Hiding in the Patent’s Shadow: Firms’ Uses of Secrecy to Capture Value from New Discoveries

Stuart J.H. Graham
College of Management, Georgia Institute of Technology
October 2004

Abstract:
This paper examines firms’ uses of secrecy and patenting in order to explore three elementary questions of firm intellectual property strategy: First, are there complementarities between patenting and secrecy that firms exploit when crafting their technology market strategies? Second, what drives the firm’s choice of a patent-secret mix when developing a strategy to sustain to itself competitive advantage? And third, what are the consequences for the firm of one or another choice or mix? I argue that the use of the U.S. "continuation" procedure affords patent applicants a strategic opportunity. Because continuation practice allows pre-issue application delay, pursuing a continuation patenting strategy may allow the firm to better control the technology development and appropriation process, in terms of the timing of disclosures and managing technological change, preserving an early patent priority date for the invention while protecting an extended period of secrecy against competitors’ discovery. A strategic opportunity arises from the added term of secrecy that the continuation procedure affords to patent applicants. I argue that this period of secrecy may be a complement to the act of patenting itself. This paper employs data on the use by firms of continuation applications in the United States from 1975-1995 in order to empirically test the uses by firms of these secrecy strategies, and to compare these uses against other proposed motivations for patentees’ uses of the continuation application. Results support complementary uses by firms of patents and secrecy in their appropriability strategies.

Keywords: Patents, Secrecy, Patent Continuations, Submarine Patents, Intellectual Property Strategy

JEL Classifications:
Intellectual Property Rights: National-International Issues; Patents, Copyrights (O340)
Management of Technological Innovation and R&D (O320)
Technological Change; Government Policy (O380)
Technological Change; Innovation; Research and Development: General (6210)
1.1 INTRODUCTION

[T]here is nothing improper . . . in filing a patent application [intending] to exclude
a known competitor’s product from the market; nor . . . to insert claims intended to
cover a competitor’s product . . . learned about during the prosecution of a patent
application.\footnote{Text from the opinion of Chief Judge Markey, Kingsdown Medical Consultants and E.R. Squibb & Sons \textit{versus} Hollister, Inc., 863 F.2d 867 (Fed. Cir. 1988).}

When a United States patent for a “Synchronous Memory Device” issued to Rambus, Inc.
in September 1999, semiconductor chip manufacturers recognized the competitive threat:
Within sixteen months, Rambus was commanding royalties-on-sales of up to 3.5% from 7 of the
top-10 DRAM manufacturers worldwide.\footnote{Rambus Incorporated (Nasdaq:RMBS) styles itself an “intellectual property company:” the company’s primary activities include the design, development, and licensing of semiconductor-chip connection technologies that allow memory devices to perform at the higher speeds demanded by new generations of processors and controllers. Rambus holds over one-hundred US and foreign patents, and has licensed its technologies widely within the semiconductor industry.}
The patent precisely covered the communication standard that the industry had adopted in the year 2000, compelling the manufacturers to accept Rambus’ unfavorable license terms to avoid being shut-down. These manufacturers knew that
the patent covered the communication technology because Rambus had helped them write the
industry standard beginning in 1991.

Rambus planned and implemented its licensing hold-up strategy with the knowledge that
the continuation application is available at the U.S. Patent Office and permits a company to keep
the existence of a pending patent secreted from competitors for extended periods. In this case,
Rambus kept the existence of its patent application hidden from its manufacturer-partners for
nine years while the industry standard was being formalized.\footnote{Although Rambus has been met with substantial legal barriers in its attempt to enforce this patent (see Rambus, Inc. \textit{v.} Infineon Technologies AG, 164 F.Supp. 2d 743 (E.D. Va, 2001)(Finding Rambus liable for fraud)), the company’s strategic choices are illustrative of the opportunities that the subject of this paper, \textit{continuation} patenting, offers to firms. While the legality of Rambus’ tactics were upheld by the Court of Appeals for the Federal Circuit, 318 F.3d 1081 (CAFC, 2003), Rambus faces, as of December 23, 2003, an ongoing Federal Trade Commission complaint that the firm’s patent strategy comprised a pattern of illegal unfair competition (FTC Docket No. 9032, complaint filed June 2002).}
The Rambus case is just one of several high-profile examples of a common yet little studied phenomenon: the strategic uses by firms of secrecy, in conjunction with patenting, to prevent dissipation of the economic rents stemming from technology discoveries.

The fundamental question in strategic management is: “How do firms create and sustain
competitive advantage?” (Teece, et al., 1997). Firms routinely pour substantial research and
development dollars into new technologies and, after these investments bear fruit, fail to
adequately appropriate the value from the discovery. Managing knowledge assets has thus
become increasingly recognized as a primary means of securing competitive advantage, and the
role of “appropriability regimes” and intellectual property protections consequently quite
important (Teece, 1986). While individual appropriability mechanisms, such as secrecy and
patenting, have been studied in isolation, few researchers have attempted to describe and test the
ways these mechanisms complement or substitute for one another, and how interactions create opportunities for the innovating firm to capture competitive advantage from its research and development investments.

This paper will examine firms’ uses of secrecy and patenting in order to explore three questions elementary to our understanding of firms’ strategic moves when using patents to capture value from discoveries. First, are there complementarities between patenting and secrecy that firms exploit when crafting their technology market strategies? Second, what drives the firm’s choice of a patent-secret mix when developing a strategy to sustain to itself competitive advantage? And third, what are the consequences for the firm of one or another choice or mix?

I seek to answer these questions by using available data on continuation patent applications. As noted Graham (2004), continuation applications are both extensively used and acutely understudied. The limited prior literature on continuation applications has suggested several explanations for applicants’ use of the continuation in patenting. A policy justification for retaining the continuation often cited by commentators and courts is to allow applicants to correct drafting errors. Another hypothesis suggests that lengthy continuing applications “wear down” Patent Office employees who would otherwise resist awarding the patent. Yet another strain in the literature suggests that applicants use the continuation to keep patents hidden in order to engage in economic hold-up after markets have developed—the so-called “submarine” patent. I suggest that these “submarines” are simply a species of a larger strategic use of the continuation: the secrecy continuation.

I argue that the use of the continuation procedure affords patent applicants a strategic opportunity. Because continuation practice allows delay, pursuing a continuation patenting strategy may allow the firm to better control the technology development and appropriation process, in terms of the timing of disclosures and managing technological change. Since continuation applications allow the patentee to file additional applications upon identical or closely amended disclosures, the process thereby preserves an early priority date for the invention while protecting an extended period of secrecy against competitors’ discovery. A strategic opportunity arises from the added term of secrecy that the continuation procedure affords to patent applicants. This period of secrecy may be a complement to the act of patenting itself.

This paper employs data on the use by firms of continuation applications in the United States from 1975-1995 in order to empirically test the uses by firms of these secrecy strategies, and to compare these uses against other proposed motivations for patentees’ uses of the continuation application. The paper is organized as follows. Parts two and three describe the motivations for continuation practice by firms and analyze the advantages stemming from continuation application strategies, presenting testable implications. Part four presents methodology and results. Part five concludes and discusses further research opportunities.

53 See Crown Cork & Seal Co. v. Ferdinand Gutmann, 304 U.S. 159 (1938). In Crown Cork, the Supreme Court upheld the principal that it is the continuity of disclosure, and not the literal claims, of the two applications that is the proper standard.
1.2 CONTINUATIONS AS OPPORTUNITIES FOR STRATEGIC ACTION

The twin benefits of “priority” and “non-disclosure” earned by the patentee when filing a continuation application are instrumental in motivating the secrecy strategies discussed in this paper. Graham (2004) described in detail that, in the U.S. “first to invent” patent system, the filing of a patent application gives the applicant “priority,” a government-sanctioned presumption that the invention is superior to later-filed applications by competitors. Because prior to 1999 all U.S. applications remained secret until the patents issued, applicants could take advantage of lengthy trade-secret protection on inventions during the pendency of their continuation applications. While this opportunity has been blunted by the operation of the 1999 application-publication requirements, preliminary evidence cited in Graham (2004) suggests that substantial numbers of applicants may be opting-out of the publication requirements by claiming U.S.-only patent status. Thus, continuation may still be offering secrecy benefits to a significant share of U.S. patent applicants.

The statistics reviewed in Graham (2004) showing both the changes in applicants’ use of continuations over time and the delaying implications of choosing to enter the continuation regime raise several questions. While questions of incidence and timing were the focus of Graham(2004), this paper seeks to find answers to the following questions of firm strategy: Was increased use of the procedure primarily fueled by “submarining,” or by other motives? And, how does the continuation application create opportunities for firms to appropriate value from innovations and protect competitive advantage? To aid in answering these questions, I now describe in more detail the circumstances under which patentees use continuation practice and derive economic benefits from its use.

1.2.1 Overcoming Information Impediments

Graham (2004) demonstrated that continuation applications offer applicants opportunities to win patents on their inventions despite the applications being declared initially “unpatentable.” The filing of a continuation application may be due to misunderstandings that create obstacles to effective communication between the parties. Because the continuation allows an applicant to correct errors in the claims that come to light during the “give and take” of the prosecution process, some patents that emerge at the end of a continuation chain are the result of disagreements concerning patentability and may not be principally a secrecy choice.

54 Much has been written concerning the differences between the “first to invent” patent system institutionalized in the United States and the “first to file” system practiced in the overwhelming share of other industrialized nations. For a review, see Takenaka, T. (2002). "Rethinking The United States First-To-Invent Principle From A Comparative Law Perspective: A Proposal To Restructure § 102 Novelty And Priority Provisions," Houston Law Review, 39, 621-665.

55 The USPTO considers that the invention was reduced-to-practice by the application date. Competitors claiming earlier invention must show why they themselves were not diligent in reducing the invention to practice or can otherwise justify delaying the application. Public policy favors the early disclosure of inventions. This underlies the requirement for “reasonable diligence” in reducing an invention to practice, not unlike the requirement that, to avoid a holding of suppression of concealment, there be no unreasonable delay in filing an application once there has been a reduction to practice. Naber v. Cricchi, 567 F.2d 382 (CCPA, 1977), quoted in Griffith v. Kanamaru, 816 F.2d 624 (CAFC, 1987).

The continuation process is costly, and *ceteris paribus* the rational applicant with an interest in being granted a quick patent would avoid investments in monetary fees and the additional time. A continuation patent, when it occurs, may be the result of translation difficulties between applicants and examiners concerning the patentability of the invention disclosed in the pending application.

Information impediments may stem from differences in actors’ knowledge of the disclosed technology, the direction or path of useful innovations, the state of the art in the field, or simply the development of the law relating to patentability. When these communication problems between the inventor and the examiner are grounded in matters related to the focal technology, and to the state of patent law, misunderstandings between the parties may be more likely. Information asymmetries between the parties are likely to be more common when the technology is new or is undergoing an era of rapid change, characteristics attributable to, for instance, software during the 1980s and 1990s (Graham & Mowery, 2003).

When the subject matter of the patent is a completely novel or a newly changed technology, applicants and their agents—as well as the examiners—have had limited time or opportunity to learn. All parties in the patent-granting transaction thus face increased uncertainty about the invention’s patentability. Similarly, information asymmetries can be expected to increase with technological complexity. An applicant disclosing an objectively patentable invention, but facing an examiner who subjectively considers the invention unpatentable, may use the continuing application to capture more time in which to educate the examiner. From these arguments I formulate the following hypotheses:

H1a: Patents are more likely to show a continuation application lineage when the technology is new or rapidly changing.

H1b: Patents are more likely to show a continuation application lineage as the technology is increasing in complexity.

1.2.2 Taking Advantage of PTO Productivity Goals

Apart from continuations used to overcome information impediments, long-standing productivity goals in the Patent Office may present a strategic opportunity to the applicant seeking to win a patent on an objectively “unpatentable” disclosure. By using the continuation, the applicant can postpone the implementation of a Patent Office examiner’s decision *not* to issue a patent, thus making the examiner, and the Patent Office, less productive as regards “final” patent dispositions. Such a strategy may offer benefits to applicants wanting to increase their likelihood of winning “junk” patents.

Because the USPTO has been long interested in serving customers (read: applicants) and boosting examiner productivity (read: reducing application pendency), forcing delay may be a particularly effective lever for improving the likelihood of securing patents on inventions that do little to advance the scientific art. Merges (1999) identifies an institutional set-up at the USPTO that rewards patent examiners with compensation for completing “final” disposals.

---

While the current bonus practices have been in place only since the mid-1990s, these practices are only the most current manifestation of long-standing USPTO policy. Corcoran and Zarfas (1999) report that “quality” enhancement programs have been USPTO policy since the early 1960s, and that during the 1980s and through the 1990s, the measure of “quality” has been increasingly based upon customer satisfaction. Patent Office productivity targets—whether embodied in remuneration or in top-down decrees—coupled with an institutional design that includes continuations may create incentives that foster patent approval on “junk” inventions.58

Rules and fiat at the Patent Office may, accordingly, present applicants with opportunities to use continuations as a means of delaying patent examiner final patentability decisions, shifting costs to the examiner, and thereby improving the likelihood of securing low-quality patents (Quillen and Webster, 2002).59 “Junk” patents may be particularly valuable in industries where the sheer number of patents is considered important, or in which patenting is used for purposes other than capturing value from the innovation. In the semiconductor industry, negotiations over patent rights or cross-licensing agreements involve the parties producing stacks of patents to intimidate competitive rivals (Hall and Ziedonis, 2001). These negotiations are described as a process in which the parties produce a “proud list” of only a few very valuable patents, but the parties also consider the sheer size of the stack of patents, thus making the absolute number of patents important in the negotiations. Hall and Ziedonis (2001) and Shapiro (2001) suggests that, in several key industries, among them semiconductors and computer products, patent thickets have become the norm, with firms increasingly seeking patents for strategic purposes. Cross-licensing “thickets” of this type have been tied to complex technologies (Somaya, 2003a; Cohen, Nelson, and Walsh, 2001; Bessen, 2003). If patentees are indeed motivated by “proud list” or cross-licensing motives in seeking patents, they may be comparatively less interested in the “quality” of the patent, or in the longevity of its term, than would patentees seeking protection over a valuable core technology. Accordingly, patentees interested in creating “proud lists” may face fewer disincentives to use the continuation application than did other patentees in the wake of the 1995 changes to the patent laws. These considerations lead to the following hypotheses:

H2: Low-quality patents are more likely to show a continuation application lineage.

1.3 CONTINUATION STRATEGIES USED TO MAINTAIN SECRECY

Apart from applicants filing these examiner-targeted continuations when presented with an “unpatentable” finding by the patent examiner, continuations are also available when the patent examiner declares that an application is “patentable.” Continuations in that circumstance are not filed by the applicant to alter the examiner’s decision. If the examiner finds that the invention fulfills the statutory requirements of patentability—that it is useful, novel, and non-obvious—the applicant is presented with three options: to allow the patent to issue, to abandon

58 As of December 2003, entering USPTO examiners at GS-5 earn a base salary of $32,819 annually, considerably below the median salaries reported by Salary.com, Inc. for entry level biologists ($34,355), chemists ($39,217) and engineers ($53,144). Thus bonuses and pay-increases based on productivity criteria are likely attractive goals for patent examiners.

59 Lemley (2001) suggests that examiners, for a host of reasons, are prone to grant patents on objectively unpatentable inventions.
the application, or to file a continuation application. I argue that benefits stemming from added secrecy and the institutional structure of the application process can create an expected payoff from continuation that is more valuable than if the applicant immediately allowed the patent to issue. The driver of this added payoff is the added period of non-disclosure that the patentee captures as a result of the filing of the continuation application. The alternative decision, abandoning a “patentable” application, is an infrequent event according to practitioners.

1.3.1 Patent-Secrecy Strategies

Both patenting and secrecy are mechanisms that enable innovators to capture value from their knowledge assets. Although the protection of knowledge assets has long been recognized as an important goal of research and development efforts (Scherer, 1965; Nordhaus, 1969), firms’ protection strategies are still not well understood. For instance, in industries where patents are seen by managers as relatively ineffective means of appropriating value as compared to secrecy, firms continue to patent, often seeking strategic benefit (Levin, et al., 1987; Hall and Ziedonis, 2001). Other firms forego patenting and use secrecy as the exclusive means of capturing value from innovations, although the mechanisms by which firms create and sustain secrecy are not well understood (Brewer, et al., 1996; Liebeskind, 2001). Despite an extensive literature on these mechanisms, the extents to which innovators use secrecy and patenting together has been given scant attention.

<table>
<thead>
<tr>
<th></th>
<th>Patent</th>
<th>Not Patent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Secrecy</strong></td>
<td>Patent-Secrecy Strategies</td>
<td>Pure Secrecy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Trade secret</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Perpetually undisclosed</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>e.g., processes</em></td>
</tr>
<tr>
<td><strong>Non-Secrecy</strong></td>
<td>Pure Patent</td>
<td>Disclosure-Publishing</td>
</tr>
<tr>
<td></td>
<td>- Reverse-engineering</td>
<td>- Little value</td>
</tr>
<tr>
<td></td>
<td>- Readable on-its-face</td>
<td>- Unprotectable</td>
</tr>
<tr>
<td></td>
<td><em>e.g., products</em></td>
<td>- A void blocking</td>
</tr>
</tbody>
</table>

**Figure 3.1: Innovators’ Uses of Patent and Secrecy**
Secrecy and patenting have been traditionally viewed as substitute mechanisms for capturing value from innovation. Secrecy, when compared with patenting, has been identified both by corporate managers (Levin, et al., 1987) and by corporate R&D labs (Cohen, et al., 2001) as a more effective mechanism for appropriating value from innovation in numerous industries. The choice for an inventor is often posed as one between preventing “reverse engineering” by seeking a patent at the cost of disclosing the invention through publication following issue (Horstman, et al., 1985). If the “anti-diffusion” effects of secrecy make trade secrecy a substitute for patenting, then the economically farsighted inventor who foregoes a patent is determining that the patent is too costly or the reward from it too minimal when compared with the value of the invention and the risks of “reverse engineering” (Friedman, Landes, and Posner, 1991).

Given the innovator’s decision, it is possible to develop a taxonomy of the uses to which patenting and secrecy are put, as presented in Figure 3.1. This matrix displays the strategic positions occupied by the innovating firm after making its choice to use patenting and/or secrecy to appropriate value. The traditional view—that patents and secrets are substitutes—is illustrated in the lower-left and upper-right quadrants of the matrix. In these “naked” forms, patenting is associated with disclosure and, conversely, non-patenting with secrecy. Pure patenting has been associated with the archetypal quick-to-market product displaying its technological advance readily on its face, such as medical devices that are easily reverse-engineered. Firms in that sector report that both patenting and lead-time are comparatively important appropriability mechanisms (Cohen, et al. 2001), and patent litigation in this sector is commonplace, suggesting that patents are critical to success.

Cases of the upper-right quadrant, pure trade secret, can be found in technologies protected exclusively with trade secret. Traditional trade secret protection has been associated with process technologies or products with a substantial tacit-knowledge component that is difficult if not impossible to translate into a patent application—indeed, patenting may be unavailable if the knowledge is entirely tacit and simply cannot be codified. Discoveries can remain hidden, either because the technological advance cannot be read on the face of the final product, as is the case with many process technologies which leave no signature on the manufactured good, or because the advance is veiled behind technological barriers, as in the software industry where product “source code” is separated from “object code” to create a technological obstacle and protect against copying. The archetypal example of pure trade secret protection is in process technologies, such as in processes for manufacturing chemical products. Survey evidence (Cohen, et al., 2001) demonstrates that secrecy is relatively important, while

---

60 In the post-1999 publication regime, the disclosure can now arise prior to the patent’s grant, although such an ex ante disclosure is not a certainty.

61 The reward may be insufficient either because the scope is too narrow, or the length too short. The inventor might also perceive that the invention is unpatentable.

62 While the Doctrine of Equivalents in U.S. patent law created opportunities for patentees to prevent reverse engineering ex post, it was a costly method of policing the boundaries of the patent, and reverse engineering after technology disclosure is always a risk in patenting, regardless of the Doctrine’s operation.

63 This view parrots the traditional justification for intellectual property protection, that the innovator is granted a monopoly for a limited time in exchange for a public disclosure of his knowledge, the latter having welfare-increasing spillover effects that rewards society for the monopoly power given the innovator.
patenting is relatively unimportant, to firms in capturing value from process innovation in the chemical sector.

Viewing patenting and secrecy exclusively as substitutes, however, fails to recognize the conditions described by the alternative quadrants in Figure 3.1. The lower-right quadrant portrays discoveries neither patented nor kept as secrets, a condition which can occur when an invention yields no net benefits given the costs of protection, or because the innovator sees the technology as either unprotectable or as the basis for some latent blocking property right in the hands of a competitor. Several prolific innovating firms, including International Business Machine and more recently the Xerox Corporation, have been disclosing discoveries in technical circulars and research notes since the 1950s, even stating explicitly that the purpose in publishing is, from an intellectual property standpoint, defensive in nature.64 Baker, Lichtman and Mezzetti (2001) suggest that these “defensive” motives are only a part of the strategic story, and supply evidence of IBM’s citation history to support their hypothesis that, through strategic disclosure, firms are able to re-set the starting point in a patent race and win for themselves a new race clock. By releasing a previously secret technological advancement into the pool of public knowledge, firms in Baker, Lichtman and Mezzetti create a new standard of prior art and novelty, thereby frustrating competitors already engaged in the patent examination process by re-setting inventive-step threshold. Whatever the motives for the firm choosing disclosure over patenting or secrecy, the choice is not one generally addressed in the literature. Similarly, the literature has seldom considered the strategies depicted in the upper-left quadrant—those in which patent and secrecy are used together to sustain in the firm a competitive advantage or otherwise capture value from new technology discoveries. Two exceptions are noteworthy, Hounshell and Smith (1988) and Arora (1997), to which I now turn my consideration.

1.3.2 Patenting and Secrecy as Complementary Appropriability Mechanisms

The appropriation strategies described in the top-left quadrant of Figure 3.1 are based on a more nuanced view of the relationship between secrecy and patenting, viewing these two instead as complementary mechanisms. Firm strategies using both patents and secrecy contemporaneously to protect different types of knowledge embedded in a technological advance were common in the early chemical industry. Hounshell and Smith’s (1988) study reveals that companies in the turn-of-the-twentieth-century German dye industry used patents and trade secrets as complements in their strategy to build walls around entire research areas. Arora (1997) builds on these findings, suggesting that patents and trade secrets can serve as complements, so long as the requisite characteristic knowledge inheres in the invention: Tacit elements of the knowledge, being difficult to transmit, are said to be better protected through secrecy, while capturing value from the codified knowledge is more effective using patent protection.

Evidence from Cohen, Nelson and Walsh’s survey (2001b) of R&D lab managers supports the argument that these two mechanisms may indeed be used as complements.

64 The IBM Technical Disclosure Bulletin was published from 1958-1998, but IBM has opted to release its disclosures as individual publications. The Xerox Disclosure Journal has been published continuously since 1976. Xerox states that “The Xerox Disclosure Journal [XDJ] is a publication by Xerox Corporation which, for patent and intellectual property purposes, is defensive in nature.” http://www2.xerox.com/research/xdj/index.html
Correlations of industry-level mean effectiveness scores of the various surveyed mechanisms (e.g., lead time, secrecy, patenting) demonstrate that in the case of process technologies, the use of these two mechanisms are positively correlated at significant levels. Moreover, factor analyses show that, in some circumstances, secrecy loads with patenting, leading the authors to suggest that there may be a premium to keeping to-be-patented innovations secret until the patent actually issues. (Cohen et al., 2001). Another explanation may be that trade secrets are being used as a complement to patents.

The continuation application may allow an applicant to realize this premium, but differently than other complementary patent-secrecy strategies. While continuation is similar to the case of the German dye industry described by Hounshell and Smith, it may offer a less complete protection. On the one hand, the German firms as described by Hounshell and Smith were able to leverage full-blown patent protection with complete trade secret protection on separate knowledge elements embodied in a process or product. Both these intellectual property protections survived and ran concurrently after the patent issued, but protected different types of knowledge as described by Arora.

The case is subtly different when innovators employ a continuation application secrecy strategy. In the case of the knowledge contained in the continuation application, trade secret protection cannot survive after the patent issues. Unlike the case that Arora describes, in which distinctly different chunks of knowledge are being protected, the continuation applies to a single, patentable chunk of knowledge. The continuation strategy thus forces the patent applicant, unlike the German dye firms as described, to make a more determined choice between patent protection and secrecy at some point in the innovation process. The implication is that the secrecy protection available through continuation practice covers the same knowledge that is being patented, unlike the situation that Arora describes when referencing the strategies employed by the German dye firms. Thus, although Arora may be read to suggest that the type of knowledge, either codified or tacit, determines the appropriate protection, either patent or trade secret, the fact that firms use continuation practice suggests that the reality may be more subtle. The wide use of continuation practice implies that there may be a premium to keeping even patentable knowledge secret for extended periods, even though the knowledge is clearly capable of being codified. This feature may suggest that firms are opting to hide their codified, easily transferable know-how inside the firm (and Patent Office) for extended periods. It may also suggest that the codified and tacit dichotomy used to describe complementary patent-secret strategies is incomplete.

The proposition that continuation patentees must make determined choices between patent and secrecy protections on the knowledge disclosed in patent applications does not eliminate the possibility that patentees may use a combination of the continuation secrecy strategy with the strategy suggested by Arora. Patentees may enjoy virtually perpetual protection of the tacit elements of an invention using trade secret, while, at the front-end, concurrently enjoying continuation secrecy over the codified components. When the applicant allows the application to grant as a patent, secrecy over the codified elements will be extinguished, but the trade secret protection over the tacit elements may continue indefinitely.

While a continuation strategy requires the applicant to choose between patent protection and secrecy, it is not simply a substitution strategy. The continuation in fact allows the patent applicant to realize overlapping benefits, to retain all the protections available under trade
secrecy, protected by law during pendency of the application before the Patent Office, along with one important benefit—early patent priority—available upon first application to the Patent Office. By using the continuation, patentees gain the benefits of both mechanisms, bypassing in some sense the classic quid pro quo demanded by the patent system that innovators are awarded a monopoly in exchange for disclosure. This option may be particularly useful to innovators working in technologies that do not have both tacit and codified knowledge embedded in the same innovation, and thus are unlike the German dye manufacturers.

Consequently, firms using the continuation strategy may be using both patent and secrecy in a complementary fashion, albeit in a different manner than the German dye firms. For firms seeking the classic “submarine” strategy, benefits are reasonably straightforward: they seek to capture rents from later-adopting firms that infringe the later-issuing patent. For other firms using the continuation strategy, benefits may be different, stemming instead from other benefits of secrecy. These may include an extended period of time in which to manage the burgeoning technology out of the light of day as a means of gaining competitive advantage over rivals, or even added time to secretly develop complementary capabilities or technologies upon which successful commercialization of the initial technology relies. The foregoing allows the formulation of the following hypotheses:

H3a: Patenting firms are more likely to file a continuation application when operating in an industry that more highly values secrecy as an appropriability mechanism.

I argue here that secrecy is a strategic choice made by firms, but by its very nature the secrecy choice requires non-disclosure, which in the case of codified knowledge is possible only by delaying the technology’s and product’s introduction in the marketplace. The firm’s economic payoffs to secrecy will be therefore constrained by the pace at which profits arrive from the patented invention. Products stemming from new technologies for which profits arrive relatively quickly will create in the innovating firm less incentive to make the secrecy choice, ceteris paribus. Thus, to the extent that lead-time is an effective mechanism for the firm in capturing value from new technology discoveries, the use of secrecy—and by extension the use of continuation in patenting—will be necessarily limited. These considerations lead to the following hypotheses:

H3b: Patenting firms are less likely to file a continuation application when operating in an industry that highly values lead-time as an appropriability mechanism.

---

65 It may be, in fact, that the institutional structure of modern U.S. patent law may make the German dye firms’ strategy difficult as compared to a continuation strategy that requires disclosure at some point in the patenting process. Arora (1997) points to the fact that the early German dye industry was operating under an institutional structure that supported the maintenance of both patent and trade secret protection upon the knowledge underlying an invention. The patent law in the United States, however, requires the patent applicant to disclose the invention so as to “enable” one skilled in the art to make and use the invention. 35 USC 112 (2000). This “enablement” requirement limits the ability of a patentee to use both full-blown patent and trade secret protections for a single invention contemporaneously, thus possibly increasing the value of using continuation practice for extending the period of pre-issue secrecy.
1.3.3 Technology Secrecy and Application Secrecy: Creating Strategic Options

To gain a better understanding of the interplay between patent and secrecy choices in firm appropriability strategies, I next consider two different types of secrecy: technology secrecy, and application secrecy. *Technology secrecy* refers to the firms’ intent—or ability—to keep knowledge about its technological discovery from spilling outside the firm. The firm’s ability to successfully hide this know-how is often dictated by technological characteristics, such as the extent to which the invention is “written on the face” of the product or process, and the amount of tacit “difficult to codify” knowledge embedded in the discovery.

Application secrecy, on the other hand, refers to a firm maintaining secrecy over the existence of the patent application itself. The applicant is aided in accomplishing *application secrecy* by the Patent Office, the latter having rules and procedures that prevent the agency or examiners from disclosing any pending application. Applications also enjoy a common law trade-secret harbor: The simple act of disclosing a discovery to the Patent Office does not prevent the availability of state trade-secret protection. For the firm choosing to disclose the existence of a patent application, the Patent Office allows a “patent-pending” mark to be attached to goods, but requires under penalty of law that the applicant must in fact have a patent under examination. However, because there is no requirement that the *technology* disclosed in the application be made public, applicants may still enjoy *technology secrecy* while disclosing the application’s existence to competitors with a “patent pending” mark. These considerations are blunted, however, by the operation of the 1999 publication requirements.

Strategic positions emerging from the relationship between these two modes of secrecy are diagramed on Figure 3.2. The matrix presents four firm strategies, conditioned on the firm having selected to patent its discovery, and assigned by reference to the extent that the firm is
willing or able to choose levels of technology and application secrecy—subject to technological and institutional constraints. At low levels of both technology and application secrecy, the firm is said to be pursuing a *Sprinting* strategy. This strategy is appropriate for firms, like Mattel, selling a quick-to-market product with technological improvements disclosed on its face in an industry in which patents are not a particularly useful appropriability mechanism. Sprinting firms may be more prone to disclose the pending application, with a “patent-pending” mark, as a disincentive to competitors’ copying, but may otherwise rely upon the competitive restrictions embodied in the patent once issued and, more than likely, on complementary appropriability mechanisms such as lead-time to capture value from their invention.

*Submarining* describes a strategy sought by firms that possess incentives to prevent disclosure of their patent applications but not necessarily of the underlying technology. An example is given in the story of George Selden’s patent for a “Road Engine” discussed in Graham (2004). Selden’s story is a classic example of the use of a *submarining* strategy: While Selden had substantial incentives to keep information concerning his pending application buried secretly in the Patent Office for sixteen years, competitors were openly adopting and making complementary investments in Selden’s invention. In fact, Selden was ultimately enriched by the *technological* information spillovers: As a consequence of the technology’s adoption by automakers, Selden was likely able to demand higher royalties when he ultimately allowed his patent to issue. Had there been *application* disclosure, however, Selden may have seen his rents dissipate as competitors instead adopted competing technologies not covered by the Selden patent, or innovated in novel areas, thus reducing Selden’s hold-up opportunities.

But Selden’s story should not be read to suggest that *submarining* is a strategy of the distant past. A modern example of the *submarining* strategy in the electronics sector can be found disclosed in the Rambus history discussed in the introduction of this paper. Rambus, while disclosing its technologies as member of the industry board setting DRAM chip-interface standards, kept the existence of its covering patent application secret, finally allowing the patent to issue from the continuation application process, claiming that competitors were infringing, and thereby securing favorable license terms. But Rambus, in order to successfully follow the *submarining* strategy, had to naturally be the first in time into the Patent Office. Two firms may attempt to follow the submarine strategy unaware of the competitor’s pending application, on the identical technological disclosure will result in only one patent, thus preventing the later firm from garnering the fruits of the strategy, and possibly being charged with infringement if the later firm had not only pursued the strategy, but also deployed the technology and become locked-into its use.

When technology secrecy is technically feasible and an objective of the firm, firm strategies are as described on the left-hand side of Figure 3.2. Firms choosing to disclose the existence of a patent application to competitors while still enjoying secrecy over the discovered technology are described as pursuing an *emptying* strategy. This strategy may be pursued to “clear the field” of potential innovators in a technology space. For products or processes with technological characteristics that make technology secrecy possible, a “patent pending” mark may introduce sufficient uncertainty into the marketplace to keep competitors from pursuing

---

66 While Patent Office interferences are designed to prevent such co-pending applications, in practice the interference is inadequately used as an administrative tool.
follow-on innovations. This uncertainty may take the form of market or technology uncertainty, but has the effect of making the net benefits from follow-on innovation less transparent to competitors, particularly given the existence of an as-yet-undefined patent in the technology space. This strategy contemplates that only the existence of the patent application would be disclosed, such as by using a ”patent pending” mark: Any disclosure of the application itself, such as is now required of international applications in the 1999 patent law amendments, would of course disclose the technology, and thus would frustrate the emptying strategy. I note that this emptying strategy is quite common in the software sector, and was used liberally by firms during the dot.com boom of the 1990s.67

High levels of both application and technology secrecy enable the last category displayed on the matrix, Optioning strategy. In Optioning, firms may be taking advantage of the opportunity that its technology secrecy affords it to pursue follow-on innovations in the shadow of secrecy, while concurrently choosing to make competing in the technology space increasingly uncertain for competing firms by foregoing the “patent-pending” mark. Thus, the patent application may be an option purchased by the firm to fix its priority of invention and ensure that rents may be captured from the early innovation within a larger strategy of technology—and application—secrecy as the optimal strategy chosen by the firm as a means of capturing value from the fruits of the technology trajectory, which the firms intends to own. This optioning strategy is used most often in the chemicals industry, according to intellectual property practitioners.

1.3.4 Patenting, Secrecy, and Sequential Innovation

The effectiveness of secrecy as a complement to patenting may be shown to have particular value to firms operating in a technology space in which valuable, and potentially disruptive or displacing, follow-on innovations are likely. I argue in this section that the patent-secrecy strategies may have more relevance when the innovating firm has gained a first-mover advantage in the technology space, and faces, as the incumbent, competition from researching entrants. I support this assertion by formalizing the economics underpinning the incumbent firm’s decision by presenting the following simple two-firm model derived from Green & Scotchmer (1995).

Consider two innovations, the first with quality \( x \) and the second with quality \( x + y \), such that the incremental improved-quality of the second is \( y \). Assume that \( x \) and \( y \) are related to the consumer’s willingness to pay for the innovations such that the revenue to the monopolist (incumbent) producing the lead innovation is \( \pi_x \) and to the monopolist (incumbent) also controlling the follow-on innovation is \( \pi_{x+y} \). The net benefits to the monopolist (incumbent) producing the first and second inventions are thus \( \pi_x - c_1 \) and \( \pi_{x+y} - c_2 \), respectively. The net benefits to two firms (incumbent and entrant) producing these goods in competition are \( \pi_x^e - c_1 \) and \( \pi_y^e - c_2 \). By assumption, \( \pi_x^e \leq \pi_x \) and \( \pi_y^e \leq \pi_{x+y}^m \).

---

67 This emptying strategy is different than that available to firms like IBM and Xerox when making their technology disclosures in technical journals: These disclosures make public information about the technology, while the emptying strategy makes public only the application’s existence.
Considering the setting in which Firm 1 (F1) discovers \( x \) and Firm 2 (F2) discovers the improvement \( y \), Figure 3.3 presents the sequence of decisions and payoffs. The schematic makes it apparent that, because \( \pi^c_x \leq \pi_x \), F1 prefers to be at the left node when the game is completed, producing product \( x \) as the monopolist. It is thus in the interest of F1 (incumbent) that F2 (entrant) foregoes, or is prevented from, innovation in \( y \), and accordingly F1 can be expected to benefit from creating disincentives in F2 to innovation by pushing F2’s expected net benefits from innovation to \( 0 \geq \pi^c_y - c_2 \). The incumbent F1 may accomplish this objective by driving F2’s innovation costs \( c_2 \) upward, or by depressing F2’s expectations over its expected revenues \( \pi^c_y \).

Patent-secrecy strategies—the choice of non-disclosure—present the firm with an opportunity to accomplish these objectives. Secrecy, by its nature, introduces uncertainty and information asymmetries into the innovation process on the technology path, having the effect of driving the costs of follow-on innovation upward for competitors. These costs may be magnified by the announcement of a “patent-pending” which introduces a hazard, with hidden and as-yet-to-be-determined boundaries, into the technology landscape and market environment. By the same token, secrecy, with or without the announcement of a “patent-pending,” may serve to introduce uncertainty and thus lower a competitor’s expected profits from the follow-on innovation \( \pi^c_y \), thus lowering the competitor’s net benefit from investing in discovery. The most favorable outcome for F1 may indeed be to pursue the necessary investment in \( y \) itself,
potentially enjoying a lower cost to innovation $c_2^*$ where $c_2 \geq c_2^*$ and the monopolist’s revenue $\pi_{c_2^*}$.

This two-firm model has implications for use by firms of the continuation procedures to engage in strategic moves to manipulate secrecy in the patenting of new discoveries. The model suggests that firms with a first-mover advantage, or dominant position, may have incentives to use the continuation procedure to prevent competitors from discovering competing technologies. Gilbert and Newberry (1982) suggest that dominant firms are able to protect monopoly rents by engaging in early, or preemptive, patenting, even suggesting that the maintenance of patent thickets and the filing—and subsequent “shelving”—of follow-on patents can thwart competitors from effectively competing in the first-mover’s technology space, thus preventing the dissipation of the incumbent firm’s super-normal profits. The above set-up suggests that technology first-movers may have an incentive to prevent follow-on innovation, and the continuation provides the institutional mechanism to incumbent technology firms to act strategically in this regard.

Such a continuation blocking strategy is distinct from that modeled in Gilbert and Newberry, however, in that the latter strategy relied upon disclosure, while the continuation strategy relies upon non-disclosure. Incumbent firms in the Gilbert and Newberry model use the legal barriers due them under the patent laws, specifically the patentee’s right to exclude competitors from using the patented technology. Because the continuation may be used after the applicant has been informed that the technology has been declared “patentable,” an incumbent firm using the continuation blocking strategy enjoys the prospect of excluding competitors’ uses as in the case of the incumbent firm modeled in Gilbert and Newberry. But the firm using the continuation blocking strategy also erects an additional barrier to competitors. By delaying the patent’s issue, the firm raises the information costs to competitors, thus increasing the costs to deploying competing products. Furthermore, if the incumbent engages in a form of the “Emptying” strategy illustrated in Figure 3.2, the incumbent can disclose the existence of the patent application with a “patent pending” mark. In this manner, the incumbent can both raise search costs to competitors while concurrently making the viability of research and development investments in the focal technology increasingly uncertain, thus depressing expected payoffs with the aim of making competitors’ investments less likely, thus leaving the technology field to the incumbent. The foregoing arguments allow me to the formulate the following hypothesis:

H4: Patenting firms are more likely to file a continuation application when the firm values secrecy and concurrently enjoys an incumbent position in the technology space covered by the focal patent.

1.4 DATA AND METHODOLOGY

The unit of analysis in this study is an issued United States patent. Many studies have used the issued patent as a unit of analysis despite the fact that inventive activity is the phenomenon of interest. In this study, I am principally interested in patenting behavior, not inventive activity, and so the unit of analysis is appropriate. I note at the outset that any decision to seek a continuation is contingent upon a decision to apply for the patent—although the availability of the continuation as an option may affect the likelihood of the initial decision to apply for the patent. Moreover, the availability and benefits of secrecy protection, as well as the
perceived stance of the courts and the Patent Office as regards patentability, may bias the types of patents that make their way into the system.

In order to empirically test theoretical implications, I use again continuation data culled from the Walter A. Haas School of Business’ Micropatent Database. Because I am principally interested in the strategic choices of firms, I restrict my sampling in this paper to patents likely to have been issued to these economic entities. A “firm” patent is defined by reference to the NBER database, using codes that limit the sample to patents assigned to non-governmental organizations, a definition that tends to include some organizations that are not corporations. These defined “firm” patents comprise nearly 80% of all patenting 1975-94 (Hall, Jaffe, and Trajtenberg, 2001). From the population of these firm patents, I truncate on the right by age, ignoring those U.S. patents issued after 1994, thus allowing me to construct measures consistently and also mitigating the effects of the 1995 regime change on firms’ patenting behavior, insulating the sample from the effects of the amendments to the Patent Act which significantly altered the incentives for patentees to use the continuation application.

This sample includes 1,258,880 issued patents assigned to entities during the period 1975-1994 inclusive, of which 250,825 (20%) show a continuation application lineage. Collecting these data enabled me to construct the dependent variable CONTINUE which takes the value = 1 if the issued patent is “continued,” and 0 otherwise. Issued patents are considered “continued” and thus coded CONTINUE = 1 if the U.S. patent document shows at least one continuation, division, or continuation-in-part.

In order to test for complementarities between patenting and secrecy, I rely principally upon the responses in the Carnegie-Mellon Survey (CMS) (Cohen et. al, 2001b) as an indicator of the importance of secrecy in various sectors. Because the CMS elicited responses only from R&D managers at firms, my restricting the sample to firm-assigned patents is again appropriate. The CMS was limited to industries in 34 separate ISIC codes, and reports responses both for process and product innovations.

I construct an explanatory variable SECRET from the CMS to test my theory on the existence of complementarities between patenting and secrecy. My principal measure is derived from the reported importance of secrecy as an appropriability mechanism to firms, reported in the CMS as aggregate statistics by sector to the following survey question: “During the last three years, for what percent of your [product / process] innovations [was Secrecy] effective in protecting your firm’s competitive advantage from those innovations?”

R&D lab manager respondents were asked to choose one of the following five categories that best reflected their experience at the firm: “Below 10%” “10-40%” “41-60%” “61-90%” and “Over 90%.” Category midpoints were used to calculate industry appropriability mean scores. Figure 3.4 demonstrates inter-industry heterogeneity, showing variation across selected sectors from lows in the Printing-Publishing sector (minimums among all process and product innovators, 21% and 33%, respectively) to highs in the Miscellaneous Chemicals sector (maximums among all process and product innovators, 76% and 71%, respectively). The mean percentage of innovations for which secrecy was considered effective for the universe of

---

68 Although I maintained the database during the years 1999-2003, I am very thankful for the original work of Dr. Michael Barnes and Dr. Arvids Ziedonis, and the ongoing efforts of Dr. Ziedonis in supplementing the database.

69 This distinction between “product” and “process” is defined subjectively by the respondent.
respondents reporting in the CMS was 51% for process innovations, and 51% for product innovations, considered separately.

I also construct a measure to differentiate firm secrecy strategies in which the payoff to using simple trade secret protection is greater than using the continuation strategy. If the value firms assign to secrecy as an appropriability mechanism is relatively strong while the value firms assign to patenting is relatively weak, the firm will likely face greater incentives to pursue the simple trade secret strategy and forego the continuation patenting strategy altogether. To measure this propensity in firms, I construct the variable TRADESECRET from the responses in the CMS, combining R&D managers’ reported importance of both “secrecy” and “patenting” as appropriability mechanisms to firms. The importance of “patenting” reported in the CMS is based on survey responses to the question: “During the last three years, for what percent of your [product / process] innovations [was Patenting] effective in protecting your firm’s competitive advantage from those innovations?”

The variable TRADESECRET is intended to gauge the extent to which secrecy is relatively important, and patenting is relatively unimportant, to firms’ value-capturing strategy. As a result, I use the following formula: TRADESECRET = (SECRET) x (1-PATENT) where SECRET is defined as above, and PATENT is the industry appropriability mean score, based as was SECRET upon category midpoints of the CMS responses. This formula creates a variable that has a relatively high score when secrecy is considered valuable but patenting is not, thus measuring the likelihood of a firm appropriability environment in which the returns to using a trade secret strategy are higher.
Assigning these industry-level variables to individual issued patents required that I construct a concordance between International-Standard-Industrial-Classed (ISIC) industries and U.S. patents. Matching the CMS survey results for 34 ISICs to individual U.S. patents was performed by assembling a new ISIC-USPTO Class concordance using the Statistics Canada-based concordance first built by Brian S. Silverman (1996). While Silverman used a distribution of international-patent-classed (IPC) Canadian patents to match with US-SIC codes, the CMS surveyed by International SIC-defined sectors, therefore necessitating that I create a matching to the ISIC codes. Silverman’s process included the following steps: First, Canadian Patents, assigned by Canadian patent examiners to both International Patent Class (version 5) and Canadian SIC (in both SIC of “use” and SIC of “manufacture”) are used to create a frequency describing the distribution of patents in each four-digit IPC assigned to industry, the latter described by four-digit SIC. Second, each Canadian SIC is then linked to corresponding US SIC codes, through a concordance published jointly by Industry Canada and the US Department of Commerce.

I use the product of the first step in the Silverman process, but I manufacture a new correspondence by linking the IPC-Canadian SIC-matched patents to the four-digit International SIC. Because I am interested in matching the survey results in Cohen et al. (2001b) to patents, I limit my concordance to the 34 ISIC-defined industries surveyed in the CMS. For the purposes of producing this correspondence, I use the NTIS CanadianSIC-InternationalSIC concordance available from the United States Census Bureau (1994).

Constructing the SECRET measure allows me to estimate the following simple model, in essence a descriptive regression for the purposes of data summary. I include only my SECRET variable along with grant year dummies and obtain the following estimate:

$$\text{Prob(continuation)} = \text{constant} + 1.627 \text{SECRET} + \text{year effects}$$

This result, significant at the 99% confidence level, summarizes the results of my sampling: Patents issued to firms in industries reporting that “secrecy” is effective in protecting 100% of inventive activity are 5.1 times more likely to engage in continuation patenting than are firms that report that “secrecy” is effective in none of its innovations. More realistically, a one standard deviation change in the value of the “secrecy” response by firms (~ 9% of discoveries) would result in an 18% increase in the likelihood of the patent showing continuation procedures in its application lineage.

1.4.1 Econometric Model

I conduct a more thorough multivariate test enabling me to test the hypotheses formulated from the alternative explanations of patentees’ motivations to use the continuation application procedure. Specifically, I intend to test my patent-secrecy explanation for the use of continuation applications against the “winning junk patents” and “information impediments” stories, while considering other independent variables.

The multivariate analysis permits me to test for the existence of complementarity between patenting and secrecy in continuation practice, while also allowing me to incorporate other independent variables. I test for the effects of firms’ valuing secrecy as an appropriability
mechanism on the likelihood of a patenting firm using the continuation process while, concurrently, considering information impediments and strategic delay explanations for increased likelihood of continuation use. I specify a binomial logit model, in which the dependent variable CONTINUE = 1 if the issued patent shows a continuation, and CONTINUE = 0 otherwise.

I let y* = Xβ + µ where y* is the latent variable reflecting the decision to employ the continuation application procedure. Using standard assumptions for µ allows me to specify a logit model. Firm decisions to file more than one continuation on a single issued patent are treated identically to those in which a single continuation is filed, and therefore each firm is counted as filing a continuation for only the first continuation filed for any given patent.70

1.4.1.1 Independent Variables: Information Impediments

I begin the discussion of my independent variables by discussing those proxying for information impediments, namely AGE, CLAIMS, and ORIGINAL. The variable AGE is constructed by measuring the average age of the citations (backward citations) contained on the face of an issued patent, this measure having been used in prior work as a proxy for the age of the technology embodied in the patented invention (Lowe, 2002). While earlier measures of AGE were constructed using either “age of citation” measured from issue date of the focal patent to issue date of the cited patent, or application date of the focal patent to issue date of the cited patent, I improve the measure. My continuation dataset includes the date at which the patent application was first filed in the Patent Office, allowing me to measure the “age of citation” from the focal patent’s “original continuation date” to the issue date of the cited patent. This “original continuation date” is more likely close in time to the true invention date than the artificial last “application date” listed upon the patent document, the latter being in some sense meaningless from a date-of-invention perspective for the majority of continuation patents.71

This AGE measure proxies for uncertainty, on the theory that “newer” technologies—those with lower measured AGE values—are likely to be characterized by greater uncertainty in a range of attributes than are disclosures relying upon older, more established technologies. Information obstacles may include, but are not necessarily limited to, technological feasibility, adequate description, demonstrating usefulness, the state of prior art, and legality of subject matter. Accordingly I expect a negative relationship between AGE and the dependent variable. I explore a curvilinear relationship between AGE and the dependent variable by including both the linear measure and the square of AGE.

As a measure of technological complexity, I use the number of CLAIMS contained in the focal patent. A patent claim is the written declaration describing the property right granted at issue. This measure proxies for complexity, although this complexity may stem from either a greater number of claims indicating a broad property right (under the construction that claims are indicative of a broader property right as in Lanjouw and Schankerman, 1997) demanding greater scope of knowledge by the agents, or a more complex “fitted” property right (under the construction that a large number of claims are indicative of attempts to “fit” a property right into

70 Work with several count-data regression techniques demonstrates that I lose very little by way of explanatory power in relying upon the binomial logit.
71 Certainly there is a small subset of continuation patent for which the continuation lag is so short that the difference is without meaning.
a crowded technology space). Therefore, I expect a positive relationship between CLAIMS and the dependent variable. I also explore curvilinear effects for the CLAIMS variable by using both the linear count of claims and its square.

I use the variable ORIGINAL as another proxy for technological complexity, this measure representing the range of technologies with which the inventor and examiner must be familiar in order to understand the invention disclosure. This variable was first given as “Originality” by Trajtenberg, Jaffe, and Henderson (1997) and is the Herfindahl concentration index giving a measure of the citations made by patent \( i \) that belong to a breadth of different technology classes. It is calculated

\[
Originality_i = 1 - \sum_{j} s_{ij}^2
\]

where \( s_{ij} \) represents the share of backward citations made by patent \( i \) that belong to patent class \( j \) from \( n_i \) patent classes. A high value in ORIGINAL thus demonstrates that the patents cited by patent \( i \) belong to a wide range of patent classes. To the extent that the focal technology is drawn from a wide breadth of technologies, the ability to adequately describe, read, understand, and make conclusions about these technologies by the specialist agents involved in the examination process are more likely to be incomplete. High values in ORIGINAL are accordingly more likely to be indicative of existing information impediments and proxies for higher complexity. Accordingly, the information impediments story suggests that the relationship between the complexity proxy ORIGINAL and the dependent variable will be positive.\(^{72}\)

1.4.1.2 Independent Variables: Patent Quality

In order to operationalize a test of Quillen and Webster’s theory describing the effects of perverse incentives within the USPTO, one must seek a measure for “unpatentable” or “low-quality” patents. To the extent that “patentability” is an objectively measurable criterion, I suggest that a meaningful proxy for patentability is market value. The market may be the best possible means to judge \textit{ex post} whether the invention was characterized \textit{ex ante} by novelty and utility, characteristics for which the marketplace will reward. I will use a proxy commonly used in the literature, “forward citation count,” as the indicator of a patent’s market value.

The definition of “unpatentable” or “low-value” patents is problematical, due to the fact that the available indicators of market value are latent. The “forward citation” measure that has been shown to correlate with value (Harhoff, Scherer, and Vopel, 1999), as well as with other indicators of value, such as litigation, opposition, and stock-market value (Lanjouw and Schankerman, 1997; Harhoff and Reitzig, 2000; Hall, Jaffe, and Trajtenberg, 2000). These so-called “forward citations” are the citations collected by a focal patent in the prior art disclosures of later-issuing patents. The forward citation measure offers an indication of the perceived importance, or technological impact, of patent \( i \) as judged by the attention awarded by practitioners in its field, as indicated by the reference to patent \( i \) as a critical technology in the lineage of later technology advances. Due to the lag effects inherent in such a measure, I

\(^{72}\) The measures AGE, CLAIMS, and ORIGINALITY show low correlation coefficients, each showing Spearman independence of one another at the 99% confidence level.
standardize by limiting the count of forward citations to those citations collected by patent \( i \) in a five-year window, measured from the date of issue of the focal patent.\(^7^{3}\)

I code my sample by assigning to each patent a ratio measure of the patent’s number of forward citations. The measure \( \text{CITERATIO} \) is the ratio of the number of forward citations the patent collected in a five-year forward window (numerator) to the mean number of citations all patents in the same broad technology class (defined by the primary IPC classification) collected in the same 5-year forward window (denominator). The five-year forward citation window is measured from the patent’s issue date. Another dummy variable is constructed, \( ZEROCITES \), taking the value of 1 only when the focal patent received zero forward citations in a five-year forward window, and 0 otherwise. The variable \( ZEROCITES \) is intended to proxy for low-quality patents, and thus is expected to show a positive effect upon the dependent variable. Because larger values in the variable \( \text{CITERATIO} \) measure the effect of increasing forward citations within broad technologies, the coefficient on \( \text{CITERATIO} \) will measure the effect that higher-quality patents have upon the likelihood of an applicant filing a continuation. The foregoing theory concerning “junk patents” suggests that the coefficient on \( \text{CITERATIO} \) will be negatively related to the dependent variable.

1.4.1.3 Independent Variables: Firms’ Use of Secrecy

In addition to the CMS-based variable \( \text{SECRET} \), I also construct an explanatory variable \( \text{LEADTIME} \) from the Cohen et al. (2001) survey to test for the effect of disincentives to the firm’s secrecy choice created by rapidly-arriving profits from innovation. My principal measure is derived from the reported importance of lead time as an appropriability mechanism to firms, reported in the CMS as aggregate statistics by sector to the following survey question: “During the last three years, for what percent of your [product / process] innovations [was Lead Time] effective in protecting your firm’s competitive advantage from those innovations?”

R&D lab manager respondents were asked to choose one of the following five categories that best reflected their experience at the firm: “Below 10%” “10-40%” “41-60%” “61-90%” and “Over 90%.” Category midpoints were used to calculate industry appropriability mean scores. I assign these industry-level survey results to individual patents using the identical method I employed to build the \( \text{SECRET} \) measure, applying the Silverman (1996) methodology and the U.S. Census Bureau (1994) concordance described previously. On the theory that the reported effectiveness of lead-time is an indicator of the rapid arrival of profits and has a depressive effect upon the use by firms of secrecy, I expect the relationship between \( \text{LEADTIME} \) and the dependent variable to be negative.\(^7^{4}\)

I create a measure of technology control that allows me to proxy for the control that firm \( j \) exercises over the technology trajectory in which the focal patent \( i \) lies. The measure is the “backward self-citation” ratio for the focal patent, formally the share of backward citations that the focal patent makes to patents owned by the owner of the focal patent. While this is the first instance of which I am aware that a researcher has used the backward self-citation ratio to proxy for a firm’s control over the technology trajectory, the concept is closely related to a

---

\(^7^{3}\) This proxy may taint the sample by failing to introduce indicators for some oft-cited patents with long latency periods.

\(^7^{4}\) While \( \text{LEADTIME} \) and \( \text{SECRET} \) show some correlation (0.2120 correlation coefficient), covariance is very low, and the two measures are Spearman independent at the 99% confidence level.
cumulative-innovation measure used by Lanjouw and Schankerman (2002). Lanjouw and Schankerman use the self-citation ratio as a measure of the relatedness between firm patents and subsequent technological activity by the firm (cumulative innovation).

Two artifacts of the patent data complicate generating the “backward self citation” ratio: identity of patent ownership is not well-defined, and these ownership characteristics of patents, to the extent meaningful, have been available only relatively recently (circa 1969). I assign the ownership characteristics of patents with reference to the NBER database (Hall, Jaffe and Trajtenberg, 2001). The authors of the NBER database assigned ownership characteristics through careful matching of patents to the Compustat Database of publicly-traded companies. This matching creates a measure of limited applicability, given that the characteristics of privately-held US firms and foreign firms are underrepresented in the data. The relatively late availability of these ownership data creates a choice for the researcher—whether to create a “self-citation” share basing the denominator of the ratio upon the universe of citations made by the focal patent \( i \) or alternatively upon only those citations for which ownership characteristics are available. I employ the latter method, thus selecting an “upper bound” of the self-citation ratio, accounting for citations made by patent \( i \) only after 1969 (Hall et al. 2001).

Because the extent to which the owner of a patent controls the technology trajectory is not a sufficient variable to test for the use of the “continuation blocking strategy” outlined in 4.4 above, I must create a derivative variable. Recall that, unlike the strategic firm modeled in Gilbert and Newberry (1982), the firm using a continuation strategy to block entry would be interested in non-disclosure. I thus create a variable SELF*SECRET which is a cross between the technology control proxy with the SECRET variable. Thus, higher scores in the variable SELF*SECRET will denote patents that are comparatively more likely to lie in a stream of research controlled by a firm in an industry that highly values secrecy as an appropriability mechanism. On the theory that this measure of technology incumbency demonstrates a firm control over the technology trajectory of patent \( i \) and creates incentives for, and reflects, the firm’s use of secrecy to prevent competitors from innovating a disruptive and dislocating follow-on innovation, I expect that the relationship between SELF*SECRET and the dependent variable will be positive.

1.4.1.4 Control Measures

I use several control measures. BACKCITES is a count of backward citations—all patents cited by the focal patent \( i \)—and controls for the tendency of the independent variables ORIGINAL and AGE to change with increasing numbers of backward citations, thus enabling me to compare among similarly situated patents. The variable US is a dummy variable equal to 1 if the assignee is a domestic firm, 0 otherwise, and controls for any tendency for increased usage of the continuation procedure by local patentees with local knowledge and presumed greater familiarity with the institutional structure of the local (US) patent laws. I also control for technology-area effects with dummies defined with reference to the primary classes given by the International Patent Classification scheme, including Human (A-), Operations (B-), Chemical (C-), Natural Fiber (D-), Constructions (E-), Mechanical (F-), Physics (G-), and Electric (H-). Year dummies 1975-1994 are also included to control for longitudinal differentiation and changes in the patent regime over time.
### 1.4.2 Summary Statistics

Summary statistics of the key variables are provided in Table 3.1. Although continuation-lineage patents comprise just more than 20% of all issued patents 1975-1994, Table 3.1 discloses that the sample has been constructed to compare the continuation patents of interest with a matched sample of non-continued patents. This comparison sample was randomly chosen from the larger population, yet matched in cohorts by international patent technology class (IPC 4-digit) and issue year.

The statistics given in Table 3.1 demonstrate that there is substantial heterogeneity in the sample. For instance, industry mean responses differ for both SECRET and LEADTIME, the former varying between 20% and 75% while the latter varies between 33% and 66%. Statistics reported on the backward self-citations of patents demonstrate that at the mean firms’ patents make 15% of their backward references to self-owned patents, although some patents show no self-cites while others self-cite exclusively (0 and 1, respectively). Geographic diversity among innovators also likely exists, given that the mean statistic on the dummy variable US FIRM shows that only 56% of the sampled patents are issued to domestic enterprises. Technological heterogeneity in the sample is also evident: Reference to the International Patent Classifications assigned at the USPTO show that 11% of the sample are classed “Human,” 22% as “Operations,” 21% as “Chemistry,” 2% and 3% respectively “Natural Fiber” and “Construction,” 9% “Mechanical,” 17% “Physics,” and 15% “Electrical.” Furthermore, the “forward citation” value-correlate also varies, with 36% of the sample patents collecting zero references in the measured 5-year window, with only 18% collecting 4 or greater references from later-patented

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Mean</th>
<th>Std.D.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTINUED</td>
<td>0.5</td>
<td>0.501</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>SECRET</td>
<td>0.49</td>
<td>0.08</td>
<td>0.2</td>
<td>0.76</td>
</tr>
<tr>
<td>LEAD TIME</td>
<td>0.52</td>
<td>0.09</td>
<td>0.33</td>
<td>0.66</td>
</tr>
<tr>
<td>SELF-SECRET</td>
<td>0.08</td>
<td>0.14</td>
<td>0</td>
<td>0.76</td>
</tr>
<tr>
<td>TRADESECRET</td>
<td>0.31</td>
<td>0.07</td>
<td>0.18</td>
<td>0.53</td>
</tr>
<tr>
<td>ORIGINAL</td>
<td>0.35</td>
<td>0.28</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>GENERAL</td>
<td>0.32</td>
<td>0.29</td>
<td>0</td>
<td>0.93</td>
</tr>
<tr>
<td>CLAIMS</td>
<td>11.7</td>
<td>10.5</td>
<td>1</td>
<td>868</td>
</tr>
<tr>
<td>AGE</td>
<td>11.3</td>
<td>7.5</td>
<td>0</td>
<td>64.6</td>
</tr>
<tr>
<td>BACKCITES</td>
<td>7.2</td>
<td>6.8</td>
<td>0</td>
<td>217</td>
</tr>
<tr>
<td>US</td>
<td>0.56</td>
<td>0.5</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>CITERATIO</td>
<td>0.99</td>
<td>1.51</td>
<td>0</td>
<td>46.5</td>
</tr>
<tr>
<td>ZERO CITES</td>
<td>0.36</td>
<td>0.48</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Summary statistics of the key variables are provided in Table 3.1. Although continuation-lineage patents comprise just more than 20% of all issued patents 1975-1994, Table 3.1 discloses that the sample has been constructed to compare the continuation patents of interest with a matched sample of non-continued patents. This comparison sample was randomly chosen from the larger population, yet matched in cohorts by international patent technology class (IPC 4-digit) and issue year.

The statistics given in Table 3.1 demonstrate that there is substantial heterogeneity in the sample. For instance, industry mean responses differ for both SECRET and LEADTIME, the former varying between 20% and 75% while the latter varies between 33% and 66%. Statistics reported on the backward self-citations of patents demonstrate that at the mean firms’ patents make 15% of their backward references to self-owned patents, although some patents show no self-cites while others self-cite exclusively (0 and 1, respectively). Geographic diversity among innovators also likely exists, given that the mean statistic on the dummy variable US FIRM shows that only 56% of the sampled patents are issued to domestic enterprises. Technological heterogeneity in the sample is also evident: Reference to the International Patent Classifications assigned at the USPTO show that 11% of the sample are classed “Human,” 22% as “Operations,” 21% as “Chemistry,” 2% and 3% respectively “Natural Fiber” and “Construction,” 9% “Mechanical,” 17% “Physics,” and 15% “Electrical.” Furthermore, the “forward citation” value-correlate also varies, with 36% of the sample patents collecting zero references in the measured 5-year window, with only 18% collecting 4 or greater references from later-patented
technology disclosures. These last statistics are broadly consistent with our understanding that few patents are valuable, and that most of the value lies in the right tail of the distribution.

1.4.3 Empirical Results

A summary of the relevant variables, their descriptions, the level at which the measure is taken, and the expected exhibited relationships between each explanatory variable and the dependent variable is given in Table 3.2. The reliability of the various explanations offered in the literature for firms’ uses of the continuation in patenting are explored in the binomial logit model results presented in Table 3.3. “Model 1” presents the results of the initial regression in which I test for the influence of both information impediments and motivations for continuation use borne of USPTO “perverse incentives” suggested in Quillen and Webster (2001). With respect to the tests of the “information impediments” story, a number of noteworthy results are evidenced. First, increasing the technological complexity suggested by a broadly-dispersed set of prior art appears to exert a positive effect upon the likelihood of a continuation. The coefficient ORIGINAL is appropriately (positively) signed and statistically significant: Increasing this measure of technological complexity by one standard deviation increases the likelihood that a firm will file a continuation by approximately 14%.

Table 3.2: Overview of Variables and Expected Signs

<table>
<thead>
<tr>
<th>VARIABLE NAME</th>
<th>TEST FOR</th>
<th>DESCRIPTION</th>
<th>LEVEL</th>
<th>EXP'D EFFECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORIGINAL</td>
<td>H1a</td>
<td>HHI concentration, backward technology breadth</td>
<td>Patent</td>
<td>+</td>
</tr>
<tr>
<td>CLAIMS</td>
<td>H1a</td>
<td>Number of claims</td>
<td>Patent</td>
<td>-</td>
</tr>
<tr>
<td>AGE</td>
<td>H1b</td>
<td>Mean age of backward citations</td>
<td>Patent</td>
<td>-</td>
</tr>
<tr>
<td>ZEROCITSES</td>
<td>H2</td>
<td>No forward citations</td>
<td>Patent</td>
<td>+</td>
</tr>
<tr>
<td>CITERATIO</td>
<td>H2</td>
<td>Ratio: forward cites / mean fwd. cites in technology group</td>
<td>Patent</td>
<td>-</td>
</tr>
<tr>
<td>SECRET</td>
<td>H3a</td>
<td>CMS effectiveness response % (SECRET)</td>
<td>Industry</td>
<td>+</td>
</tr>
<tr>
<td>TRADESECRET</td>
<td>H3a</td>
<td>CMS effectiveness (%): = (1-PATENT) x (SECRET)</td>
<td>Industry</td>
<td>-</td>
</tr>
<tr>
<td>LEAD TIME</td>
<td>H3b</td>
<td>CMS effectiveness % (LEAD TIME)</td>
<td>Industry</td>
<td>-</td>
</tr>
<tr>
<td>SELF*SECRET</td>
<td>H4</td>
<td>Owns Technology Trajectory (Self-citation ratio) x CMS effectiveness % (SECRET)</td>
<td>Patent-industry</td>
<td>+</td>
</tr>
<tr>
<td>BACKCITES</td>
<td>control</td>
<td>Number of backward citations</td>
<td>Patent</td>
<td>n/a</td>
</tr>
<tr>
<td>US (dummy)</td>
<td>control</td>
<td>Domestic firm patentee</td>
<td>Firm</td>
<td>n/a</td>
</tr>
</tbody>
</table>
The coefficients on the complexity measure CLAIMS and SQUARECLAIMS demonstrate a curvilinear relationship between this measure and the dependent variable. Calculating the appropriate change in the dependent variable over the relevant range of claims demonstrates that the relationship is convex throughout the range \{1,868\} with a global minimum at CLAIMS=29. The effect of the number of CLAIMS upon the dependent variable is falling in the range \{0,29\} with particularly dramatic negative effects in \{0,21\}, but the relationship is reasonably flat for values larger than 25. Because 50% of the patents have 9 or fewer claims, and 90% of patents have 22 or fewer claims, it is clear that this negative relationship between the number of CLAIMS and the likelihood of a continuation dominates.

Table 3.3: Binomial Logit Model Results

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SECRET</td>
<td>- -</td>
<td>0.9866 (16.34)**</td>
<td>- -</td>
</tr>
<tr>
<td></td>
<td>LEADTIME</td>
<td>- -</td>
<td>-0.8378 (-23.76)**</td>
<td>- -</td>
</tr>
<tr>
<td></td>
<td>SELF*SECRET</td>
<td>- -</td>
<td>1.0068 (45.97)**</td>
<td>- -</td>
</tr>
<tr>
<td></td>
<td>TRADESECRET</td>
<td>- -</td>
<td>-0.3467 (-5.10)**</td>
<td>- -</td>
</tr>
<tr>
<td></td>
<td>ORIGINAL</td>
<td>0.3195 (28.41)**</td>
<td>0.3399 (30.01)**</td>
<td>0.3195 (28.41)**</td>
</tr>
<tr>
<td></td>
<td>CLAIMS</td>
<td>-0.0257 (-37.5)**</td>
<td>-0.0260 (-37.67)**</td>
<td>-0.0257 (-37.5)**</td>
</tr>
<tr>
<td></td>
<td>SQUARECLAIMS</td>
<td>0.0005 (33.76)**</td>
<td>0.0005 (33.71)**</td>
<td>0.0005 (33.76)**</td>
</tr>
<tr>
<td></td>
<td>AGE</td>
<td>0.0203 (16.68)**</td>
<td>0.0293 (23.67)**</td>
<td>0.0203 (16.68)**</td>
</tr>
<tr>
<td></td>
<td>SQUAREAGE</td>
<td>-0.0006 (-18.12)**</td>
<td>-0.0008 (-22.44)**</td>
<td>-0.0006 (-18.12)**</td>
</tr>
<tr>
<td></td>
<td>US</td>
<td>0.3465 (57.01)**</td>
<td>0.3186 (51.95)**</td>
<td>0.3465 (57.01)**</td>
</tr>
<tr>
<td></td>
<td>BACKCITES</td>
<td>0.0289 (50.12)**</td>
<td>0.0291 (50.15)**</td>
<td>0.0289 (50.12)**</td>
</tr>
<tr>
<td></td>
<td>CITERATIO</td>
<td>-0.0124 (-5.37)**</td>
<td>-0.0065 (-2.82)**</td>
<td>-0.0124 (-5.37)**</td>
</tr>
<tr>
<td></td>
<td>ZEROCITES</td>
<td>0.1143 (16.05)**</td>
<td>0.1000 (13.89)**</td>
<td>0.1143 (16.05)**</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>-0.4378 (-15.84)**</td>
<td>-0.5282 (-14.42)**</td>
<td>-0.4378 (-15.84)**</td>
</tr>
<tr>
<td>Difference</td>
<td>Likelihood Ratio:</td>
<td>32878.47(35)</td>
<td>35725.52(39)</td>
<td>2847.05(4)</td>
</tr>
</tbody>
</table>

Although the global maximum is at 868 claims, 99% of the observations display less than 50 claims. The observations showing greater than 100 claims comprise less than 1/10 of 1% of the sample and play an insignificant role.
This inverse relationship is not consistent with what one expects from the foregoing theory, suggesting either that patents’ technological complexity may not be driving continuation use by firms, or alternatively that the number of CLAIMS may not be an appropriate proxy for the level of technological complexity embodied in a patent. To the extent that a greater number of claims indicates technological complexity, the convexity in the range \{1,29\} is inconsistent with the information impediments theory, and may instead suggest that patentees’ claiming patterns reflect inconsistent patent-prosecution strategies, including claiming strategies in which applicants use low numbers of broadly-worded claims in an attempt to capture wide areas of the technology space, thus creating greater complexity for—or resistance from—the patent examiner. The result here is similar to that identified for European Patent Office-issued patents in Graham, et al. (2003), wherein the number of claims below 10 was found to have an insignificant effect, while those above 10 had a positive and statistically significant impact, upon the incidence of an opposition being filed to a patent’s validity in the European Patent Office. The negative relationship is also consistent with observations made in Graham, et al. (2003) that a greater number of claims may proxy for the “crowdedness” of the innovation space within which a firm is operating.

The coefficients on the time-based complexity measure AGE and SQUAREAGE also demonstrate a curvilinear relationship between this measure and the dependent variable, but a concave one. Calculating the appropriate change in the dependent variable over the relevant range of AGE shows that the relationship is concave, rising throughout range \{0,17\} and falling throughout the range \{18,65\}, with a global maximum at AGE=17 and a minimum at AGE=0. Because 50% of the patents show an average backward-citation age of 9 or fewer years, and 85% of patents show an AGE of 18 years or less, it is clear that a positive relationship between the variable AGE and the likelihood of a continuation dominates in the sample.

This upward-sloping shape that dominates the relationship is inconsistent with the predicted inverse relationship between AGE and the dependent variable, suggesting that patents with technology pedigrees of “old age” are more likely to be continued than are patents with a relatively young technological lineage. This relationship is inconsistent with theory. Thus, the results do not support the theory suggesting that, as a technology embodied in patent \(i\) becomes more established, innovators and their agents are less likely to use the continuation as means of purchasing delay so as to resolve information asymmetries over technology and law with patent examiners.

Given that the relationships found between both the CLAIMS and AGE variables and the dependent variable are significant and oppositely signed than expected under hypotheses H1a and H1b, the findings throw considerable doubt on the efficacy of the “information impediments” and “complexity” theories. These findings are consistent with the descriptive findings of Graham (2004), in which the less “complex” chemical sector showed higher continuation use, while the new and rapidly changing sector, software, showed a growth in continuation use throughout 1997 until the effects of the 1995 regime change apparently altered the growth. This growth occurred during the 1990s despite software technologies becoming less “new” throughout that period, being by the 1990s reasonably well established (Graham and
Mowery, 2003). Given that these explanations are not supported by the analysis, it may be that other strategic motivations are the primary drivers of continuations’ uses.

The market-value based “quality” measures used to test Quillen and Webster’s theory enter at significant levels in the specification. Consistent with theory, the coefficient on the proxy for low-quality patents, ZERO\textsc{cites}, is significant and positively signed, demonstrating that patents with relatively low forward citation counts, correlative with other latent measures of “low value,” are more likely to show firm continuation use. Moreover, “high value” patents with relatively high forward citation counts are less likely to show firm continuation use, as demonstrated by the negatively-signed coefficient on regression results for the C\textsc{iteratio} variable. Consistent with the hypotheses, the likelihood of continuation filing appears to decrease with an increase in the latent measure of value—and by argument “quality”—of the patent. Conversely, the coefficient of my measure of “low quality” patents—those patents earning zero citations by later-citing inventions—is both appropriately (positively) signed and significant.

Indeed, arguably the “junkiest” patents—those patents receiving zero citations as prior art in five years from issue date—are approximately 21% more likely to have been continued than the baseline (mean cited) patent in the same broad technology class. Patents collecting only one citation as prior art in the same window (and thus below the mean in all broad technology classes) are 7% more likely to have been continued. In the case of valuable, and by definition high-quality patents, the regression results demonstrate that the likelihood of having been continued during application falls. For patents collecting forward citation counts in the above-the-mean quartile, the coefficient is both appropriately (negatively) signed and significant, demonstrating that a patentee is 9% less likely to have pursued the continuation. Because the continuation equates with delay, these results are noteworthy because the technology that is the basis for the continued patent tends to be older and has thus had more time to become “known” by other citers by the time the citation clock (at issue) begins to run.\footnote{The institutional rules at the Patent Office did not aid in disclosure prior to 1999, but to the extent that spillovers occur from the firm’s research, the added time can only increase the likelihood that knowledge of the applied-for technology spills out.}

While these results may reflect the importance of gaining a “quick” patent on a valuable technological improvement, the result is nevertheless puzzling. Although decisionmakers in firms are presumably in the best position to judge the value of the patent, they appear to be incurring additional costs through continuation to earn patents on arguably less-valuable property rights. An alternative explanation for this result is that officers/agents of the firm are allowing the valuable portions of their disclosures to issue as quick, valuable patents, while leaving the less-valuable “junk” disclosures behind in the form of a continuation application. It is not clear, however, that firms would expend the resources to win patents on the “junk” technology leavings, absent benefits unassociated with traditional correlates of value. Indeed, other work in the field has suggested that firms patent for purposes superfluous to capturing value from commercialization of the patented discovery (Hall and Ziedonis, 2002; Shapiro, 2002; Tirole, 1988), and such an expenditure of firm resources to continue the “junk” in a technological disclosure may have alternative benefits.
Before examining the results of the full model, one result found in the control variables is noteworthy. The coefficient of the geographic-origin variable US shows that domestic identity has a strong effect upon the incidence of continuation: The coefficient is both positively signed and significant, showing that domestic (US) firms have a 43% greater likelihood than foreign firms to use the continuation procedure. One explanation for such a disparity is the familiarity, and possibly the political influence, that domestic firms enjoy with their local institutional environment.

Table 3.3 also presents the full model, “Model 2,” which includes the variables associated with secrecy explanations for the use of continuation in firms’ patenting. SECRET appears to exert a strong effect, and improves the model significantly. Consistent with my argument that continuations allow the firm to take advantage of complementary secrecy in their patenting, the coefficient of the variable SECRET is both appropriately (positively) signed and significant at the 99% level. The magnitude of the coefficient indicates that firms in an industry reporting that “secrecy” is effective at capturing value in 100% of firm innovations would be more likely by a factor of 2\(\times\) to seek a continuation when patenting than a firm patenting in an industry reporting that “secrecy” was 0% effective in capturing value. More realistically, a change in the value of the SECRET coefficient by one standard deviation (+ 9% in reported “secrecy” effectiveness) indicates that a firm in that industry is 7% more likely to engage in continuation patenting. This result suggests that the share of innovations for which a firm considers “secrecy” an effective means of capturing competitive advantage is significantly, positively, and strongly correlated with the firm’s use of the continuation procedure in its patenting of new discoveries. The derivative variable TRADESECRET also enters the specification at a significant level. The coefficient of this measure is appropriately (negatively) signed, indicating that a firm valuing secrecy relatively highly and patenting relatively lowly—and accordingly more likely to pursue simple trade secret strategies—are less likely to employ the continuation (when the firm patents at all).

Likewise, the explanatory variable LEADTIME appears to exert a strong influence upon the dependent variable, and improves the estimation significantly. Consistent with the suggestion that the rate at which profits arrive from innovation will influence the choice of delay or secrecy by firms, LEAD TIME is both appropriately (negatively) signed and significant at the 99% level. The magnitude of the LEADTIME coefficient indicates that, in industries reporting that “lead time” is effective at capturing value for every innovation, a patenting firm would be less likely by a factor of 2\(\times\) to pursue a continuation than a firm patenting an innovation in an industry reporting that “lead time” was effective in no cases. More realistically, a change in the value of the LEADTIME coefficient by one standard deviation (+ 9% in reported “lead time” effectiveness) indicates that a firm in that industry is 7% less likely to engage in continuation patenting. This finding may suggest that the rate at which profits arrive for an innovation strongly influences the economic benefits associated with pursuing delay and secrecy strategies through continuation patenting.

The derivative variable SELF*SECRET also enters the specification at a significant level. The coefficient of this measure is appropriately (positively) signed, indicating that a firm that both values secrecy as an appropriability mechanism and demonstrates ownership over the technology trajectory in which a patent lies is more likely to employ the continuation. This proxy for the element of technology control by a secrecy-valuing firm appears to have a
substantial impact: The magnitude of the coefficient suggests that a firm valuing secrecy on all of its innovations and owning all of the patents in the focal patent’s backward-citation lineage is 2.74 times more likely to use the continuation procedure in patenting than is a patenting firm that values secrecy on none of its innovations and owns none of the patents to which the focal patent refers. More realistically, a firm owning 50% of the patents in the technology trajectory and valuing secrecy in 50% of its innovations is approximately 80% more likely to use the continuation than is a firm owning 10% of the patents in the technology trajectory and valuing secrecy in 10% of its innovations. This result is strong evidence that firms that both value secrecy as an appropriability mechanism, and are carrying on “cumulative innovation,” are substantially more likely to engage in continuation patenting, consistent with the theory on continuation patent blocking as firm strategy.

In sum, these appropriately signed and significant coefficients on the explanatory variables SECRET, TRADESECRET, LEADTIME, and SELF*SECRET demonstrate that Model 2, which includes these “secrecy” explanations for the likelihood of a firm engaging in continuation patenting, is a significant improvement. Further evidence of the increased power of the full regression is given in the difference in the likelihood ratio (2,821.11 for 3 degrees of freedom). That these variables enter the specification suggests that secrecy may indeed play a meaningful role in creating incentives for the firm to use the continuation application for the purpose of securing secrecy as a complement to its patenting.

1.5 CONCLUSION

When the United States Congress considered the 1995 changes in the Patent Law aimed at harmonizing the U.S. patent regime with the rest of the industrialized world, one of the benefits touted was the elimination of incentives to engage in submarine patenting. The other uses to which firms put the continuation—including complementary uses of the secrecy afforded by the continuation with patenting itself—was not considered by the legislature. The analysis in this paper clarifies the complementarity between patenting and secrecy, the strategic opportunities that continuation patenting offers to firms, the extensive use of continuation patenting by firms, and the likely role that secrecy plays in driving the firm’s choice of continuation in patenting behavior. Naturally, a complementary analysis would focus on post-1995 changes in continuation patenting practice, thus either legitimating or invalidating the predictions of the empirical and theoretical discussion in this paper. Given the timing of patent issue, and particularly the long grant-lagged continuation patents, however, this compelling analysis must await the appearance of the needed data, and is the grist of future research.

This paper has explored three elementary questions: First, are there complementarities between patenting and secrecy that firms exploit when crafting their technology market strategies? Second, what drives the firm’s choice of a patent-secret mix when developing a strategy to sustain competitive advantage? And third, what are the consequences for the firm of one or another choice or mix? I was able answer these questions employing novel patent-based data, the continuation application, showing in the process that firms’ use of the continuation is widespread and that the procedure’s use in patenting is an economically important phenomenon worthy of study.

I exploited these continuation patent applications to observe firms’ choice of secrecy in their overall appropriation strategies. I argued and provided evidence that the continuation
application affords the patentee a strategic opportunity, to secure a more valuable secrecy than simple trade secret allows. And while the literature has traditionally viewed secrecy as a substitute to patenting (Landes, et al., 1985), I demonstrated that secrecy functions routinely as a complement to the act of patenting itself.

Because I contended that a key driver of continuation patenting is the firm’s secrecy motives, I test various alternative explanations for firms’ use of the procedure. To develop refutable implications, I model the competitive interaction of innovating firms, and find that incentives to acquire strategic secrecy are particularly strong in incumbent firms. I also created a strategic framework for understanding complementary uses of patenting and secrecy that supports my core arguments: The value firms attach to secrecy in appropriating rents from inventions is an important determinant of the use of continuation application strategies in firm patenting.

I tested my hypotheses by creating a new database, collecting continuation application data on over 1.2 million patents issued to firms between 1975 and 1994. Because the value that firms attach to secrecy is not readily observable, I constructed a measure of this value derived from the Cohen, et al. (2001b) surveys. Using this measure required that I develop another analytic innovation, and I manufacture a concordance matching U.S. patents to International Standard Industrial Classifications (ISIC), using the framework pioneered by Silverman (1996) as a starting point. I found support for my hypotheses that as firms attach increasing importance to secrecy as a mechanism for capturing value, they are more likely to choose continuation patenting as a strategic option.

This paper makes four main contributions to the existing literature. First, I create and test a framework for understanding firms’ choices in developing patenting and secrecy strategies, demonstrating that these mechanisms are routinely used as complements. Second, I provide an econometric specification for the use by firms of secrecy, a strategic choice by firms that has heretofore been hidden from us. Third, I exploit a rich new data source, the continuation application in U.S. patenting, that promises to spawn a wide array of studies. Finally, I contribute to the existing literature on firm patenting strategy, substantially informing our understanding of an economically important and complex phenomenon.

Discovering how firms capture and sustain competitive advantage from their intangible assets is fundamental to our understanding of the strategic management of technology. With the growing importance of “knowledge” as a driver of economic value, unresolved questions concerning the role and effectiveness of different firm appropriability mechanisms loom large. This paper contributes to the literature a means, a framework, and empirically-supported hypotheses that enlighten firm secrecy strategies. Secrecy, long known to be the most effective method of capturing value from discoveries, has heretofore been hidden from us. This paper furthers our understanding of the relationship between secrecy and patenting in corporate appropriation strategies, and as such will be a welcome addition to researchers, managers, and policy-makers alike.
REFERENCES


