Gross Domestic Product.

Permanent changes in S, can be included using a simple modification of this applications model, as follows:

\[
\ln(A_t) = \beta_0 + \beta_1 \cdot TIME + \sum_{i=2}^{3} \beta_i \ln(RD_{t-i}) + \beta_4 \ln(GDP_t) + \beta_5 T + \beta_6 (T \cdot TIME) + \varepsilon_t, \quad (6)
\]

where T is a dummy variable that is 0 before the year of the predicted change and 1 the year of the change and beyond. The intercept and slope shifters in (6) enable the model to explain permanent changes in applications due to discrete policy or procedural shifts.

58 Griliches, supra n. 36, at 292.
Our analysis however focuses on the success rate, not application numbers. Hence, to Equation (6), we must add to the demand variable of application numbers and potential patent supply, or, actually, capacity variables, the USPTO capacity to review and grant patents. Total annual patent applications filed ($A_t$) reflects the demand for patents. Because the patent review process can stretch across several years, it is necessary to model explicitly the effect of year $t$ applications upon applications filed in $t-1$, $t-2$, etc. This necessitates the inclusion of application lead variables, $A_{t+1}$. According to USPTO data, the current average review period is about 18 months, nearly half the historical average. 59 We therefore include contemporaneous applications ($A_t$), as well as three years of lead application variables ($A_{t+1}$, $A_{t+2}$, $A_{t+3}$) when modeling $S_t$. Note that while $A_t$ and $S_t$ are determined endogenously, the relationship is highly non-systematic due to shifting examination periods over the study frame, caused in part by exogenous variations in examiner numbers (see below).

The second patent demand variable included is total annual expenditures on research and development (R&D), $RD_t$. We hypothesize that increased R&D will affect $S_t$ by increasing both the quality and quantity of patent applications filed. Again, the timing of the effect is important. In this case, there is clearly a lagged effect of R&D on the patent success rate. In our general model, we include two lagged R&D variables ($RD_{t-2}$, $RD_{t-3}$).60 Recognizing that an increasing share of the demand for U.S. patents comes from overseas and that foreign R&D affects this component of U.S. patent demand, total OECD R&D expenditures are more appropriate.61 Yet that data series is inconsistent over the entire 1965-1997 period analyzed here.62 As a proxy, we use U.S.-only R&D data which track very closely the rise in OECD values in the later period (See Figure 2 in Appendix).

We model the capacity of the USPTO to review and grant patents primarily by including total USPTO patent examiner staff, $E_t$, as an explanatory variable. The sign is indeterminate. Again there is an important time dimension to the expected relationship between $E_t$ and $S_t$. Specifically, year $t$ available examiner staff should affect the capacity of the USPTO not only to review patent applications filed that year, but also those prior applications from $t-1$, $t-2$

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60 These lags were determined using a general-to-specific modeling strategy in which F-tests were used to assess the appropriate lag length. See D.F Hendry, Dynamic Econometrics at 269-70 (C.W.J. Granger & G.E. Mizon eds. Oxford Univ. Press 1995).


62 Id.
still under review. When modeling $S_t$, we therefore include two lead examiner variables ($E_{t+1}, E_{t+2}$) in addition to the contemporaneous variable ($E_t$).\(^{63}\)

The completely specified model is:

$$
\ln(S_t) = \beta_0 + \sum_{i=0}^{3} \beta_{i+1} \ln(A_{t,i}) + \sum_{i=2}^{3} \beta_{i+1} \ln(RD_{t-i}) + \sum_{i=0}^{2} \beta_{i+1} \ln(E_{t+i}) + \epsilon_t
$$

*Short term* changes in $S_t$ can be analyzed using model (7) by examining whether $S_t$ exceeds or falls below $\hat{S}_t$. Alternatively, it is possible to examine the pattern of the residuals—whether they increase and return to zero over a one to two-year period. For purposes here, short term refers to the one to two-year period following a USPTO policy change before inventors can respond to lower patentability standards with increased applications.

The *long-term* effect policy changes and court decisions have on success rates can be modeled using slope and intercept dummy variables in model (7). Intercept dummy variables reflect changes in the long run equilibrium success rate. For the *short-term* effect, quadratic slope dummy variables capture any eventual return to equilibrium.

### C. Data

Models (6) and (7) are estimated over the 1965-1997 period, the latter date representing the most recent usable date with reasonable certainty by which all applications will have been acted on assuming customary examination lags. The calculated patent success rate employs USPTO data on total annual utility patent applications and total utility patent grants by application date.\(^{64}\) Annual examiner staff counts were also provided by the USPTO. We use total U.S. R&D expenditure data assembled by the National Science Foundation.\(^{65}\) Gross Domestic Product (GDP) data are in (1996) real dollars and collected from the Bureau of Economic Analysis.\(^{66}\)

We make the classic regression model assumptions and proceed to estimate the model using standard Ordinary Least Squares (OLS) regression.

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\(^{63}\) These leads were determined using F-tests and a general-to-specific strategy. See Hendry, *supra* n. 60.

\(^{64}\) These utility patent applications data exclude reissue applications, which constitute a negligible portion of total applications received.


As the percentage of applications that ultimately mature into patents, the dependent variable is technically constrained between 0 and 1 (i.e., \( S_i \in [0,1] \)). This introduces the possibility of truncated dependent variable problems. Since the observed range of \( S_i \) is well within these theoretical bounds \( (S_i, 0.5, 0.75) = [0, 1] \), see Figure 3), however, truncated dependent variable estimation techniques (e.g., Tobit) are identical to standard OLS.\(^67\)

IV. RESULTS

A. Application Numbers

The general estimation results of model (5) are shown in Table 2. The fit of this model, by most conventional statistical standards, is quite good. The model in (6) was subsequently estimated with slope and intercept changes for each of the changes identified in Table 1 with the results shown in Table 3. (See Table 2 in Appendix.)

The results indicate a statistically significant effect for each of the six policy change years identified in Table 3. The fact that the intercept and slope dummies in all six estimations are significant validates what is graphically evident in Figure 1, namely that there was a dramatic increase in applications around 1980. Based on the pattern of adjusted R-squares of these models, the shift in applications likely came in the early 1980’s, but that too is evident from the figure. The tests of model (5) provide no evidence regarding USPTO patent granting procedures. (See Table 3 in Appendix.)

B. Short-Term Success Rate

Short-term changes in the success rate are analyzed using the methodology described in Section III(B) with expectations summarized in Table 1. The general results of the estimation are shown in Table 4; Figure 3 depicts the actual and the predicted success rates. Judging from the graph and the R\(^2\) of 0.82, the fit is very good over most of the time period. Only during the early 1970’s and early 1990’s are there any appreciable deviations between the actual

\(^67\) For example, a standard estimation technique for truncated variable models is to apply maximum likelihood estimation separately to the non-truncated data and the truncated data. When there are no truncated data, this simply reduces to standard maximum likelihood estimation, which under the assumptions of the classic regression model (including normality assumptions) is identical to OLS. See W.H. Greene, *Econometric Analysis* at 965 (3d Prentice Hall 1997).
and predicted success ratios. No notable USPTO policy changes occurred in the beginning of the 1970’s, but several took place at the beginning of the 1990’s.68 For a more specific analysis of effects of the identified policy changes, discrepancies between the predicted and the actual success rates can be analyzed using the residuals plotted in Figure 4. The only year with a deviation greater than 2 standard deviations is 1992, a year when no policy change occurred. More significantly, for the 1990’s, the deviations are in the opposite direction from what the identified policy changes were predicted to cause (Table 1). (See Figure 3, Table 4 and Figure 4 in Appendix.) Overall, there is no evidence the discrete policy shifts identified in Table 1 are responsible for any direct exogenous shocks to the success rate. While attempting to read causality into residuals can be problematic, it does appear that any substantial discrete shock could be identified in the residuals given the good fit of the model.

C. Long-Term Success Rate

The model in (7) was also estimated for long-term changes by using intercept, slope and slope-squared dummies for each of the six identified policy changes. None of these dummy variables were statistically significant (Table 5), indicating no discernible long-term changes in success ratios attributable to the policy changes. Thus, neither short-term nor long-term effects are evident in the data. In sum, neither the graphical nor the econometric analysis yields any evidence of changes in success rates due to the policy changes and court decisions in question. (See Table 5 in Appendix.)

V. CONCLUSIONS

Critics of the USPTO have suggested patents have been too easily come by of late.69 Our analysis provides no support for those charges. This in no way says there are no policy problems with recent USPTO practices. Rather, it suggests any problems are specific to particular types of technologies or user groups, or possibly even to an identifiable handful of patents. In our view, any remedies should be directed to those specifically identified problem areas and not to USPTO practices in general.

We conclude major changes in applications are the result of technological opportunities and/or changing business practices. While the

68 See Policy Changes, supra in Section III.
69 See quotes, supra, Section I.
possibility of patent-induced problems still exists in specific areas and cases, we suggest refocusing analysis away from patent supply issues, which is to say USPTO practice, and onto corporate patenting behavior—patent demand consideration—which is poorly understood. The USPTO is a technical service agency; we conclude the demand for its services has changed more than the provision of those services.
APPENDIX


Volume 44—Issue 3
FIGURE 2—R&D in US and total R&D in OECD (US, UK, France, Germany, Japan), 1981-1998. (Sources: OECD, National Science Foundation.)
FIGURE 3—Actual and predicted success ratios (1965-1997). (Source: Computed and Compiled by authors – see text).
FIGURE 4—Residuals from patenting success rate model. (Source: Computed by authors).
TABLE 1
Anticipated effects of changes in practices on patent applications and success ratios

<table>
<thead>
<tr>
<th>Year</th>
<th>Change</th>
<th>Applications</th>
<th>Success Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Long Term</td>
<td>Short Term</td>
</tr>
<tr>
<td>1980</td>
<td>Chakrabarty: &quot;Everything under the sun...&quot;</td>
<td>RISE</td>
<td>?</td>
</tr>
<tr>
<td>1982</td>
<td>Creation of CAFC</td>
<td>RISE</td>
<td>FALL</td>
</tr>
<tr>
<td>1984</td>
<td>Reduce novelty standard</td>
<td>RISE</td>
<td>—</td>
</tr>
<tr>
<td>1987</td>
<td>Reduce invention standard</td>
<td>RISE</td>
<td>—</td>
</tr>
<tr>
<td>1991</td>
<td>Reduce nonobviousness standard</td>
<td>RISE</td>
<td>—</td>
</tr>
<tr>
<td>1993</td>
<td>USPTO commitment to service</td>
<td>RISE</td>
<td>FALL</td>
</tr>
</tbody>
</table>

— = no change
? = inconclusive
TABLE 2
Utility patent applications model, 1965-1997
[dependent variable: ln(A_t)].

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>StdErr</th>
<th>tValue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>9.46</td>
<td>7.70</td>
<td>1.23</td>
</tr>
<tr>
<td>Time</td>
<td>0.03</td>
<td>0.03</td>
<td>0.89</td>
</tr>
<tr>
<td>ln(RD_{t-2})</td>
<td>-1.86</td>
<td>0.58</td>
<td>-3.19</td>
</tr>
<tr>
<td>ln(RD_{t-3})</td>
<td>1.71</td>
<td>0.59</td>
<td>2.90</td>
</tr>
<tr>
<td>ln(GDP_t)</td>
<td>0.42</td>
<td>0.91</td>
<td>0.46</td>
</tr>
<tr>
<td>Adjusted-R^2</td>
<td>0.88</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Do Patents Come Too Easy?**

**TABLE 3**
Intercept and slope shift variables in selected years for applications model

<table>
<thead>
<tr>
<th>Dummy Year</th>
<th>Intercept</th>
<th>Slope</th>
<th>Adj-$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>none</td>
<td>-</td>
<td>-</td>
<td>0.884</td>
</tr>
<tr>
<td>1980 Estimate</td>
<td>-0.69</td>
<td>0.05</td>
<td>0.980</td>
</tr>
<tr>
<td>(t-statistic)</td>
<td>(-9.97)</td>
<td>(11.99)</td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>-0.80</td>
<td>0.04</td>
<td>0.980</td>
</tr>
<tr>
<td></td>
<td>(-9.00)</td>
<td>(12.25)</td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>-0.90</td>
<td>0.05</td>
<td>0.980</td>
</tr>
<tr>
<td></td>
<td>(-8.36)</td>
<td>(11.83)</td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td>-1.16</td>
<td>0.05</td>
<td>0.982</td>
</tr>
<tr>
<td></td>
<td>(-8.96)</td>
<td>(11.54)</td>
<td></td>
</tr>
<tr>
<td>1991</td>
<td>-1.50</td>
<td>0.06</td>
<td>0.975</td>
</tr>
<tr>
<td></td>
<td>(-6.10)</td>
<td>(7.45)</td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td>-2.28</td>
<td>-6.35</td>
<td>0.972</td>
</tr>
<tr>
<td></td>
<td>(0.08)</td>
<td>(7.17)</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 4

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>StdErr</th>
<th>tValue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-1.10</td>
<td>0.46</td>
<td>-2.41</td>
</tr>
<tr>
<td>ln($A_{t-3}$)</td>
<td>0.35</td>
<td>0.07</td>
<td>4.87</td>
</tr>
<tr>
<td>ln($A_{t-2}$)</td>
<td>0.19</td>
<td>0.08</td>
<td>2.25</td>
</tr>
<tr>
<td>ln($A_{t-1}$)</td>
<td>0.16</td>
<td>0.09</td>
<td>1.86</td>
</tr>
<tr>
<td>ln($A_t$)</td>
<td>-0.32</td>
<td>0.07</td>
<td>-4.58</td>
</tr>
<tr>
<td>ln($RD_{t-2}$)</td>
<td>-0.52</td>
<td>0.12</td>
<td>-4.21</td>
</tr>
<tr>
<td>ln($RD_{t-3}$)</td>
<td>0.42</td>
<td>0.13</td>
<td>3.22</td>
</tr>
<tr>
<td>ln($E_{t-2}$)</td>
<td>-0.10</td>
<td>0.05</td>
<td>-2.03</td>
</tr>
<tr>
<td>ln($E_{t-1}$)</td>
<td>-0.02</td>
<td>0.06</td>
<td>-0.33</td>
</tr>
<tr>
<td>ln($E_t$)</td>
<td>-0.11</td>
<td>0.05</td>
<td>-2.34</td>
</tr>
</tbody>
</table>

Adjusted-$R^2$ 0.81
**TABLE 5**
Intercept and slope shift variables in selected years for success rate model

<table>
<thead>
<tr>
<th>Dummy Year</th>
<th>Intercept</th>
<th>Slope</th>
<th>Slope²</th>
<th>Adj-R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>none</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.814</td>
</tr>
<tr>
<td>1980</td>
<td>0.077</td>
<td>-0.009</td>
<td>0.0002</td>
<td>0.794</td>
</tr>
<tr>
<td>(t-statistic)</td>
<td>(0.42)</td>
<td>(-0.54)</td>
<td>(0.76)</td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>0.079</td>
<td>-0.005</td>
<td>0.0002</td>
<td>0.808</td>
</tr>
<tr>
<td></td>
<td>(0.46)</td>
<td>(-0.37)</td>
<td>(0.69)</td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>0.148</td>
<td>-0.014</td>
<td>0.0004</td>
<td>0.797</td>
</tr>
<tr>
<td></td>
<td>(0.61)</td>
<td>(-0.74)</td>
<td>(0.94)</td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td>0.750</td>
<td>-0.057</td>
<td>0.0011</td>
<td>0.807</td>
</tr>
<tr>
<td></td>
<td>(1.34)</td>
<td>(-1.38)</td>
<td>(1.43)</td>
<td></td>
</tr>
<tr>
<td>1991</td>
<td>-0.388</td>
<td>0.020</td>
<td>-0.0002</td>
<td>0.823</td>
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<tr>
<td></td>
<td>(-0.22)</td>
<td>(0.16)</td>
<td>(-0.11)</td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td>-8.486</td>
<td>0.542</td>
<td>-0.0086</td>
<td>0.826</td>
</tr>
<tr>
<td></td>
<td>(-1.33)</td>
<td>(1.31)</td>
<td>(-1.29)</td>
<td></td>
</tr>
</tbody>
</table>