Did the Sarbanes-Oxley Act Impede Corporate Innovation? An Analysis of the Unintended Consequences of Regulation

Jerry Cao
Singapore Management University
jerrycao@smu.edu.sg

Aurobindo Ghosh
Singapore Management University
Aurobindo@smu.edu.sg

Jeremy Goh
Singapore Management University
Jeremygoh@smu.edu.sg

F. Ted Tschang
Singapore Management University
ttschang@smu.edu.sg

This Draft: 31 July 2016

Did the Sarbanes-Oxley Act Impede Corporate Innovation? An Analysis of the Unintended Consequences of Regulation

Abstract

We investigate whether innovation by publicly listed U.S. companies deteriorated significantly after the adoption of the Sarbanes-Oxley Act of 2002. Using data on patent filings as proxies for firms' innovative activities, we find firms' innovation as measured by patents and innovation efficiency dampened significantly after the enactment of the Act. The degree of impact is related to firm-specific characteristics such as the firm's value (Tobin's Q) and its measure of corporate governance (G-Index), as well as the firm's operating conditions (i.e., the firm being in an high-tech industry, and being delisted or not). We find evidence that the SOX's impact on firms is more pronounced for growth firms, firms with low governance scores, firms operating in high-tech industries and firms that continued to stay listed. In sum, the results suggest that the SOX has an unintended consequence of stifling corporate innovation.

1. Introduction

The history of the regulation of markets and firms shows significant social and economic costs, including substantial and unintended effects on industrial competitiveness (Hahn 1998). These effects on firm performance have been examined mostly through an economist's lens. In recent years, and especially with regards to the advent of regulations such as the Sarbanes-Oxley Act, the effects on innovativeness have started to be more keenly felt (The Economist 2007). This is particularly worrisome since economies and firms are becoming increasingly competitive with time, and technological change (i.e., innovation) is increasingly an integral aspect of that competitiveness. As such, regulations can now not only increase the costs of doing business, but can also affect firms' global competitiveness (Hahn and Hird 1991).

Despite this emerging concern, we still lack a deep understanding of the effects of economy-wide regulations on value creating activities such as innovation. Regulations simply have not been studied as much in the innovation and management literature, especially with regards to their effects on innovation. This with the exception of studies on the stimulative effects of specific regulations on innovation, such as ones in the environmental arena, and with regards to university patenting via the Bayh-Dohl Act (Mowery et al. 2001). To address this gap, we will examine the effect of a regulation addressed to corporate governance in general - the Sarbanes-Oxley Act - on the innovativeness of business.

The Sarbanes-Oxley Act of 2002 was one of the most far reaching regulations in recent decades. It was enacted to curb the worst of corporate excesses and to bring a denouement to the series of corporate governance scandals seen with the likes of the Enron and Worldcom cases. The SOX legislation ushered in an era of increased power and accountability with external board members, audit controls, and overall responsibilities and greater liabilities for corporate leadership and auditors alike. However, the regulation's "heavy-handed" influence also became the focus of corporate concern early on. The former chairman of the Securities Exchange Commission (SEC), William Donaldson, wondered if *"…by unleashing 'batteries of lawyers across the country' the legislation would lead to a 'loss of risk-taking zeal' due to a "huge preoccupation with the dangers and risks of making the slightest mistake"*. It was observed that there was a decrease in IPOs, starting in 2008 and running through 2011 (Wall Street Journal 2012). A natural empirical question then is, did SOX put innovative risk-taking, and therefore, corporate innovation, at risk?

With this question in mind, we sought to understand the negative effects of SOX on firm-level innovation, as an unintended effect of the regulation.[1] Early studies suggested that the effects of SOX have been benign, but as with studies of other regulations, these were often predicated on the *direct costs* of compliance and involved measuring these effects against the public benefits, or framing them in equity (across companies) terms (Coates and Srinivasan 2014). Recent studies have been concerned with the regulation's effect on corporate competitiveness, including by way of firms' ability to innovate (Shadab 2008, Bargeron et. al. 2010, Waters 2013). In particular, SOX was shown to be affecting US corporations' R&D investments by causing them to assume less risk and hoard more cash (as shown to happen after the legislation) (Bargeron et al. 2010). We contribute to this line of research by examining the SOX legislation's effect on *innovation output*, as seen in the evidence on corporate patents. The problem is that firms respond to their institutional environment and in doing so may attend to other interests than to the firms' and their managers' primary purposes (Jensen and Meckling 1976). The question is, in the interests of guarding against corrupt practices, has the SOX's enhancement of firm's governance structure now reduced managers' natural risk-taking tendencies, and thus, innovative outputs themselves?

In section 2, we discuss the background behind our hypothesis - that the enactment of SOX stifles innovation. In section 3, we build on established methodology in the innovation literature, using patent filings and innovation efficiency as measures of corporate innovation, directly testing the hypothesis (Hall, et al. 2001, Hall, et al. 2005). In section 4, we discuss our findings. In our baseline regression, we find that after controlling for a number of concomitant variables like firm size, firm age, return on assets

---

[1] There are different types of regulation, and while these having differing effects on corporate decisions, they also have the generally common effect of increasing the costs of doing business. This is particularly the case for environmental regulations (Coeurderoy and Murray 2008, List et al. 2003). SOX legislation may fall in this category.

(ROA), a measure of firm value (Tobin's Q), amount of cash holdings, leverage, capital and R&D expenditures, and a measure of industry concentration (Herfindahl Index) with both industry and year specific fixed effects, the enactment of Sarbanes-Oxley legislation can be shown to have a significant negative impact on firm innovation.[2] Since the enactment of SOX, we find an unmistakable downward spiral of innovation measured in terms of the number of patents and innovation efficiency (Hershleifer et al. 2013). The results hold even after controlling for high vs. low growth potential (Tobin's Q or firm value), high vs. low levels of governance (G-Index) , and hi-tech vs. non-hi-tech sectors. One important finding of this paper is that even though SOX has a negative impact on firms' innovativeness, firms that are delisted at the advent of SOX are affected less negatively than those that remained listed. Finally, in section 5, we discuss the possible mechanisms underlying management decision-making and corporate behavior with the help of the corporate governance, innovation and management literature.

2. The Nature of Regulatory Influences on the Firm

To understand theoretically how SOX may impact negatively on innovation, we review some of the pertinent literature. One pertains to theories relating to the causes and effects of regulation. It is a fundamental tenet of modern economics that negative externalities or spillovers can be corrected by regulations, but at certain direct costs. Since the advent of neoclassical economics at the time of Adam Smith until the current era, most regulations have been of the form that "protect the public interest" by making the competition fairer (Krugman 2011). Regulations were generally designed to counter various negative aspects of behavior among economic agents, causing negative spillovers or externalities to society at large.[3] Since the beginning of the last century, a number of cases of industry misconduct or

---

[2] The result is robust to different quintiles of firm asset size (or log of firm size) and value (measured by Tobin's Q) although it is much more pronounced for the biggest quintile of firms.

[3] One major feature of regulation involves the internalization of pollution-type externalities caused by private sector activities, as was seen in the variety of environmental and health laws signed into effect over the past few decades, one of the earliest being the 1963 Clean Air Act.

behavior led to regulations that sought to rein in these business excesses, usually promulgated for one specific industry at a time. The earliest and most famous cases were more related to problems of industry structure and concentration, leading up to the various episodes of antitrust regulation, where "fair competition" was the desired regulatory outcome (Hart 2001).[4]

Underlying these traditional notions of regulation are two conceptions of behavior. The first is that increasing industry power (such as that accrued from industry concentration) could lead to misconduct by economic agents. Misconduct or inappropriate action can be brought on by a variety of factors, including cultural (e.g. "bad" corporate cultures and poor ethics), psychological (in way of increased expectations) (Akerlof 1970, Aguilera 2005, Greve et al. 2010, Mishina et al. 2010), and personality-based (Hayward and Hambrick 1997) ones. The second idea inherent in notions of regulation pertains to the ability of regulations to "target" certain outcomes and to then compel firms to shift their strategy in desired directions. In the environmental arena for instance, "command and control" environmental regulations enacted to create emissions standards were expected to lead to compliance, and even theorized to possibly stimulate technological innovation.[5]

That regulations could easily fall astray of their intended purposes is not new, as has been the case with many industry regulations historically.[6] While most of the costs expected of regulation are the

---

[4] The Interstate Commerce Act of 1887 was one of the first, to regulate railroads. While the theory of regulation was largely an issue in the public administrative and legal disciplines, and subjected to economics so far as cost-benefit analyses were warranted, during the 1970s, self-interest was incorporated into the economic theory of regulation, intertwining of the interests of the industry and the regulators themselves (Posner 1974). In practice, this sort of individualistic bent was exacerbated in the socio-political sphere with the rightwing political lurch and deregulation impulses of the 1980s. To some degree, this has been associated with the unfettered (*Laissez-faire*) nature of business practice that ensued in the 1990s and later, with "business deal making" (mergers and acquisitions in particular) becoming *de rigueur*. While few theories can explain these pendulum "lurches" in the political sphere, by coupling management theory with behavioral models, we can in limited fashion understand why firms' leaders act the way they do (e.g. Li and Tang 2010, Mishina et al. 2010), and in the case of our study, understand how regulations may come to constrain their decision making on innovative actions.

[5] The "Porter hypothesis" (Porter and Van der Linde 1995), described even earlier by Ashford and others (Ashford and Heaton 1983, Ashford et al. 1985), suggested that firms would innovate to get out of regulatory mandates.

[6] Regulations have historically also been known to have unintended consequences, including the Prohibition Act of 1920 - enacted ostensibly to control alcohol, with the consequence being increased underground and criminal activity. The series of banking regulations enacted in the wake of the Great Depression, starting with the Banking Act of 1933 and the accompanying Glass-Steagall Act (1932), some of which were eventually partially repealed.

direct costs of compliance (as is commonly seen in environmental regulations), other hidden (or implicit) costs are derived from the unintended consequences of the regulations and unanticipated behavioral responses. Thus, while regulations as these initially have a well-intended social purpose, their typically heavy hand and coarse manner by which they target perceived problems make it difficult for them to achieve their desired behavior.

The SOX follows in the long tradition of the regulation of corporate misconduct and good governance. Although white collar in nature, the ostensibly criminal acts committed by Enron, Worldcom and other corporate leaders was determined to be the result of a lack of independent board oversight on activities, and the insufficient powers of auditors. Articles in the SOX legislation resolved to strengthen these poor governance controls, at the expense of CEOs' independence. The most typical and direct of mechanisms cited is the increased cost of compliance - for publicly traded firms and smaller firms alike (Coates and Srinivasan 2014).

The enactment of the SOX legislation in July 2002 provides us with a natural experiment under two different regimes (pre and post SOX) to evaluate the impact of SOX on corporate innovation. As previously noted, SOX has been shown to have decreased R&D investments, and presumably, risk-taking (Bargeron et al. 2010, Dey 2010). Our premise is that decisions on the input side as R&D investments will translate into specific effects on the output side, i.e., decreased patenting. Since innovation is costly, involving a process that is long, idiosyncratic, uncertain, and often with a high probability of failure (Holmstrom 1989), SOX's effect on risk-taking can make such a process less attractive to corporate decision-makers (Bargeron et al. 2010). Although the exact mechanisms have yet to be explored or discussed, it is presumed that the very same instruments that SOX uses to guard against misconduct -

---

More recently, environmental regulations that "target" behaviors with increased standards may lead to unintended consequences such as the shifting of "dirty plants" across borders (Coeurderoy and Murray 2008). Thus, such regulations affect not only direct decision-making on investment in pollution control equipment, but a higher level strategic decision such as whether to "escape" such regulations, or to invest in such R&D (with one study finding the former effect, but not the latter [Jaffe and Palmer 1997]).

increasing auditing, outside director oversight, and the specification of liabilities – are disruptive of corporate innovation.[7] We thus hypothesize the following effect of SOX on innovation:

Hypothesis 1. The enactment of SOX has a negative impact on corporate innovation.

3. Data and sample summary

3.1. Data

Patents remain the most direct measure of the extent and quality of firms' innovation (Griliches 1990), and the use of patenting activity to measure of innovation productivity is widely accepted in the extant literature, the limits of patents notwithstanding (Lerner et al. 2011).[8] We use patent innovation data on publicly listed US corporations from Harvard University's patent database. This database includes all patents filed and granted by the United States Patent and Trademark Office (USPTO) from 1990 to 2009. The database provides detailed information on patent assignee (owner) names, the patent number , and a patent's 3-digit technology class. For specifying the year of the patent, we use the patent's application year instead of the grant year, following Griliches et al. (1988).

If patents are measures of innovative output, R&D expenditures are the direct measure of the input to innovation, in effect, measuring the initial commitment to innovate. Our second measure of innovation, proposed by Hershleifer et al. (2013), is *innovation efficiency* (*IE*). We construct this measure by taking the number of patents scaled by the previous year's R&D expenditure. Specifically, IE is calculated by taking

---

[7] For example, SOX does this through specific governance mechanisms such as shaping the corporate's board of directors. Specifically, several sections of the legislation expand the role of and expanded liability of independent directors. SOX legislation mandates US listed firms to have significant (75%) external or independent board members.

[8] Nevertheless, the number of patents is but only one measure of innovative productivity. For example, some inventions are protected as trade secrets, such as the formula for Coca-Cola, and others like software are protected in other ways. Besides different industries have different innovation cycles and patenting propensities.

the number of patents of firm *i* applied in year *t* which were eventually granted ($NoPat_{i,t}$) scaled by firm *i*'s cumulative R&D investment in fiscal year ending from year *t-4* through year *t*:

$$NoPat_{i,t} / (XRD_{i,t} + 0.8*XRD_{i,t-1} + 0.6*XRD_{i,t-2} + 0.4*XRD_{i,t-3} + 0.2*XRD_{i,t-4}),$$

where $XRD_{i,t}$ indicates firm *i*'s R&D investment in fiscal year ending in year t, and so on. We adopt this 5-year cumulative R&D investment based on the assumption of an annual depreciation rate of 20% on R&D investment, following from Chan et al. (2001) and Lev et al. (2005). Innovative efficiency highlights the effectiveness of R&D expenditures in terms of the number of patents that are applied for (successfully) for every unit of an exponentially smoothed average R&D dollar, i.e. "…innovative bang for the R&D buck…"

Any corporate decision in a firm is affected by various external and internal factors, and innovation is no different. Identification of factors that are instrumental in innovative efficiency requires controlling for concomitant variables that might affect innovative activity in a firm. The control variables are collected from the COMPUSTAT database. These control variables include size (*Total Assets*), firm age, book to market, R&D expenses scaled by lagged PPE, return on assets (*ROA*); growth opportunities (*Tobin's Q*), cash, leverage, capital expenditures scaled by lagged PPE (*CAPX*); and product market competition, given by the Herfindahl index of the 3-digit SIC industry of the firm based on sales (*Herfindahl Index*). These control variables are used in the extant literature (e.g., Hall and Ziedonis 2001, Aghion, et al. 2005, Chemmanur and Tian 2011, Atanassov 2012, Chang et al. 2015, He and Tian 2013, Tian and Wang 2013, Van Reenen and Zingales 2013).[9]

---

[9] The most relevant control to the innovation literature is firm size. Ever since Schumpeter, differential firm size has always been known to have an effect on the ability to innovate (Cohen and Levin 1989). SOX has already been shown to have differential impact on firms at least in terms of costs of compliance and the likelihood of firms listing in the U.S. (Coates and Srinivasan 2014, Piotroski and Srinivasan 2008). Along with firm size, firm age is also a historically relevant measure, given that age has implications for firms' ability to innovate, particularly with regards to their explorative innovative ability (Sorensen and Stuart 2000). Our approach also examines the possibility not covered in Bargeron et al. (2010) that under SOX, R&D might have become more efficient which is beneficial to firms without impacting innovation significantly (Hirshleifer et al. 2013).

3.2. Summary of Analysis

Figure 1 depicts the general pattern of innovation 3 years before and 3 years after the 2002 enactment of the SOX legislation. We calculate the sample mean of patents and innovation efficiency of all firms each year. Figure 1 shows a noticeable pattern with both measures of innovation decreasing after the SOX event. In particular, the number of patents shows an increasing trend before 2002 and a decreasing pattern after the enactment of SOX. The caveat is that not all parts of the SOX legislation came into immediate effect. However, it can be conjectured that firms started taking decisions in advance of the legislation and that were in anticipation of the impending but phased rollout of SOX and its provisions.

Table 1 reports the summary statistics of the innovation variables and control variables 3 years before and 3 years after the year of the initial SOX legislation. The sample mean of patents before SOX was 0.41; after SOX the mean dropped to 0.40, but this was not a statistically significant drop. The innovation efficiency measure drops in the post SOX period by 0.03, a nearly 50% drop from the pre-SOX value that was statistically significant. We further note that the sample means of controls such as firm size, ROA, Tobin's Q do not exhibit much difference before and after SOX legislation. Interestingly, without conditioning on other control variables, neither R&D expenses nor CAPEX show significant drops after the advent of SOX legislation.

Table 2 reports the correlation matrix of all variables. Both measures of innovation, the patent count and innovation efficiency, are not highly correlated with each other at 0.063. Firm size has non-zero correlations with the measures of innovation; R&D expenses has correlations of 0.37 with the patent innovation measure.

4. Empirical Results

4.1. Baseline Analysis

We first examine what factors drive firm innovation in a multiple regression framework for panel data. Specifically, we estimate the following model:

$$Innovation_{i,t} = \alpha + \beta\ SOX\ signal + \delta\ Controls_{i,t} + \theta FE + \varepsilon_{i,t} \qquad (1)$$

where *i* indexes firms and *t* indexes years. The dependent variable, $Innovation_{i,t}$ is one of our innovation measures (i.e., the patents' innovative efficiency). *SOX signal* is a dummy or binary variable that equals one if the year is 2003, 2004, and 2005, and zero otherwise.

Table 3 reports the baseline OLS regression results as specified in model (1). Holding all other control variables constant, the number of patents drops by approximately 11.5% after the enactment of SOX. In a similar vein, *ceteris paribus*, innovative efficiency drops by 0.055 patents for every average dollar of R&D expenses spent on an average. The coefficients are both statistically and economically significant after controlling for the different external factors (such as the H-Index) and internal factors (such as total assets, firm age, ROA, Tobin's Q, Cash, Leverage ratio, CAPEX, R&D Expenses etc.). The results in Table 3 show that firms experience a substantial drop in innovation after the enactment of SOX in the baseline model.

4.2. Subsampling Analysis

Although the baseline model on the impact of SOX enactment on innovation effectiveness does highlight the significant negative relationship, we still have to establish the plausible channels for such a decline. One natural channel of decline that we hypothesize is that firms with higher growth potential through innovation might be impacted by SOX legislation more adversely than firms with lower growth potential i.e. less innovation. Tobin's Q measures the firm's market values with respect to its asset value, and a high Tobin's Q signifies a "growth" firm rather than a "value" firm with low growth potential. O'Connor and Rafferty (2012) proposed that although the conventional wisdom supports the hypothesis that good governance might increase innovation and hence firm value, the relationship is weaker once issues of *endogeneity* or endogenously selected explanatory variables are taken care of. However, the relationship that is quite persistent is between innovation and firm value. Table 4 reports the regression results of the impact of SOX on innovation when firms are divided into 2 subsamples according to the median value of the firms' Tobin's Q. The regressions results show that the SOX's impact on patents and innovation efficiency becomes more pronounced in firms with higher Q. This result suggests that SOX stifles innovation in general but that the effect is greater for "growth" firms with higher growth potential. For firms with lower growth potential, the impact of SOX on innovation is substantially dampened. The result indicates that for growth firms, the SOX legislation precipitated a nearly 20% drop in patents, while the drop was only 1.5% (statistically insignificant) among the firms with a low Tobin's Q, *ceteris paribus*. For the innovative efficiency of high Q firms, the SOX legislation caused a statistically significant drop of 6.4 patents per R&D dollar spent. The corresponding drop for low Q firms of 4.7 patents per R&D dollar is statistically insignificant, which we surmise as possibly being due to sampling variation.

The link between governance and innovation has been explored if not strongly established in the extant literature (O'Connor and Rafferty, 2012). Table 5 divides the firms according to the quality of their corporate governance as that could be another possible channel for the decline in innovative activity. We follow Gompers et al. (2003) in dividing firms into 2 subsamples according to the mean value of the G-index, which captures shareholder protection. The regressions results show that SOX's impact on patents remains pronounced only for firms with poor corporate governance, that is, poorer rights protection lead to a bigger drop in patents and innovation efficiency. All else being equal, a poorly governed firm saw a drop in 15.5% patents compared to only 6.9% for a better governed firm. In terms of innovative efficiency, a poorly governed firm had 0.33 fewer patents per dollar of R&D expenses, compared to a 0.03 drop for better governed firms. This result of SOX not having as big an impact for companies with better governance was to be expected, if poorly governed firms had been innovating in less justifiable or more risky fashion.

Innovation through investing in R&D and patenting has widely been regarded as a primary pursuit of the hi-tech industry. The 2000-2001 bursting of the tech sector's bubble allegedly could have led to significant declines in the fortunes of companies which were involved in long term research and innovation, thus having a deleterious impact on innovation. If this hypothesis were true, and the *causal* impact of the decline truly rests with the tech sector bubble's bursting, and not with SOX, the impact would be felt disproportionately more in the high tech sector while the non-tech sector should have been relatively unscathed. Given the importance of innovation (and hence, patenting) to the high tech sectors, we investigate the impact of SOX on firms operating in the high-tech industries as opposed to the non-high-tech industries. This helps us to understand the impact of the SOX legislation by controlling for the innovativeness of the industry. There are two main issues to consider. The first is that the tech sector bubble burst in the 2000-2001 period. The second is that the ease of innovating or patenting in these two types of sector are inherently different and might have had a differential impact of SOX. We split the sample into two subsamples and report the regression results in Table 6. The effect of SOX legislation is significant and negative in both subsamples but is greater in magnitude for high-tech industries, as expected. On the other hand, the impact of SOX on innovation efficiency only remains statistically significant and negative for firms in high-tech sectors but becomes insignificant in the low-tech industries possibly due to sampling variations. A high-tech firm had a drop in patents of 15% compared to the non-tech firms registering a drop in 3.5% controlling for other factors. We further report a 0.055 drop in the number of patents filed per R&D dollars spent after accommodating for depreciation and controlling for other factors. In sum, we can say that firms in the high-tech industry did indeed play a role in the reduction in innovation as an aftermath of SOX, but only part of it can be explained by the funding crunch in the aftershock of the tech-sector bubble.

4.3. Impact on Delisted Firms

As has been discussed at length, the impact of regulations could be so detrimental to the affected firms or players that they might decide to "vote with their feet."The surge of delisting that first ensued with the advent of SOX, and continued later with its full deployment, is a case in point. There is increasing evidence that SOX might have prompted firms to delist (John and Marano 2007), and even to list elsewhere in the world.[10] One possible hypothesis that may be worth investigating is, whether firms which delisted to avoid the scrutiny, oversight of, and needed compliance with SOX, could possibly gain in comparison to the peer group that continued to be listed. We next examine the nature of the decline in innovation as the result of companies actively delisting during and after the SOX legislation. The main thrust of the argument is that companies which found it difficult to be sustainable in a post-SOX regime actively sourced for funds to "go private" in order as to avoid the cost of compliance and additional supervision that the enactment of SOX entailed. However, such an analysis of private firms is not without its own shortcomings. One potential concern with our results are the omitted variables in the regressions, since the SOX could also affect other corporate behaviors that may not be captured in the regressions. We therefore utilize a set of firms that delisted at the time of the SOX legislation, and compare the impact of SOX on delisted firms as opposed to those that remained listed. The results are reported in Table 7.

The regression in Table 7 includes the post-SOX dummy, the delisting dummy, their interaction term and the control variables used in other tables. The coefficient on the delisting dummy is negative and significant, hence directly controlling for the impact of delisting. The post-SOX dummy is significant and negative, suggesting that the SOX legislation causes firms to innovate less. The interaction term between the SOX dummy and delisting dummy is positive and significant, suggesting that firms which delisted are less adversely affected by the SOX legislation than firms that remained public. The results also stay the same even when we do not control for any of the standard covariates (Table 7 panel (1)). Our findings in Table 7 confirm the negative impact of SOX on innovation, and our findings are not caused by endogeneity (or selection) concerns such as an omitted variable bias. Summing up, SOX had a significant negative impact on innovation, but this result is not driven by firms delisting alone. In fact, the firms that stayed public seem to be less innovative after the implementation of SOX.

---

[10] Piotroski and Srinivasan (2008) have showed that SOX had a recognizable effect on firm listings, increasing the likelihood of small firms listing in the UK over the US.

5. Discussion: Possible Explanations for SOX's Effects on Innovative Performance

The public need for SOX notwithstanding, our findings offer evidence that such regulations are having perverse effects on firms' innovative behavior, and presumably, on their eventual competitiveness. In this section, we suggest possible managerial models or processes by which these impacts may happen. That SOX simply clamped down on managerial indiscretion by itself may not directly translate into a lower propensity to innovate, although SOX has been said to constrain managers' risk-taking by its requiring of independent oversight and its other provisions (Bargeron et al. 2010). To further understand the effect of SOX on innovation, we examine how regulatory mechanisms may yield unintended consequences by their influence on managerial decision-making.[11] To reiterate observations from the earlier literature, while regulations have historically had negative side effects as the direct costs of compliance (Hahn 1998, Hahn and Hird 1991), they have also had unintended negative consequences. We have shown evidence indicating SOX's possible effect on certain other decisions such as public listings. We also have results on governance (showing that well-governed firms suffer less adverse effects on patenting); this in turn suggests that firms with weaker governance processes or regimes and presumably higher risk profiles (i.e. may be undertaking "risky" innovations), may be have their propensity to innovate decreased by SOX, as is appropriate.

While the corporate governance literature is strongly defined by the notion of "misconduct" and its appropriate governance, such governance is complicated by multidisciplinary facets (Aguilera and Jackson 2010), and corporate misconduct itself has been attributed to a plethora of possible underlying reasons (Greve et al. 2010).[12] It is also known that individual traits and behaviors can interact with

---

[11] While anecdotal evidence surfaced on concerns that SOX was having unnecessarily negative effects, understanding of its potential effects on innovation took longer to gestate. On top of this, academia was generally recognized to be lagging behind practice in understanding the negative effects, including at the time of SOX (Aguilera and Cuervo-Cazurra 2009).

[12] Reasons traditionally cited as underlying CEO misconduct include organizational culture, cognitive biases, ethical decision-making processes, hubris (which has an aspect of behavioral bias but also personality traits), willful blindness (partly based on cognitive inabilities of seeing one's acts from other perspectives) (Greve et al. 2010, Hefferman 2011), as well as rationally-governed misconduct (i.e., the self-interested nature of the economic paradigm) as taught in theories of business (Pfeffer 2005).

organizational incentives and expectations in more complex ways than straightforward economic self-interest would suggest (Mishina et al. 2005). Our findings that better governed firms suffered less impact on innovation suggests that the more poorly governed firms either had more problematic activities (and hence were "controlled" by SOX), or were not problematic, and yet somehow adversely affected by SOX. If we make the (reasonable) assumption that some if not most poorly governed firms were not ones with misconduct, especially in the years after SOX's initial effect, this means that SOX somehow affected "risk-taking". To understand this effect better, we need to look at the wider expanse of corporate behavior that encompasses the 'rational conduct' that SOX may somehow be interfering with. That is, how a 'well-intentioned regulation, unintended bad side effect' mechanism may be at work.

Discussing our findings in the context of other theories may shed light on this issue. Relating to the notion that SOX may have affected the propensity to take risks (Bargeron et al. 2010, Fama 1980), our findings on higher growth firms and high tech firms (which are the typically ones taking on more risks), suggests that the regulations could also be punishing risk-taking, including properly assessed risks, associated with those types of firm. It is known for instance that the more "sustaining" innovations are by definition not "disruptive", and tend to involve less risky investments (Christensen and Bower 1996). These less risky innovations would presumably be more immune to SOX, and furthermore, could also by nature be the type found in "lower growth" firms.

We next examine possible reasons underlying the general tendency of SOX to constrain innovation decisions. We examine the interaction of the regulations with *appropriate but riskier* corporate behavior using simple cognitive models of decision-making. Instead of simply restricting firms' behavior as command and control regulations did, SOX provided for greater accountability and independent oversight by treating the corporation as a system of activities and stakeholders, and seeking to enhance accountability through increased transparency (via audit trails) and shifting the balance of power (by way of independent directors). In this way, SOX could be seen to be following well-established findings showing that independent boards act as controls on corporate excesses (Fama 1980, Fama and Jensen

1983, Pozner 2007). Since managerial discretion enhances the positive relationship between traits as CEO hubris and firm risk-taking (Li and Tang 2010), by increasing external monitoring and clamping down on such managerial indiscretion, SOX can be said to be seeking to control such behavior and conditions by promoting "low-discretion" environments (Hambrick and Finkelstein 1987, Peteraf and Reed 2007). In general, hubristic CEOs (which are not a small proportion of the population) will exercise strong control over innovation, but this effect is weakened when task complexity increases (Tang et al. 2012). Regulations may very well add to that task complexity, weakening that strong control (Hahn 1998), this being quite in-line with conventional assumptions on decision-making.

Another type of problem may occur with the classically viewed innovation activities of R&D and new product development. In these situations, the manager's decision problem consists of creating and deciding from amongst a feasible set of strategic choices within the firm. This is often typically described as creating a "funnel" of project ideas, most of which are winnowed out over time. The question is: how are regulations acting on managers' mindsets and shaping (or restricting) such actions? The decision to pursue a particular innovative product (or service) or the project leading up to it (including the scientific or technical research) is often made using rational calculi, weighing the benefits and likelihoods of technical and market success.[13] Much of what firms already do in the way of making technology decisions involves mitigating the risks of product and investment decisions, thereby reducing the uncertainty of those decisions.[14] The resulting set of "investment options" would largely consist of what remains feasible technologically, financially and strategically. Regulations that increase the risks of taking certain technological choices (say by suggesting new levels of risks that could be penalized), can act as further constraints on the set of viable choices or range of permissible actions. In addition to this, technological choices nowadays (but especially just before 2000) are associated with (that is, enacted by) new business

---

[13] The stage gate process exemplifies this, using certain stages of the product development process as cut off points at which projects are allowed to proceed or to be halted (Krishnan and Ulrich 2001, Ulrich and Eppinger 1995).

[14] Firms employ means such as cross-functional and cross-level teams to increase the different views on a problem or solution, technology scanning and other predictive methods (Brown and Eisenhardt 1997, Calantone et al. 2003), and shortening the product cycle in order to increase information (Krishnan and Bhattacharya 2002).

models, some of which incorporate different economic arrangements with external parties (Osterwalder and Pigneur 2010, Teece 2010, Zott and Amit 2008), but which may also entail different types of risks (risks of diversifying or moving beyond stakeholders' understandings and expectations being a simple example). Thus, what on the surface appears to be a technological investment decision in a risky technology may actually be associated with a particular business model predicated on extracting value from external partnerships – one that may be deemed riskier (at risk of being penalized) under the new regulatory regime.[15]

As regulations shape choices within an industry, through firms' mimetic behavior or other "coerced" means (e.g. consultants indicating the new risks and penalties across their clients), they can become embedded in new "industry recipes" that further act to sanction or otherwise limit the set of actions available to the entire industry (Peteraf and Reed 2007, Spender 1989). These are just some of the pathways envisioned by which regulations may impact on the innovative behaviors and underlying decision-making of firms. More detailed research could be warranted to examine the efficacy of these pathways, and to test whether some pathways have clearer or stronger effects than others.

6. Conclusion

The question that more informed regulators would like to ask is, how can regulations such as SOX implement mechanisms and incentives appropriately in order to correct for individual and systemic failures to conduct business appropriately, all the while without jeopardizing corporate performance? While this cannot be easily answered, we can shed light on the conditions and possible means by which failures and unintended can occur: a more likely concern of corporate audiences. In the research, we

---

[15] Presumably then, some risky technologies require more creative engagements with external parties and parts of the value chain. Tesla's branching into charging stations (creating its own value chain) is an example integrating new technology with a new business model. In general, the concept of innovation is itself considered by some to be expanding to recognize its effects and desired properties of helping firms bridge and capture value *across* established industry boundaries (Hacklin 2007), and when modern entrepreneurial thought promotes firms having an even freer hand to innovate, to experiment and even to fail (Blank 2013).

directly examine the hypothesis that SOX stifles corporate innovation. We provide direct evidence for the first time in the literature that such impacts exist. For example, for the four years after the enactment of SOX, US listed firms continue to experience a significant drop in innovation.

We show that the impact of SOX on innovation has interesting cross-sectional patterns. Growth firms especially those with above average growth opportunities experience a greater drop in innovation. Similarly, SOX's impact on innovation is more pronounced in firms operating in high-tech industries or firms with poor corporate governance; the latter being consistent with the regulatory purpose of increasing the compliance requirements of "riskier" firms. Finally, we show that the impact of SOX on innovation is not solely driven by the status of being publicly listed, since no such effect is found for firms which went private before SOX. Our research shows that general regulations that aim to promote good governance may still have unintended consequences. Given the indirect and counterintuitive effects of SOX that have been observed, we have also taken care to provide several candidate explanations for the effect. This has potentially important implications for policy makers, particularly ones interested in the competitive implications of any regulation.

References

Aghion, P., Bloom, N., Blundell, R., Griffith, R., and Howitt, P., 2005. Competition and Innovation: An Inverted-U Relationship. The Quarterly Journal of Economics, 120(2), 701-728.

Aguilera, R. V., 2005. Corporate Governance and Director Accountability: an Institutional Comparative Perspective. British Journal of Management, 16(s1), S39-S53.

Aguilera, R. V., and Cuervo-Cazurra, A., 2009. Codes of good governance, Corporate Governance: an International Review. 17(3), 376-387.

Aguilera, R. V., and Jackson, G., 2010. Comparative and international corporate governance. The Academy of Management Annals, 4(1), 485-556.

Akerlof, G. A., 1970. The market for" lemons": Quality uncertainty and the market mechanism. The Quarterly Journal of Economics, 488-500.

Wall Street Journal, 2012. America as Number Two, Wall Street Journal, January 4, 2012. http://www.wsj.com/articles/SB10001424052970204720204577129052317747614 (Accessed February 8, 2016).

Ashford, N. A., and Heaton, G. R., 1983. Regulation and technological innovation in the chemical industry. Law and Contemporary Problems, 109-157.

Ashford, N. A., Ayers, C., and Stone, R. F., 1985. Using regulation to change the market for innovation. Harvard Environmental Law Review, 9, 419.

Atanassov, J., 2013. Do hostile takeovers stifle innovation? Evidence from antitakeover legislation and corporate patenting. Journal of Finance, 68(3): 1097–1131.

Bargeron, L. L., Lehn, K. M., and Zutter, C. J., 2010. Sarbanes-Oxley and corporate risk-taking. Journal of Accounting and Economics, 49(1), 34-52.

Bena, J., and Li, K., 2014. Corporate innovations and mergers and acquisitions. The Journal of Finance, 69(5), 1923-1960.

Blank, S., 2013. Why the lean start-up changes everything. Harvard Business Review, 91(5), 63-72.

Brown, S. L., and Eisenhardt, K. M., 1997. The art of continuous change: Linking complexity theory and time-paced evolution in relentlessly shifting organizations. Administrative Science Quarterly, 1-34.

Calantone, R., Garcia, R., and Dröge, C., 2003. The effects of environmental turbulence on new product development strategy planning. Journal of Product Innovation Management, 20(2), 90-103.

Chan, L. K., Lakonishok, J., and Sougiannis, T., 2001. The stock market valuation of research and development expenditures. The Journal of Finance, 56(6), 2431-2456.

Chang, X., Fu, K., Low, A., and Zhang, W., 2015.Non-executive employee stock options and corporate innovation. Journal of Financial Economics, 115(1), 168-188.

Chemmanur, T. J., and Tian, X., 2013. Do anti-takeover provisions spur corporate innovation? AFA 2012 Chicago Meetings Paper.

Christensen, C. M., and Bower, J. L., 1996. Customer power, strategic investment, and the failure of leading firms. Strategic Management Journal, 17(3), 197-218.

Coates, J. C., and Srinivasan, S. 2014. SOX after ten years: A multidisciplinary review. *Accounting Horizons*, *28*(3), 627-671.

Coeurderoy, R., and Murray, G., 2008. Regulatory environments and the location decision: Evidence from the early foreign market entries of new-technology-based firms. Journal of International Business Studies, 39(4), 670-687.

Cohen, W. M., and Levin, R. C., 1989. Empirical studies of innovation and market structure. Chapter, Handbook of Industrial Organization, 1059-1107. Elsevier.

Fama, E. F. 1980.Agency problems and the theory of the firm. Journal of Political Economy, 88, 288–307.

Fama, E.F., and Jensen, M.C. 1983. The separation of ownership and control. Journal of Law and Economics, 26, 301–325.

The Economist, 2007. Five years under the thumb, July 26, 2007, The Economist. http://www.economist.com/node/9545905 (Accessed 8 February 2016).

Gompers, P. A., Ishii, J., and Metrick, A., 2004. Incentives vs. control: An analysis of US dual-class companies (No. w10240). National Bureau of Economic Research.

Gompers, P. A., Ishii, J., and Metrick, A., 2010. Extreme governance: An analysis of dual-class firms in the United States. Review of Financial Studies, 23(3), 1051-1088.

Greve, H. R., Palmer, D., and Pozner, J. E., 2010. Organizations gone wild: The causes, processes, and consequences of organizational misconduct. The Academy of Management Annals, 4(1), 53-107.

Griliches, Z., 1990. Patent statistics as economic indicators: a survey (No. w3301). National Bureau of Economic Research.

Griliches, Z., Pakes, A., and Hall, B. H, 1988. The value of patents as indicators of inventive activity (No. w2083). National Bureau of Economic Research.

Hacklin, F., 2007. Management of convergence in innovation: strategies and capabilities for value creation beyond blurring industry boundaries. Springer Science & Business Media.

Hahn, R. W. 1998. Policy watch: government analysis of the benefits and costs of regulation. The Journal of Economic Perspectives, 201-210.

Hahn, R. W., and Hird, J. A. 1991. The Costs and Benefits of Regulation: Review and Synthesis. Yale J. on Reg., 8, 233-511.

Hall, B. H., and Ziedonis, R. H., 2001. The patent paradox revisited: an empirical study of patenting in the US semiconductor industry, 1979-1995. RAND Journal of Economics, 101-128.

Hall, B. H., Jaffe, A. B., and Trajtenberg, M., 2001. The NBER patent citation data file: Lessons, insights and methodological tools (No. w8498). National Bureau of Economic Research.

Hall, B. H., Jaffe, A., and Trajtenberg, M., 2005. Market value and patent citations. RAND Journal of Economics, 16-38.

Hall, B. H., and Lerner, J., 2010. The financing of R&D and innovation. Handbook of the Economics of Innovation. 1, 609-639. Elsevier.

Hambrick, D. C., and Finkelstein, S., 1987. Managerial discretion: A bridge between polar views of organizational outcomes. Research in Organizational Behavior.

Hart, D. M., 2001. Antitrust and technological innovation in the US: ideas, institutions, decisions, and impacts, 1890–2000. Research Policy, 30(6), 923-936.

Hayward, M. L., and Hambrick, D. C. 1997. Explaining the premiums paid for large acquisitions: Evidence of CEO hubris. *Administrative Science Quarterly*, 103-127.

He, J. J., and Tian, X., 2013. The dark side of analyst coverage: The case of innovation. Journal of Financial Economics, 109(3), 856-878.

Hefferman, M., 2011. Wilful Blindness: Why we ignore the obvious. Simon and Schuster.

Hershleifer, D., Hsu, P., and Li, D., 2013. Innovative efficiency and stock returns. Journal of Financial Economics 107, 632-654.

Holmstrom, B., 1989. Agency costs and innovation. Journal of Economic Behavior & Organization, 12(3), 305-327.

Jaffe, A. B., and Palmer, K., 1997. Environmental regulation and innovation: a panel data study. Review of Economics and Statistics. 79(4), 610-619.

Jensen, M. C., and Meckling, W.H., 1976. Theory of the firm: Managerial behavior, agency costs, and ownership structure. Journal of Financial Economics 3, 305-360.

Krishnan, V., and Ulrich, K. T., 2001. Product development decisions: A review of the literature. Management Science, 47(1), 1-21.

Krishnan, V., and Bhattacharya, S., 2002. Technology selection and commitment in new product development: The role of uncertainty and design flexibility. Management Science, 48(3), 313-327.

Krugman, P. 2011. Financial Romanticism, New York Times, October 9, 2011 http://krugman.blogs.nytimes.com/2011/10/09/financial-romanticism/?_r=0

Lerner, J., Sorensen, M., and Strömberg, P., 2011. Private equity and long-run investment: The case of innovation. The Journal of Finance, 66(2), 445-477.

Lev, B., Sarath, B., and Sougiannis, T., 2005. R&D Reporting Biases and Their Consequences. Contemporary Accounting Research, 22(4), 977-1026.

Li, J., and Tang, Y. I., 2010. CEO hubris and firm risk taking in China: The moderating role of managerial discretion. Academy of Management Journal, 53(1), 45-68.

List, J. A., Millimet, D. L., Fredriksson, P. G., and McHone, W. W., 2003. Effects of environmental regulations on manufacturing plant births: evidence from a propensity score matching estimator. Review of Economics and Statistics, 85(4), 944-952.

John, D. C. and Marano, N. M., 2007. The Sarbanes-Oxley Act: Do We Need a Regulatory or Legislative Fix? Backgrounder #2035 on Regulation, The Heritage Foundation. http://www.heritage.org/research/reports/2007/05/the-sarbanes-oxley-act-do-we-need-a-regulatory-or-legislative-fix. (Accessed February 11, 2016).

Mishina, Y., Dykes, B. J., Block, E. S., and Pollock, T. G., 2010. Why “good” firms do bad things: The effects of high aspirations, high expectations, and prominence on the incidence of corporate illegality. Academy of Management Journal, 53(4), 701-722.

Mowery, D. C., Nelson, R. R., Sampat, B. N., and Ziedonis, A. A., 2001. The growth of patenting and licensing by US universities: an assessment of the effects of the Bayh–Dole act of 1980. Research Policy, 30(1), 99-119.

O’Connor, M., and Rafferty, M., 2012. Corporate Governance and Innovation, Journal of Financial and Quantitative Analysis, 47(2), 397–413.

Osterwalder, A., and Pigneur, Y., 2010. Business model generation: a handbook for visionaries, game changers, and challengers. John Wiley and Sons.

Peteraf, M., and Reed, R., 2007. Managerial discretion and internal alignment under regulatory constraints and change. Strategic Management Journal, 28(11), 1089-1112.

Pfeffer, J. 2005. Why do bad management theories persist? A comment on Ghoshal. Academy of Management Learning and Education, 4(1), 96-100.

Piotroski, J. D., and Srinivasan, S., 2008. Regulation and bonding: The Sarbanes-Oxley Act and the flow of international listings. Journal of Accounting Research, 46(2), 383-425.

Porter, M. E., and Van der Linde, C., 1995. Toward a new conception of the environment-competitiveness relationship. The Journal of Economic Perspectives, 97-118.

Posner, R. A., 1974. Theories of economic regulation. NBER Working Paper No. 41, May 1974, National Bureau of Economic Research.

Pozner, J.E., 2007. An exploration of the social mechanisms driving the consequences of earnings restatements for organizational elites. Unpublished doctoral dissertation. Northwestern University, Evanston, IL.

Schumpeter, J. A., 2000. Entrepreneurship as innovation. Entrepreneurship: The Social Science View, 51-75.

Shadab, H. B., 2008. Innovation and corporate governance: The impact of Sarbanes-Oxley. University of Pennsylvania, Journal of Business and Employment Law, 10(4).

Sørensen, J. B., and Stuart, T. E., 2000. Aging, obsolescence, and organizational innovation. Administrative Science Quarterly, 45(1), 81-112.

Spender, J. C., 1989. Industry recipes. Oxford: Basil Blackwell.

Tang, Y., Li, J., and Yang, H., 2015. What I See, What I Do How Executive Hubris Affects Firm Innovation. Journal of Management, 41(6), 1698-1723.

Teece, D. J., 2010. Business models, business strategy and innovation. Long Range Planning, 43(2), 172-194.

Tian, X., and T. Wang, 2014.Tolerance for Failure and Corporation Innovation. Review of Financial Studies, 27(1), 211-255.

Ulrich, K. T., and Eppinger, S. D., 1988. Product Design and Development. International Editions: McGraw-Hill.

Van Reenen, and Zingales, L. 2013. Innovation and Institutional Ownership. American Economics Review Vol. 103, 277-304.

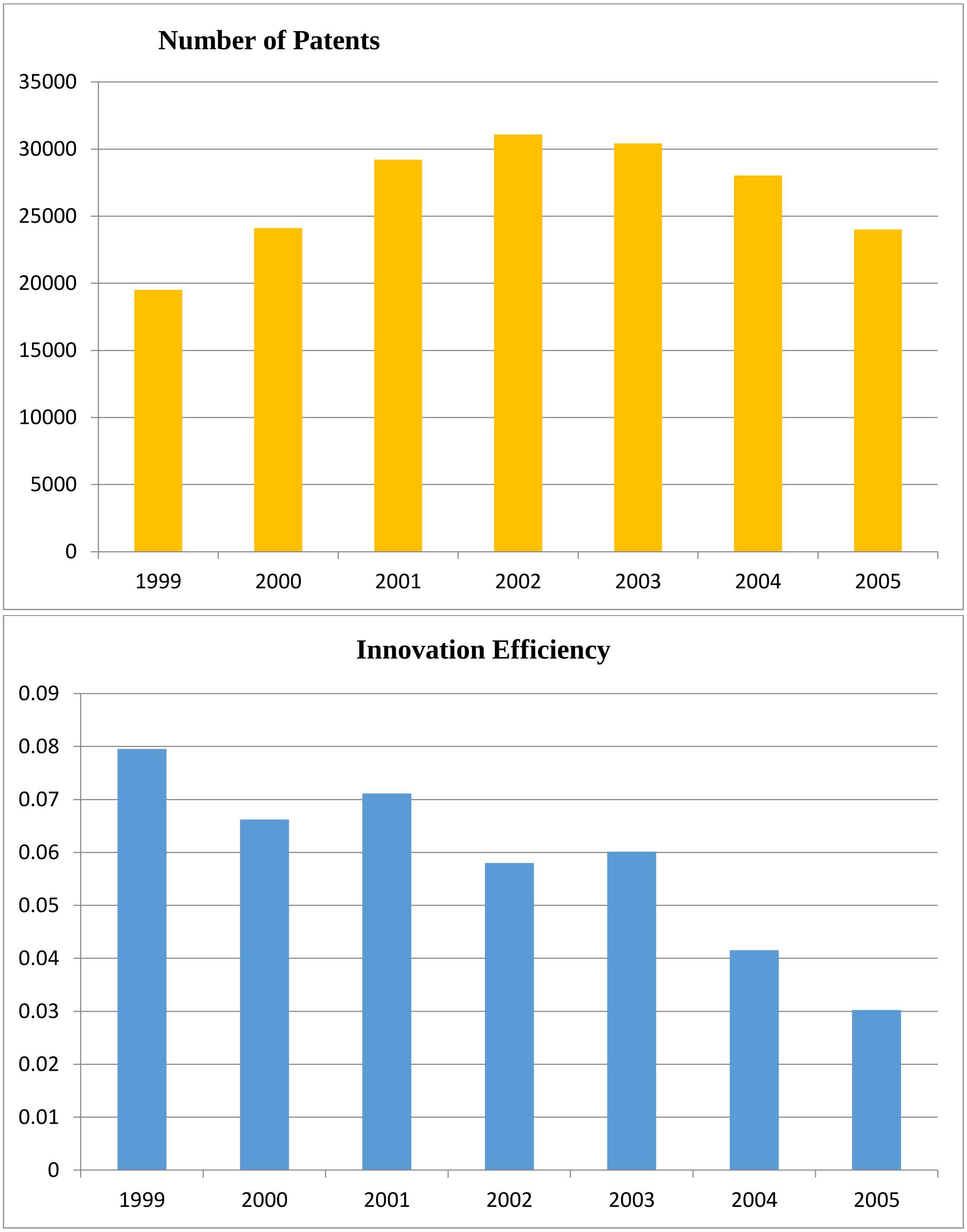
Zott, C., and Amit, R., 2008. The fit between product market strategy and business model: implications for firm performance. Strategic Management Journal, 29(1), 1-26.

Appendix A

Variable Definitions

Variable	Definition
Innovation measures	
Patent Number	Patent number is defined as number of patent applications filed in year *t* of each firm. Only patents that are later granted are included. The patent number is set to zero for companies that have no patent information available from the NBER database.
Innovation efficiency	number of patent scaled by the previous four years' R&D investment (Hershleifer, Hsu and Li, 2013).
Control variables	
Ln(Asset)	The logarithm of the book value of total assets (AT from COMPUSTAT) measured at the end of fiscal year *t*.
Age	The logarithm of the book value of total assets (AT from COMPUSTAT) measured at the end of fiscal year *t*.
ROA	Firm operating income before depreciation (OIBDP from COMPUSTAT) divided by the book value of total assets (AT), measured at the end of fiscal year *t*.
Tobin's Q	The market value of equity (PRCC_F×CSHO from COMPUSTAT) plus the book value of assets (AT) minus the book value of equity (CEQ from COMPUSTAT) minus balance sheet deferred taxes (TXDB from COMPUSTAT)] divided by the book value of assets (AT), measured at the end of fiscal year *t*.
Cash Flow-to-Assets	Income before extraordinary items (IB from COMPUSTAT) plus depreciation and amortization (DP from COMPUSTAT) divided by the book value of assets (AT), measured at the end of fiscal year *t*.
Leverage	The book value of debt (DLTT+DLC from COMPUSTAT) divided by the book value of total assets (AT) measured at the end of fiscal year *t*.
R&D Expense-to-Assets	Research and develop expenditure (XRD from COMPUSTAT) divided by the book value of assets (AT), measured at the end of fiscal year *t*.
CAPX-to-Assets	Capital expenditure (CAPX from COMPUSTAT) divided by book value of assets (AT), measured at the end of fiscal year *t*.
Herfindahl Index	Herfindahl index of 3-digit SIC industry of each firm measured at the end of fiscal year *t* based on sales.

Figure 1: Innovation Productivity over Time, 1999 – 2005



Notes: This figure plots trends in total *Patent Number* and sample mean of *Innovation Efficiency* (Hirshleifer, Hsu and Li 2013) over the sample period 1999 – 2005.

Table 1: Summary and Univariate Test

	3 years pre- SOX				3 years post- SOX				Comparison between two samples
	Obs	Mean	Median	S.D.	Obs	Mean	Median	S.D.	Mean-Difference
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Innovation Productivity Measurement									
Log(1+Patent)	20153	0.41	0.00	1.00	20143	0.40	0.00	1.01	-0.01
									(1.29)
Innovation Effeciency	20153	0.07	0.00	1.13	20143	0.04	0.00	0.63	-0.03***
									(3.11)
Panel B: Control Variables									
Log (Total Asset)	18594	5.37	5.54	2.71	18745	5.60	5.84	2.82	0.23
Firm Age	20153	14.18	9.00	12.90	20143	18.17	13.00	12.88	3.98
ROA	18594	-0.11	0.07	0.88	18745	-0.14	0.07	1.22	-0.04
Tobin's Q	18594	3.21	1.24	7.76	18745	3.74	1.46	12.00	0.52
Cash	18594	-0.19	0.04	1.14	18745	-0.23	0.05	1.63	-0.04
Leverage Ratio	18594	0.29	0.20	0.42	18745	0.33	0.18	0.72	0.04
CAPX	18594	0.05	0.03	0.07	18745	0.04	0.02	0.05	-0.01
R&D Expense	18594	0.06	0.00	0.15	18745	0.05	0.00	0.14	0.00
Herfindahl Index	20153	0.18	0.10	0.23	20143	0.19	0.11	0.24	0.02

Notes:
This table reports descriptive statistics for the sample of firms with innovation data in both pre-SOX (1999-2001) and post-SOX (2003-2005) periods. Columns (1) to (4) and (5) to (8) report the number of observations (N), mean median and standard deviation (S.D.) of the subsample that cover three years before and after the Sarbanes-Oxley Act (SOX), respectively. Column (9) report the difference of mean of each variable for the two subsamples. In Panel A, two innovation measures are listed: the logarithm of one plus the number of successfully granted patent applications filed in each year of each firm, and the firms' *Innovation Efficiency* (Hirshleifer, Hsu and Li 2013), which is defined by using number of patent application that is eventually granted divided by the R&D Expense of previous years. And Panel B includes all of the control variables: logarithm of total asset, firm age, return on asset (ROA), Tobin's Q, leverage, R&D expense, capital expenditure (CAPX) and Herfindahl Index based on the three-digit SIC code. Column (9) reports the difference in means between the two groups. ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively using t-statistics for two-tailed tests.

Table 2: Correlation Matrix

	Patent	Innov. Eff.	Log (Asset)	Firm Age	ROA	Tobin's Q	Cash Flow /Assets	Leverage	CAPEX/ Assets	R&D Expense/ Assets	Hindex	G Index
Patent	1.000											
Innovation Efficiency	0.063	1.000										
Log (Asset in $ millions)	0.151	0.004	1.000									
Firm Age (years)	0.149	0.020	0.376	1.000								
ROA	0.048	0.008	0.097	0.056	1.000							
Tobin's Q	0.218	0.002	-0.192	-0.176	-0.008	1.000						
Cash Flow/Assets	0.024	0.007	0.119	0.066	0.894	-0.043	1.000					
Leverage	-0.066	0.002	0.156	0.116	-0.279	-0.121	-0.265	1.000				
CAPEX/Assets	-0.030	0.005	-0.103	-0.007	0.209	0.100	0.170	0.006	1.000			
R&D Expense/Assets	0.372	0.005	-0.291	-0.200	-0.321	0.327	-0.306	-0.016	-0.066	1.000		
Hindex	-0.006	-0.004	-0.019	0.110	0.098	-0.044	0.069	-0.009	0.060	-0.171	1.000	
G Index	0.054	-0.003	0.147	0.320	0.044	-0.090	0.038	0.045	-0.018	-0.083	0.045	1.000

Notes:

This table reports the correlation between the innovation variables and the explanatory variables used in the regression models over the entire sample period 1999-2005. The two innovation measures are listed: the number of successfully granted patent applications filed in each year of each firm, and the firms' *Innovation Efficiency* (Hirshleifer, Hsu and Li 2013), which is defined by using number of patent application that is eventually granted divided by the R&D Expense of previous years. All the control variables included are logarithm of total asset, firm age, return on asset (ROA), Tobin's Q, leverage ratio, R&D expense, capital expenditure (CAPX), *Herfindahl Index* based on the three-digit SIC code, the *G-Index* (Gompers et al. 2004).

Table 3: Baseline Regression of Impact of SOX on innovation

	Log(1+Patent)		Innovation Efficiency	
	(1)	(2)	(3)	(4)
SOX Signal	0.041***	-0.115***	-0.038***	-0.055***
	(3.57)	(-6.64)	(-4.62)	(-3.87)
Log Total Asset		0.171***		-0.002
		(5.14)		(-0.90)
Firm Age		0.007***		0.001
		(3.17)		(0.86)
ROA		0.011		-0.005
		(0.65)		(-1.25)
Tobin's Q		0.012***		0.000*
		(4.22)		(1.84)
Cash		-0.019***		0.005
		(-2.81)		(1.41)
Leverage		-0.096***		-0.017***
		(-3.06)		(-3.20)
CAPEX		0.248		0.029
		(0.73)		(0.53)
R&D Expense		0.537***		-0.112***
		(4.34)		(-2.75)
Hindex		0.161		-0.025
		(0.80)		(-0.68)
Constant	0.357***	-0.807***	0.029***	0.043*
	(15.88)	(-3.93)	(3.50)	(1.91)
Industry F.E.	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes
N	40296	37339	40296	37339
adj. R-sq	0.188	0.344	0.004	0.004

Notes: This table reports the OLS estimation results of the baseline panel regressions examining the effects of Sarbanes-Oxley Act on innovation productivity from year 1999 to 2005 (without 2002). The dependent variables in Columns (1) to (2) are the logarithm of one plus the number of successfully granted patent applications filed in each year of each firm and the dependent variables in Columns (3) to (4) is firms' *Innovation Efficiency* (Hirshleifer, Hsu and Li, 2013). The main independent variable is SOX Signal, which equals to one if observations are of years no less than 2002 and zero otherwise. All regressions control for the logarithm of total asset, firm age, return on asset (ROA), Tobin's Q, leverage, R&D expense, capital expenditure (CAPX), Herfindahl Index based on the three-digit SIC code, as well as year, two-digit SIC industry. Detailed definitions of each variable are provided in the Appendix. Robust t-statistics with standard errors clustered at the industry (two-digit SIC code) and year level are reported in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

Table 4: Impact of SOX on high Q vs. low Q firms

	Log(1+Patent)		Innovation Efficiency	
	High Q	Low Q	High Q	Low Q
	(1)	(2)	(3)	(4)
SOX Signal	-0.202***	-0.015	-0.064***	-0.047
	(-5.59)	(-0.72)	(-4.24)	(-1.04)
Log Total Asset	0.212***	0.117***	-0.003	-0.002
	(5.83)	(4.34)	(-0.78)	(-0.54)
Firm Age	0.011***	0.003*	0.000	0.001
	(4.40)	(1.93)	(0.21)	(0.86)
ROA	-0.030**	-0.031	-0.008	-0.006
	(-2.03)	(-0.43)	(-1.03)	(-0.27)
Tobin's Q	0.010***	0.330***	-0.000	0.053*
	(4.33)	(4.29)	(-0.75)	(1.95)
Cash	-0.010*	-0.007	0.005	0.005
	(-1.79)	(-0.16)	(1.51)	(0.36)
Leverage	-0.051**	-0.361***	-0.017**	-0.002
	(-2.07)	(-5.85)	(-2.42)	(-0.06)
CAPEX	0.203	0.096	0.017	0.004
	(0.54)	(0.40)	(0.32)	(0.04)
R&D Expense	0.427***	0.930**	-0.126***	-0.184*
	(4.24)	(2.05)	(-3.06)	(-1.94)
Hindex	-0.099	0.362**	0.038	-0.076
	(-0.41)	(1.98)	(0.67)	(-1.46)
Constant	-0.880***	-0.725***	0.056	-0.002
	(-3.62)	(-3.54)	(1.39)	(-0.07)
Industry F.E.	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes
N	19501	17838	19501	17838
adj. R-sq	0.389	0.277	0.005	-0.000

Notes: This table reports the estimation results of subsample regressions examining how the effects of Sarbanes-Oxley (SOX) Act on innovation productivity vary between the high-growth firms and low-growth firm. In each year, firms with Tobin's Q that higher than median are considered as high-growth firms and low-growth otherwise. The dependent variables in Columns (1) to (2) are the logarithm of one plus the number of successfully granted patent applications filed in each year of each firm, and the dependent variables in Columns (3) to (4) is firms' *Innovation Efficiency* (Hirshleifer, Hsu and Li 2013); the main independent variable is SOX Signal, which equals to one if observations are of years no less than 2002 and zero otherwise. All regressions control for the logarithm of total asset, firm age, return on asset (ROA), Tobin's Q, leverage, R&D expense, capital expenditure (CAPX), Herfindahl Index based on the three-digit SIC code, as well as year, two-digit SIC industry. Detailed definitions of each variable are provided in the Appendix. Robust t-statistics with standard errors clustered at the industry (two-digit SIC code) and year level are reported in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

Table 5: Impact of SOX on good governance vs. poor governance firms

	Log(1+Patent)		Innovation Efficiency	
	Good G	Poor G	Good G	Poor G
	(1)	(2)	(3)	(4)
SOX Signal	-0.069	-0.155**	-0.030**	-0.332**
	(-1.14)	(-2.24)	(-2.09)	(-2.18)
Log Total Asset	0.415***	0.379***	0.007	-0.002
	(6.27)	(6.36)	(1.51)	(-0.17)
Firm Age	0.010***	0.004	-0.000	0.003
	(3.43)	(0.93)	(-0.20)	(0.96)
ROA	0.527	0.614***	0.061	0.064
	(1.11)	(3.13)	(0.96)	(0.70)
Tobin's Q	0.085***	0.097***	0.005	-0.002
	(4.00)	(4.69)	(1.64)	(-0.26)
Cash	-0.053	-0.398***	-0.024	-0.033
	(-0.13)	(-3.00)	(-0.64)	(-0.57)
Leverage	-0.518**	-0.407**	-0.040	-0.063
	(-2.25)	(-2.37)	(-1.22)	(-1.26)
CAPEX	0.590	-0.308	0.007	-0.279
	(0.40)	(-0.30)	(0.03)	(-0.58)
R&D Expense	7.032***	5.098**	-0.367	0.228*
	(5.31)	(2.54)	(-1.30)	(1.68)
Hindex	0.524	-0.200	0.019	-0.067
	(1.53)	(-0.48)	(0.28)	(-0.53)
Constant	0.476	-2.690***	0.088	0.215
	(0.80)	(-8.42)	(1.59)	(1.41)
Industry F.E.	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes
N	3903	2980	3903	2980
adj. R-sq	0.587	0.539	0.042	-0.012

Notes: This table reports the estimation results of subsample regressions examining how the effects of Sarbanes-Oxley (SOX) Act on innovation productivity vary with the firms' level of corporate governance, which measured by G-Index. In each year, firms with G-Index that higher than median are considered as Good governance firms and Poor governance otherwise. The dependent variables in Columns (1) to (2) are the logarithm of one plus the number of successfully granted patent applications filed in each year of each firm, and the dependent variables in Columns (3) to (4) is firms' *Innovation Efficiency* (Hirshleifer, Hsu and Li 2013); the main independent variable is SOX Signal, which equals to one if observations are of years no less than 2002 and zero otherwise. All regressions control for the logarithm of total asset, firm age, return on asset (ROA), Tobin's Q, leverage, R&D expense, capital expenditure (CAPX), Herfindahl Index based on the three-digit SIC code, as well as year, two-digit SIC industry. Robust t-statistics with standard errors clustered at the industry (two-digit SIC code) and year level are reported in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

Table 6: Impact of SOX on high-tech vs. low-tech firms

	Log(1+Patent)		Innovation Efficiency	
	High Tech	Non-High	High Tech	Non-High
	(1)	(2)	(3)	(4)
SOX Signal	-0.151***	-0.035***	-0.055***	-0.023
	(-4.74)	(-3.60)	(-3.18)	(-0.75)
Log Total Asset	0.361***	0.113***	-0.003	-0.002
	(25.90)	(18.23)	(-0.42)	(-0.64)
Firm Age	0.010***	0.008***	-0.001	0.001
	(3.81)	(6.93)	(-0.65)	(1.21)
ROA	-0.091**	0.015	-0.007	-0.005
	(-2.37)	(1.18)	(-0.85)	(-0.53)
Tobin's Q	0.015***	0.008***	-0.000	0.000
	(6.82)	(10.17)	(-0.38)	(0.74)
Cash	-0.004	-0.013*	0.012	0.004
	(-0.19)	(-1.70)	(1.18)	(1.14)
Leverage	-0.089***	-0.078***	-0.003	-0.020**
	(-3.02)	(-5.90)	(-0.24)	(-2.38)
CAPEX	0.720**	-0.175	0.237***	-0.068
	(2.44)	(-1.52)	(3.21)	(-1.42)
R&D Expense	0.720***	0.642***	-0.169**	-0.045
	(8.44)	(7.51)	(-2.15)	(-1.32)
Hindex	-0.375	0.267**	-0.401**	0.019
	(-0.87)	(2.56)	(-2.36)	(0.46)
Constant	-2.351***	-0.461	0.080	0.035
	(-19.38)	(-1.41)	(1.09)	(1.41)
Industry F.E.	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes
N	8790	28549	8790	28549
adj. R-sq	0.444	0.280	0.005	0.002

Notes: This table reports the estimation results of subsample regressions examining how the effects of Sarbanes-Oxley (SOX) Act on innovation productivity vary within high-technology industries and non-high-technology industries. As in Hall and Lerner (2010) the high-technology sectors include drugs, office and computing equipment, communications equipment and electronic components, and the rest are classified as non-high-technology sectors. The dependent variables in Columns (1) to (2) are the logarithm of one plus the patent number and the dependent variables in Columns (3) to (4) is firms' *Innovation Efficiency* (Hirshleifer, Hsu and Li 2013); the main independent variable is SOX Signal, which equals to one if observations are of years no less than 2002 and zero otherwise. All regressions control for the logarithm of total asset, firm age, return on asset (ROA), Tobin's Q, leverage, R&D expense, capital expenditure (CAPX), Herfindahl Index based on the three-digit SIC code, as well as year, two-digit SIC industry. Detailed definitions of each variable are provided in the Appendix. Robust t-statistics with standard errors clustered at the industry (two-digit SIC code) and year level are reported in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

Table 7: Impact of SOX on firms gone private vs. remaining listed

	Log(1+Patent) (1)	Log(1+Patent) (2)
SOX * Delisted Signal	0.188^{***}	0.150^{***}
	(5.72)	(4.42)
Delisted Signal	-0.531^{***}	-0.210^{***}
	(-11.25)	(-5.16)
SOX Signal	-0.245^{***}	-0.357^{***}
	(-13.68)	(-16.17)
Log (Total Asset)		0.254^{***}
		(22.39)
Firm Age		0.003^{**}
		(2.05)
ROA		-0.002
		(-1.64)
Tobin's Q		0.001^{***}
		(4.49)
Cash Flow/Assets		0.001
		(1.26)
Leverage		0.001^{*}
		(1.86)
CAPX/Assets		1.152^{***}
		(5.11)
R&D Expense/Assets		0.009
		(0.99)
Herfindahl Index		0.291^{**}
		(2.15)
Constant	1.501^{**}	-0.422
	(2.00)	(-0.64)
Year F. E.	Yes	Yes
Industry F. E.	Yes	Yes
Observations	22013	21782
Adj. R^2	0.173	0.374

Notes: This table reports the estimation results of subsample regressions examining how the effects of Sarbanes-Oxley (SOX) Act on innovation productivity vary between firms did not delist until 2006 and firms delisted during 2001 to 2003. It use the NBER dataset to include sample of patent number for both listed and delisted firms. The sample period is from 1998 to 2006. The Delisted Signal equals to one if the firm delisted during 2001 to 2003 and zero otherwise. The dependent variables are measures of innovation productivity including patents; the main explanatory variable is the SOX Signal's interaction term with Delisted Signal. Regressions control for the logarithm of total assets, firm age, return on assets (ROA), Tobin's Q, Cash Flow-to-Assets, Leverage, R&D Expense-to-Assets, CAPX-to-Assets and Herfindahl Index based on the three-digit SIC code as well as year, two-digit SIC industry. Detailed definitions of each variable are provided in the Appendix. Robust t-statistics with standard errors clustered at the industry (two-digit SIC code) and year level are reported in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.