

# Law and Innovation: Evidence from the Uniform Trade Secrets Act

I.P.L. Png\*

Revised, August 2011

## Abstract

Most research and policy on protecting innovation focus on patents. Yet, almost all technology managers report secrecy to be more important than patents.

Here, I show theoretically that stronger secrecy laws could increase or reduce R&D. By reducing spillovers, secrecy laws might reduce or raise the return to R&D, depending on whether spillover and own R&D are complements or substitutes. By strengthening appropriability, secrecy laws would raise the return to R&D.

Empirically, I find that, among U.S. manufacturers between 1976 and 2006, the Uniform Trade Secrets Act (UTSA) was associated with an average 5.2% ( $\pm 2.5\%$ ) reduction in R&D. This negative effect suggests that, on average, own and spillover R&D are complements. The impact of the UTSA was quite nuanced, being significant among low-tech companies, but not significant among high-tech companies.

Further, I show theoretically that stronger secrecy laws could increase or reduce patenting depending on their relative impact on the exclusivity of the patentable innovation vis-a-vis complementary know-how. Empirically, the UTSA was associated with reduced patenting in industries where patents are relatively effective in protecting process innovations.

JEL: O32, O34

\*National University of Singapore. I thank Qiu-hong Wang, Lu Yi, Sampsa Samila, Katie Robinson (Uniform Law Commission), Myles Shaver, Sendil Ethiraj, Kai-lung Hui, Will Mitchell, Ke-wei Huang, Richard Lai, Jim Pooley, Emek Basker, Suresh Kotha, Bronwyn Hall, and audiences at Heinz College, Carnegie-Mellon University, University of Bern, WIPO, the Ludwig Maximilians University, and the Searle Centre, Northwestern University, for helpful discussions and advice, and Linxi Chang, Emily Jothidas, Xueji Liang, Oon Pei Gan, and Shi Yuan for research assistance. Financial support from the NUS Academic Research Fund (R-313-000-089-112) is gratefully acknowledged.

# 1 Introduction

“Hurd will be in a situation in which he cannot perform his duties for Oracle without necessarily using and disclosing HP’s trade secrets and confidential information to others.” (Hewlett-Packard Company, September 7, 2010).

Wall Street Journal: “Is it true that the original WD-40 formula is locked in a bank vault?”

Mr. Ridge (CEO, WD-40 Company): “Absolutely. We have only ever taken it out of the vault, well, twice. Once when we changed banks. ... It’s a trade secret.”

*Wall Street Journal*, May 23, 2006.

“Google avidly protects every aspect of its search technology from disclosure, even including the total number of searches conducted on any given day.” (Nicole Wong, Associate General Counsel, Google Inc., February 17, 2006).

Innovation depends on tangible investments such as plant and equipment and intangible investments such as research and development (R&D) and marketing. In turn, commercial investment depends on formal and informal property rights. To date, policy makers and scholars of innovation have tended to focus attention on technical innovation and on patents (Jaffe and Lerner 2004; Hall 2007).

However, almost all European and American technology managers consistently report secrecy to be more important than patents as a way to appropriate the returns from technical innovation (Arundel and Kabla 1998; Cohen et al. 2000; Arundel 2001). Coca Cola (probably the world’s most famous trade secret), WD-40, and Google’s algorithms exemplify the importance of secrecy to technical and business innovation.

Patents provide broad exclusivity but only for a fixed period of time, are limited to technical innovations that meet particular standards, and require disclosure of the innovation as well as application fees and other expenses. By contrast, trade secrets can be unlimited in time, are not limited by particular technical standards, do not require disclosure, and cost relatively little. (But secrecy does not protect against accidental disclosure, independent discovery, or reverse engineering.)

Moreover, the scope of trade secrecy is much broader than that of patents. While patents give protection only to completed innovations, trade secrecy protects work in

progress. Further, trade secrecy extends beyond technical innovations to commercial innovations including business ideas, marketing concepts, and customer lists. To some extent, these can be protected through trademark and copyright. However, some fall outside the scope of trademark and copyright – an important example is customer lists, which were the subject of almost one-third of federal trade secrets cases in federal courts between 1950-2008 (Almeling et al. 2010). For such marketing investments, trade secrecy is the only available legal protection.

Like intellectual property in general, the purpose of trade secrecy is to encourage innovation and ultimately foster economic growth. In general, secrecy can affect innovation at two stages – the investment stage where the innovator decides on the amount of R&D, by affecting the extent of spillovers from the innovation of others, and the exploitation stage, where the innovator decides how to commercialize and protect the innovation. Secrecy may have conflicting effects on investment in innovation. On the one hand, stronger secrecy laws would provide better assurance of exclusivity, and hence increase the innovator’s return from investment. On the other hand, stronger secrecy laws would reduce the extent to which innovators would receive spillovers from others. The impact of reduced spillovers would depend on whether spillovers are complements or substitutes for own investment in innovation.

Despite the practical importance of trade secrecy to innovation, there has been little empirical research into the economic impact of trade secrets. The only work to date is indirect (focusing on patent rather than secrecy laws) and based on innovations presented at 19th century World’s Fairs. In twelve countries, inventors specialized by industry according to whether their home country allowed patents (Moser 2005). However, in Britain and the USA, most innovations were not patented and the extent of patenting did not vary with national patent laws (Moser 2010).

Here, I use analytical modeling and a rich data set compiled from multiple sources to address two research questions:

- How does trade secrets law affect investment in R&D?
- How does trade secrets law affect patenting?

This paper makes four contributions. First, drawing on various legal authorities, I compile a chronology of U.S. state-level trade secrets laws. In the United States, patents, trademarks, and copyrights are governed by federal law. By contrast, civil rights to trade secrecy lie within state jurisdiction, and historically, secrecy was governed by common

law.<sup>1</sup> Since 1979, most states have enacted the Uniform Trade Secrets Act (UTSA). My chronology of state-level trade secrets laws includes details of their legislative history.

Second, I develop a simple model of innovation over two stages. In the investment stage, the innovator decides on R&D expenditure, while, in the exploitation stage, the innovator decides whether to patent the innovation. I show theoretically that the impact of stronger secrecy laws on R&D depends on a balance of two factors. By reducing spillovers, secrecy laws might reduce or raise the return to R&D, depending on whether spillover and own R&D are complements or substitutes. By strengthening appropriability, secrecy laws would raise the return to R&D. The impact of secrecy laws on patenting depends on their effect on the exclusivity of the patentable innovation itself relative to their effect on complementary know-how (know-how that cannot be patented but needed to commercialize the innovation).

Third, I combine the chronology of state-level trade secrets laws with data from multiple sources including company-level data on innovation (R&D expenditure and patenting) from Compustat and the NBER Patent Database to assemble a rich data-set of U.S. manufacturers between 1976 and 2006. I use the variation across and within states in enactment of the UTSA to identify the impact of the UTSA on company-level R&D through difference-in-differences estimation. I find that the UTSA was associated with an average 5.2% ( $\pm 2.5\%$ ) reduction in R&D. The impact of the UTSA was quite nuanced, being significant among low-tech companies, but not significant among high-tech companies.

I interpret the empirical findings as showing that, on average, own and spillover R&D are complements, so, the UTSA, by reducing spillovers, lowered the expected return from R&D, and hence, led to less R&D. This finding was confirmed through multiple robustness checks for omission of possibly relevant variables, geographic samples, and timing. In addition, the findings were robust to multiple falsification exercises that tested the impact of the UTSA on other categories of company-level expenditure and the impact of other uniform laws on R&D.

Fourth, I find that, controlling for R&D expenditure, the UTSA was associated with reduced patenting among industries in which patenting has been reported to be relatively effective in appropriating *process innovations* (Cohen et al. 2000). So, the UTSA

---

<sup>1</sup>Federal law does regulate the criminal misappropriation of trade secrets. The federal Economic Espionage Act of 1996 provides criminal penalties for misappropriation of trade secrets that benefit a foreign government or that involve inter-state commerce. Some states also subject trade secrets to criminal law.

affects patenting of process innovations – the context in which secrecy does substitute for patenting.

I interpret these results as showing that, broadly, the principal effect of the UTSA on innovation was to reduce R&D spillovers at the investment stage, while its effect at the subsequent exploitation stage was limited to circumstances where secrecy and patents are substitutes. Given the importance of innovation for economic growth, my empirical findings are significant for public policy and management practice. Policy-makers and managers should look beyond patents, copyright, and trademarks. Trade secrecy matters. By harnessing the property rights arising from this relatively under-explored area of the law, nations and businesses can increase innovation, and achieve faster economic growth and higher long-run welfare.

## 2 Background Literature

The prior empirical literature on trade secrecy mostly comprises analyses of litigation and surveys of technology managers. Computer programming accounted for the most (10.6%) of California and Massachusetts trade secret cases decided in state and federal courts up to 2006 (Lerner 2006).<sup>2</sup> Among federal trade secrets cases between 1950-2007, the top three issues were: (i) technical information and know-how (46%), (ii) customer lists (32%), and (iii) internal business information (31%) (Almeling et al. 2010).

The pattern of litigation points to the importance of trade secrecy for technical innovations which cannot be patented and for commercial innovation. Until the 1980s, the United States did not allow patenting of software, and so, software developers had to rely on copyright and secrecy. An innovation may be patented only if it is novel, not obvious, and has utility. Mere “know-how” might not meet these standards and so, might not be patentable, hence the innovator must rely on secrecy.<sup>3</sup>

Various surveys have asked technology managers about the ways by which they appropriate the returns to innovation. European R&D managers were more likely to patent product innovations than process innovations, and the propensity to patent increased

---

<sup>2</sup>While trade secrets are a state matter, federal courts have jurisdiction over cases in which plaintiffs and defendants reside in different states and the amount at stake exceeds \$75,000 (Perritt 2005: 10-3).

<sup>3</sup>The federal Economic Espionage Act of 1996 provides criminal penalties for misappropriation of trade secrets that benefit a foreign government or that involve inter-state commerce. Searle (2010) studied 95 cases filed between 1996 and 2008 and found that relatively more prosecutions involved the secrets of smaller companies.

with sales and the importance of patents, but did not vary with R&D intensity (Arundel and Kabla 1998). European R&D managers generally rated secrecy as more valuable than patents, but the advantage of secrecy over patents decreased with R&D expenditure for product innovations, but not for process innovations (Arundel 2001). U.S. R&D managers cited secrecy and lead time most frequently as providing effective protection for product innovations, and cited secrecy and complementary manufacturing most frequently as providing effective protection for process innovations (Cohen et al. 2000). However, German businesses rated patents as being more important than secrecy (Hussinger 2006).

Two empirical studies were based on innovations presented at 19th century World's Fairs. Moser (2005) found that patent laws affected the direction of innovation in 12 countries. Inventors specialized by industry according to whether their home country allowed patents. Separately, Moser (2010) found that most British and U.S. innovations were not patented and that the extent of patenting did not vary with national patent laws. However, neither of these studies addressed the impact of patent laws on the *extent* of innovation.

Most analytical research on trade secrecy has focused on technical innovation and assumed that secrecy and patents are substitute means of protection. One set of analyses includes three stages. First, the innovator decides on R&D, then, the innovator chooses between patents and secrecy, and finally, the innovator engages with possible competitors. Anton and Yao (2004) addressed the competitor's decision whether to imitate and possibly infringe the innovator's patent.<sup>4</sup> Denicolo and Franzoni (2004) considered the competitor's investment in possibly duplicative R&D. In related work, Kultti et al. (2007) studied the choice between patents and secrecy when multiple innovators may discover the same innovation. In research closer to ours, Ottoz and Kugno (2008) allowed patents and secrecy to be complements, and analyzed the innovator's decision on the fraction of innovations to patent.

All of the previous analytical research overlooked the protection of innovation during the R&D stage. The previous analyses focused on protection of completed innovations. However, leakage of work in progress could be as serious as leakage of completed innovations. Patents cannot protect work in progress, and the only available protection is secrecy.

The various surveys suggest that trade secrecy plays an important role in technical

---

<sup>4</sup>Anton and Yao (2004) predicted that the innovator would patent minor innovations and use secrecy for major innovations. Their analysis is supported by evidence from France (Pajak 2009).

innovation. However, the analytical research overlooked the protection of innovation during the conduct of R&D. There are no empirical studies, not even surveys, of the impact of secrecy investment in R&D (as distinct from appropriating the returns to R&D that has already been completed). Apparently, the impact of trade secrets law on innovation continues to be an open issue.

### 3 Model

Trade secrets law possibly affects innovation at two stages. In the first stage, where the innovator decides on investment in R&D, trade secrets law possibly affects the extent of spillovers from the R&D of others. In the second stage, where the innovator decides how to exploit the innovation, trade secrets law affects the exclusivity of the patentable innovation itself as well as complementary know-how.

Referring to Figure 1, in the investment stage, a manufacturer must decide how much,  $R$ , to invest in R&D to yield an innovation. The innovation could be either a new product that would generate additional revenues, or a new process that would reduce the costs of production. The R&D would succeed and produce the innovation with probability,  $\alpha(R, S(L)) \in [0, 1]$ , where  $S(L)$  represents spillovers from the R&D of other manufacturers and  $L$  characterizes the strength of trade secrets law.

The likelihood of R&D success is increasing,  $\partial\alpha/\partial R > 0$ , and concave in the investment. It is also increasing,  $\partial\alpha/\partial S > 0$ , and concave in spillovers. Own and spillover R&D are substitutes if  $\partial^2\alpha/\partial R\partial S < 0$  and complements if  $\partial^2\alpha/\partial R\partial S > 0$ . Spillovers decrease with stronger trade secrets law,  $dS/dL < 0$ .

If the R&D succeeds, in the exploitation stage, the manufacturer must then decide how to exploit the innovation. Exploitation involves manufacturing and marketing the product either internally or through licensing, and also protection of the innovation through intellectual property or other means. As emphasized by practitioners, the manufacturing process may involve the use of complementary know-how which is not patentable: “Patents and trade secrets are not incompatible but dovetail: the former can protect patentable inventions, and the latter, the volumes of important, if not essential, collateral know-how associated with such inventions” Jorda (2008: 1). Moreover, the exploitation also depends on marketing and internal business knowledge such as customer lists that can only be protected by secrecy.

Accordingly, in the exploitation stage, I suppose that trade secrets law affects the

manufacturer in two ways. One is through the likelihood,  $\varsigma(L)$ , that the complementary know-how, protected by trade secrecy, would leak out. I assume that  $\varsigma(L)$  decreases in the strength of trade secrets law,  $d\varsigma/dL < 0$ . The other is through the likelihood that the innovation itself, if not protected by patent, would leak out.

For simplicity, I assume that, if the manufacturer chooses to patent the innovation, it would enjoy exclusive use of the innovation. In this case, the manufacturer's net earnings would depend only on whether the complementary know-how leaks out. If the know-how does not leak out, the manufacturer would earn  $M - R - c_P$ , where  $M > 0$  is the contribution margin (revenue net of production costs) from the innovation, and  $c_P$  represents the cost of obtaining and defending the patent and also any losses arising from the revelation of information that must be published with the patent. If the know-how leaks out, I assume, for simplicity, that competition would drive down the contribution margin to zero, while the manufacturer would still incur the costs of R&D and patenting, and so, its earnings would be just  $-R - c_P$ . Since the probability of a leak is  $\varsigma(L)$ , the manufacturer's expected profit if it does patent is

$$\varsigma(L)[-R - c_P] + [1 - \varsigma(L)][M - R - c_P] = [1 - \varsigma(L)]M - R - c_P. \quad (1)$$

However, if the manufacturer chooses not to patent the innovation, it faces the risk that either the innovation itself or the complementary know-how would leak out to competitors. The obvious way by which the innovation or complementary know-how could leak out is through reverse engineering. Trade secrets law does not protect against reverse engineering. If neither the innovation nor know-how leaks out, the manufacturer would earn profit,  $M - R - c_S$ , where  $c_S$  represents the cost of maintaining secrecy. If either innovation or know-how leaks out, the manufacturer's contribution margin would be driven to zero, hence its profit would be  $-R - c_S$ .

Let the innovation leak out with probability,  $\rho(L)$ , which decreases in the strength of trade secrets law,  $d\rho/dL < 0$ . Further, let the probabilities of the innovation and the complementary know-how leaking out be independent. Hence, the manufacturer's expected profit if it does not patent is

$$\begin{aligned} & \{1 - [1 - \varsigma(L)][1 - \rho(L)]\}[-R - c_S] + [1 - \varsigma(L)][1 - \rho(L)][M - R - c_S] \\ & = [1 - \varsigma(L)][1 - \rho(L)]M - R - c_S. \end{aligned} \quad (2)$$

Referring to Figure 1, by (1) and (2), in the exploitation stage, the manufacturer would patent the innovation if and only if  $[1 - \varsigma(L)]M - R - c_P \geq [1 - \varsigma(L)][1 -$

$\rho(L)]M - R - c_S$ , or,

$$c_P - c_S \leq [1 - \varsigma(L)]\rho(L)M. \quad (3)$$

The parameters,  $1 - \varsigma(L)$  and  $1 - \rho(L)$ , characterize the exclusivity of the complementary know-how and the non-patented innovation as provided by trade secrets law.<sup>5</sup>

With this set-up, my first result addresses the impact of trade secrets law on patenting. Since the decision to patent arises only if the manufacturer invests in R&D and only if R&D is successful, the patenting result is conditional on R&D.<sup>6</sup>

**Proposition 1** *If trade secrets law is stronger, conditional on R&D expenditure, the manufacturer would reduce patenting if and only if trade secrets law has a relatively larger impact on exclusivity of the complementary know-how than the non-patented innovation, specifically,*

$$\frac{\varsigma(L)}{1 - \varsigma(L)} \cdot \frac{1}{\varsigma(L)} \frac{d\varsigma(L)}{dL} > \frac{1}{\rho(L)} \frac{d\rho(L)}{dL}. \quad (4)$$

Stronger trade secrets law would affect the manufacturer's choice of whether to patent the innovation in two ways. It reduces the probability,  $\rho(L)$ , that the innovation itself, if not patented, would leak out. This raises the expected profit from not patenting. The stronger trade secrets law also reduces the probability,  $\varsigma(L)$ , that the complementary know-how would leak out, i.e., raises the exclusivity of the complementary know-how. This raises the expected profit from both patenting as well as from not patenting. However, the marginal impact on the expected profit from patenting is relatively higher because, with patenting, the innovation itself would not leak out. By contrast, without patenting, the innovation itself might leak out, and so, the increased exclusivity of the complementary know-how would not raise the manufacturer's expected profit so much.

On balance, the manufacturer would reduce patenting on and only on condition (4). On the left-hand side of (4), the second fraction is the the elasticity of the likelihood of leak of the complementary know-how. The right-hand side is the elasticity of the likelihood of leak of the innovation itself when not patented. Accordingly, I interpret the condition as being that trade secrets law has a relatively larger impact on the exclusivity of the complementary know-how than on exclusivity of the innovation itself if not patented.

---

<sup>5</sup>The model can be generalized in two ways. One recognizes that the contribution margin with secrecy might differ from that with a patent by some factor. The other considers that the innovator might still earn some contribution if the complementary know-how leaks out but the main innovation is protected.

<sup>6</sup>Please refer to the Appendix for the proofs of the two propositions.

Having analyzed the impact of trade secrets law in the exploitation stage, the next issue is the impact of trade secrets law in the investment stage. Let  $\Pi_2$  represent the manufacturer's expected profit looking forward from the exploitation stage,

$$\begin{aligned}\Pi_2 &= \max\{[1 - \varsigma(L)]M - R - c_P, [1 - \varsigma(L)][1 - \rho(L)]M - R - c_S\} \\ &= [1 - \varsigma(L)]M - \min[c_P, [1 - \varsigma(L)]\rho(L)M + c_S] - R = G - R,\end{aligned}\quad (5)$$

where

$$G \equiv [1 - \varsigma(L)]M - \min[c_P, [1 - \varsigma(L)]\rho(L)M - c_S] > 0 \quad (6)$$

is the expected contribution margin. (For the situation not to be trivial,  $\Pi_2 \geq 0$ , which implies that  $G \geq R$ , and, so,  $G > 0$ .)

Looking forward from the investment stage, if the R&D succeeds, the manufacturer's expected profit would be  $\Pi_2$ , while, if the R&D fails, its expected profit would be  $-R$ . Accordingly, the manufacturer's unconditional expected profit would be

$$\Pi_1 = \alpha(R, S(L))\Pi_2 + [1 - \alpha(L)][-R] = \alpha(R, S(L))G - R, \quad (7)$$

after substituting from (5). Hence, the manufacturer would maximize profit by investing the amount  $R$  given by the first-order condition,  $\partial\Pi_1/\partial R = 0$ , or

$$\frac{\partial\alpha}{\partial R} \cdot G = 1. \quad (8)$$

I can now prove the following result.

**Proposition 2** *If trade secrets law is stronger,*

- (i) *The manufacturer would increase R&D expenditure if own and spillover R&D are substitutes; and*
- (ii) *The manufacturer would reduce R&D expenditure only if own and spillover R&D are complements.*

The condition that own and spillover R&D be substitutes for stronger trade secrets law to result in higher R&D is clearly not necessary. If the impact of stronger trade secrets law on exclusivity (lower  $\rho(L)$  and  $\varsigma(L)$ ) is large enough, it could outweigh the complementarity of own and spillover R&D to yield a net increase in R&D.

Technology managers report greater reliance on secrecy relative to patents for process innovations as compared with product innovations (Arundel and Kabla 1998; Cohen et

al. 2000; Arundel 2001). This seems reasonable since, by their very nature, product innovations would be more exposed to outsiders than process innovations. However, my model suggests that this empirical finding should not be directly extended to the relative impact of trade secrets law on process vis-a-vis product R&D. For process innovations, leakage,  $\rho(L)$  and  $\varsigma(L)$ , might be lower than for product innovations. However, by the same token, spillovers (which benefit the innovator),  $S(L)$ , would also be lower. Accordingly, the net effect depends on the balance between spillovers and exclusivity.

## 4 Trade Secrets Law

Historically, in the United States, trade secrets were governed by common law, which originated in England. The seminal case is *Peabody v. Norfolk*, a Massachusetts decision in 1868 (Bone 1998). Subsequently, the Restatement (First) of Torts (1939), in its consolidation of the common law of torts, included section 757 on trade secrets.<sup>7</sup> The Restatement (Section 757, Comment b (1939)) defined a trade secret to “consist of any formula, pattern, device or compilation of information which is used in one’s business, and which gives him an opportunity to obtain an advantage over competitors who do not know or use it”.

In 1968, the National Conference of Commissioners on Uniform State Laws appointed a committee to prepare a uniform trade secrets law. Then, in 1979, the Commissioners approved and recommended the Uniform Trade Secrets Act (UTSA) for enactment by the states. The Commissions explained the need for the UTSA on two grounds. Many states did not have extensive case law on trade secrets. Even in states with substantial case law, the case law was not clear on the parameters of trade secret protection and the appropriate remedies for misappropriation.<sup>8</sup>

Relative to the state common law, the UTSA was significant for three reasons:<sup>9</sup>

- It provided a comprehensive statute for states without extensive case law.

---

<sup>7</sup>The Restatements of the Law are published by the American Law Institute, an organization of legal academics and practitioners, to codify the common law in specific fields. They are not binding authority. However, as the product of a respected group of lawyers, they are influential in legal cases.

<sup>8</sup>“Uniform Trade Secrets Act Prefatory Note”, *Uniform Laws Annotated*, Vol. 14.

<sup>9</sup>Subsequently, in 1985, the Commissioners made three technical amendments to the UTSA, which “did not alter the underlying philosophy of the Act” (Lydon 1987: 439).

- It clarified injunctive and damages remedies, and the statute of limitations (Samuels and Johnson 1990: 53).
- It expanded the definition of a trade secret. Compared with the Restatement (First) of Torts, the UTSA does not require that the secret be business related or in continuous use. The UTSA covers negative information (Lydon 1987: 430), information that has been developed but not yet used, and one-off information (Samuels and Johnson 1990: 62-63). In particular, it would encompass work in progress (see, for instance, *BlueEarth Biofuels, LLC* (2011)<sup>10</sup>).

Based on the compendium, *Uniform Laws Annotated*, the treatises, *Milgrim on Trade Secrets*, Perritt (2005), and Pooley (1997), and various law review analyses (Root and Blynn 1982; Lydon 1987; Samuels and Johnson 1990; Hutter 1999), Table 1 presents a chronology of the UTSA in the various states. Twelve states enacted the UTSA with effect between 1981-85, and then the pace accelerated, with a further twenty-five states enacting the UTSA with effect between 1986-90. Figure 2 shows the states with the UTSA in effect by 1990.<sup>11</sup>

A key issue is why the states enacted the UTSA. The concern for my research into the effect of the UTSA on R&D is that the states' enactment of the UTSA might be endogenous to companies' decisions on R&D. Such endogeneity would present a serious challenge to the interpretation of any regression of R&D on UTSA enactment.

One possible source of endogeneity is reverse causality – that the states enacted the UTSA in response to pressure from businesses that were planning to change R&D. To check for reverse causation, following Romanosky et al. (2010), I compiled the lag between enactment of the UTSA and the year in which the UTSA was first tabled in the legislature (in some states, the UTSA was tabled multiple times). In states where businesses were planning to raise R&D relatively more and would benefit relatively more from trade secrets protection, they would invest relatively more in lobbying, so the legislative lag ought to be shorter.

Figure 3 presents a scatter-plot, by state, of the lag in UTSA legislation against the growth of R&D in the previous year or the year before the previous.<sup>12</sup> If, indeed,

---

<sup>10</sup>*BlueEarth Biofuels, LLC v. Hawaiian Electric Company, Inc. et al.*, U.S. District Court for the District of Hawaii, 2011 U.S. Dist. Lexis 56665, May 25, 2011

<sup>11</sup>The map was produced with the system, “Mapping: AgriLife IT”, Texas A&M University System, <http://monarch.tamu.edu/maps2/us.htm>

<sup>12</sup>Most states enacted the UTSA in the period 1981-90. However, for period 1977-97, the U.S. National

businesses in states which planned to increase R&D relatively more had invested more in lobbying, the legislative lag would have been shorter. In that case, the scatter-plot would slope downward from left to right, i.e., would present a negative slope. However, Figure 3 reveals no apparent relation between the legislative lag and R&D growth. Indeed, in a least squares regression, the coefficient of R&D growth, 0.0252 ( $\pm 0.0222$ ), was positive although not significant.

To further investigate possible sources of endogeneity, Table 2 reports regressions applying the Cox proportional hazard model to the effective year of the UTSA in the various states.<sup>13</sup> <sup>14</sup> As reported in Table 2, column (1), state enactment of the UTSA was negatively related to the percentage of gross state product (GSP) due to manufacturing, and positively related to the growth of GSP. Importantly, state enactment of the UTSA was not significantly related to either the level or growth of R&D.<sup>15</sup>

Besides reverse causation, endogeneity may arise from omitted variables, in particular, unobserved state-level policies affecting R&D expenditure. Various studies of R&D expenditure and financing (Wu 2005; Brown et al. 2009; Wilson 2009) mention only one state-level policy directed at R&D – the state tax credit for R&D expenditure. In 1981, the U.S. government introduced a federal tax credit for R&D expenditure, and 32 states followed with state-level tax credits (Wilson 2007).<sup>16</sup> To supplement the prior studies, it is also worth checking for the presence of unobserved policies that affect R&D. Biderman et al. (2010) suggest to check for unobserved policies by checking for the impact of observable policies as it is likely that governments implement both observable and unobserved policies in tandem.

The ideal measure of the state-level R&D tax credit would be the effective rate of the tax credit. However, the historical effective rates are not available and only the rates for the year 2006 have been published (Wilson 2007: Table 1). Accordingly, Table 2, column (2), reports a specification including an indicator for the presence of a state-level tax

---

Science Foundation published state-level R&D statistics only for odd-numbered years. Owing to the missing data, I used the growth of R&D in either the previous year or the year before the previous.

<sup>13</sup>I excluded South Carolina, which enacted the UTSA with effect from 1992 and then, in 1997, replaced the UTSA with its own state trade secrets act (Pooley 1997: 2-30.5).

<sup>14</sup>Typically, there was some lag between introduction of the UTSA as a bill and the law taking effect. Accordingly, with respect to introduction of the legislation, this specification amounts to regressing the law with a lag.

<sup>15</sup>Below, in difference-in-differences tests of the impact of the UTSA on R&D and patenting, I control for company revenue. This would be similar, at the company level, to gross state product at the state level.

<sup>16</sup>New Hampshire introduced the credit in 1993 and withdrew it two years later (Wilson 2007: footnote 48).

credit for R&D expenditure. This was not significant, suggesting that the states' only known policy to encourage R&D was not significantly related to UTSA enactment.<sup>17</sup>

Besides explicit policies directed at R&D, it is also useful to check for the impact of background factors that might possibly be correlated with policies that affect R&D. Wu (2005) points to state support for higher education. Table 2, column (3), reports a specification including the numbers of master and doctoral graduates. While the number of master graduates was not significant, the number of doctoral graduates was negative and significant. Collectively, the estimates including the presence of a state R&D tax credit and the numbers of master and doctoral graduates suggest that enactment of UTSA was not systematically related to state-level R&D policies.<sup>18</sup>

I then turned to investigate what factors might explain enactment of the UTSA. In the only comprehensive empirical analysis of the Uniform Law Commissioners to date, Ribstein and Kobayashi (1996) showed that states with part-time legislatures and those which consider fewer bills are more likely to adopt uniform laws.

*The Book of the States* publishes details, including numbers of bills, sitting days, and political composition of the state legislatures. Table 2, column (4), reports a specification including a measure of the legislative workload. The legislatures of some states meet in regular session only in alternate years. *The Book of the States* reports only the total number of bills, introduced in the lower and upper houses. Accordingly, I constructed the measure of workload as the two-year moving average of the number of bills relative to the total number of legislators (lower and upper house). Table 4, column (4), reports the estimate of a specification including the legislative workload. Consistent with the findings of Ribstein and Kobayashi (1996), the coefficient was negative, suggesting that state legislatures with a higher workload were *less* likely to enact the UTSA. However, the coefficient was not precisely estimated.

Table 4, column (5), reports the estimate of a specification including the length of the legislative session. The sample was substantially reduced as the states vary in their reporting of sittings. As with the measure of workload, to account for legislatures that meet only in alternate years, I specified the length of the session as a two-year moving average of the number of calendar days that the legislature was in session. Consistent with the findings of Ribstein and Kobayashi (1996), the coefficient was negative and

---

<sup>17</sup>In an unreported regression including the effective rate of tax credit as of 2006, the coefficient of the effective rate was negative and significant, suggesting that the model was misspecified.

<sup>18</sup>In Table 2, column (3), the indicator for R&D tax credit was positive and marginally significant. This was the only specification in which R&D tax credit was even marginally significant.

significant, suggesting that state legislatures with longer sessions were *less* likely to enact the UTSA.

Finally, laws to regulate trade secrets might reasonably be thought of as being part of a “pro-business” agenda. To the extent that the Republican Party is more “pro-business” than the Democratic Party and that the UTSA helps business, states governed by Republicans should be more likely to enact the UTSA. Table 2, column (6), reports a specification including the percent of Republicans in the lower and upper houses of the state legislature.<sup>19</sup> Neither political measure was significant, suggesting that UTSA enactment was not associated with any pro-business agenda.

In summary, enactment of UTSA was not significantly related to either the level or growth of state-level R&D. UTSA enactment was, at most, tenuously associated with the state-level R&D tax credit – being only marginally significantly related to the credit in one specification. Further, UTSA enactment was not significantly related to state politics. By contrast, consistent with prior research into uniform laws (Ribstein and Kobayashi 1996), I found evidence that UTSA enactment was influenced by a purely legislative agenda. On balance, it seems reasonable to conclude that enactment of UTSA was not related to any observed or unobserved policy to influence R&D.<sup>20</sup>

## 5 Empirical Strategy and Data

My main objective was to study the impact of trade secrets laws on technical innovation, specifically, R&D expenditure and patenting. I applied an empirical strategy similar to those in recent studies of the impact on innovation of various U.S. state-level laws, including wrongful discharge laws (Bird and Knopf 2009; Acharya et al. 2010), and enforcement of non-competition covenants (Garmaise 2011; Marx et al. 2010; Samila and Sorensen 2011). Essentially, the research design is one of difference in differences

---

<sup>19</sup>The estimate excluded Nebraska as its legislature consists of one chamber whose legislators may not be affiliated to any party.

<sup>20</sup>California and New York provide further support for the view that UTSA enactment is unrelated to substantive policy considerations. Pooley (2010) represented the American Electronics Association before a committee of the California Senate when it considered the UTSA in 1982 and again in 1983. He described the process as “whimsical”. Neither the senator who introduced the bill nor other committee members appeared to be concerned with the substance of the bill. Hutter (1999) drafted legislation to implement the UTSA in New York. The state Senate passed his draft, but the Assembly blocked it. Hutter (2010) explained the reason as “solely the opposition of the NY State Trial Lawyer’s Association ... The Trial Lawyers donate a lot of money to the Assembly.”

(Bertrand et al. 2004).

The various states enacted the UTSA with effect in different years. Accordingly, panel estimation of the following specification implements differences in differences in a setting of multiple treatment groups over multiple years (Acharya et al. 2010):

$$\ln R_{ist} = \beta_i + \beta_t + \beta \cdot X_{ist} + \gamma \cdot \text{UTSA}_{st} + \epsilon_{ist}. \quad (9)$$

In (9),  $R_{ist}$  represents R&D expenditure,  $X_{ist}$  represents time-varying characteristics, and  $\epsilon_{ist}$  is idiosyncratic error for company  $i$  in state  $s$  in year  $t$ . Further,  $\text{UTSA}_{st} = 1$  for any year  $t$  in which the UTSA was effective in state  $s$  and zero otherwise. The  $\beta_i, \beta_t$  are company and year fixed effects, while  $\beta$  and  $\gamma$  are the coefficients of the time-varying controls and the UTSA indicator respectively.

In (9), the treatment group comprises the companies located in states which have the UTSA in effect, and the control group comprises the companies in states which do not yet have the UTSA in effect (but which eventually enact the UTSA) *and* companies in states which never enact the UTSA. Following Bertrand et al. (2004), in all estimates, the standard errors were clustered by state.

Technical innovation is relatively more important in manufacturing than service industries. Accordingly, much previous research into the protection of technical innovation has focused on manufacturing (Arundel and Kabla 1998; Cohen et al. 2000; Arundel 2001). Likewise, I also focused on manufacturing and compiled, from Compustat, company-level financial information including R&D expenditure, sales revenue, EBITDA (earnings before interest, tax, depreciation, and amortization), market value, book value, industry (SIC 4-digit), and location.

I then matched these with information on patents from the NBER Patent Database (Hall, Jaffe, and Trajtenberg 2001; Bessen 2009). The UTSA was first enacted with effect from 1981, hence, I set the beginning of the study as 1976, being five years before the first effective date of the UTSA, and the end of the study as 2006, which was the last year covered by the NBER Patent Database. I deflated sales revenue and EBITDA by the U.S. GDP deflator, and R&D expenditure by the U.S. deflator for gross private domestic investment.

As the empirical analysis focuses on R&D and patenting, I dropped observations for which either R&D or the number of patent applications were missing. Further, I dropped extreme outliers those with negative R&D, or ratio of R&D to sales revenue exceeding the 99th percentile, or ratio of patent applications to sales revenue exceeding the 99th

percentile. Table 3 presents summary statistics of the data, and the Data Appendix provides details of the variables including sources and construction.

## 6 Results – R&D

Using least squares, I first regressed, at the company level, R&D expenditure on the following controls – sales revenue, market-book ratio, EBITDA, all lagged by one year, company fixed effects, year fixed effects, and state-specific year trends. Sales revenue represented the scale of the company and controlled for any economies of scale in R&D, the ratio of the market-to-book value of the company controlled for other investment opportunities (Acharya et al. 2010), while EBITDA represented cash flow and controlled for the availability of investment funds. The company fixed effects accounted for non time-varying heterogeneity across companies, the year fixed effects accounted for changes over time that affected all companies in all states, such as interest rates and the federal R&D tax credit, while the state-specific year trends accounted for any state-level trends that affected all companies in the state.<sup>21</sup> As reported in Table 4, column (1), the coefficients of sales revenue and EBITDA were positive and significant. The coefficient of market-book ratio was positive but not significant.

In all regressions, I specified absolute measures such as R&D expenditure and sales in logarithms, and relative measures such as the market-book ratio and indicators such as UTSA in their native form. I lagged all corporate variables by one year and all legal variables by two years, which allowed reasonable time for corporate resources and state policies to affect R&D. For brevity, in the discussion below, I simply refer to the variable itself and omit mention of the logarithm and lag.

The next specification included two legal variables. One was an indicator for the UTSA being in effect (= 1 if the UTSA was in effect in the year in the state where the company was located, and = 0 otherwise), which is the treatment of key interest. The other was the number of trade secrets law cases, which controlled for differences in the development of state common law. (Recall that one of the Uniform Law Commissioners justifications of the UTSA was to assist states without extensive case law.) I compiled the number of trade secrets cases from the Lexis-Nexis database of Federal and State cases.

---

<sup>21</sup>R&D intensity, being an industry-level characteristic, does not vary within companies. It is essentially a constant, and so, cannot be identified in a regression with company fixed effects.

Table 4, column (2), reports the results. The coefficients of the company-level financials were similar to those in the regression including only company financials. Importantly, the coefficient of UTSA,  $-0.052$  ( $\pm 0.025$ ) ( $p = 0.044$ ), was negative and precisely estimated. Apparently, the UTSA was associated with a 5.2% ( $\pm 2.5\%$ ) *reduction* in company-level R&D expenditure.<sup>22</sup> The coefficient of the number of trade secrets cases was negative but not precisely estimated.

By Proposition 2, the result for UTSA implies that own and spillover R&D are complements. Stronger trade secrets law would have reduced spillovers of R&D. For the reduction in spillovers to have resulted in lower R&D, the reduced spillovers must have reduced the return to own R&D, implying that own and spillover R&D must be complements.

In constructing the sample, I stipulated the location of R&D as the company’s headquarters state as reported in Compustat. This might be misspecified to the extent that companies moved their head office between states or conducted R&D away from their head office state. (Regarding the former issue, just 5% of Compustat companies shifted their headquarters between 1992-2004 (Garmaise 2011).)

Absent data on R&D by company location, I used the NBER Patent Database to construct, for each company and year, the fraction of patent applications from each state (applications from the state in the year divided by total applications for that year). I then used the fraction of patent applications to allocate the company R&D to locations by state. This procedure substantially trimmed the sample to 1005 companies with 1382 state-wise locations. These companies were relatively more patent- and R&D-intensive than the baseline sample.<sup>23</sup>

Table 4, column (3), reports the regression of R&D at the state-wise location on the company-level financials and legal variables with location fixed effects, year fixed effects, and state-specific year trends. The fit,  $R^2 = 0.127$ , was worse than in the regression on company-level R&D. Among the company-level financials, the coefficient of sales revenue was significant and similar to the baseline estimate. Importantly, the coefficient of UTSA,  $-0.064$  ( $\pm 0.037$ ) ( $p = 0.089$ ), was quite close to the baseline estimate, albeit marginally significant. This result lent support to the inference that the UTSA was associated with a reduction in R&D. However, I preferred the regression on company-

---

<sup>22</sup>The dependent variable in the R&D regressions is the logarithm of R&D expenditure.

<sup>23</sup>Some companies applied for one patent over the entire sample period from particular states. These sporadic applications might not represent systematic R&D activity, so, to reduce measurement error, I excluded all such companies.

level R&D, which encompassed a much larger sample and did not rely on geographical allocation of R&D by patents.

Various studies have reported systematic differences in company-level R&D strategy and the impact of R&D between high-tech and other industries. The differences include faster growth of R&D (Brown et al. 2009), and stronger impact of R&D on labour productivity, whether measured by sales per employee (Harhoff 1998) or value-added per employee (Ortega-Argiles et al. 2010). Accordingly, it seemed appropriate to distinguish the impact of the UTSA on R&D between high-tech and other industries.

Table 4, column (4), reports an estimate including the UTSA indicator as well as the UTSA indicator for a high-tech industry, using the classification published by the U.S. Department of Commerce (1983) as refined by Brown et al. (2009).<sup>24</sup> The coefficient of UTSA, which represents the effect of the UTSA on low-tech companies, was negative and very precisely estimated. This implies that the UTSA was associated with a relatively large,  $-0.096\%$  ( $\pm 0.034\%$ ) reduction in R&D among companies in low-tech companies.

The coefficient of UTSA x high-tech was positive and very precisely estimated. Hence, the impact of the UTSA clearly differed between high-tech and other companies. The sum of the coefficients of the UTSA indicator and UTSA x high-tech,  $-0.096 + 0.095 = -0.001$  ( $\Pr(F(1, 44) > 0.00) = 0.975$ ), represents the effect of the UTSA on R&D in high-tech companies.

This estimate reveals an important nuance in the impact of the UTSA of R&D. Apparently, the UTSA was associated with a significant reduction in R&D among low-tech companies, but no significant change in R&D among high-tech companies. My estimate adds to previous research that found systematic differences in company-level R&D and its impact between high-tech and other industries.

As a further check on systematic differences in the impact of the UTSA on high-tech vis-a-vis other companies, I estimated a specification including the UTSA indicator as well as the interaction between UTSA and industry-level R&D intensity. The interaction was constructed as the product of UTSA with the difference of the R&D intensity from its mean. I used the Compustat data to compute the industry-level R&D intensity as the ratio of R&D expenditure to sales over all companies in the 4-digit SIC excluding the company itself over the entire sample period.

---

<sup>24</sup>I included aerospace (SIC 372 and 3760), which Brown et al. (2009) excluded as they focused on financing of R&D. I excluded software computer and data processing services (SIC 737) as it is not a manufacturing industry.

As reported in Table 4, column (5), the coefficients of the financial variables were similar to the preferred estimate. The coefficient of UTSA x R&D intensity, 1.340 ( $\pm 0.275$ ), was positive and significant. The mean R&D intensity was 0.060 in the sample and 0.0190 among companies in low-tech industries. Accordingly, the effect of the UTSA on low-tech companies was  $-0.033 + 1.340 \times (0.060 - 0.019) = -0.088$  ( $\pm 0.0316$ ) ( $p = 0.008$ ), which was similar to the estimate with the binary categorization of low- and high-tech companies reported in Table 4, column (4).

Finally, given previous research on the choice between patents and secrecy, it seemed useful to explore any differential impact of the UTSA according to the substitution between patents and secrecy. To the extent that secrecy simply substituted for patents, the impact of the UTSA on R&D should be relatively less. Secrecy is a relatively more effective substitute for patents in appropriating process as compared with product innovations (Arundel and Kabla 1998; Cohen et al. 2000; Arundel 2001; Jorda 2008).

Accordingly, I estimated a specification including the UTSA indicator as well as the interaction between UTSA and Cohen et al.'s (2000) percentage of technology managers reporting that patents were effective in appropriating process innovations, with the percentage measured as the difference from its mean. Owing to the limited industry coverage of Cohen et al.'s (2000) survey, the sample was reduced by more than one-third. As reported in Table 4, column (6), the coefficients of the financial variables were similar to the preferred estimate. The coefficient of UTSA was similar to the preferred estimate but less precise. As conjectured, the coefficient of the interaction between UTSA and the reported effectiveness of patents in appropriating process innovations was negative. However, it was not precisely estimated.

Overall, my estimates suggest that, on average, the UTSA was associated with a 5.2% ( $\pm 2.5\%$ ) reduction in R&D. By Proposition 2, stronger trade secrets law would lead to less R&D only if own and spillover R&D are complements. Accordingly, my results imply that, on average, own and spillover R&D were complements – a reduction in spillovers reduced companies' return to own R&D, and so, led them to reduce R&D.

However, the impact of the UTSA was quite nuanced, being larger among low-tech companies, and not significant among high-tech companies. One possible explanation is that high-tech companies focused relatively more on original innovation, while low-tech companies undertook more reverse engineering. Since trade secrets law has a larger impact on reverse engineering than original innovation, it would then have a larger impact on manufacturers that focus on reverse engineering.

## Robustness

To confirm the robustness of my findings, I checked for omission of possibly relevant variables, geographic samples, and timing. Table 5 reports the robustness checks, and, for easy reference, column (1), reproduces the preferred estimate from Table 4, column (2).

In the first robustness check, I addressed the sensitivity of the results to omission of state policies influencing R&D. As reviewed in Section 4 above, the only state policy directed at R&D was the state R&D tax credit. Table 5, column (2), reports a specification including the indicator for the state R&D tax credit. The coefficient of UTSA was close to the preferred estimate. The coefficient of the indicator of the state R&D tax credit was not significant. This result is consistent with previous research which found that the main effect of the state R&D tax credit was to divert R&D among states rather than grow R&D within states (Wilson 2009). My estimate, with company fixed effects, amounts to testing the impact of the UTSA on differences relative to company averages and would not detect diversion of R&D.

The second robustness check addressed the sensitivity of the results to omission of state educational policies, which also possibly influence company-level R&D. Table 5, column (3), reports an estimate including the numbers of graduates with bachelor, master, and doctoral degrees in science and engineering. The coefficient of UTSA was smaller than the preferred estimate, but still significant. However, none of the education measures were significant.

The third robustness check aimed to reduce unobserved heterogeneity and confounds. It limited the sample to companies in states that did enact the UTSA, so excluding states that never enacted a trade secrets act, or enacted one that substantially differed from the UTSA. Since the states enacted the UTSA at different times, the staggered timing could provide the identifying variation. In this context, the control group was the states which had not yet enacted the UTSA (but which eventually did).

Limiting the sample to states that did enact the UTSA reduces potential bias in two ways (Biderman et al. 2010). One, it reduces the unobserved heterogeneity between the control and treatment groups – states that enacted the UTSA, either earlier or later, would be relatively more similar than states which did enact or never enacted the UTSA. Further, limiting the sample would reduce the risk of confounds from unobserved policies. The states that enacted the UTSA later might adopt unobserved policies later, or the states that enacted the UTSA earlier might adopt unobserved policies earlier, and

so, confounding the empirical tests. However, the unobserved policies must be timed to coincide with the UTSA enactment, which makes the confound less likely.

As reported in Table 5, column (4), the estimates on the sample limited to companies in states that did enact the UTSA were similar to the preferred estimate. In particular, the coefficient of UTSA was negative, precisely estimated, and somewhat larger than the preferred estimate. Accordingly, I infer that my findings were robust to how the control vis-a-vis treatment states were specified.<sup>25</sup>

Finally, I investigated the sensitivity of the estimates to the profile of lags – one year for company financial variables and two years for legal variables. Table 5, column (5), reports an estimate with no lags. The coefficient of EBITDA was *negative* and significant, which does not make economic sense, and casting doubt on this specification. With regard to the central issue, the coefficient of UTSA was negative, about 30% smaller than the preferred estimate, but not precisely estimated.

Table 5, column (6), reports an estimate with all variables lagged by one year. The results were quite similar to the preferred estimate. Notably, EBITDA was positive and significant. However, the coefficient of UTSA was negative, about 30% smaller than the preferred estimate, but not precisely estimated. I infer from the estimates with no lag and one year lag for all variables that changes in the law did affect R&D more slowly than company-level financials.

In addition, I estimated two specifications (unreported, for brevity): one included lags of two, three, and four years of UTSA, while the other included a one-year lead, contemporaneous UTSA, and lags of one, two, three, and four years. Comparing the two estimates, the one-year lead was not significant, suggesting that there was no pre-existing trend for R&D to fall before the UTSA came into effect.

To summarize, the central finding that the UTSA was associated with a reduction in company-level R&D was robust to multiple checks for omission of possibly relevant variables, geographic samples, and timing.<sup>26</sup>

---

<sup>25</sup>Further, in an unreported estimate, I limited the sample to states that enacted some trade secrets act, whether conforming to the UTSA or not, after 1979, when the Uniform Law Commissioners published the UTSA. Again, the results were similar to the preferred estimate.

<sup>26</sup>To address any concern that UTSA might be endogenous, I tested for endogeneity using sitting days as an instrument. My analysis in Section 4 identified sitting days as the only factor that influenced UTSA enactment. The test statistic was  $\chi^2(1) = 0.001$  ( $p = 0.9704$ ), so, the null hypothesis that UTSA was exogenous could not be rejected.

## Falsification

As a further check of the validity of my findings, I conducted a set of validation and falsification exercises to test the impact of the UTSA on other company-level categories of expenditure and the impact of other uniform laws on company-level R&D. For easy reference, Table 6, column (1), reproduces the preferred estimate, as originally presented in Table 4, column (2).

The first exercise tested the impact of the UTSA on selling, general, and administrative (SG&A) expenditures. Two elements of SG&A – general and administrative expenses – are overhead items. There would be little reason for trade secrets law to affect overhead expenses. On the other hand, the scope of trade secrets law encompasses marketing innovation, and one of most common subjects of federal trade secrets litigation is customer lists (Almeling et al. 2010). Hence, UTSA enactment might affect expenditure in selling to new customers, and thus, affect SG&A. To this extent, I maintain an agnostic view as to the possible impact of the UTSA on SG&A.

As Table 6, column (2), reports a regression on SG&A. The coefficient of UTSA was negative, about a third of the coefficient in the baseline R&D regression, but not precisely estimated. The negative coefficient was consistent with the UTSA reducing spillovers of marketing investment, and own and spillover marketing investments being complements. However, the effect of the UTSA on selling expenses may have been too small relative to the whole category of SG&A for the coefficient to be significant.

Next, I tested the impact of the UTSA on capital expenditure. Generally, businesses gain a tax advantage by expensing rather capitalizing their investments as they would reduce their immediate taxable income. Accordingly, businesses would expense if they can, and so, would record expenditures on technical innovation as R&D, and expenditures on non-technical innovation in SG&A rather than capitalize such expenditures. Thus, changes in trade secrets law should not have a significant effect on capital expenditure. Indeed, as reported in Table 6, column (3), in the regression on capital expenditure, the coefficient of UTSA was small and not significant.

In the third exercise, I tested the impact of the UTSA on depreciation and amortization. Depreciation and amortization are determined by rules on the basis of past capital expenditures, and hence, would not be affected by trade secrets law. Indeed, as reported in Table 6, column (4), in the regression on depreciation and amortization, the coefficient of UTSA was trivial and not significant.

Finally, I tested the impact of two other uniform laws which respectively should have

little and no effect on company-level R&D. I chose two laws that were published around the same time as the UTSA, one of which was commercial and the other not commercial. The Uniform Law Commissioners published the Uniform Limited Partnership Act (ULPA) in 1976, three years before the UTSA, and the Uniform Determination of Death Act (UDDA) in 1980, just one year after the UTSA.

By refining and codifying the law on limited partnerships, the ULPA would facilitate investments made through limited partnerships and so, R&D. However, the main applications of limited partnerships are in real estate, and to a much smaller degree, venture capital and mining. Accordingly, the effect of the ULPA on R&D would be small. Indeed, as Table 6, column (5), reports, ULPA being in effect had a small and not significant effect on R&D.

Finally, Table 6, column (6), reports a regression of R&D on the UDDA being in effect. There is absolutely no reason why the UDDA would affect R&D. Indeed, the coefficient of UDDA was not significant.<sup>27</sup>

In summary, my finding that the UTSA affected R&D was supported by various validation and falsification exercises. The results of the exercises were in line with theory and intuition.

## 7 Results – Patents

Much of the existing analytical and empirical literature on trade secrets has focused on the substitution between patents and secrecy in appropriating innovation (Anton and Yao 2004; Denicolo and Franzoni 2004; Kultti et al. 2007; Moser 2005; Moser 2010). By contrast, practitioners (Jorda 2008) and some scholars (Ottoz and Kugno 2008) have emphasized that patents and trade secrecy are complementary in appropriating the returns from innovation. Taking account of both the substitution and complementarity, Proposition 1 predicts that, controlling for R&D, stronger trade secrets law would lead to less patenting under condition (4).

So, empirically, how did the UTSA affect patenting? The dependent variable is a count. With Poisson estimation, the coefficients are consistent if the mean specification is correct and the robust standard errors are consistent although the distribution is mis-

---

<sup>27</sup>I conducted several other falsification exercises (unreported, for brevity), using other uniform laws that were published around the same time as the UTSA. None of them had significant effect on R&D.

specified (Wooldridge 2002: 646-649). Accordingly, following Hall and Ziedonis (2001), I used the Poisson model with robust standard errors clustered by state.

I first estimated a background specification, regressing patent applications on sales revenue and R&D expenditure (both lagged by one year), and including company and year fixed effects and state-specific year trends.<sup>28</sup> As reported in Table 7, column (1), the coefficient of sales revenue was positive and significant, which is consistent with economies of scale in patenting. The coefficient of R&D expenditure was positive and significant. This result does help to validate the model underlying Proposition 1, which implies that patenting increases with R&D and is consistent with previous empirical studies of patenting (for instance, Hall and Ziedonis (2001)).

Next, I estimated the baseline specification – including the indicator for the UTSA and number of trade secrets cases. (In the patent regressions, as in the R&D regressions, company financial variables were lagged by one year, and legal variables were lagged by two years. For brevity, in the discussion, I simply refer to the variable itself and do not explicitly mention the lag.) As Table 7, column (2), reports, the coefficients of the controls were similar to those in the background estimate. Neither UTSA nor the number of trade secrets cases was significant.

Table 7, column (3), reports the estimate of a specification including the interaction of UTSA with the percentage of managers in Cohen et al.’s (2000) survey reporting that patents were effective in ensuring the appropriability of *process* innovations.<sup>29</sup> Cohen et al.’s (2000) survey covered a limited number of manufacturing industries, and so, the inclusion of this interaction reduced the sample by more than half. The coefficient of the interaction of UTSA with the effectiveness of patents for process innovation,  $-0.036 (\pm 0.016)$ , was negative and precisely estimated.

Referring to Table 3, the standard deviation of the effectiveness of patents for process innovation was 0.074. So, an increase in effectiveness by one standard deviation would be associated with a change in the expected number of patents by  $\exp(0.0744 \times -0.036)$  or 0.997, or about one. This is economically significant relative to the average number of patents per company, 11.796.

As a validation, I also estimated a specification including the interaction of UTSA

---

<sup>28</sup>I focused on patent applications rather than patent grants, since the issue is how businesses seek to appropriate the returns from their innovations. In practice, most patent applications are eventually granted, so applications and grants are highly correlated (Jaffe and Lerner 2004).

<sup>29</sup>To facilitate interpretation, as with all interactions of UTSA with continuous covariates, the continuous covariate was measured relative to its sample mean.

with the percentage of managers reporting that patents were effective in ensuring the appropriability of *product* innovations. To the extent that secrecy is less effective in protecting products than processes, the coefficient of this interaction should be smaller than the coefficient for process innovation. Indeed, as reported in Table 7, column (4), the coefficient was much smaller, but not precisely estimated.

I interpret the findings reported in Table 7 as showing that, overall, the UTSA had no significant effect on patenting, while having a significant negative impact where patenting was effective for processes. These results are quite reasonable as trade secrecy can only substitute for patents where patents are effective. Moreover, the impact on patents for processes is consistent with the prior academic and practitioner literature which suggests that trade secrecy is relatively more useful in protecting processes as compared with products (Arundel and Kabla 1998; Cohen et al. 2000; Arundel 2001; Jorda 2008).

The absence of a significant overall impact on patenting could be interpreted in two ways. Referring to Proposition 1, one is that trade secrets law affects the exclusivity of the complementary know-how relatively less than the exclusivity of the innovation itself. The other possible explanation is that innovators patented for strategic objectives not directly related to appropriability. These include blocking competitors, as a defensive measure, for use in negotiations, and to attract venture capital investments (Cohen et al. 2000; Hall and Ziedonis 2001). Changes in trade secrets law might have little effect on patenting for such reasons. Trade secrecy cannot be used to block a competitor and trade secrets might not help to attract venture capitalists.

## 8 Concluding Remarks

Through various empirical tests, I have robustly shown that the UTSA was associated with a nuanced effect on company-level innovation. At the investment stage, it was associated with lower R&D among companies, particularly those in low-tech industries. I interpret the results as showing that own and spillover R&D are complements. By reducing spillovers among manufacturers, the UTSA reduced the expected return from R&D, and so, led to less R&D.

At the patenting stage, the UTSA was associated with significantly less patenting among companies in industries where patents are relatively effective in protecting process innovation. These results suggest that, outside of industries where patents are effective for processes, either the UTSA affected the exclusivity of complementary know-how

relatively less than the exclusivity of the innovation itself, or strategic objectives for patenting were more important than directly protecting appropriability.

My results imply that trade secrets law matters for investment in R&D generally, and, for particular industries, also might matter for the decision whether to patent technical innovations. These findings are significant for public policy and managerial practice. Policy-makers concerned about technical innovation should look beyond patents, and give more attention to trade secrets. Managers should pay attention to the nuanced impact of secrecy. Secrecy affects both R&D and patenting, and with differential effect across industries.

For academic purposes, my findings suggest that the theoretical literature on trade secrecy should be re-oriented from focusing on trade secrecy as an alternative to patents as a way to protect the appropriability of innovation. Patents and secrecy might possibly fulfill distinct objectives, with the role of secrecy being mainly to regulate spillovers of knowledge at the investment stage of innovation.

A limitation of my analysis is that it treated all state enactments of the UTSA as identical. In fact, the states were prone to enact the UTSA with variations (Samuels and Johnson 1990; Pooley 1997). While I did control for differences in state common law, one direction for deeper legal research would be to catalogue the differences in the states' versions of the UTSA and then to study the impact of the state laws on innovation. The challenge to such a study is that there is no ready legal analysis of the differences among the states' versions of the UTSA, unlike that available for non-competition agreements.<sup>30</sup>

Most importantly, my study points to a new research agenda – the impact of trade secrets law on (i) entrepreneurship and venture capital, (ii) collaboration, (iii) business and marketing innovation, and (iv) international trade and investment.

Gilson (1999) famously argued that California is more entrepreneurial than Massachusetts because it does not enforce non-competition agreements. However, the laws of the two states differ not only with respect to enforceability of non-competition agreements. California enacted the UTSA with effect from 1985, while Massachusetts relies on a very simple statute, published in 1967, and common law. Indeed, Hewlett-Packard's suit mentioned trade secrets but not any non-competition agreement. So, does entrepreneurship thrive in California in spite of a tougher trade secrets regime? This

---

<sup>30</sup>While the Bureau of National Affairs has published a state-level survey of trade secrets law (Pedowitz et al. 1997), the results of the survey cannot be so readily codified as their corresponding survey for non-competition agreements (Malsberger et al. 2008).

would imply that the effect of non-competition law is even stronger – strong enough to outweigh the trade secrets law. This is a question that is obviously deserving of further investigation.

It is worth emphasizing that stronger trade secrets law would not necessarily affect entrepreneurship in a negative way. Stronger trade secrets law might reduce spillovers of knowledge, and so reduce entrepreneurship. On the other hand, stronger trade secrets law would increase security of property rights, and so facilitate agreements for collaboration and spin-off businesses.

Related to the above, the second important direction for future research is the impact of trade secrets law on collaboration between businesses. A major risk in any business or technical collaboration is that one party might steal the ideas of the other. By providing security of property rights over work in progress, trade secrecy may foster collaboration and sharing of information. Secrecy is the only available protection for innovation which has not reached the stage to qualify (if at all) for patent or trademark protection. To the extent that the UTSA strengthens trade secrecy whether in law or simply in the minds of businesses, it might foster collaboration.

A third useful direction for future research is the impact of trade secrets law on business and marketing innovation. One of the most common subjects of trade secrets litigation is customer lists (Almeling et al. 2010). The challenge to this research would be to procure the relevant data on investment in business and marketing innovation. One possible proxy is advertising expenditure, which is reported by Compustat. However, it is imperfect to the extent that the advertising copy and media placement are public, hence only the planning and resource allocation are secret.

Finally, trade secrets law possibly affects international trade and investment. The multilateral Agreement on TRIPS (Trade-Related Aspects of Intellectual Property Rights) came into effect on January 1, 1995. TRIPS, in Article 39.2, specifically provides for protection of trade secrets. However, just as trade secrets law varies within the United States, it varies across countries. Even the European Union, which has energetically sought to harmonize patent, copyright, and trademark laws, has not done so with trade secrets. Given the international variation of trade secrets law (and enforcement), it would be very useful to study their impact on international trade and investment.

## References

- Almeling, David S., Darin W. Snyder, Michael Sapoznikow, Whitney E. McCollum, and Jill Weader, “A Statistical Analysis of Trade Secret Litigation in Federal Courts”, *Gonzaga Law Review*, Vol. 45 No. 2, 2010.
- Anton, James J., and Dennis A. Yao, “Little patents and big secrets: Managing intellectual property”, *RAND Journal of Economics*, Vol. 35, No. 1, Spring 2004, 1-22.
- Acharya, Viral V., Ramin P. Baghai, and Krishnamurthy V. Subramanian, “Wrongful Discharge Laws and Innovation”, Working Paper 1570663, SSRN, March 14, 2010.
- Arundel, Anthony, “The relative effectiveness of patents and secrecy for appropriation”, *Research Policy*, Vol. 30, 2001, 611-624.
- Arundel, Anthony, and Isabelle Kabla, “What percentage of innovations are patented? Empirical estimates for European firms”, *Research Policy*, Vol. 27, 1998, 127-141.
- Bertrand, Marianne, Esther Duflo, and Sendil Mullainathan, “How Much Should We Trust Differences-in-Differences Estimates?”, *Quarterly Journal of Economics*, Vol. 119 No. 1, 2004, 249-75.
- Bessen, James, “NBER PDP Project User Documentation: Matching Patent Data to Compustat Firms”, Version: Beta, May 2009 [www.nber.org/jbessen/matchdoc.pdf](http://www.nber.org/jbessen/matchdoc.pdf) [Accessed, December 6, 2010].
- Biderman, Ciro, Joao M.P. De Mello, and Alexandre Schneider, “Dry Laws and Homicides: Evidence from the Sao Paulo Metropolitan Area”, *Economic Journal*, Vol. 120 No. 543, March 2010, 157-182.
- Bird, Robert C., and John D. Knopf, “Do Wrongful-Discharge Laws Impair Firm Performance?” *Journal of Law and Economics*, Vol. 52, No. 2, May 2009, 197-222.
- Bone, Robert G., “New Look at Trade Secret Law: Doctrine in Search of Justification”, *California Law Review*, Vol. 86 No. 2, March 1998, 241-314.
- Brown, James R., Steven M. Fazzari, Bruce C. Petersen, “Financing Innovation and Growth: Cash Flow, External Equity, and the 1990s R&D Boom”, *Journal of Finance*, Vol. 64, No. 1, February 2009, 151-185.
- Cohen, Wesley M., Richard R. Nelson, and John P. Walsh, “Protecting Their Intellectual Assets: Appropriability Conditions and Why US Manufacturing Firms Patent (or Not)”, NBER Working Paper 7552, 2000.
- Denicolo, Vincenzo, and Luigi Franzoni, “Patents, Secrets, and the First Inventor Defense”, *Journal of Economics and Management Strategy*, Vol. 13 No. 3, 2004, 517-538.
- Garmaise, Mark J., “Ties that Truly Bind: Noncompetition Agreements, Executive Compensation, and Firm Investment”, *Journal of Law, Economics, and Organization*, forthcoming 2011.
- Gilson, Ronald J., “The Legal Infrastructure of High Technology Industrial Districts: Silicon Valley, Route 128, and Covenants Not to Compete”, *New York University Law Review*, Vol. 74, 1999, 575-629.
- Hall, Bronwyn H., “Patents and Patent Policy”, *Oxford Review of Economic Policy*, Vol. 23 No. 4, Winter 2007, 568-587.
- Hall, Bronwyn H., and Rosemarie Ham Ziedonis, “The patent paradox revisited: an empirical study of patenting in the U.S. semiconductor industry, 1979-1995”, *RAND Journal of Economics*, Vol. 32. No. 1, Spring 2001, 101-128.

Hall, Bronwyn H., Adam B. Jaffe, and Manuel Trajtenberg, “The NBER Patent Citations Data File: Lessons, Insights and Methodological Tools”, Working Paper 8498, National Bureau of Economic Research, Cambridge, MA, October 2001.

Harhoff, Dietmar, “R&D and productivity in German manufacturing firms”, *Economics of Innovation and New Technology*, Vol. 6 No. 1, 1998, 29-49.

Hewlett-Packard Company v Mark V. Hurd, Superior Court, County of Santa Clara, September 7, 2010.

Hussinger, Katrin, “Is Silence Golden? Patents versus Secrecy at the Firm Level”, *Economics of Innovation and New Technology*, Vol. 15 No. 8, 2006, 735-752.

Hutter, Michael, “The Case For Adoption Of A Uniform Trade Secrets Act in New York”, *Albany Law Journal of Science and Technology*, Vol. 10, 1999, 1-64.

Hutter, Michael, Email, November 1, 2010.

Jacobson, Louis S., Robert J. LaLonde, and Daniel G. Sullivan, “Earnings Losses of Displaced Workers,” *American Economic Review*, Vol. 83 No. 4, September 1993, 685-709.

Jaffe, Adam B., and Josh Lerner, *Innovation and Its Discontents: How Our Broken Patent System Is Endangering Innovation and Progress, and What To Do About It*, Princeton, NJ: Princeton University Press, 2004.

Jorda, Karl F., “Patent and Trade Secret Complementariness: An Unsuspected Synergy”, *Washburn Law Journal*, Vol. 48 No. 1, Fall 2008, 1-32.

Kultti, Klaus, Tuomas Takalo, and Juuso Toikka, “Secrecy versus patenting”, *RAND Journal of Economics*, Vol. 38 No. 1, March 2007, 22-42.

Lerner, Josh, “Using Litigation to Understand Trade Secrets: A Preliminary Exploration”, Working Paper 922520, SSRN, August 2006.

Lydon, James C., “The Deterrent Effect of the Uniform Trade Secrets Act”, *Journal of the Patent & Trademark Office Society*, Vol. 69, 1987, 472-444.

Malsberger, Brian M., Richard Alfred, Thomas Christopher, and Arnold H. Pedowitz, *Covenants Not to Compete: A State-by-State Survey*, 6th edition, Arlington, VA: BNA Books, 2008.

Marx, Matt, Jasjit Singh, and Lee Fleming, “Regional Disadvantage? Non-Compete Agreements and Brain Drain”, INSEAD, Singapore, September 22, 2010.

*Milgrim on Trade Secrets*, Matthew Bender, updated.

Moser, Petra, “How Do Patent Laws Influence Innovation? Evidence from Nineteenth-Century World’s Fairs”, *American Economic Review*, Vol. 95 No. 4, September 2005, 1214-1236.

Moser, Petra, “Innovation Without Patents – Evidence from World Fairs”, Working Paper 930241, SSRN, July 2010.

Ortega-Argiles, Raquel, Lesley Potters, and Marco Vivarelli, “R&D and productivity: testing sectoral peculiarities using micro data”, *Empirical Economics*, DOI 10.1007/s00181-010-0406-3, October 2010.

Ottoz, Elisabetta, and Franco Cugno, “Patent-Secret Mix in Complex Product Firms”, *American Law and Economics Review*, Vol. 10 No. 1, 2008, 142-158.

Pajak, Serge, “Do Firms Rely on Big Secrets? An Analysis of IP Protection Strategies with the CIS 4 Survey”, ENST Telecom ParisTech, Department of Economics, April 2009.

Perritt, Henry H., *Trade Secrets: A Practitioner’s Guide*, 2nd Edition, New York, NY: Practising Law Institute, 2005.

Pedowitz, Arnold H., Robert W. Sikkel, Robert A. Dubault, and Brian M. Malsberger, *Trade secrets: A state-by-state survey*, Washington, DC: Bureau of National Affairs, 1997.

Pooley, James, *Trade Secrets*, New York: Law Journal Press, 1997-.

Pooley, James, Personal conversation with author, November 30, 2010.

Ribstein, Larry E., and Bruce H. Kobayashi “An Economic Analysis of Uniform State Laws”, *Journal of Legal Studies*, Vol. 25, No. 1, January 1996, 131-199.

Romanosky, Sasha, Rahul Telang, and Alessandro Acquisti, “Do Data Breach Disclosure Laws Reduce Identity Theft?” Heinz School of Public Policy and Management, Carnegie Mellon University, 2010.

Root, Joseph E., and Guy M. Blynn, “Abandonment of Common-Law Principles: The North Carolina Trade Secrets Protection Act”, *Wake Forest Law Review*, Vol. 18 No. 5, October 1982, 823-855.

Samila, Sampsa, and Olav Sorensen, “Non-compete Covenants: Incentives to Innovate or Impediments to Growth”, *Management Science*, forthcoming 2011.

Samuels, Linda B., and Bryan K. Johnson, “The Uniform Trade Secrets Act: The States’ Response”, *Creighton Law Review*, Vol. 24, 1990, 49-98.

Searle, Nicola, “The determinants of trade secret intensity: An empirical investigation using evidence from the Economic Espionage Act”, 5th European Policy for Intellectual Property Conference, Maastricht University, 2010.

Simcoe, Tim, “XTPQML: Stata module to estimate Fixed-effects Poisson (Quasi-ML) regression with robust standard errors”, Statistical Software Components S456821, Boston College Department of Economics, revised, September 22, 2008.

*The Book of the States*, Lexington, KY: Council of State Governments.

*Uniform Laws Annotated*, St. Paul, MN: West Publishing Company, 1968-.

U.S. Department of Commerce, *An Assessment of United States Competitiveness in High-Technology Industries*, Washington D.C., February 1983.

U.S. Office of Management and Budget, *International concordance between the industrial classifications of the United Nations (ISIC Rev 3) and Canada (1980 SIC), the European Union (NACE Rev 1), and the United States (1987 SIC)*, Washington, DC, 1997.

Wilson, Daniel J., “Beggar thy Neighbor? The In-State, Out-of-State, and Aggregate Effects of R&D Tax Credits”, Working Paper 2005-08, Federal Reserve Bank of San Francisco, August 2007

Wilson, Daniel J., “Beggar thy Neighbor? The In-State, Out-of-State, and Aggregate Effects of R&D Tax Credits”, *Review of Economics and Statistics*, Vol. 91, No. 2, May 2009, 431-436.

Wooldridge, Jeffrey M., *Econometric Analysis of Cross Section and Panel Data*, Cambridge, MA: MIT Press, 2002.

Wong, Nicole, Associate General Counsel, Google Inc., “Response to the DoJ motion”, Google Blog, February 17, 2006 <http://googleblog.blogspot.com/2006/02/response-to-doj-motion.html> [Accessed, December 5, 2010].

Wu, Yonghong, “The effects of state R&D tax credits in stimulating private R&D expenditure: A cross-state empirical analysis”, *Journal of Policy Analysis and Management*, Vol. 24 No. 4, Autumn 2005, 785-802.

*Wall Street Journal*, “WD-40 CEO repackages a core product”, May 23, 2006.

Table 1. Uniform Trade Secrets Act

State	Year	State	Year
Arkansas	1981	District of Columbia	1989
Idaho	1981	Hawaii	1989
Kansas	1981	Maryland	1989
Louisiana	1981	New Mexico	1989
Minnesota	1981	Utah	1989
Delaware	1982	Arizona	1990
Indiana	1982	Georgia	1990
Washington	1982	Iowa	1990
Connecticut	1983	Kentucky	1990
North Dakota	1983	Mississippi	1990
California	1985	New Hampshire	1990
Montana	1985	South Carolina	1992-97
Colorado	1986	Ohio	1994
Oklahoma	1986	Missouri	1995
Rhode Island	1986	Vermont	1996
Virginia	1986	Michigan	1998
West Virginia	1986	Nebraska	1998
Wisconsin	1986*	Tennessee	2000
Alabama	1987*	Pennsylvania	2004
Maine	1987	Wyoming	2006
Nevada	1987	Massachusetts	
Alaska	1988	New Jersey	
Florida	1988	New York	
Illinois	1988	North Carolina	
Oregon	1988	Texas	
South Dakota	1988		

Notes: Wisconsin and Alabama enacted trade secrets acts that differed substantially from the UTSA. Massachusetts and North Carolina enacted trade secrets acts that do not comply with the UTSA. South Carolina enacted the UTSA with effect from 1992, and then replaced the UTSA with its own trade secrets act with effect from 1997.

Table 2. State enactment of UTSA

VARIABLES	(1) Macro- economic	(2) Tax credit	(3) Education	(4) Legislative agenda	(5) Session length	(6) Politics
GSP (ln)	-1.244 (2.046)	-1.295 (2.113)	-1.034 (1.912)	-1.107 (3.172)	-0.073 (4.175)	-1.899 (2.252)
R&D (ln)	0.209 (0.229)	0.200 (0.235)	-0.126 (0.410)	0.163 (0.487)	-8.494* (4.545)	0.237 (0.302)
Manufacturing (%)	-7.065* (3.778)	-7.390* (4.181)	-16.459** (6.587)	-16.356** (7.639)	-123.577* (69.688)	-6.412 (5.836)
Population (ln)	0.512 (2.417)	0.572 (2.494)	0.931 (2.218)	0.648 (3.714)	3.768 (3.619)	0.995 (2.712)
GSP growth	24.587** (10.868)	24.500** (10.924)	32.064 (28.216)	20.186* (12.142)	151.391*** (57.233)	28.190** (12.367)
R&D growth	0.541 (0.631)	0.551 (0.660)	0.826 (1.059)	-1.044 (2.500)	-3.709 (3.362)	-0.557 (1.399)
Population growth	-45.099 (29.339)	-45.696 (30.289)	-10.274 (49.520)	-92.792*** (31.590)	-14.128 (68.097)	-46.470 (46.802)
R&D tax credit		0.178 (0.907)	2.058* (1.111)	1.624 (1.088)	9.262 (6.791)	0.434 (1.005)
Master graduates (ln)			0.015 (0.012)			
Doctoral graduates (ln)			-0.070*** (0.025)			
Legislative workload				-0.019 (0.024)		
Session days (ln)					-0.811*** (0.189)	
Lower house Republican						-4.276 (5.060)
Upper house Republican						3.696 (4.429)
Observations	224	224	157	177	92	216

Notes: Estimation by Cox proportional hazard regression of UTSA in effect. Focal variables: Column (2): Indicator of state-level tax credit for R&D; Column (3): Numbers of graduates with master and doctoral degrees; Column (4): Two-year moving average of number of bills tabled relative to number of legislators; Column (5): Two-year moving average of number of calendar days legislature in session (in logarithm); Column (6): Percent of Republicans in lower house and upper houses of legislature (excluding Nebraska which has a unicameral legislature and whose members may not be affiliated to any party); All estimates exclude South Carolina. Robust standard errors clustered by state in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

Table 3. Summary statistics

Variable	Unit	Observations	Mean	Std. Dev.	Min	Max
R&D	\$ million	49240	55.080	319.542	-0.056	13215.67
Sales revenue	\$ million	49240	1731.839	9129.766	-0.020	332313.8
Market/book value		42388	2.800	294.600	-51820.5	22719
EBITDA	\$ million	49144	248.239	1429.600	-1672.06	66968.09
Patents		49240	11.796	60.160	0	2355
R&D intensity (industry)		49240	0.060	0.055	0	0.218
Complex industry		23418	0.568	0.495	0	1
High-tech industry		49240	0.534	0.499	0	1
Effectiveness of patents for product	%	30551	36.492	11.861	12.08	54.7
Effectiveness of patents for process	%	30551	25.416	7.440	8.64	36.67
Trade secrets cases		48587	30.359	24.232	0	120

Table 4: R&amp;D expenditure

VARIABLES	(1) Company	(2) UTSA	(3) State-wise locations	(4) High tech	(5) Hetero- geneity	(6) Patent effective (process)
Sales revenue	0.644*** (0.024)	0.653*** (0.024)	0.542*** (0.029)	0.650*** (0.024)	0.650*** (0.024)	0.650*** (0.029)
Market/book value (mill)	9.788 (6.346)	11.111** (5.275)	251.986 (180.432)	10.040* (5.263)	10.296* (5.290)	12.321* (6.312)
EBITDA	0.025*** (0.006)	0.023*** (0.006)	-0.015 (0.018)	0.023*** (0.006)	0.022*** (0.006)	0.027*** (0.009)
Trade secrets cases		-0.013 (0.025)	0.041 (0.087)	-0.015 (0.027)	-0.013 (0.027)	-0.041 (0.043)
UTSA		-0.052** (0.025)	-0.064* (0.037)	-0.096*** (0.034)	-0.033 (0.030)	-0.059* (0.035)
UTSA x high-tech				0.095*** (0.024)		
UTSA x R&D intensity					1.340*** (0.275)	
UTSA x patent effectiveness (process)						-0.004 (0.005)
Constant	-1.737*** (0.096)	-1.744*** (0.123)	-1.513*** (0.178)	-1.730*** (0.123)	-1.737*** (0.122)	-1.538*** (0.146)
Observations	30362	28382	9723	28382	28382	16731
R-squared	0.659	0.660	0.127	0.661	0.661	0.694
No. of companies	3254	3087	1005	3087	3087	1847
No. of locations			1382			

Notes: Estimation by ordinary least squares with company and year fixed effects and state-specific year trends. Dependent variable was log R&D expenditure, all company-level financial variables were lagged by one year, and all trade secrets law-related variables were lagged by two years. Column (3): Dependent variable was log R&D expenditure at the state-wise location; Column (4): High-tech industries as classified by U.S. Department of Commerce (1983) but excluding software computer and data processing services (SIC 737); Column (5): UTSA x difference of R&D intensity from sample mean; Column (6): UTSA x difference of Cohen et al.'s (2000) percentage of technology managers reporting that patents were effective in appropriating process innovations from sample mean. Robust standard errors clustered by state in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ ).

Table 5. R&amp;D – Robustness

VARIABLES	(1) UTSA (preferred)	(2) R&D tax credit	(3) Education	(4) UTSA states	(5) No lag	(6) One lag
Revenue	0.653*** (0.024)	0.653*** (0.024)	0.632*** (0.022)	0.660*** (0.027)	0.745*** (0.028)	0.644*** (0.024)
Market/ book value (mill)	11.111** (5.275)	11.299** (5.458)	-9.070 (5.594)	12.859*** (3.666)	7.702 (8.056)	10.004 (6.606)
EBITDA	0.023*** (0.006)	0.023*** (0.006)	0.014* (0.008)	0.019*** (0.004)	-0.041*** (0.008)	0.025*** (0.006)
Trade secrets cases	-0.013 (0.025)	-0.008 (0.027)	0.031 (0.039)	-0.022 (0.031)	0.011 (0.027)	0.010 (0.028)
UTSA	-0.052** (0.025)	-0.050** (0.023)	-0.041** (0.016)	-0.059** (0.026)	-0.035 (0.025)	-0.035 (0.024)
Tax credit		-0.012 (0.024)				
Bachelor graduates			-0.013 (0.110)			
Master graduates			0.026 (0.050)			
Doctoral graduates			0.003 (0.013)			
Constant	-1.744*** (0.123)	-1.754*** (0.132)	-1.520** (0.723)	-1.757*** (0.142)	-2.125*** (0.133)	-1.760*** (0.120)
Observations	28382	28382	18964	20969	32773	29983
R-squared	0.660	0.660	0.619	0.669	0.693	0.661
Companies	3087	3087	2569	2254	3412	3207

Notes: Estimation by ordinary least squares with company and year fixed effects and state-specific year trends. Dependent variable is log R&D expenditure, and except in columns (5) and (6), all company-level financial variables were lagged by one year, and all trade secrets law-related variables were lagged by two years. Column (2): Indicator of state R&D tax credit in effect; Column (3): Logarithm of numbers of bachelor, master, and doctoral graduates; Column (4): Excluded states which did not enact UTSA (AL, MA, NC, NJ, NY, SC, TX, WI); Column (5): All financial and law variables were contemporaneous; Column (6): All financial and law variables were lagged by one year. Robust standard errors clustered by state in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ ).

Table 6. R&amp;D – Validation and falsification

VARIABLES	(1) UTSA (preferred)	(2) SG&A	(3) Capital expenditure	(4) Depreciation	(5) ULPA	(6) UDDA
Revenue (ln)	0.653*** (0.024)	0.783*** (0.013)	0.498*** (0.016)	0.706*** (0.019)	0.652*** (0.024)	0.653*** (0.024)
Market/ book value (mill)	11.111** (5.275)	13.426*** (1.524)	-22.628*** (3.996)	-9.770*** (3.136)	10.496* (5.230)	10.186* (5.328)
EBITDA (ln)	0.023*** (0.006)	-0.004 (0.004)	0.162*** (0.006)	0.007 (0.004)	0.023*** (0.006)	0.023*** (0.006)
Trade secrets cases	-0.013 (0.025)	-0.013 (0.020)	0.007 (0.045)	0.006 (0.026)	-0.011 (0.024)	-0.003 (0.024)
UTSA	-0.052** (0.025)	-0.015 (0.012)	-0.028 (0.024)	-0.010 (0.013)		
ULPA					-0.011 (0.014)	
UDDA						0.036 (0.030)
Constant	-1.744*** (0.123)	-0.248*** (0.074)	-0.780*** (0.127)	-1.698*** (0.084)	-1.744*** (0.121)	-1.758*** (0.118)
Observations	28382	27719	28014	28368	28382	28382
R-squared	0.660	0.812	0.450	0.722	0.660	0.660
Companies	3087	3018	3082	3087	3087	3087

Notes: Estimation by ordinary least squares with company and year fixed effects and state-specific year trends, all company-level financial variables were lagged by one year, and all law-related (UTSA, UDDA, ULPA) were lagged by two years. Column (1): Dependent variable: log R&D expenditure; Column (2): Dependent variable: log selling, general, and administrative expenditure; Column (3): Dependent variable: log capital expenditure; Column (4): Dependent variable: log depreciation and amortization; Column (5): Dependent variable: log R&D expenditure, Uniform Limited Partnership Act (ULPA) in effect; Column (6): Dependent variable: log R&D expenditure, Uniform Determination of Death Act (UDDA) in effect. Robust standard errors clustered by state in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ ).

Table 7. Patents

VARIABLES	(1) Company	(2) UTSA	(3) Patent effectiveness (process)	(4) Patent effectiveness (product)
Revenue (ln)	0.301*** (0.066)	0.322*** (0.062)	0.245** (0.098)	0.261*** (0.096)
R&D (ln)	0.391*** (0.075)	0.377*** (0.071)	0.406*** (0.094)	0.416*** (0.100)
Trade secrets cases		-0.010 (0.094)	0.153 (0.151)	0.133 (0.154)
UTSA		0.004 (0.067)	-0.086 (0.099)	-0.050 (0.094)
UTSA x patent effect (process)			-0.036** (0.016)	
UTSA x patent effect (product)				-0.004 (0.010)
Observations	39532	35022	21768	21768
Companies	3193	2882	1827	1827

Notes: Estimation by Poisson regression with company and year fixed effects and state-specific year trends. Dependent variable is number of patent applications by company and year; all company-level financial variables were lagged by one year, and all trade secrets law-related variables were lagged by two years. Columns (5)-(6): UTSA x difference of Cohen et al.'s (2000) percentage of technology managers reporting that patents were effective in appropriating process/product innovations from respective sample mean. Robust standard errors clustered by state in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ ).

Figure 1. Decision on R&D and patenting

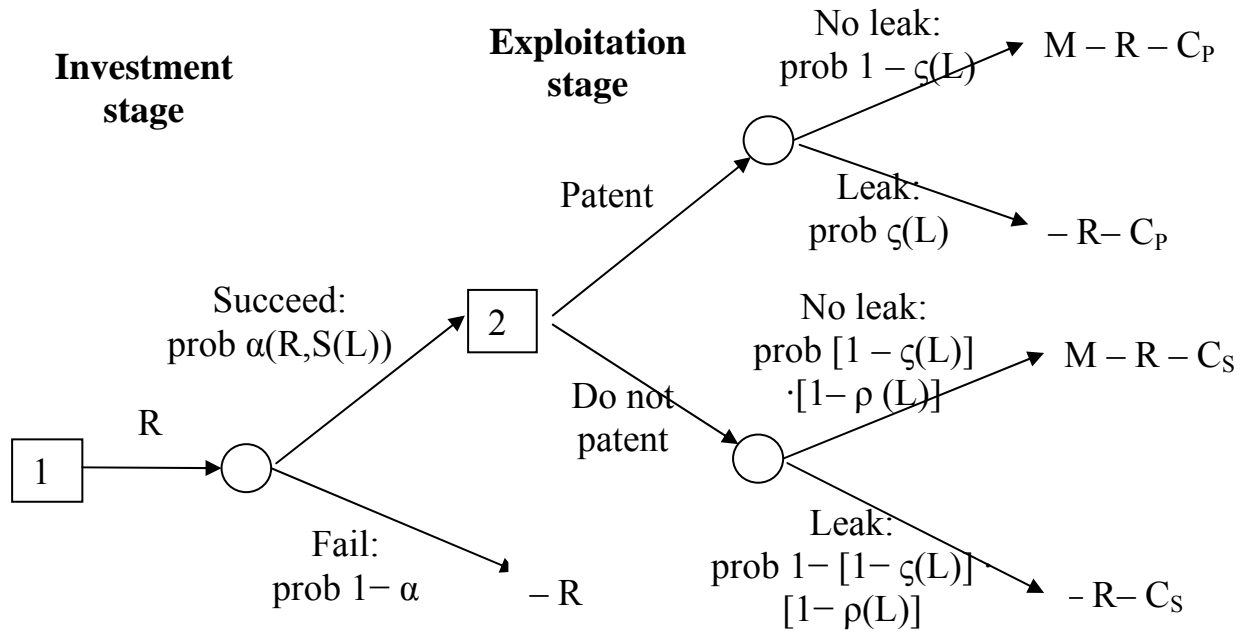
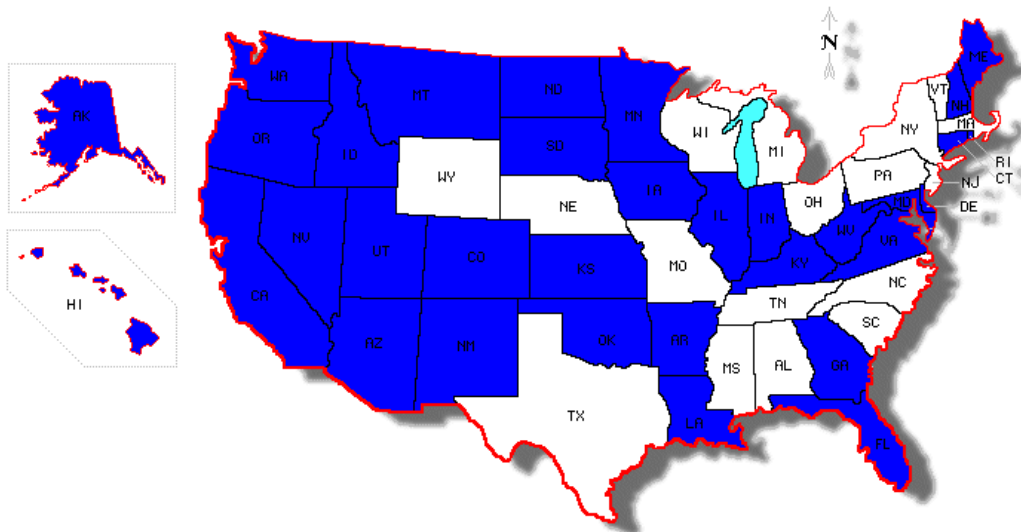


Figure 2. UTSA enactment, 1990



Notes: States with UTSA in effect shaded in blue.

