Was Sarbanes-Oxley Costly? Evidence from Optimal Contracting on CEO Compensation[1]

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Abstract

This paper investigates the effects of regulatory interventions on contracting relationships within firms by examining the impacts of the Sarbanes-Oxley Act (SOX) on CEO compensation. Using panel data of the S&P 1500 firms quantifies welfare gains from a dynamic principal-agent model of hidden information and hidden actions. It finds that SOX: (i) did not change CEOs' risk attitude, (ii) improved the shareholders–CEOs interest alignment by reducing shareholders' loss from CEOs shirking and CEOs' benefits from shirking, and (iii) slightly reduced the administrative costs and mainly increased the agency costs embedded in CEO compensation. Cross-sectionally, it finds favorable impacts of SOX most often in the consumer goods sector, which is the least regulated among the three sectors we study. It finds no systematic patterns of SOX's impact by firm size.

JEL C10, C12, C13, J30, J33, M50, M52, M55

1 Introduction

We empirically investigate the changes in CEO compensation resulting from the passage of the Sarbanes-Oxley Act (SOX)[1] in 2002, a legislative response to a wave of corporate governance failures at many prominent companies and "the most extensive regulation of the securities markets since the Securities Act of 1933 and the Securities Exchange Act of 1934 (Ball [2009])." The impact of such a regulatory intervention on contracting relationships within firms is controversial (Hart [2009]). With the ultimate goal of restoring investors' confidence, SOX affects CEO compensation directly by prohibiting option backdating and perks[2] but also potentially through other provisions that may change the primitive determinants of CEO compensation by enhancing the board independence[3], internal control[4], and disclosure quality[5]. Shareholders use the compensation contracts directly incentivize CEOs' behaviors before and after the passage of SOX. However, some of the CEO's actions formerly incentivized by the compensation contracts are incentivized via SOX's legal provisions. SOX's consequences for CEO compensation are thus an essential factor in any overall evaluation of this intervention.

Despite the importance, the findings in the literature are inconclusive. Carter et al. [2009] finds an increased weight on positive earnings changes in CEOs' bonus contracts after SOX and a decrease in the proportion of salary. They attribute the findings to

[1]SOX is often used for brevity in the literature to collectively refer to both the SOX and contemporary listing rules changed by the NYSE and the NASDAQ. After all, "SOX signifies a turning point, and its enactment represents a significant inroad by the government into governance (Linck et al. [2009])." We follow this practice, as seen in Linck et al. [2009], Carter et al. [2009], Cohen et al. [2013], Zhang [2007], Bargeron et al. [2010], Hart [2009], among others.

[2]SOX Section 402 prohibited personal loans to CEOs. Option backdating was curbed by Section 304 that enforces the "clawback" penalty and Section 409 (A) that adds various restrictions on the deferred compensation.

[3]SOX Section 301 and the NYSE/NASDAQ listing rules require that each firm must keep an independent majority board as well as a fully independent audit committee, compensation committee, and nomination committee. The monitoring and advisory roles of these governance infrastructures are rebalanced, who oversight CEOs' behaviors and are involved in the design of CEO compensation.

[4]SOX Section 302 requires that the CEOs and CFOs are responsible for establishing, maintaining, assessing, and disclosing the quality of internal controls of the firm. Section 404(A) requires disclosure of these responsibilities. Improved internal control could enhance CEOs' productivity but, meanwhile, divert their attention from value-added activities. Both effects may result in changes in optimal compensation.

[5]SOX Section 302 requires that CEOs and CFOs must certify the integrity of financial statements. It may affect CEO compensation that motivates CEOs to reveal the financial status of firms truthfully .

firms' response to the improved disclosure quality and conclude with no evidence of compensating the CEOs for bearing more risk after SOX. Nekipelov [2010] attributes an increase in post-SOX salary and bonuses to increased risk aversion. Cohen et al. [2013] find a decline in pay-performance sensitivity (PPS), increased bonus, and no significant decrease in total compensation. They also find that the PPS in the post-SOX period was lower in firms with less than majority independent boards before SOX. Chhaochharia and Grinstein [2009] document decreased CEO compensation after SOX in firms with less than more independent directors on their boards in 2002. However, their results may not be robust to outliers, as suggested by Guthrie et al. [2012], who instead find that the compensation committee independence requirement increased CEO compensation after SOX. It is possible that "directors ...prefer better-aligned incentives but are not particularly interested in restraining pay levels (Murphy [2013])." Therefore, we complement and contribute to the literature by quantifying several theory-based measures of shareholders' benefits and costs and investigating the following unanswered questions: through which channels and to what extent did SOX affect the shareholders-CEOs interest alignment and the costs associated with CEO compensation?

Our research design features estimation of a principal-agent model with the control of a model-based time-specific effect, which is adapted from Gayle and Miller [2015], who quantify agency costs due to hidden action and hidden information using semiparametric estimation and set identification techniques. This design suits the research questions and has several advantages. In our dynamic model of optimal contracting, a risk-neutral principal (the shareholders) and a risk-averse agent (the CEO) are asymmetrically informed of both the CEO's actions and the firm's prospects. We emphasize the communication role of accounting information potentially played in compensation contracts under hybrid moral hazard. The structural model's conceptual framework enables decomposing the change of CEO compensation to the changes in costs in agency theory. The model also guides the control for the economy-wide trend since it allows for model implied bond prices to summarize aggregate variations and serve as the anchor of estimates across SOX.

Meanwhile, the semiparametric approach frees our analysis of the SOX effect from stringent functional form restrictions on the compensation scheme and the performance measure's distribution. It makes the results less sensitive to outliers. The set identification technique accommodates a rich group of theoretical restrictions, in-

cluding inequalities to derive set estimates' tight bounds. Such tightness is especially vital in comparing regimes as this paper does.

In addition to including the model-based time-specific effect to isolate the SOX effect, we also use a structural difference-in-difference approach by choosing a control group and a treatment group. Previous reduced form studies use firms that were compliant with the SOX provisions of board structure[6] before SOX as the control group in the difference-in-differences design to examine the impact of corporate governance on CEO compensation (Chhaochharia and Grinstein [2009], Cohen et al. [2013], Guthrie et al. [2012]), investment (Cohen et al. [2013], Banerjee et al. [2015], Lu and Wang [2015]), firm performance (Duchin et al. [2010]), and Bargerson et al. [2010]) and earnings management (Chen et al. [2015] and Joo and Chamberlain [2017]). We define the noncompliant firms as those wo missed at least one of the following criteria before SOX: (1) a majority independent board, (2) an entirely independent audit committee, and (3) an entirely independent compensation committee. The rest of our sample of S&P 1500 firms are denoted as compliant firms. If SOX affects the primitive in the contracting environment of CEO compensation mainly through changing board structure as regulators intend to, the noncompliant firms are expected to experience more favorable changes in our measures after SOX than the compliant firms.

Four main findings emerge from structural estimation. First, we do not find evidence that the preference for risk-taking by CEOs changed with SOX, contradicting concerns raised by directors (Cohen, Dey, and Lys [2013]) and politicians such as Alan Greenspan and William Donaldson (former SEC chairman) that CEOs would overreact to provisions in SOX provisions and exercise undue caution in investment decisions, thus destroying shareholder value (see Coats and Srinivasan [2014]).

Second, we find evidence that SOX improved the interest alignment between shareholders and CEOs. From the shareholders' perspective, the first measure (ρ_1) The alignment of shareholders and CEOs interests equals the gross loss shareholders would bear if managers shirked. We find that implementing SOX reduced this loss in 10 of the 12 firm categories and that the noncompliant firms not only faced more severe conflicts of interests (larger loss) before SOX but also experienced a strong/moderate

[6]The major relevant provisions mandated by SOX and the exchanges include: (1) the board must have a majority of independent directors; (2) the compensation and the nominating/governance committees must consist entirely of independent directors; (3) the audit committee must consist entirely of independent directors and one member must be an "audit committee financial expert."

favorable impact[7] after SOX in five out of the six firm categories[8]. Alternatively, from the CEOs' perspective, the second measure (ρ_2) equals to the compensating differential that the CEO is paid to work rather than shirk. We find it decreased after SOX in half of the firm categories. Similar to the equalizing effect found on shareholders' loss, noncompliant firms had a larger compensating differential before SOX and exhibited a favorable impact in four out of the six firm categories.

Third, we find little evidence that SOX reduced the costs embedded in the CEO compensation. The first component, defined as administrative costs (τ_1), is the premium that a CEO would be paid over the inclusive annuitized value of his outside option if there were no agency problems. We find the administrative costs were reduced in only one of the three sectors. Our finding echoes practitioners' concern on the effort diversion of certain SOX provisions[9]. Noticeably, the strongly favorable impact clusters in the consumer goods sector. The second component, defined as aggregate agency costs (τ_2), measures the gross costs that shareholders would be willing to pay for perfect monitoring and thus avoid the penalties induced by the incentive compatibility and truth-telling constraints. We further decompose the aggregate agency costs to the cost of hidden actions (τ_3) and cost of hidden information (τ_4). More astonishingly, we find that SOX increased agency costs within most categories of all three sectors. In the primary sector, this is mainly attributable to the higher cost of hidden actions, whereas in the consumer goods sector, the cost of hidden information tended to increase. The subsample analyses present a strong favorable impact of SOX on the aggregate agency costs only in small firms in the primary and consumer goods

[7]We denote three levels for a favorable impact of SOX. We label an impact as "strong favorable" if the measure decreased in the noncompliant firms and increased in the compliant firms, meaning that an unfavorable trend is reversed. We label an impact as "moderate favorable" if the measure decreased in both the compliant firms and noncompliant firms but more in the latter, meaning that the noncompliant firms improved on the margin. We label an impact as "mild favorable" if the measure increased in both the compliant firms and noncompliant firms but less in the latter, meaning that an unfavorable trend was alleviated to some extent. We also denote three levels (strong, moderate, and mild) for an unfavorable impact following the same logic.

[8]The full sample analyses consider three dimensions of heterogeneity including industrial sector (primary, consumer goods, and service), firm size (binary), and financial leverage (binary), which together generate twelve firm categories. To maintain a sufficient amount of observations in each subsample, we only keep the industrial sector and firm size in the subsample analyses, reducing the number of firm categories to six.

[9]As a senior officer of the U.S. Chamber of Commerce, Michael Ryan expressed concerns that "The time and energy required by SOX can be a distraction.", since "The amount of time management is spending on the process to comply with SOX takes them away from running the business, increasing sales and developing new products." (Farrell [2007]).

sectors.

Fourth, our cross-section analyses respond to the concern of "one-size-fits-all" failure, which commonly faces SOX and previous regulations on CEO compensation. Interestingly, we find moderate/strong favorable impacts of SOX more often in the consumer goods sector than in the other two sectors that include more regulated industries.[10] Each sector has eight cases to evaluate a SOX impact (two firm sizes by four major measures including ρ_1, ρ_2, τ_1, and τ_2). We find that the ratio between the moderate/strong favorable impacts and the moderate/strong unfavorable impacts is four to one in the primary sector, seven to zero in the consumer goods sector, and two to four in the service sector. This finding is consistent with both the practitioners' concerns[11] and the academic findings[12] specific to the SOX impacts on regulated firms. Besides, we do not find systematic patterns of the SOX impacts that vary with firm size in our sample of S&P 1500 firms, suggesting that the notion that small firms bear negative consequences of SOX[13] may exist only below certain thresholds.

The inferences of our findings are subject to several caveats. First, the robustness tests appeal to a subset of SOX provisions such that the changes of compliant firms bear the impact of SOX provisions that apply to all firms and the entire SOX effects may be underestimated.[14] Also, the primary goal of the model is to provide a lens

[10]Industries in the primary sector include energy, materials, industrials, and utilities. The consumer goods sector includes consumer discretionary and consumer staples. The service sector includes health care, financial, and information technology, and telecommunication services.

[11]An article on the Energybiz Magzine (Anand and Schwind [2006]) discussing the SOX challenges confronting the energy industry mentioned that "Depending on the area of focus (oil, gas, electricity, nuclear, wind, hydro, etc.), the industry contends with many regulations and regulatory bodies... Add to that the Sarbanes-Oxley legislation with internal control audit and disclosure requirements. Energy companies find themselves being pulled in many directions to meet all of their regulatory obligations. Sometimes those requirements appear to conflict with each other."

[12]Filbeck et al. [2011] document that regulated firms did not outperform and even sometimes underperformed non-regulated firms after SOX. Labro and Stice-Lawrence [2020] The benefits of an accounting system update triggered by regulatory pressures such as SOX 404 are insignificant in hospitals.

[13]Chhaochharia and Grinstein [2007] find a positive market reaction to the announcement of the new rules in firms that are less compliant with the provisions of the regulations, among which large firms earn positive abnormal returns, but small firms make negative abnormal returns. Wintoki [2007] suggests that small firms were adversely affected by SOX. Linck, Netter, and Yang (2009, RFS) also find that overall director costs are larger among small firms.

[14]We acknowledge two alternative control groups. In a Regression Discontinuity design, Iliev [2010] uses U.S. firms with a public float lower than $75 million and foreign firms with a public float lower than $700 million as control groups. By contrast, our sample consists of S&P 1500 firms with a much larger public float, in which agency problems may behave significantly different from Iliev's sample. For a similar reason, the corporate governance and compensation provision of foreign firms

through which we quantify various efficiency measures associated with CEO compensation. Though we allow the rebalanced monitoring and advisory roles of the board to affect the primitives of CEO compensation in optimal contracting, the model abstracts away from The trade-offs between using different governance mechanisms.[15] Lastly, we maintain the assumption that the compliant firms and noncompliant firms react to other contemporary events in a similar fashion, in addition to the evidence that the changes in board structure and behaviors after SOX are more pronounced in the noncompliant firms[16]. It seems difficult to detect another mechanism which can bring about the entire set of our results.

We connect and contribute to three lines of literature. The most closely related are studies on the SOX consequences for CEO compensation, which have been focusing on the shape of compensation schemes. We complement the literature by quantifying various driving forces behind the changes of CEO compensation. More broadly, our findings of the pervasive increase of agency costs after SOX complement previous studies who document the direct costs from control system expenditures incurred as a result of SOX's new requirements (Coats and Srinivasan [2014]). Meanwhile, our findings of reduced shareholders' loss from CEO shirking after SOX within most categories of all three sectors complement previous studies who document mixed results of the effects of SOX passage on shareholders' wealth (Zhang [2007] and Jain and Rezaee [2006] on the stock returns and Chhaochharia and Grinstein [2007]on long-term firm performances). Overall, our findings evidence that legislators were primarily concerned with the potential for large losses rather than their expected value, which takes into account the probability of their occurrence.

Also, our findings are related to the literature on the regulations of CEO compensation. Murphy [2013] reviews the history of these regulations and concludes that "With few exceptions, the regulations have been either ineffective or counterproductive, typically increasing (rather than reducing) agency problems and pay levels, and

could be quite different from US firms and are not used for our control groups either. Also, the Regression Discontinuity design may face the typical concern of generalizability (Gow et al. [2016]).

[15]A few theory papers explore the asset pricing implications of corporate governance and agency frictions and are related to compensation contract (Gorton, He, and Huang [2014], Jung, Subramanian, and Zeng [2019]). These models usually make stronger assumptions and require more data than available to us to identify and estimate. The challenges of recovering these models from data are sufficient to justify a separate study in the future.

[16]Linck et al. [2009] documents increased frequency of board meetings, increased independence of board committees, and more financial experts included in boards after SOX. The effects are more pronounced in the firms that were not compliant with the new governance rules before SOX.

leading to a host of unintended consequences." Edmans et al. [2017] recommend that regulatory authorities introduce "guidelines" that leave firms with more discretion than what "prescription" type of regulations offer. Our findings of the soft intervention of SOX on CEO compensation shed light on the ongoing debate of the governmental and regulatory intervention of incentive contracts in firms by suggesting that the regulation existing in place may play an important role in predicting the consequences of any new intervention.

In addition, we join an emerging line of accounting literature that estimates structural models of firm behaviors. By far most attention has been given to the disclosure behaviors (Zakolyukina [2018], Beyer et al. [2019], Bertomeu et al. [2020], Bertomeu et al. [2020], Bird et al. [2019], Choi [2018], and Breuer and Windisch [2019], Cheynel and Liu-Watts [2020]). Few exceptions include McClure [2020] who studies the tax avoidance by estimating a single-agent dynamic optimization model and Li [2019] who examines the compensation design of top management teams by estimating moral hazard models of multiple agents. We distinguish by estimating a principal-single agent model of hidden action and hidden information and investigating the policy effect of a sweeping regulatory regime shift through the lens of optimal contracting.

2 Motivational Observations

2.1 Data

Financial and accounting data on the S&P 1500 were extracted from Compustat, whereas data on executive compensation were taken from ExecuComp and data on the independent members of board and committees were from RiskMetrics. Bond prices were constructed from the yield curve of Treasure Bill from the Federal Reserve Economic dataset. Supplementary Appendix A explains how the data were assembled and Table A1 provides descriptive statistics. Figure 1 presents the timeline of reform following the bankruptcy of Enron in December 2001 through the passage of SOX in mid-2002 to the approval by the SEC of the proposals of the New York Stock Exchange (NYSE) and National Association of Securities Dealers Automated Quotations (NASDAQ) in November 2003 following internal reviews of their respective corporate governance requirements.

Our sample covers 13 years, 1993 through 2005. The ending year is chosen to make

results comparable with previous studies who stop around 2006 to mitigate the effects of later events, including the changes in ExecuComp disclosure in 2006, the financial crisis starting in winter 2007, and the enactment of SFAS 123r on the accounting treatment of stock options effective after June 15, 2005 (Linck et al. [2009], Banerjee et al. [2015], Chhaochharia and Grinstein [2009], Carter et al. [2009], Cohen et al. [2013], Merz [2017]). Also, in the main text, we omit data on the two years when legislation was in a flux (2002 and 2003) by defining the pre-SOX era as the years 1993 through 2001 and the post-SOX period as the years 2004 and 2005.

We take care of the observable heterogeneity along three dimensions: the industrial sector, firm size, and capital structure. The three industries based on GICS code are the primary sector (energy, materials, industrials, and utilities), consumer goods sector (consumer discretionary and consumer staples), and service sector (health care, financial, and information technology and telecommunication services). Firm size is measured by the total assets of firm n at the end of the annual period t, denoted by A_{nt}.Firm size plays an important role not only in generally explaining the evolution of CEO compensation due to moral hazard cost (Gayle and Miller [2009]) but also in addressing the common concern of the "one-size-fits-all" failure[17]. The capital structure is captured by the debt-to-equity ratio by $C_{nt} \equiv D_{nt}/\left(A_{nt} - D_{nt}\right)$, where D_{nt} denotes debt at the end of the period. Theoretical papers suggest that capital structure influence the agency problems within firms (Stulz [1990] and Zwiebel [1996]). A practical reason for focusing on these three dimensions is that our nonparametric method requires a relatively large number of observations in each firm category to maintain the estimator's good properties and prevents finer classification. Also, doing so makes our results comparable with previous studies using similar methods and dataset[18].

Specifically, we classify each firm by whether its total assets averaged in the pre-SOX era were less than or greater than the median of the averaged total assets for

[17]Engel et al. [2007]and Leuz et al. [2008] indicate that the SOX provision may have different implications for firms with different sizes. Linck, Netter, and Yang [2009] find that increase of board independence after SOX differs by firm size. Chhaochharia and Grinstein [2007] find a positive market reaction to the announcement of the new rules in firms that are less compliant with the rules' provisions. Large firms earn positive abnormal returns, but small firms earn negative abnormal returns. Wintoki [2007] suggests that small firms were adversely affected by SOX. Besides, the cost of information acquisition affects the efficiency of the board, which largely correlates with size (Duchin et al. [2010]).

[18]For example, Gayle and Miller [2009a, 2009b,2015], Gayle, Golan, and Miller [2015], and Li [2019].

firms in the same sector and whether its debt-to-equity ratio averaged in the pre-SOX period was less or greater than the median of the averaged debt-to-equity ratio for firms in the same industry in the pre-SOX era. Therefore, firm type is measured by the coordinate pair (A, C) with each corresponding to whether that element is above (L) or below (S) its median of that sector in the pre-SOX era.

Another input of our estimation is the proxy of CEOs' private information about the firms' perspective. The model requires the proxy to be subject to managerial discretion in reporting and be comprehensive to accommodate various communication information that may include but is not restricted to the income statements. Therefore, accounting returns are defined by $r_{nt} \equiv (A_{nt} - D_{nt} + I_{nt})/(A_{n,t-1} - D_{n,t-1})$[19], where I_{nt} denotes the total value of dividends (and stock repurchases) paid throughout the preceding financial period. Likewise, Bad_{nt} means the accounting return r_{nt} is lower than the average for all firms within the same sector, size, and capital structure categories, and $Good_{nt}$ means the reverse.

Our measure of total compensation follows Antle and Smith [1985, 1986], Hall and Liebman [1998], and Margiotta and Miller [2000] and includes salary, bonus, options, promised retirement benefits, and restricted stocks, as well as the change in wealth attributable to holding financial securities in the firm rather than a fully diversified portfolio.[20] In this way, executive compensation depends directly on the excess returns of the firms they manage, which we denote by $x_{nt} \equiv \pi_{nt} - \pi_t$, where π_{nt} represents financial returns on equity in firm n at t, and π_t is the financial return from holding the market portfolio. On average, CEO compensation is highest in the service sector and lowest in the primary industry.

To determine whether a firm belongs to the compliant group or the noncompliant group, we define the noncompliant firms as those who missed at least one of the following criteria: (1) an independent majority board before February 13, 2002, when the SEC asked NYSE and NASDAQ to review their corporate governance requirements, (2) an entirely independent audit committee before December 31, 2000, following Duchin et al. [2010] who suggest that the exchanges adopted the recommendations

[19]Whether other accounting numbers may play a more significant role in communication is by itself interesting and worth a separate study. Therefore we leave it for future research.

[20]The construction of this measure reflects the concept of certainty equivalent, which serves as the basis of preference revelation and decision making in theoretical models. When the CEOs are life-time consumption smoother and are free to borrow and save, as considered in our model, there is no theory ground to justify the separation of different analysis components.

of the independence of audit committee as early as the end of 1999, and (3) an entirely independent compensation committee before July 25, 2002, when the SOX was approved. The rest of our sample of S&P 1500 firms are denoted as compliant firms.

2.2 Testing for Structural Change

CEO compensation depends on excess returns. Therefore, a structural shift occurs if the distribution of excess returns changes and/or the relationship between excess returns and CEO compensation changes. Here we test for equality between the pre- and post-SOX eras of the probability density functions for excess returns and the compensation schedule's shape. These tests make use of point-wise information and thus are expected to reflect more information in the data than a test on the mean.

Change in the distribution of excess returns Denote the set of 24 categorical variables (formed from 3 sectors, 2 firm sizes, 2 capital structures, and 2 accounting states) by Z, and let $f_{pre}(x_{nt}|z_{nt})$ denote the probability density function of excess returns in the pre-SOX era conditional on $z_{nt} \in Z$. Also define $f_{post}(x_{nt}|z_{nt})$ in a similar manner. Under the null hypothesis of no change, $f_{pre}(x|z) = f_{post}(x|z)$ for all $(x, z) \in \mathcal{R} \times Z$. Li and Racine [2007, page 363] propose a one-sided test for the null, in which the test statistic is asymptotically distributed standard normal. Panel A in Table 2 reports the test outcome for the 24 cases. (Supplementary Appendix B provides a detailed explanation of both tests conducted in this section.) Aside from the bad state of (S, L) in the consumer goods sector, the statistic's values lie above the critical value of the 1 percent confidence level (2.33). Consequently, we reject the null hypothesis of no change in the excess returns density from the pre-SOX to post-SOX eras for practically all firm types in both accounting states.

Change in the shape of the contract Let $w_{pre}(x_{nt}, z_{nt})$ denote CEO compensation as a function of (x_{nt}, z_{nt}) in the pre-SOX era and similarly define $w_{post}(x_{nt}, z_{nt})$ in the post-SOX era. A straightforward way of testing whether the two mappings are equal is to include an indicator variable for the post-SOX regime in nonparametric regressions of compensation on the excess return x_{nt} for each z_{nt}. The one-sided test of the null hypothesis of equality is asymptotically standard normal. Panel B in Table 2 reports the test statistics for a change in the shape of the compensation schedule for each of the 24 cases. In all but two cases, the value of the statistic exceeds 1.64,

the 5 percent level, implying the null hypothesis of no change in the compensation contract shape is rejected. Moreover, in these two exceptions, Panel A shows we reject the null hypothesis that the excess returns density function was unaffected, which implies that the probability distribution of managerial compensation in those cases did change when SOX was implemented.

Illustrating the differences To convey some sense of what lies behind rejecting the null hypothesis of No change, Figure 2 shows how the shape of the excess returns probability density function and the estimated compensation schedule adjusts for small, low-leverage firms in the consumer goods sector, controlling for the state of the firm (bad versus good) and the two eras (pre-SOX versus post-SOX). The two top panels show that in both states, density for excess returns shifted to the right and became more concentrated about the mean after SOX. Comparing Panel A with B, the mean returns are not surprisingly higher in the good state. The bottom panels show that the compensation schedule is steeper in the excellent state in both eras than the bad. Also, both plots in the post-SOX period (Panel D) tend to be flatter than in the pre-SOX period (Panel C). The overall effect of concentrating the excess returns distribution and flattening the compensation schedule's extremes is to reduce the dispersion of compensation between the pre- and post-SOX eras, as reported in Table A1.

3 Model and Equilibrium

This paper's structural model is borrowed from the hybrid moral hazard model of Gayle and Miller [2015], which is built within the empirical framework developed by Margiotta and Miller [2000]. These papers introduce market incompleteness due to information asymmetry between shareholders and CEOs and undiversifiable risk exposed to CEOs into an equilibrium model of competitive and complete markets. These models use contingent claims to characterize consumption smoothing and asset returns. Assuming that CEOs' preferences fall into the class of HARA utility function, a CEO's financial portfolio can be described by a bond that pays a unit of consumption and security that delivers a random quantity of consumption units in the future when contingent claim prices apply and channel the aggregate shocks to contracting decisions.

These two papers also apply the results of Grossman and Hart [1983] and Fudenberg et al. [1990] to solve the optimal contract so that long-term incentives can be delivered by implementing a series of a short-term contract. Throughout this paper, we maintain the same technical assumptions as Gayle and Miller [2015] do to apply their approach. To save space, we delegate the details to Gayle and Miller [2015] and a textbook treatment by Altug and Labadie [1994].

The hybrid moral hazard model helps to answer our research questions for several reasons. First, this model captures two significant agency frictions (hidden action and hidden information) in the interest alignment between shareholders and CEOs, whose importance is reinsured by the empirical regularities across SOX, as shown in Figure 2. An essential feature of this model is that it treats accounting information as a non-verifiable statement by the CEO, whose credibility depends on the incentives that determine his or her payoff as a function of what the CEO reports. Correspondingly, SOX provisions affect both the effort supply and information revelation. Broadly speaking, SOX (i) required top management to certify the accuracy of financial individually information, (ii) increased the oversight role of boards of directors and the independence of the outside auditors who review the accuracy of corporate financial statements, and (iii) penalized fraudulent financial activities more severely than previously. Therefore, this model provides good angles to evaluate the SOX impacts. Second, the model offers direct channels for the primitives to affect the compensation, which may change with the implementation of SOX. The explicit parameterization also efficiently extracts information from the nonlinear shape of observed compensation schedules. Third, this model accommodates aggregate shocks into contracting through the contingent claim price in CEOs' value function, so that the bond prices (calculated from the Treasure Bill yield) can serve as a model-based time-specific effect of controlling economy-wide trend across SOX.

3.1 Model Set-up

To this end, we now layout a dynamic principal-agent model of optimal contracting between risk-neutral shareholders and a risk-averse CEO, in which the CEO has hidden information and also takes actions that cannot be directly observed by shareholders. The shareholders are well-diversified, and the CEO has access to well-functioning market to smooth consumption streams and pay for penalties. We assume a complete set

of markets for all publicly disclosed events exists, effectively attributing all deviations from the law of one price to the dual information asymmetries under consideration.

At the beginning of the typical period t, the CEO is paid compensation denoted by w_t for working during the previous period, denominated in terms of period-t consumption units. The CEO makes consumption choice (c_t) and receives endowment (e_t), which can be monitored by shareholders via enforcing public disclosure laws. The board announces how CEO compensation will be determined as a function of what he will disclose about the firm's prospects, denoted by $r_t \in \{1, 2\}$[21], and its subsequent performance, measured by excess returns x_{t+1}, revealed at the beginning of the next period. We denote this mapping by $w_{rt}(x)$, where the subscript t designates that the optimal compensation schedule may depend on current economic conditions, such as bond prices.

Then the CEO chooses whether to be engaged by the firm or not. Denote this decision by the indicator $l_{t0} \in \{0, 1\}$, where $l_{t0} = 1$ if the CEO chooses to be engaged outside the firm and $l_{t0} = 0$ if he chooses to be engaged inside the firm. If the CEO accepts employment with the firm, $l_{t0} = 0$, the firm's prospects are now fully revealed to the CEO but partially hidden from the shareholders. There are two states, $s_t \in \{1, 2\}$, and we denote the probability that state s_t occurs by $\varphi_{st} \in (0, 1)$. We assume that CEOs privately observe the true state, $s_t \in \{1, 2\}$, in period t, gaining information that affects the distribution of the firm's next-period excess returns, and reports r_t to the board. If the CEO discloses the second state, meaning $r_t = 2$, then the board can independently confirm or refute it; thus, if $s_t = 1$, he reports $r_t = 1$. If $s_t = 2$, the CEO then truthfully declares or lies about the firm's prospects by announcing $r_t \in \{1, 2\}$, effectively selecting one of two schedules, $w_{1t}(x)$ or $w_{2t}(x)$, in that case.

The CEO then makes an unobserved labor effort choice, denoted by $l_{stj} \in \{0, 1\}$ for $j \in \{1, 2\}$ for period t, which may depend on his private information, about the state. There are two possibilities: to diligently pursue the shareholders objectives of value maximization by working, thus setting $l_{st2} = 1$, or to accept employment with the firm but follow the objectives he would pursue if he were paid a fixed wage by setting $l_{st1} = 1$, called shirking. Let $l_{st} \equiv (l_{t0}, l_{st1}, l_{st2})$. Since leaving the firm, working and shirking are mutually exclusive activities, $l_{t0} + l_{st1} + l_{st2} = 1$.

We parameterize the CEO's preference by a utility function exhibiting absolute

[21] $r_t = 1$ if the private the state is bad and $r_t = 2$ if it is good.

risk aversion that is additively separable over periods and multiplicatively separable concerning consumption and work activity within periods. In the model we estimate, lifetime utility can be expressed as

$$-\sum_{t=0}^{\infty}\sum_{j=0}^{2}\beta^{t}\alpha_{j}l_{stj}\exp\left(-\gamma c_{t}\right), \tag{1}$$

where β is the constant subjective discount factor, γ is the the constant absolute level of risk aversion and α_j is a utility parameter that measures the distaste from three mutually exclusive options $j \in \{0 \text{ (outside option)}, 1 \text{ (shirking)}, 2 \text{ (working)}\}$. We assume working is more distasteful than shirking, meaning $\alpha_2 > \alpha_1$, and normalize $\alpha_0 = 1$ in the estimation stage.

We also assume other regularity conditions as follows. At the beginning of period $t+1$, excess returns for the firm, x_{t+1}, are drawn from a probability distribution that depends on the true state, s_t, and the CEO's action, l_{st}, in period t. We denote the probability density function for excess returns when the CEO works diligently and the state is $s$by $f_s(x)$. Similarly, let $f_s(x)g_s(x)$ denote the probability density function for excess returns in period t when the CEO shirks. Thus, for both states $s_t \in \{1, 2\}$:

$$\int xf_{s}(x)g_{s}(x)\mathrm{d}x \equiv E_{s}[xg_{s}(x) < E_{s}[x] \equiv \int xf_{s}(x)\mathrm{d}x,$$

the inequality reflecting the shareholders' preference for diligent work over shirking. Because $f_s(x)g_s(x)$ is a density, $g_s(x)$ is positive and integrating $f_s(x)g_s(x)$ with respect to x demonstrates $E_s\left[g_s(x)\right] = 1$. We assume the likelihood of shirking declines to zero as excess returns increase without bound:

$$\lim_{x\to\infty}\left[g_{s}(x)\right] = 0 \tag{2}$$

for each $s \in \{1, 2\}$. We assume the weighted likelihood ratio of the second state occurring relative to the first given any observed value of excess returns, $x \in R$ converges to an upper finite limit as x increases, such that

$$\lim_{x\to\infty}\left[\varphi_{2}f_{2}(x)/\varphi_{1}f_{1}(x)\right] \equiv \lim_{x\to\infty}\left[h(x)\right] = \sup_{x\in R}[h(x)] \equiv \overline{h} < \infty. \tag{3}$$

3.2 Equilibrium

CEO's intertemporal consumption optimality The fundamental building block of the optimal contract is the CEO's indirect utility from choosing consumption and labor input, which takes two steps to obtain. First, we derive the indirect utility from solving the consumption smoothing problem upon retirement. Then, following Bellman's [1957] principle, we solve a two-period consumption optimization for the last employment period. The utility for the second period is just the indirect utility derived in the first step. This part is heavily drawn from Gayle and Miller [2015] and Margiotta and Miller [2000].

At retirement on entering period $t+1$, the CEO's indirect utility is derived from maximizing

$$-E_t\left[\sum\nolimits_{t'=t}^{\infty}\beta^{t'}\alpha_0\exp\left(-\gamma c_{t'}\right)\right]. \tag{4}$$

subject to his budget constraint

$$E_t\left[\sum\nolimits_{t'=t}^{\infty}\lambda_{t'}c_{t'}\right]\leq\lambda_t e_t$$

where c_t is the consumption chosen and e_t is the endowment received by the CEO in period t. Assuming complete contingent claim market exists, the contingent claim prices $\lambda_{t'}$ in future periods help determine the consumption allocation. The CARA utility allows using only a bond and a security to characterize the optimal choices of consumption and financial portfolio. The bond, contingent on the history through date t, pays a unit of consumption from period t in perpetuity, whose price is defined as $p_t\equiv E_t\left[\sum_{t'=t}^{\infty}\lambda_{t'}\right]$. To simplify the exposition, we assume p_{t+1} is known at period t. The security pays the random quantity $(\ln\lambda_{t'}-t'\ln\beta)$ of consumption units from period t onward, whose price is defined as $q_t\equiv E_t\left[\sum_{t'=t}^{\infty}\lambda_{t'}(\ln\lambda_{t'}-t'\ln\beta)\right]$.

Following the Proposition 1 in Margiotta and Miller [2000], the value function from the above consumption smoothing problem is

$$-\alpha_0 p_t\exp\left(-\frac{q_t+\gamma\lambda_t e_t}{p_t}\right).$$

In the second step, the intertemporal consumption problem maximizes the two-

period expected utility

$$-\alpha_j \beta^t \exp\left(-\gamma c_t\right) - \alpha_0 E_t \left[p_{t+1} \exp\left(- \frac{q_{t+1} + \gamma \lambda_{t+1} e_{t+1} + \gamma \lambda_{t+1} w_{r_{t+1}(s)t+1}}{p_{t+1}} \right) \right]$$

subject to

$$\lambda_t c_t + E_t \left[\lambda_{t+1} e_{t+1} \right] \leq \lambda_t e_t$$

Lemma A1 in Gayle and Miller [2015] derives the indirect utility of the proceeding two-period problem, which is formally stated in Lemma 1 with a simplified notion of bond price $b_t \equiv p_t / \lambda_t$.

Lemma 1 *If the CEO, offered a contract of $w_{rt}(x)$ for announcing r, retires in period t or $t+1$ by setting $(1 - l_{t0})(1 - l_{t+1,0}) = 0$, upon observing the state s and reporting $r_t(s)$, he optimally chooses $l_{st} \equiv (l_{t0}, l_{st1}, l_{st2})$ to minimize*

$$\sum_{s=1}^{2} \varphi_s \left\{ l_{t0} + \left(\alpha_1 l_{st1} + \alpha_2 l_{st2} \right)^{1/(b_t - 1)} E_s \left[\exp\left(- \frac{\gamma w_{r_t(s)t}(x)}{b_{t+1}} \right) \left[g_s(x) l_{st1} + l_{st2} \right] \right] \right\}. \quad (5)$$

Aggregate shocks to the optimal contracting arise (only) through anticipated changes in bond prices, which affects the CEO's decision at his intertemporal optimality. The employment and effort choices do not depend on his current (outside) wealth but rather on the income subject to idiosyncratic risk only.

Feasible contracts In this framework, there are no gains from a long-term arrangement between shareholders and the CEO. Recall that there is no wealth effect on preference, there are complete contingent claims markets, and the output distribution is independent of the CEO's past actions or private information. Consequently, the optimal long-term contract between shareholders and the CEO decentralizes to a sequence of short-term one-period contracts. Following Lemma A2 in Gayle and Miller [2015], Lemma 2 formally state this feature of our model.

Lemma 2 *Denote by $\bar{\varsigma}$ the date the CEO retires. The optimal long-term contract can be implemented by a $\bar{\varsigma}$-period replication of the optimal short-term contract.*

Now we focus on the optimal short-term contract for well-diversified shareholders, which is found by minimizing the expected compensation subject to four constraints

that the CEO prefers (i) to work for a period rather than leave the firm, (ii) to be truthful rather than lie, (iii) to work rather than shirk, and (iv) to be truthful and to work diligently rather than to lie and shirk. Suppressing for expositional convenience, the bond price b_{t+1} and recalling our assumption that b_{t+1} is known at period t, we now let $v_{st}(x)$ measure how (the negative of) utility is scaled up by $w_{st}(x)$:

$$v_{st}(x) \equiv \exp\left(-\gamma w_{st}(x)\,/b_{t+1}\right). \tag{6}$$

First, to induce an honest, diligent CEO to participate, his expected utility from employment must exceed the utility he would obtain from retirement. Setting $(l_{t2}, r_t) = (1, s_t)$ in (5) and substituting in $v_{st}(x)$, the participation constraint is thus

$$\sum\nolimits_{s=1}^{2} \int \varphi_s v_{st}(x) f_s(x) \mathrm{d}x \leq \alpha_2^{-1/(b_t-1)}. \tag{7}$$

Second, given his decision to stay with the firm one more period and to truthfully reveal the state, the incentive-compatibility constraint induces the CEO to prefer working to shirking for $s_t \in \{1, 2\}$. Substituting the definition of $v_{st}(x)$ into (5) and comparing the expected utility obtained from setting $l_{t1} = 1$ with the expected utility obtained from setting $l_{t2} = 1$ for any given state, we obtain the incentive compatibility constraint for work:

$$0 \leq \int \left(g_s(x) - (\alpha_2/\alpha_1)^{1/(b_t-1)}\right) v_{st}(x) f_s(x) \mathrm{d}x. \tag{8}$$

Information hidden from shareholders further restricts the set of contracts that can be implemented. Comparing the expected value from lying about the second state and working diligently with the expected utility from reporting honestly in the second state and working diligently, we obtain the truth-telling constraint:

$$0 \leq \int \left[v_{1t}(x) - v_{2t}(x)\right] f_2(x) \mathrm{d}x. \tag{9}$$

An optimal contract also induces the CEO not to understate and shirk in the second state, behavior we describe as sincere. Comparing the CEO's expected utility from lying and shirking with the utility from reporting honestly and working diligently, the

sincerity condition reduces to

$$0 \leq \int \left[(\alpha_1/\alpha_2)^{\frac{1}{b_t - 1}} \, v_{1t}(x) g_2(x) - v_{2t}(x) \right] f_2(x) \mathrm{d}x, \tag{10}$$

where $(\alpha_1/\alpha_2)^{1/(b_t-1)} \, v_{1t}(x)$ is proportional to the utility obtained from shirking and announcing truthfully in the first state and $f_2(x)g_2(x)$ is the probability density function associated with shirking when the second state occurs. Minimizing expected compensation amounts to choosing $v_{st}(x)$ that maximizes

$$\sum\nolimits_{s=1}^{2} \int \varphi_s \ln \left[v_{st}(x) \right] f_s(x) \mathrm{d}x. \tag{11}$$

Noting $\ln v_{st}$ is concave increasing in v_{st}, the expectation operator preserves concavity, so the objective function is concave in $v_{st}(x)$ for each x. Each constraint is a convex set and their intersection is too. Therefore, we can appeal to the Kuhn-Tucker theorem, which guarantees there is a unique positive solution to the equation system formed from the first-order conditions augmented by the complementary slackness conditions.

Comparing the pure and hybrid model contracts The optimal contract for a parameterization of the hybrid model is plotted in the left panel of Figure 4. This parameterization follows Margiotta and Miller [2000] in assuming that excess returns is drawn from a truncated distribution, with a common lower bound for all states and independent of the effort level.[22] For comparison purposes, the right panel plots the optimal compensation for the analogous two-state pure moral hazard model (where there are hidden actions, but the state is known), denoted by $y_{st}(x)$. Details explaining the solution and computation of $y_{st}(x)$ are provided in supplementary Appendix C.

Figure 4 illustrates four essential features. As compensation in both models is a function of the likelihood ratio between the densities of the excess return for working and shirking, not the excess return itself, the wage contract is not necessarily monotonically increasing in excess returns.

The other two noteworthy features relate to differences between the pure and hybrid contracts. The slope of the hybrid compensation schedule is greater everywhere in the good state than the bad, whereas in the pure moral hazard model the slope in

[22] If the lower bound depends on whether the agent works or shirks, a first-best solution is attained by imposing a sufficiently harsh penalty on the agent when abnormal returns can be achieved only by shirking, and otherwise paying the agent the first-best fixed wage. See Mirrlees [1975].

the bad state is greater than in the good over the the intermediate range where much of the probability mass of both excess return distributions lie. Thus, the point where the schedules cross is higher in the pure moral hazard model than in the hybrid model. Figure 4 also illustrates two analytical results: In the hybrid model, the expected utility of the agent is greater in the good state than the bad but in the pure moral hazard model,expected utilities are equalized across states. Intuitively, the argument is that in the hybrid model, the principal induces the agent to truthfully reveal the good state by promising (i) more expected utility in the good state and(ii) a flatter compensation profile in the bad state.

Finally, because the constraints in the pure moral hazard optimization problem are not a subset of those in the hybrid model, there is no presumption that the expected compensation in the pure moral hazard case is lower than in the hybrid model. In other words, the principal may find it cheaper not to know the private information if he can optimally spread the utility the agent receives across both states rather than meet the participation constraint in each state.[23] Indeed, our parameterization illustrates an instance where the agency cost in the pure moral hazard model is greater than in its hybrid counterpart. The parameterization demonstrates a paradox: To the extent, it succeeds in making financial disclosure more transparent, SOX may have perverse consequences in some sectors.

4 Welfare Measures

The catalyst for SOX was a failure in corporate governance that led to the dismissal of executives and, in some cases, subsequent prosecution for fraud, conviction, and imprisonment. These executives violated legal constraints that were subject to auditing. SOX was not confined to, or even primarily directed towards, realigning the incentives of law-abiding managers. After its enactment, bringing greater accountability to financial statements, enforcing property rights in governance more rigorously, and increasing the penalties for fraud, might have reduced white-collar crime. Implementing SOX changed firm value because of its effects on the willingness of managers to

[23]These are assumptions guaranteeing expected compensation in the hybrid model is more expensive than in the pure moral hazard model. For example, if the two distributions for the good state are simply a shift of the distributions in the bad state by a constant amount to the right, the optimal contract in the pure moral hazard model depends only on the state through the translation parameter and is, therefore, cheaper than the optimal contract of the hybrid model.

break the law, as well as its impact on the twin agency costs of motivating managers to act in the firm's interest instead engage in legal activities they prefer, and to disseminate unverifiable financial information to the board accurately. Our welfare analysis focuses on these agency issues via two groups of measures, which are, in turn, intimately related to CEO compensation.

4.1 Interest Alignment

The ultimate goal of SOX is to restore investors' confidence, which motivates the first group of measures that gauge the interest alignment between a firm's shareholders and their CEO. We estimate the discrepancy of the production output and the discrepancy of the effort cost between two scenarios, that is, when the CEO works (on the equilibrium path) and when the CEO shirks (off the equilibrium path). Taking a shareholders' perspective, the first measure $\rho_{1t} \equiv E_{st}[x - xg_{st}(x)]$ is the loss shareholders would incur from a CEO shirking instead of working. Enhanced monitoring of CEOs' behavior can reduce the room of detrimental activities that a shirking CEO could take.[24] To the extent SOX provided more protection to shareholders from shirking managers, we would predict that $\Delta\rho_{1t} < 0$, where Δ denotes the change from the pre-SOX to the post-SOX era.

The second measure in this group takes the CEOs' perspective. This welfare measure, $\rho_{2t} \equiv b_{t+1}\left[(b_t - 1)\,\gamma\right]^{-1}\ln(\alpha_2/\alpha_1)$, is the difference between a CEO's pecuniary cost of working and that of shirking. Faced up with a higher probability of being detected and more severe punishment, CEOs find shirking less desirable. If the monitoring strengthened and the penalties imposed by SOX diminished the incentives to shirk without imposing administrative burdens on working managers, then $\Delta\rho_{2t} < 0$.

4.2 Compensation Costs

Achieving the goals of SOX may turn to be costly. The other group of measures focuses on various costs embedded in CEO compensation. Figure 3 is a schema for the welfare measures we investigate. Total expected compensation in the pre-SOX era, defined as $\sum_{s=1}^{2}\varphi_{st}E_{st}\left[w_{st}(x)\right]$, can be decomposed into administrative costs in the

[24] Chhaochharia, and Grinstein [2007] conducted an empirical analysis of the effect of SOX on firm value, and found it increased the value of firms that were less compliant with SOX relative to those which more compliant.

pre-SOX era, denoted by τ_{1t}, and agency costs, τ_{2t}. Agency costs are further divided into $\tau_{3t},$, which arises from a pure moral hazard or the costs of hidden actions, and τ_{4t}, the extra cost from hidden information when there is moral hazard. We now explain how each of these measures appears in our model and why SOX might affect their values.

Absent agency considerations, shareholders would pay the CEO in the pre-SOX era a fixed amount τ_{1t}, which we interpret as an administrative wage to work for the firm instead of pursuing an outside option — in other words, the certainty equivalent of being employed as a CEO. These costs are broadly interpreted within our model and include the legal jeopardy executives were exposed to following the legislation's enactment. Formally, $\tau_{1t} \equiv b_{t+1} \left[\left(b_t - 1 \right) \gamma_t \right]^{-1} \ln \alpha_{2t}$, where b_t denotes the bond price in period t. SOX imposed additional responsibilities on executive management that make the job more demanding. For example, Section 302 of SOX holds the principal executive officer(s) and the principal financial officer(s) responsible for establishing and maintaining internal controls. Denoting the change in the administrative wage from the pre-SOX to post-SOX eras, by $\Delta\tau_{1t}$, the increased regulations lead us to speculate that $\Delta\tau_{1t} > 0$. Meanwhile, if the increased independence of the board, along with expertise complementary to the management, may enable a better advisory role of the board, the effort diversion may be mitigated to some extent.

The difference between expected total compensation and the administrative wage a CEO would receive, τ_2 in the pre-SOX era, is the risk premium of accepting employment that pays uncertain compensation rather than a fixed wage, which shareholders pay because of agency problems, and as such represents the amount shareholders are willing to pay for perfect monitoring. We define $\tau_{2t} \equiv \sum_{s=1}^{2} \varphi_{st} E_{st} \left[w_{st}(x) \right] - \tau_{1t}$. The SOX provisions induced the firm to be more transparent about its future profitability. For example, Section 302 requires the principal an executive officer(s) and the principal financial officer(s) to certify in each annual or quarterly report filed or submitted that the financial statements and other financial information fairly present financial conditions and results and refrain from making misleading statements. Using legal machinery to enforce the truthful revelation of financial conditions may remove or ease the burden of the compensation committee in designing incentives that resolve the agency issues. For these reasons we might expect $\Delta\tau_{2t} < 0$. If the monitoring obligation can be enhanced through increasing independence of the board and committees, we would expect the agency costs are further decreased in the noncompliant

firms.

This component of agency costs is solely attributable to pure moral hazard — or the amount shareholders would pay to eliminate hidden action in the absence of private information — is the difference between the expected compensation in the pure moral hazard case, which for the pre-SOX era we denote by $y_{st}(x)$, and the certainty equivalent of being employed as a CEO. Thus, $\tau_{3t} \equiv \sum_{s=1}^{2} \varphi_{st} E_{st}\left[y_{st}(x)\right] - \tau_{1t}$. Because SOX increased the penalties associated with fraudulent financial reporting, we might predict that the benefits from shirking relative to working declined, and hence $\Delta\tau_{3t} < 0$. However, many of the SOX mandated requirements apply whether CEOs pursue their objectives subject to their legal obligations or receive compensation that induces them to work in the interests of shareholders, and consequently would not affect the difference in utility from shirking versus working.

This component of the agency costs is solely attributable to private information — or the amount shareholders would pay to eliminate private information — is the difference between the expected compensation under the current optimal contract and expected compensation in the pure moral hazard case, which for the pre-SOX era we denote by $y_{st}(x)$. Thus, $\tau_{4t} \equiv \sum_{s=1}^{2} \varphi_{st} E_{st}\left[w_{st}(x) - y_{st}(x)\right]$. By construction $\tau_{4t} \equiv \tau_{2t} - \tau_{3t}$. If shareholders could observe the CEO's effort, then a first-best constant-wage the contract would be paid regardless of whether the CEO had private information or not (Gayle and Miller [2009b]). Therefore, the only reason hidden information might be costly, meaning $\tau_{4t} > 0$, is that it exacerbates rather than ameliorates the pure moral hazard model, which we show is an empirical question as the theory does not give a decisive answer. One purpose of SOX was to enhance auditors' independence and boards conducting monitoring functions, making shareholders more informed, presumably to reduce the role of hidden information. For example, Section 304 of SOX requires the CEO and CFO to reimburse the firm for any compensation received during the 12 months following equity issue filing if there was misconduct in filling a financial statement for that equity issue. This regulation makes CEO compensation less liquid and can mitigate the CEO's incentives to take opportunistic advantage by misrepresenting financial states and enforcing the truthful revelation of financial condition. Consequently, we might expect $\Delta\tau_{4t} < 0$.

5 Identification and Estimation

The parameters defining the model are characterized by $f_{st}(x)$ and $g_{st}(x)$ for $s_t \in \{1, 2\}$, which together define the probability density functions for excess return in each state, and φ_{st}, the probability of each state occurring. CEO preferences are defined, relative to the normalized utility from taking the outside option, by their distaste for working, α_{2t}, and shirking, α_{1t}, as well as their risk aversion parameter, γ_t. In equilibrium, CEOs truthfully reveal the state, implying $s_t = r_t(s)$, so $r_t = s_t$ is observed in the data. Hence, the reported state is sampled from a Bernoulli distribution with parameter φ_{st}, and the data on returns are generated by $f_{st}(x)$, implying those parameters are identified, the latter non-parametrically, along with $h_t(x)$. Aside from observing returns from working, we assume that compensation, $w_{st}(x)$, is also observed for different values of (x, s). This leaves only $g_{st}(x)$ plus $(\alpha_{1t}, \alpha_{2t}, \gamma_t)$ to identify from the first-order conditions, the complementary slackness conditions, plus a constraint that working is an optimal choice, from observations on (x_{nt}, s_{nt}, w_{nt}) generated from the CEO working.[25] This section explains the intuition supporting identification and estimation; the supporting technical details are relegated to Supplementary Appendix D.

We motivate the identification of this model by comparing the equilibrium compensation schedule and the excess return density is shown in Figure 4 with the sample estimates displayed Figure 2. Both the theoretical and the empirically estimated compensation schedules vary with excess returns, for the most part, increasing and flatten at very high rates of excess returns. These features illustrate the agency problem. Moreover, in the estimated schedules for both states and in the hybrid model, but not in the model of pure moral hazard, the schedules for the good state are everywhere steeper than for the bad state and also cross at negative excess returns. This suggests that hidden information, not just hidden actions, may be a part of the agency problem. Following Gayle and Miller [2015], we can separate the analysis of identification into two pieces: given $f_{st}(x)$, representing $g_{st}(x)$ and $(\alpha_{1t}, \alpha_{2t})$ as mappings of γ_t, and identifying the observationally equivalent values of γ_t. Estimation proceeds by forming a sample analog of the identified sets.

[25] Although $(\widetilde{w}, x, r)$ rather than (w, x, r) is observed, there is no loss in generality from assuming (w, x, r) is observed because $w_r(x) = E[\widetilde{w}|X = x, R = r]$.

5.1 Mapping risk preferences into the remaining parameters

The mappings from the risk aversion to the remaining parameters follow directly from the first-order condition of the compensation contract, the participation and incentive compatibility constraints (both of which are binding), and the regularity conditions for $g_{st}(x)$ and $h_t(x)$ that for every period t:

$$\begin{aligned}
\alpha_{2t} &= E\left[v_{st}(x,\gamma_t)\right]^{1-b_t} \\
\alpha_{1t} &= \alpha_{2t}\left\{\overline{v}_{2t}\left(\gamma_t\right)^{-1} - E_{2t}\left[v_{2t}(x,\gamma_t)^{\ -1}\right]\right\}^{b_t-1}\left\{\overline{v}_{2t}\left(\gamma_t\right)^{-1} - E_{2t}\left[v_{2t}(x,\gamma_t)\right]^{-1}\right\}^{1-b_t} \\
g_{2t}(x) &= \frac{\overline{v}_{2t}\left(\gamma_t\right)^{-1} - v_{2t}(x,\gamma_t)^{-1}}{\overline{v}_{2t}\left(\gamma_t\right)^{-1} - E_{2t}\left[v_{2t}(x,\gamma_t)^{-1}\right]} \\
g_{1t}(x) &= \frac{\left(\frac{\alpha_{2t}}{\alpha_{1t}}\right)^{1-b_t}\left\{\overline{v}_{1t}\left(\gamma_t\right)^{-1} - v_{1t}(x,\gamma_t)^{-1} + \eta_{3t}\left[\overline{h}_t - h_t(x)\right]\right\} - \eta_{4t}g_{2t}(x)h_t(x)}{\overline{v}_{1t}\left(\gamma_t\right)^{-1} - E_t\left[v_{st}(x,\gamma_t)\right]^{-1} + \eta_{3t}\overline{h}_t},
\end{aligned} \tag{12}$$

where $\overline{v}_{st}(\gamma_t) \equiv \lim v_{st}(x,\gamma_t)$ as $x \to \infty$ and the Kuhn-Tucker multipliers η_{4t} and η_{3t} have the following representation[26]:

$$\begin{aligned}
\eta_{4t} &= \frac{\frac{E_{1t}[v_{1t}(x,\gamma_t)]}{E_t[v_{st}(x,\gamma_t)]} - E_{1t}\left[v_{1t}(x,\gamma_t)h_t(x)\right]\left\{E_{2t}\left[v_{2t}(x,\gamma_t)\right]^{-1} - E_t\left[v_{st}(x,\gamma_t)\right]^{-1}\right\} - 1}{\left(\frac{\alpha_{2t}}{\alpha_{1t}}\right)^{1-b_t} E_{1t}\left[v_{1t}(x,\gamma_t)g_{2t}(x)h_t(x)\right] - E_{1t}\left[v_{1t}(x,\gamma_t)h_t(x)\right]} \\
\eta_{3t} &= E_{2t}\left[v_{2t}(x,\gamma_t)\right]^{-1} - \eta_{4t} - E_t\left[v_{st}(x,\gamma_t)\right]^{-1}.
\end{aligned} \tag{13}$$

Combining the nonparametric estimates of the density of excess return and relationship between excess return and compensation presented in Figure 2 with the formulas for the structural parameters in equation(12), one can glean the sources of variation in the data that identify the other structural parameters given a known γ_t. The first three equations entirely apply to a pure moral hazard model in which the good state occurs with probability 1. First, α_{2t} is identified from the ex-ante expected discounted utility derived from the compensation schedule.[27] The identification of α_{1t}/α_{2t}, and hence α_{1t}, comes from the concavity of the compensation schedule relative to the maximum compensation in the good state. The likelihood ratio in the (verifiable) good state, $g_{2t}(\cdot)$, is identified from the slope of the compen-

[26] η_{3t} corresponds to the truth-telling constraint and η_{4t} corresponds to the sincerity constraint.

[27] This expectation is taken before the realization of the hidden information states to the manager.

sation schedule in the good state. The last equation identifies $g_{1t}(\cdot)$ given all the other parameters in the model. As with $g_{2t}(x)$, it also depends on the slope of the compensation schedule in the same state (unverifiable in this case), but $g_{1t}(x)$ also depends on the slope of the compensation schedule in the other state, as well as $h_t(x)$, the likelihood ratio of either state given x.

5.2 Set identification

Our model fully accounts for aggregate fluctuations through the volatility of bond prices, which in turn provides a source of identifying information about the risk-aversion parameter. To demonstrate this point, suppose that $b_t \neq b_{t'}$ for periods t and t', but that both periods fall within the same regime (pre-SOX or post-SOX), implying from our exclusion restrictions that $(\gamma_t, \alpha_{2t}) = (\gamma_{t'}, \alpha_{2t'})$. Differencing out α_{2t} in the first equation in (12) and taking logarithms we obtain $(1 - b_t) \log \{E[v_{st}(x, \gamma_t)]\} = (1 - b_{t'}) \log \{E[v_{st}(x, \gamma_t)]\}$. Given data on compensation, the firm's state, and excess returns, the solution(s) to γ_t yield a set of identifying restrictions. Because this equation is nonlinear in γ_t, there is no guarantee it has a unique solution, thereby ruling out a strict application of, but not the intuitive connection with, a difference-in-differences estimator.

There are also cross-sectional restrictions, in the form of equalities and inequalities implied by the model, that can be used to obtain bounds for admissible values of γ_t. At least one of the truth-telling constraints, and the sincerity constraint bind. The three other Kuhn-Tucker multipliers are non-negative. Similarly, the complementary slackness conditions for the truth-telling and sincerity constraints yield two more equalities. We impose an exclusion restriction that α_{1t} does not depend on the private states. The likelihood for the bad state, $g_{1t}(\cdot)$, is positive with unit mass.[28] Value maximization implies another three inequalities reflecting that shareholders prefer the CEO working in both private states rather than shirking in either or both of them. Finally, we restrict that the risk aversion does not depend on bond price. Formally, Gayle and Miller [2015] obtained sharp and tight bounds for the set of observational equivalent risk aversion parameters, and we can adapt their methods and results in our framework. Accordingly, let $\Gamma_t \equiv \{\gamma_t : Q_t(\gamma) = 0\}$ denote the Borel set of permissible values of γ_t for data generated in period t, where $Q_t(\gamma_t)$ is a quadratic form of the

[28] One can show that $g_{2t}(\cdot)$ is positive without imposing any restrictions on γ_t. See Gayle and Miller [2015].

minus norm of equalities and inequalities implied by the model.[29] Thus, Γ_t denotes all the values of γ that are observationally equivalent given the probability distributions generating the data at the period t. Imposing additional restrictions that arise from multiple periods is straightforward. For example, if γ is time-invariant across the first two periods, labeled 1 and 2, then the set of admissible risk aversion parameters is the intersection $\Gamma_1 \bigcap \Gamma_2$. We denote by Γ the identified set that arises from imposing all the relevant restrictions for the different periods, and it is quadratic form by $Q(\gamma)$.

As γ is not identified pointwise but only up to the set Γ, it follows that the other taste parameters, the likelihood ratios, and the measures of agency cost are also only set identified. For example, we can write $\alpha_{1t}(\gamma)$ as the value of α_1 identified from data generated at t by the hybrid model when the agent's risk aversion parameter is γ. Thus, α_1 is identified up to the set $\{\alpha_{1t}(\gamma) : \gamma \in \Gamma\}$. Further restrictions obtained from the panel are imposed so that admissible values of γ are restricted.

5.3 Estimation

We estimated a confidence region for Γ by exploiting the fact that approximations to $Q(\gamma)$ formed from the data deviate from 0 only because of differences between expectations (or, in some equations, population limits) and their sample analogs. Accordingly, let $Q^{(NT)}(\gamma)$ denote a sample analog to $Q(\gamma)$ and define $\Gamma^{(NT)} \equiv \left\{\gamma : Q^{(NT)}(\gamma) \leq c_{0.95}\right\}$, where $c_{0.95}$ is the critical value, below which $Q^{(NT)}(\gamma)$ falls 95 percent of the time under the null hypothesis that $\gamma \in \Gamma$.

To implement the subsampling procedure, we draw 100 subsamples from the original full sample, following the public states' joint distribution and the private states. Each subsample contains 80% of the observations in the original sample. For each subsample, we calculate the value of the objective function and use these values to estimate the 95% critical value of the confidence region.

Once $\Gamma^{(NT)}$ has been numerically determined (by subsampling in our application), we can deduce that the estimated confidence region for $\{\alpha_{1t}(\gamma) : \gamma \in \Gamma\}$, for example, is $\left\{\alpha_{1t}(\gamma) : \gamma \in \Gamma^{(NT)}\right\}$. Estimated confidence regions for the other primitive parameters and the welfare measures are derived by following the same procedure.

[29] The minus norm of q, denoted $\|q\|_-$, is the norm of the maximum of $-q$ and 0, that is, $\|q\|_- = \|\max(-q, 0)\|$.

5.4 Three approaches to isolate the SOX effect

We make three efforts to isolate the SOX effect. First, we test the null hypothesis that the risk parameter was constant across SOX. To do so, we look for a common region of the two 95 percent confidence regions of the risk aversion parameter for the pre-SOX and post-SOX periods. Values within this common region can rationalize our model in both periods, indicating no need to appeal to a risk preference shift to explain CEO compensation's observed changes after SOX. Thus, we focus on the changes of other primitives in the model to examine the SOX effect, including the effort disutility parameters (α_{1t}, α_{2t}) and the likelihood functions ($g_{1t}(x)$, $g_{2t}(x)$).

Second, the bond price that shows up in the CEOs' utility function allows the contingent claim price plays a role in the contracting decisions. Also, this is the only channel for the aggregate shock to affect the decisions in this framework. Therefore, we anchor our estimation on the same values of the bond price in the pre-SOX and post-SOX period. To be specific, we run nonparametric regression of the CEO compensation on the same bond price value (and other covariates) in both periods and use this fitted value of compensation to estimate the primitive parameters. Doing so effectively controls for the time-specific effect of aggregate variation.

Lastly, we follow the literature to choose a control group and a treatment group for robustness tests. Previous studies use compliant firms with the SOX provisions of board structure[30] before SOX as the control group in the difference-in-differences design to examine the impact of corporate governance on firm behaviors[31]. We define the noncompliant firms as those who missed at least one of the following criteria before SOX: (1) a majority independent board, (2) an entirely independent audit committee, and (3) an altogether independent compensation committee. The rest of our sample of S&P 1500 firms are denoted as compliant firms. If SOX affects the primitives in the contracting environment of CEO compensation mainly through changing board structure as regulators intend to, the noncompliant firms are expected to experience more favorable changes in our measures after SOX than the compliant firms. Though

[30]The major relevant provisions mandated by SOX and the exchanges include: (1) the board must have a majority of independent directors; (2) the compensation and the nominating/governance committees must consist entirely of independent directors; (3) the audit committee must consist entirely of independent directors and one member must be an "audit committee financial expert."

[31]These studies have examined CEO compensation (Chhaochharia and Grinstein [2009], Cohen et al. [2013], Guthrie et al. [2012]), investment (Cohen et al. [2013], Banerjee et al. [2015], Lu and Wang[2015]), firm performance (Duchin et al. [2010]), and Bargerson et al. [2010]), and earnings management (Chen et al. [2015] and Joo and Chamberlain [2017]).

we have to restrict to a subset of SOX provisions and may underestimate the SOX effect, doing so can, to a large extent, control for the impacts of contemporary events.

6 Empirical Findings

Here we report estimates obtained by omitting the two years bordering on the SOX legislation, namely, 1993 through 2001 (16,894 observations) and 2004 through 2005 (3,781 observations). The estimation is also conditional on the firm type (defined by sector, assets, and capital structure) to account for heterogeneity. As a robustness check, the supplementary Appendix reports estimates for the extended sample covering 1993 through 2002 for the pre-SOX era (containing 18,855 observations) and 2003 through 2005 for the post-SOX era (5,670 observations). The differences are minor, suggesting that a precise determination of the two regimes' cutoff dates is empirically unimportant.

We did not reject the null hypothesis that φ_{st}, $f_{st}(x)$, α_{1t}, α_{2t}, and γ_t are time-invariant within each era. Thus, bond prices and the stock market index (which differences out in our model) are sufficient to capture all aggregate variation within each era. To achieve comparability between the two eras, we estimated the confidence regions of welfare measures for each of the two bond prices that occurred in both eras, 16.4 and 16.8. Estimating the confidence intervals for the overlapping bond prices permits us to attribute all changes in social welfare costs to the changes in primitives rather than aggregate factors in the macroeconomy. The differences between the two sets of estimates are negligible; therefore, we report only those for 16.4.

6.1 Risk preferences

The procedure used to obtain a confidence region for changes in the welfare measures depend somewhat on whether the risk aversion parameter γ changes between the pre- and post-SOX eras. If the null hypothesis — that the risk parameter was constant over this period — is maintained, then it is straightforward to compute confidence regions for $\Delta\tau_{it}$ for $i \in \{1, \ldots, 4\}$ by substituting those values of $\gamma_t \in \Gamma^{(NT)}$ into the formulas for $\Delta\tau_{it}$ (that come from evaluating τ_{it} in the pre- and post-SOX eras). On the other hand, if the null hypothesis is rejected, the confidence region computed for $\Delta\tau_{it}$ is based on admissible values of two parameters γ_{pre} and γ_{post}, not just one,

and an additional component in the decomposition is introduced, which measures the contribution of the change in risk attitude to $\Delta\tau_{it}$.

For these reasons, we first tested whether the null hypothesis — that risk aversion did not change — is rejected; only then did we construct the appropriate confidence regions for the welfare measures. The test is of independent interest. One concern raised by directors (Cohen, Dey, and Lys [2013]) and bankers such as Alan Greenspan and William Donaldson (former SEC chairman) is that CEOs would overreact to SOX provisions and exercise undue caution in investment decisions, thus destroying shareholder value (see Coats and Srinivasan [2014]).

The 95 percent confidence region of the risk aversion parameter for the (main) sample is common to both periods (0.0695, 0.6158); every observationally equivalent risk aversion parameter for one regime appears in the other's confidence region.[32] Therefore, we do not reject the null hypothesis that no significant change in risk attitude occurred after SOX.[33]

To give economic meaning to our estimates of risk aversion, we also computed the amount a CEO would pay to avoid an equiprobable gamble with losing or winning \$1,000,000. At the right boundary of the confidence region for the main sample in the pre-SOX period, the risk aversion parameter is 0.6158. The CEO would pay \$290,206 to avoid the gamble, but at the left boundary of 0.0695 would pay only \$34,722.[34] We conclude that changes to the distribution of excess returns and its mapping to CEO compensation documented in Section 2 did not arise because the implementing SOX legislation induced CEOs to think differently about risk. Other factors in our model caused the changes. We now investigate these other factors under the maintained hypothesis that the risk aversion parameter was constant over the entire sample period.

[32]The confidence region for the full sample of the post-SOX period covers a broader range (0.0616, 0.2335) than that of the pre-SOX period (0.0784, 0.2335), and the confidence region for risk aversion parameters for both periods in the full sample is a proper subset of the corresponding region in the restricted sample. Thus, adding the restrictions for the years 2002 and 2003 to the sample yields more precise results. See Table D2 in supplementary Appendix D for a more detailed report of these findings.

[33]These findings contrast with those of Nekipelov [2010], who finds the risk aversion of top executives in the retail apparel industry significantly increased after SOX was introduced. Three notable differences between his work and ours are that Nekipelov assumes the contract is linear, approximate compensation by salary and bonus, and, of course, estimates from a different sample population.

[34]These estimates are in line with previously published work. See Gayle and Miller [2009a, 2009b, 2015] and Gayle, Golan, and Miller [2015].

6.2 Interest alignment

Gross loss to shareholders from CEO shirking (ρ_1) The agency problem sources arise from conflicting interests between the shareholders (who want the CEO to work to maximize their returns) and the CEO (who prefers to shirk). The expected gross loss to shareholders that would occur from the CEO shirking instead of working, denoted by ρ_{1t}, is reported as a percentage of market value in Table 2. Similar to estimates found in previous studies, they range from 5.0 to 20.2 percent per year.[35] As Table A1 shows, the variation explained by the firm category far outweighs the indeterminacy from observational equivalence that arises from a set, rather than point, identification. In particular, large firms tend to lose proportionately less than small firms from a shirking CEO. Given size and leverage, shareholders owning firms in the service sector have the most to lose when management objectives do not align with their own.

The striking result in Panel A of Table 2 is that $\triangle\rho_{1t} < 0$ occurs in 11 of the 12 categories, suggesting that implementing SOX reduced the gross loss shareholders would bear when managers shirked. Our subsample estimation in Panel B further supports this finding by presenting an equalizing effect. Compared with the compliant firms, the noncompliant firms not only faced a more severe conflict of interests before SOX (larger ρ_1) but also experienced a more significant decrease of the conflict of interest discrepancy after SOX (negative intervals in the "NC vs. C" column) in five out of six firm categories. Overall, SOX's effect as to limit the expected loss a CEO would impose on his firm by not pursuing a goal of expected value maximization.

Benefit to CEO from shirking (ρ_2) The other measure of the conflicting interests between the shareholders and the CEO is the compensating differential the CEO is paid to work rather than shirk, denoted by ρ_{2t}. Table 3 shows that our estimates are a tiny fraction of the losses shareholders would incur with shirking, ranging between \$1.1 million and \$10.8 million annually. The main finding in Panel A of Table 3 is that when SOX was introduced, the differential mostly declined in the firm categories where it was relatively high. This equalizing effect is further confirmed in the subsample results reported in Panel B of Table 3. Compared with the compliant firms in the primary and consumer goods sectors, the noncompliant firms had larger ρ_2 before

[35] A variety of different models and different estimators corroborate these estimates; see Margiotta and Miller [2000], Gayle and Miller [2009a, 2009b, 2015], and Gayle, Golan, and Miller [2015].

SOX. They experienced a favorable impact in either a more significant decline or a smaller increase in the conflict of interest discrepancy. To some extent, greater management regulation imposed by SOX, including the attendant legal responsibilities, enforcement, and penalties, channeled the type of shirking that occurs if CEOs lack proper incentives.

6.3 Costs in CEO compensation

Administrative costs (τ_1) Administrative costs, denoted by τ_{1t}, are the premium that a CEO would be paid over the inclusive annuitized value of his outside option if there were no agency problems. Panel A of Table 4 shows that these costs vary significantly by sector and firm type. For example, in the pre-SOX regime, the 95 percent confidence region for the administrative cost of (S, L) firms in the primary sector is covered by the interval ranging from \$0.9 to \$1.0 million. In (L, S) companies in the service sector, the corresponding region is covered by the interval ranging from $7.9to$ 11.0 million. Every firm category within the primary sector experienced increased administrative costs of between \$2.3 and \$4.6 million and every category within the service sector experienced declines between \$0.5 and \$4.1 million. These results broadly reflect our findings in Table A1, which shows that mean CEO compensation significantly increased in every subcategory within the primary sector following the passage of SOX, but did not increase substantially in any subcategory of the service sector.

The subsample estimates in Panel B of Table 4 provide a few new findings. First, in five out of the six-firm categories, the sign of the interval in the "NC vs. C" column is the same as that of the noncompliant firms (column (4)), suggesting that the noncompliant firms that are subject to more provisions of SOX indeed bear a more substantial impact and dominate the trend found in the compliant firms. This finding lends further support on attributing the change of the administrative costs to SOX.

Also, we find a strong favorable impact of SOX only in the consumer goods sector, in the sense that the administrative costs decrease in the noncompliant firms. At the same time, they increase in compliant firms. The change of board structure does not seem to offset the consequence of effort diversion, except for the consumer goods sector. Overall, the findings do not support that SOX broadly helps firms reduce

administrative costs. If any, it depends on the regulations in place before SOX was enacted. In the other two sectors, both the compliant firms and the noncompliant firms move in the same direction as the full sample result shows, except for the large firms in the service sector.

The increase in the primary sector and consumer goods sector is consistent with the widely held concern that internal control compliance requirement brings in extra burden to the management and divert managerial attention to nonproductive activities.

Agency costs (τ_2) Agency costs, τ_{2t}, measure the gross costs that shareholders would Be willing to pay for perfect monitoring and thus avoid the penalties induced By the incentive compatibility and truth-telling constraints. Table 5 reports the 95 percent confidence region for the observational equivalent values of τ_{2t} in the pre-SOX period and its change $\triangle\tau_{2t}$. In the full sample, as reported in Panel A, the agency costs are small in some firm categories, as low as \$22,000 per year in (S, L) firms within the primary sector, but the service sector, these costs are much greater: between \$105,000 and \$3.425 million. SOX increased agency costs in 10 of 12 firm categories. For the most part, The absolute values of the changes are small to moderate, exceeding 1 million dollars only in the (L, S) consumer goods category. However, as a proportion of the levels, they are quite substantial; the estimated upper bound on $\triangle\tau_{2t}$ is at least as large as the lower bound of τ_{2t} in several categories.

Panel B of Table 5 confirms the prevalent increase found in the full sample by showing that both the compliant firms and the noncompliant firms broadly experience an increase in aggregate agency costs. Even though the "NC vs. C" column shows favorable consequences (negative regions) in the primary and consumer goods sector, a close look reveals that a strong favorable impact exists only in small firms, among which the aggregate agency costs decrease in the noncompliant firms and increases in compliant firms. In large firms, both types of firms in fact experienced an increase.

Cost of hidden actions (τ_3) Shareholders' costs due to hidden actions, denoted by τ_{3t}, are the difference between the expected compensation that would have been paid if there were only a pure moral hazard problem and the certainty equivalent wage if CEOs could be perfectly monitored. Table 6 reports the estimated 95 percent confidence region for τ_{3t} in the pre-SOX era and the change it heralded, $\triangle\tau_{3t}$. The

estimated bounds of the confidence intervals for the pre-SOX era range between $6,000 and $9.0 million depending on the firm type, markedly lower in the primary sector than the other two. The effects of SOX on the estimated cost of hidden actions vary by sector and firm type; all the increases occur within the primary sector.

Cost of hidden information (τ_4) Recall that the costs of hidden information, τ_{4t}, are the difference between the expected compensation and what they would have been with hidden actions but not hidden information about the firm's state. Table 7 displays a property foreshadowed in Figure 2. With a single exception, hidden information ameliorates pure moral hazard. In these cases, adding truth-telling and sincerity constraints to the principal's optimization problem is less costly than adding the extra participation constraint that would arise in a pure moral hazard model. The net benefits range from -$29,000 in (L, L) firms in the primary sector to $6.7 million in (L, L) firms in the service sector. In the consumer goods sector, there is evidence that $\triangle\tau_{4t} > 0$: The welfare costs of hidden information increased after SOX was introduced. Overall, the null hypothesis of no change is not rejected in half of the firm categories. Therefore, if anything, the clawback provision in Section 304 of the SOX made the hidden information problem more severe.

Noticeably, the compliant firms and noncompliant firms have opposite trends between the moral hazard costs and the hidden information costs. That is, in the post-SOX period, compared with compliant firms, noncompliant firms present a larger increase in the moral hazard costs and a larger decline in the hidden information costs. This distinction between the compliant firms and noncompliant firms further supports that SOX indeed influences the firms differently (though maybe not always as intended), which help validate the "NC vs. C" research design and identify some unintended consequences. Furthermore, the opposite pattern between compliant firms and noncompliant firms provide a new insight behind the no-change results are found often in the full sample.

6.4 Overview

Analyzing the six measures together generates the main messages of our findings. In Panel A of Table 8, each measure has four rows in each firm category. The top two rows, namely "Compliant" and "Non-compliant", label the results in Panel B of Table 2 to Table 7 with "increase" (positive region in the "Post-Pre" column) or "decrease"

(negative region in the "Post-Pre" column). Comparing between the compliant firms and noncompliant firms, we classify the relative impact into a favorable category and an unfavorable category, each with three levels in the third row "NC relative to C". A favorable (unfavorable) impact corresponds to a negative (positive) region in the "NC vs. C" column of the original Table 2 to Table 7. A region covering zero means indifference between the two types of firms.

Panel B defines the ranks of the SOX impact reported in the fourth row in Panel A. In the favorable category, if the measure decreases in the noncompliant firms and increases in the compliant firms, meaning that an unfortunate trend is reversed in the noncompliant firms, we label the SOX impact as "F-Strong". If the measure decreases in both the compliant and noncompliant firms, meaning that the noncompliant firms improve on the margin, we label the SOX impact as "F-Moderate". If the measure increases in both the compliant firms and noncompliant firms, meaning that an unfavorable the trend is alleviated only to some limited extent in the noncompliant firms, we label the SOX impact as "F-Mild". Following In the same sense, in the unfavorable category, if the measure increases in the noncompliant firms but decreases in the compliant firms, the adverse consequence only happens to the noncompliant firms. We label the SOX impact as "UF-Strong". Suppose the measure increases in both the compliant and noncompliant firms, meaning that the noncompliant firms experience a common unfavorable trend with a more substantial impact. In that case, we label the SOX impact as "UF-Moderate". If the measure decreases in both the compliant firms and noncompliant firms, meaning that a favorable trend is eliminated to some extent in the noncompliant firms, we label the SOX impact as "UF-Mild".

As reported in Panel C of Table 8, the frequency of Each type of SOX impact reveals three main messages. First, the betterment Of interest, alignment is more prevalent than the reduction in the costs embedded in the CEO compensation. Out of the total twelve "NC vs. C" comparisons, ρ_1 and ρ_2 fall in the F-Moderate/Strong category for eight times and into the UF-Moderate/Strong category only once (ρ_2 in the small firms in the service sector). By contrast, the two cost measures (τ_1 and τ_2)[36], fall in the F-Moderate/Strong category for five times and in the UF-Moderate/Strong category four times. Such a sharp contrast suggests that regulators seem to prioritize restricting the self-interest activities of CEOs to restore investors' confidence, as revealed by the two measures based on the CEOs' production output (ρ_1) and CEOs'

[36]Note That τ_3 and τ_4 are components of τ_2

effort input (ρ_2). Such improvement comes at various costs that are embedded in CEO compensation to provide appropriate incentives. Both the noncompliant firms and compliant firms broadly experience an increase in these costs. Overall, reducing those costs does not appear to be the primary goal from the regulators' perspective, at least when the board structure rules were issued.

Second, across the three sectors, we find that the moderate/strong favorable impact appears more often in the consumer goods sector than in the other two sectors. Each sector makes eight C-NC comparisons (two firm sizes by four measures including ρ_1, ρ_2, τ_1, and τ_2). The primary sector presents four F-Moderate/Strong cases and one UF-Moderate/Strong case. This ratio is seven over zero in the consumer goods sector and two over four in the service sector. More regulated industries are included in the primary sector (for example, energy, and utilities) and the service sector (for example, health care, financial services, and telecommunication). Our finding is consistent with proceeding concerns that regulated industries who had been subject to mandatory guidance on business practice before SOX may have to follow the SOX requirements with extra burdens.

Third, responding to the "one-size-fits-all" criticism, we find no systematic pattern between small firms and large firms. Our results do not support the one-size-fits-all concern as a significant issue for SOX. The caveat is that our sample covers relatively large firms. The small firms in our sample are above the threshold of SOX compliance and much larger than those going dark or going private.

7 Conclusion

SOX was a legislative response by the U.S. government to corporate governance failures at many prominent companies. This article describes an empirical analysis of its effects on CEO compensation using panel data constructed for the S&P 1500 firms. Our structural empirical investigation is motivated by the empirical facts that after SOX was enacted, there were significant changes in (i) the relation between a firm's excess returns and CEO compensation and (ii) the underlying distribution of excess returns.

We follow Gayle and Miller [2015] to construct a dynamic principal-agent. The model explains the implications of proceeding findings for the interest alignment between shareholders and CEOs and the compensation costs. Each period a CEO

has private information about his firm and takes hidden actions, neither of which is observed by the shareholders. Accounting disclosures are treated as unverifiable discretionary messages sent by the agent to the principal about the firm's state at the beginning of the period. The optimal contract motivates the CEO to make productive efforts that maximize shareholders' interests and truthfully disclose the firm perspective through financial reports.

We identify and estimate the model using data on compensation, stock returns, and accounting disclosure, controlling for different firm categories and aggregate conditions. The risk aversion parameter of the agent in our model is set identified, and the remaining parameters of the model are identified up to the value of the risk aversion parameter for each of the firm categories.

In summary, four main conclusions emerge from estimating the structural model. First, variation in our data can be accounted for without resorting to an explanation based on changing tastes. We do not find evidence that the preference for risk-taking by CEOs changed with SOX, contradicting concerns raised by directors (Cohen, Dey, and Lys [2013]) and politicians such as Alan Greenspan and William Donaldson (former SEC chairman) that CEOs would overreact to provisions in SOX provisions and exercise undue caution in investment decisions, thus destroying shareholder value (see Coats and Srinivasan [2014]).

Second, SOX improved the interest alignment between shareholders and CEOs. We find that implementing SOX reduced the gross loss shareholders would bear if managers shirked in 10 of the 12 firm categories and that the noncompliant firms not only faced more severe conflicts of interests (larger loss) before SOX but also experienced a strong/moderate favorable impact after SOX in five out of the six firm categories. Again, the compensating differential that the CEO is paid to work rather than shirk decreased after SOX in half of the company types. Noncompliant firms had a larger compensating differential before SOX and exhibited a favorable impact in four out of the six firm categories.

Third, SOX, to a limited extent, reduced the costs embedded in CEO compensation. We find the administrative costs were reduced in only one of the three sectors. Our finding echoes practitioners' concern on the effort diversion of certain SOX provisions[37]. More astonishingly, we find that SOX increased agency costs within most

[37]As a senior officer of the U.S. Chamber of Commerce, Michael Ryan expressed concerns that "The time and energy required by SOX can be a distraction.", since "The amount of time management is

categories of all three sectors. Overall, our findings evidence that legislators were primarily concerned with the potential for large losses rather than their expected value, which considers the probability of their occurrence.

Fourth, we find moderate/substantial favorable impacts of SOX more often in the consumer goods sector than in the other two industries that include more regulated sectors, suggesting that the regulation existing in place may play an important role in predicting the consequences of any new intervention. Besides, we do not find systematic patterns of the SOX impacts that vary with firm size in our sample of S&P 1500 firms, suggesting that the notion that small firms bear negative consequences of SOX may exist only below certain thresholds.

A Appendix

Proof of Lemma 1. Let $\lambda_{t'}$ be the date-t price of a contingent claim made on a consumption unit at date t', implying the bond price is defined as $b_t \equiv E_t\left[\sum_{t'=t}^{\infty}\lambda_{t'}\right]$, and let q_t denote the date-t price of a security that pays off the random quantity $q_t \equiv E_t\left[\sum_{t'=t}^{\infty}\lambda_{t'}\left(\ln\lambda_{t'} - t'\ln\beta\right)\right]$. From equation (15) of Margiotta and Miller [2000, p. 680], the value to a CEO with current wealth endowment e_{nt} of announcing state $r_t(s)$ in period t when the true state is s and choosing effort level l_{st2} in anticipation of compensation $w_{r_t(s)t}(x)$ at the beginning of period $t+1$ when he retires one period later is

$$-b_t\alpha_{2t}^{1/b_t}\left\{E_t\left[\exp\left(-\tfrac{\gamma_t w_{r_t(s)t}(x)}{b_{t+1}}\right)\right]\right\}^{1-1/b_t}\exp\left(-\tfrac{q_t+\gamma_t e_{nt}}{b_{t+1}}\right).$$

The corresponding value from choosing effort level l_{st1} is

$$-b_t\alpha_{1t}^{1/b_t}\left\{E_t\left[\exp\left(-\tfrac{\gamma_t w_{r_t(s)t}(x)}{b_{t+1}}\right)[g_{st}(x)]\right]\right\}^{1-1/b_t}\exp\left(-\tfrac{q_t+\gamma_t e_{nt}}{b_{t+1}}\right),$$

whereas from equation (8) of Margiotta and Miller (2000, p. 678), the value from retiring immediately is $-b_t\exp\left(-\frac{q_t+\gamma_t e_{nt}}{b_{t+1}}\right)$. Dividing each expression through by the retirement utility, it immediately follows that the CEO chooses $l_{st} \equiv (l_{t0}, l_{st1}, l_{st2})$ to minimize the negative of expected utility:

$$l_{t0} + \left\{\left(\alpha_{1t}l_{st1} + \alpha_{2t}l_{st2}\right)^{1/(b_t-1)}E_t\left[\exp\left(-\tfrac{\gamma_t w_{r_t(s)t}(x)}{b_{t+1}}\right)[g_{st}(x)l_{st1} + l_{st2}]\right]\right\}^{(b_t-1)/b_t}.$$

spending on the process to comply with SOX takes them away from running the business, increasing sales and developing new products." (Farrell [2007]).

Because $l_{t0} \in \{0,1\}$ and $b_t > 1$, the solution to this optimization problem also solves

$$l_{t0} + (\alpha_1 l_{st1} + \alpha_2 l_{st2})^{1/(b_t-1)} E_t \left[\exp\left(-\frac{\gamma_t w_{r_t(s)t}(x)}{b_{t+1}} \right) [g_{st}(x) l_{st1} + l_{st2}] \right].$$

Summing over the two states $s \in \{1,2\}$ yields the minimand in Lemma 1. ■

Proof of Lemma 2. In our model, the proof of Proposition 5 in Margiotta and Miller [2000] can be simply adapted to show that Theorem 3 of Fudenberg, Holmstrom, and Milgrom [1990] applies, thus demonstrating that the long-term optimal contract can be sequentially implemented. An induction completes the proof by establishing that the sequential contract implementing the optimal long-term contract for a CEO who will retire in $\overline{\varsigma}$ periods replicates the one-period optimal contract. In the optimal short-term contract, the participation constraint is satisfied with strict equality, which implies that at the beginning of period $\overline{\varsigma} - 1$ the expected lifetime utility of the CEO is determined by setting $t = \overline{\varsigma} - 1$ in the equation

$$-b_t \exp\left(-\frac{a_t + \gamma_t e_t}{b_t} \right). \tag{A1}$$

Suppose that at the beginning of all periods $t \in \{\varsigma + 1, \tau + 2, \ldots, \overline{\varsigma} - 1\}$; the expected lifetime utility of the CEO is given by equation (A1). We first show the expected lifetime utility of the CEO at ς is also given by Equation (A1). From Lemma 3.1 in the main text, the problem shareholders solve at ς is identical to the short-term optimization problem solved in the text. In the solution to each cost-minimization subproblem for the four (L_{1t}, L_{2t}) choices, the CEO's participation constraint is met with equality. Consequently, the CEO achieves the expected lifetime utility given by equation (A1), as claimed. Therefore, the problem of participating at time ς and possibly continuing with the firm for more than one period reduces to the problem of participating at time ς for one period at most, solved in Lemma 1. The induction step now follows. ■

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Table 1: Nonparametric Tests

A: Test on PDF of Abnormal Returns						
Sector	Primary		Consumer goods		Service	
(A, C)	Bad	Good	Bad	Good	Bad	Good
(S, S)	24.16	27.82	15.52	14.67	23.65	23.76
(S, L)	8.31	6.85	-0.62	2.98	14.98	6.69
(L, S)	8.59	19.36	4.66	3.02	7.84	18.29
(L, L)	43.55	17.36	9.06	12.56	61.39	22.34
B: Test on Contract Shape						
	Primary		Consumer Goods		Service	
(A, C)	Bad	Good	Bad	Good	Bad	Good
(S, S)	10.25	1.81	2.55	1.25	1.70	1.52
(S, L)	8.24	8.28	2.16	2.30	5.09	11.78
(L, S)	28.16	7.86	3.43	1.72	5.70	3.33
(L, L)	16.28	9.62	2.26	5.02	8.90	5.75

Note: Firm type is measured by the coordinate pair (A, C), where A is assets and C is the debt–to-equity ratio with each corresponding to whether that element is above (L) or below (S) its industry median. Accounting return is classified as "Good (Bad)" if it is greater (less) than the industry average. Both tests are one-sided test and both statistics follow a standard normal distribution $N(0, 1)$.

Table 2: ρ_1: Gross Loss to Shareholders from CEO Shirking (in %)

A: Full Sample

Sector	(Size, D/E)	Pre	Post-Pre
Primary	(S, S)	(11.09, 11.31)	(-2.69, -1.96)
	(S, L)	(9.20, 11.70)	(-6.92, -4.75)
	(L, S)	(7.70, 9.67)	(-2.82, -2.10)
	(L, L)	(4.97, 5.70)	(-1.96, -1.95)
Consumer	(S, S)	(15.65, 16.28)	(-9.16, -8.72)
	(S, L)	(9.13, 13.15)	(2.12, 12.21)
	(L, S)	(6.60, 9.13)	(-0.40, 1.54)
	(L, L)	(5.46, 7.58)	(-2.68, -2.11)
Service	(S, S)	(19.64, 20.25)	(-8.93, -6.34)
	(S, L)	(10.48, 13.94)	(-3.02, -1.03)
	(L, S)	(17.25, 19.76)	(-16.59, -15.37)
	(L, L)	(7.63, 10.11)	(-5.97, -5.07)

B: Subsample

		Compliant (C)		Non-compliant (NC)		NC vs. C
Sector	Size	(1) Pre	(2) Post-Pre	(3) Pre	(4) Post-Pre	(4) - (2)
Primary	S	(9.62, 9.65)	(-3.18, -3.17)	(14.14, 14.19)	(-4.45, -4.04)	(-1.27, -0.86)
	L	(4.84, 4.89)	(-0.60, -0.60)	(7.45, 7.51)	(-1.40, -1.38)	(-0.80, -0.78)
Consumer	S	(14.48, 14.56)	(-8.18, -8.11)	(16.44, 16.45)	(-8.46, -8.38)	(-0.35, -0.21)
Goods	L	(5.91, 6.01)	(1.73, 1.89)	(9.61, 10.20)	(-4.86, -4.39)	(-6.74, -6.12)
Service	S	(20.94, 20.98)	(-9.13, -9.07)	(18.07, 18.24)	(-6.08, -6.01)	(3.05, 3.06)
	L	(10.96, 11.05)	(-5.93, -5.83)	(12.60, 12.75)	(-9.83, -9.78)	(-4.01, -3.85)

Note: $\rho_1 \equiv \sum_{s=1}^{2} \varphi_{s,pre} E_{s,pre} \{x [1 - g_{s,pre}(x)]\}$. The confidence region is estimated for the single common bond price (16.4).

Table 3: ρ_2: Benefit to CEO from Shirking (in $ thousands)

A: Full Sample

Sector	(Size, D/E)	Pre	Post-Pre
Primary	(S, S)	(2262, 2879)	(122, 221)
	(S, L)	(1108, 1299)	(-57, -24)
	(L, S)	(1459, 1904)	(1716, 2125)
	(L, L)	(1395, 1665)	(100, 380)
Consumer	(S, S)	(5325, 7854)	(-3213, -2091)
	(S, L)	(1947, 2596)	(287, 476)
	(L, S)	(3314, 5727)	(18, 792)
	(L, L)	(2976, 5384)	(-1078, -654)
Service	(S, S)	(4024, 5728)	(-780, -487)
	(S, L)	(1549, 2455)	(67, 446)
	(L, S)	(6492, 10841)	(-7697, -5721)
	(L, L)	(4286, 6472)	(-2041, -1985)

B: Subsample

		Compliant (C)		Non-compliant (NC)		NC vs. C
Sector	Size	(1) Pre	(2) Post-Pre	(3) Pre	(4) Post-Pre	(4) - (2)
Primary	S	(1610, 1699)	(668, 691)	(3281, 3542)	(-496, -382)	(-1187, -1049)
	L	(780, 830)	(1335, 1456)	(2541, 2719)	(1024, 1069)	(-387, -311)
Consumer	S	(4403, 4795)	(-668, -586)	(6556, 7224)	(-3090, -2644)	(-2504, -1977)
Goods	L	(2473, 2843)	(911, 1501)	(5831, 6715)	(-937, -745)	(-2246, -1848)
Service	S	(5013, 5522)	(-1102, -918)	(2824, 3188)	(2213, 2602)	(3131, 3703)
	L	(6988, 7673)	(-4640, -4465)	(5887, 6857)	(-3104, -3070)	(1370, 1570)

Note: $\rho_2 \equiv b_{t+1}\left[\left(b_t - 1\right)\gamma\right]^{-1} \ln(\alpha_{2,pre}/\alpha_{1,pre})$. . The confidence region is estimated for the single common bond price, 16.4.

Table 4: τ_1: Administrative Costs (in $ thousands)

A: Full Sample

Sector	(Size, D/E)	Pre	Post-Pre
Primary	(S, S)	(1440, 1860)	(2285, 2455)
	(S, L)	(872, 1043)	(3182, 3209)
	(L, S)	(3699, 4079)	(4113, 4648)
	(L, L)	(3727, 3994)	(2829, 3165)
Consumer	(S, S)	(-279, 1282)	(-437, 31)
	(S, L)	(931, 1407)	(-25, 110)
	(L, S)	(2467, 4560)	(-1041, 590)
	(L, L)	(4734, 6766)	(-767, -389)
Service	(S, S)	(2348, 3701)	(-1473, -1153)
	(S, L)	(1877, 2642)	(-462, -112)
	(L, S)	(7942, 10951)	(-4129, -3888)
	(L, L)	(7684, 9374)	(-1738, -1262)

B: Subsample

		Compliant (C)		Non-compliant (NC)		NC vs. C
Sector	Size	(1) Pre	(2) Post-Pre	(3) Pre	(4) Post-Pre	(4) - (2)
Primary	S	(1393, 1456)	(2988, 3060)	(1917, 2095)	(1358, 1417)	(-1702, -1572)
	L	(3614, 3674)	(3424, 3526)	(4423, 4566)	(3686, 3777)	(251, 263)
Consumer	S	(977, 1232)	(410, 480)	(668, 1117)	(-1279, -1063)	(-1760, -1473)
Goods	L	(5160, 5607)	(277, 720)	(6285, 6999)	(-1158, -1071)	(-1792, -1435)
Service	S	(3481, 3882)	(-2458, -2305)	(2650, 2959)	(1074, 1298)	(3379, 3755)
	L	(9732, 10212)	(-1667, -1561)	(9335, 10058)	(-2862, -2753)	(-1202, -1192)

Note: $\tau_1 \equiv \gamma^{-1} \frac{b_{t+1}}{b_t - 1} \ln \alpha_{2,pre}$. The confidence region is estimated for the single common bond price, 16.4.

Table 5: τ_2: Aggregate Agency Cost (in $ thousands)

A: Full Sample

Sector	(Size, D/E)	Pre	Post-Pre
Primary	(S, S)	(56, 477)	(20, 190)
	(S, L)	(22, 194)	(3, 30)
	(L, S)	(50, 430)	(76, 611)
	(L, L)	(35, 302)	(43, 379)
Consumer	(S, S)	(222, 1783)	(-527, -59)
	(S, L)	(65, 542)	(21, 156)
	(L, S)	(302, 2395)	(182, 1812)
	(L, L)	(290, 2323)	(81, 459)
Service	(S, S)	(187, 1540)	(-360, -41)
	(S, L)	(105, 869)	(45, 395)
	(L, S)	(416, 3425)	(113, 355)
	(L, L)	(233, 1924)	(53, 529)

B: Subsample

		Compliant (C)		Non-compliant (NC)		NC vs. C
Sector	Size	(1) Pre	(2) Post-Pre	(3) Pre	(4) Post-Pre	(4) - (2)
Primary	S	(32, 95)	(37, 108)	(93, 270)	(-90, -32)	(-199, -69)
	L	(31, 91)	(53, 155)	(73, 216)	(45, 136)	(-19, -8)
Consumer	S	(133, 388)	(45, 115)	(237, 687)	(-333, -117)	(-448, -161)
Goods	L	(233, 681)	(240, 683)	(374, 1088)	(58, 144)	(-539, -182)
Service	S	(209, 610)	(-232, -80)	(161, 470)	(126, 349)	(206, 582)
	L	(248, 728)	(47, 153)	(380, 1104)	(75, 185)	(28, 38)

Note: $\tau_2 \equiv \sum_{s=1}^{2} \varphi_{s,pre} E_{s,pre}\left[w_{s,pre}(x)\right] - \tau_1$. The confidence region is estimated for the single common bond price, 16.4.

Table 6: τ_3: Hidden Action Cost (in $ thousands)

A: Full Sample

Sector	(Size, D/E)	Pre	Post-Pre
Primary	(S, S)	(103, 1072)	(228, 1532)
	(S, L)	(73, 342)	(-39, 165)
	(L, S)	(91, 535)	(96, 1774)
	(L, L)	(6, 1149)	(265, 380)
Consumer	(S, S)	(1116, 7441)	(-4387, -600)
	(S, L)	(208, 1934)	(-817, -202)
	(L, S)	(1028, 5419)	(-3111, -649)
	(L, L)	(1067, 6876)	(-3848, -332)
Service	(S, S)	(492, 2612)	(-328, -150)
	(S, L)	(121, 1012)	(-399, 268)
	(L, S)	(1078, 9040)	(-6438, 433)
	(L, L)	(588, 8599)	(-2621, 479)

B: Subsample

		Compliant (C)		Non-compliant (NC)		NC vs. C
Sector	Size	(1) Pre	(2) Post-Pre	(3) Pre	(4) Post-Pre	(4) - (2)
Primary	S	(81, 225)	(633, 2027)	(77, 371)	(34, 299)	(-1728, -599)
	L	(45, 110)	(132, 394)	(448, 1004)	(272, 950)	(140, 556)
Consumer	S	(577, 2095)	(-2095, -578)	(849, 2278)	(-652, -290)	(288, 1444)
Goods	L	(487, 1337)	(-796, -267)	(1827, 6354)	(-1093, 395)	(-297, 942)
Service	S	(391, 1113)	(-350, -135)	(294, 519)	(493, 1065)	(627, 1415)
	L	(1950, 4168)	(-3332, -1504)	(914, 2265)	(1272, 1988)	(2775, 5282)

Note: $\tau_3 \equiv \sum_{s=1}^{2} \varphi_{s,pre} E_{s,pre}[y_{s,pre}(x)] - \tau_1$. The confidence region is estimated for the single common bond price, 16.4.

Table 7: τ_4: Hidden Information Cost (in $ thousands)

A: Full Sample

Sector	(Size, D/E)	Pre	Post-Pre
Primary	(S, S)	(-596, -47)	(-1342, -208)
	(S, L)	(-149, -51)	(-135, 42)
	(L, S)	(-106, -41)	(-1163, -20)
	(L, L)	(-846, 29)	(-227, 87)
Consumer	(S, S)	(-5657, -893)	(540, 3860)
	(S, L)	(-1391, -143)	(223, 973)
	(L, S)	(-3024, -725)	(831, 4923)
	(L, L)	(-4553, -776)	(413, 4307)
Service	(S, S)	(-1072, -305)	(-32, 217)
	(S, L)	(-144, -16)	(-218, 795)
	(L, S)	(-5615, -663)	(-320, 6788)
	(L, L)	(-6675, -355)	(-348, 3150)

B: Subsample

		Compliant (C)		Non-compliant (NC)		NC vs. C
Sector	Size	(1) Pre	(2) Post-Pre	(3) Pre	(4) Post-Pre	(4) - (2)
Primary	S	(-130, -49)	(-1918, -596)	(-101, 16)	(-389, -66)	(530, 1529)
	L	(-19, -15)	(-239, -79)	(-788, -375)	(-814, -227)	(-575, -148)
Consumer	S	(-1707, -444)	(622, 2211)	(-1591, -611)	(173, 324)	(-1892, -449)
Goods	L	(-656, -254)	(507, 1479)	(-5266, -1453)	(-286, 1237)	(-1318, -242)
Service	S	(-502, -182)	(55, 117)	(-133, -49)	(-716, -367)	(-833, -422)
	L	(-3440, -1702)	(1551, 3486)	(-1161, -533)	(-1819, -1196)	(-5251, -2747)

Note: $\tau_4 \equiv \sum_{s=1}^{2} \varphi_{s,pre} E_{s,pre} \left[w_{s,pre}(x) - y_{s,pre}(x) \right]$. The confidence region is estimated for the single common bond price, 16.4.

Table 8: Overview of the Welfare Measures

A. Comparison between Compliant (C) Firms and Non-Compliant (NC) Firms (F: Favorable, UF: Unfavorable)

Sector	Primary		Consumer Goods		Service	
Firm Size	Small	Large	Small	Large	Small	Large
ρ_1: Gross Losses to Shareholders from CEO Shirking						
Compliant	decrease	decrease	decrease	increase	decrease	decrease
Non-Complaint	decrease	decrease	decrease	decrease	decrease	decrease
NC relative to C	decrease more	decrease more	decrease more	opposite	decrease less	decrease more
Consequence	F-Moderate	F-Moderate	F-Moderate	F-Strong	UF-Mild	F-Moderate
ρ_2: Benefits to CEO from Shirking						
Compliant	increase	increase	decrease	increase	decrease	decrease
Non-Complaint	decrease	increase	decrease	decrease	increase	decrease
NC relative to C	opposite	increase less	decrease more	opposite	opposite	decrease less
Consequence	F-Strong	F-Mild	F-Moderate	F-Strong	UF-Strong	UF-Mild
τ_1: Administrative Costs						
Compliant	increase	increase	increase	increase	decrease	decrease
Non-Complaint	increase	increase	decrease	decrease	increase	decrease
NC relative to C	increase less	increase more	opposite	opposite	opposite	decrease more
Consequence	F-Mild	UF-Moderate	F-Strong	F-Strong	UF-Strong	F-Moderate
τ_2: Aggregate Agency Cost						
Compliant	increase	increase	increase	increase	decrease	increase
Non-Complaint	decrease	increase	decrease	increase	increase	increase
NC relative to C	opposite	increase less	opposite	increase less	opposite	increase more
Consequence	F-Strong	F-Mild	F-Strong	F-Mild	UF-Strong	UF-Moderate
τ_3: Cost of Hidden Action						
Compliant	increase	increase	decrease	decrease	decrease	decrease
Non-Complaint	increase	increase	decrease	no change	increase	increase
NC relative to C	increase less	increase more	decrease less	no change	opposite	opposite
Consequence	F-Mild	UF-Moderate	UF-Mild	IND	UF-Strong	UF-Strong
τ_4: Cost of Hidden Information						
Compliant	decrease	decrease	increase	increase	increase	increase
Non-Complaint	decrease	decrease	increase	no change	decrease	decrease
NC relative to C	decrease less	decrease more	increase less	increase less	opposite	opposite
Consequence	UF-Mild	F-Moderate	F-Mild	F-Mild	F-Strong	F-Strong

B. Definition

Favorable		Unfavorable	
Label	If Non-compliant firms:	Label	If Non-compliant firms:
F-Mild	increase less	UF-Mild	decrease less
F-Moderate	decrease more	UF-Moderate	increase more
F-Strong	decrease & go opposite	UF-Strong	increase & go opposite

C. Comparison among the Six Measures

	Primary		Consumer Goods		Service		
	Small	Large	Small	Large	Small	Large	Sum
Interest Alignment (ρ_1 - ρ_2)							
Favorable: Moderate/Strong	2	1	2	2	0	1	8
Unfavorable: Moderate/Strong	0	0	0	0	1	0	1
Costs (τ_1 - τ_2)							
Favorable: Moderate/Strong	1	0	2	1	0	1	5
Unfavorable: Moderate/Strong	0	1	0	0	2	1	4
Costs (τ_1 - τ_4)							
Favorable: Moderate/Strong	1	1	2	1	1	2	8
Unfavorable: Moderate/Strong	0	2	0	0	3	2	7

TABLE A1: FIRM CHARACTERISTICS AND COMPENSATION

	Primary Sector			Consumer Goods Sector			Service Sector		
	Pre	Post	t-/F-stat	Pre	Post	t-/F-statt	Pre	Post	t-/F-statt
Total assets	4460	6971	6.7	3460	5091	4.0	13678	20311	3.3
	(7436)	(11549)	(0.4)	(8242)	(11358)	(0.5)	(42619)	(78265)	(0.3)
Debt-to-equity	1.792	2.092	3.5	1.559	1.498	-0.9	3.651	2.798	-6.9
	(1.428)	(2.646)	(0.3)	(1.589)	(1.779)	(0.8)	(5.273)	(4.231)	(1.6)
Accounting return	1.110	1.135	3.2	1.117	1.070	-4.7	1.180	1.090	-11.7
	(0.233)	(0.231)	(1.0)	(0.283)	(0.258)	(1.2)	(0.342)	(0.258)	(1.8)

Total Compensation

		Overall			Bad			Good		
		Pre	Post	t-/F-stat	Pre	Post	t-/F-stat	Pre	Post	t-/F-stat
Primary	(S, S)	1837	4704	3.6	387	2268	2.1	3593	8600	3.5
		(12126)	(13797)	(0.8)	(8132)	(12283)	(0.4)	(15480)	(15174)	(1.0)
	(S, L)	1099	4675	4.7	-131	3173	4.5	2818	6927	2.4
		(7970)	(8906)	(0.8)	(7520)	(5679)	(1.8)	(8267)	(11970)	(0.5)
	(L, S)	4300	10074	4.4	3225	8525	3.3	5772	11924	2.9
		(11983)	(16369)	(0.5)	(9827)	(15074)	(0.4)	(14305)	(17717)	(0.7)
	(L, L)	4204	8362	5.2	3147	7106	4.3	5595	10115	3.2
		(11571)	(14816)	(0.6)	(10662)	(12921)	(0.7)	(12540)	(17003)	(0.5)
Consumer goods	(S, S)	1425	2151	0.6	-1874	-2903	-0.9	6056	7875	0.9
		(21403)	(18474)	(1.3)	(15927)	(12315)	(1.7)	(26629)	(22279)	(1.4)
	(S, L)	1702	2355	0.4	-691	-1516	-0.4	4754	5120	0.1
		(14362)	(13605)	(1.1)	(11263)	(9682)	(1.4)	(17079)	(15316)	(1.2)
	(L, S)	6074	6793	0.2	1355	1399	0.0	12012	10903	-0.2
		(32090)	(31953)	(1.0)	(23206)	(24290)	(0.9)	(39848)	(36345)	(1.2)
	(L, L)	7297	9015	1.0	3460	4590	0.6	12710	13283	0.2
		(26565)	(28798)	(0.9)	(21908)	(22864)	(0.9)	(31228)	(33068)	(0.9)
Service	(S, S)	3757	2149	-1.9	590	-953	-1.8	7766	5700	-1.3
		(21304)	(18728)	(1.3)	(15543)	(14180)	(1.2)	(26350)	(22352)	(1.4)
	(S, L)	3311	4318	0.6	2041	1725	-0.2	4706	7579	0.9
		(16672)	(19656)	(0.7)	(13242)	(12581)	(1.1)	(19696)	(25703)	(0.6)
	(L, S)	11231	7135	-1.6	6065	205	-2.1	18877	14515	-1.0
		(38738)	(32155)	(1.5)	(31249)	(25182)	(1.5)	(46727)	(36918)	(1.6)
	(L, L)	9438	9185	-0.2	6383	6221	-0.1	14114	14365	0.1
		(26040)	(24173)	(1.2)	(22689)	(19051)	(1.4)	(29875)	(30536)	(1.0)

Note: In the columns "Pre" and "Post" indicating the pre- and post- SOX eras, standard deviation is listed in parentheses below the corresponding mean. The columns "t-/F-stat" report the statistics of a two-sided t-test on equal mean with critical value equal to 1.96 at the 5% confidence level, and the one-sided F-test on equal variance with critical value equal to 1. Firm type is measured by the coordinate pair (A, C), where A is assets and C is the debt–to-equity ratio with each corresponding to whether that element is above (L) or below (S) its industry median. Accounting return is classified as "Good (Bad)" if it is greater (less) than the industry average. Assets (Compensation) is measured in millions (thousands) of 2006 U.S. dollars.

Figure 1: Timeline of Events That Led to SOX and the Exchange Regulations

November
2001
11/8/2001
Enron files earnings restatement with the SEC.

December
2001
12/2/2001
Enron files for bankruptcy.

January-March
2002

Senate Banking committee hearings.
House Financial Services committee hearings.

2/13/2002
SEC asks NYSE and NASDAQ to review their corporate governance requirements.

April
2002
4/12/2002
NASDAQ's Executive Committee approves first round of new corporate governance requirements.

4/24/2002
The House passes the bill of Senator Oxley to enhance corporate and auditing accountability, responsibility, and transparency.

May
2002
5/22/2002
NASDAQ's board approves the Executive Committee proposals.

June
2002
6/6/2002
NYSE committee unveils its new governance requirements.

6/25/2002
WorldCom announces that its profits had been inflated by $3.8 billion.

6/28/2002
NASDAQ's committee discusses 2nd round of proposals that would follow NYSE proposals.

July
2002
7/15/2002
The Senate passes the bill of Senator Sarbanes to enhance auditing related procedures, corporate responsibility, and financial disclosure.

7/24/2002
NASDAQ's board approves 2nd round of proposals.

House and Senate reach a consensus on a joint SOX bill.

7/25/2002
House and Senate approve the SOX bill.

7/30/2002
President G.W. Bush signs the SOX into law.

August
2002
8/1/2002
NYSE board approves proposals.

8/16/2002
NYSE submits its proposed rules to the SEC.

September
2002

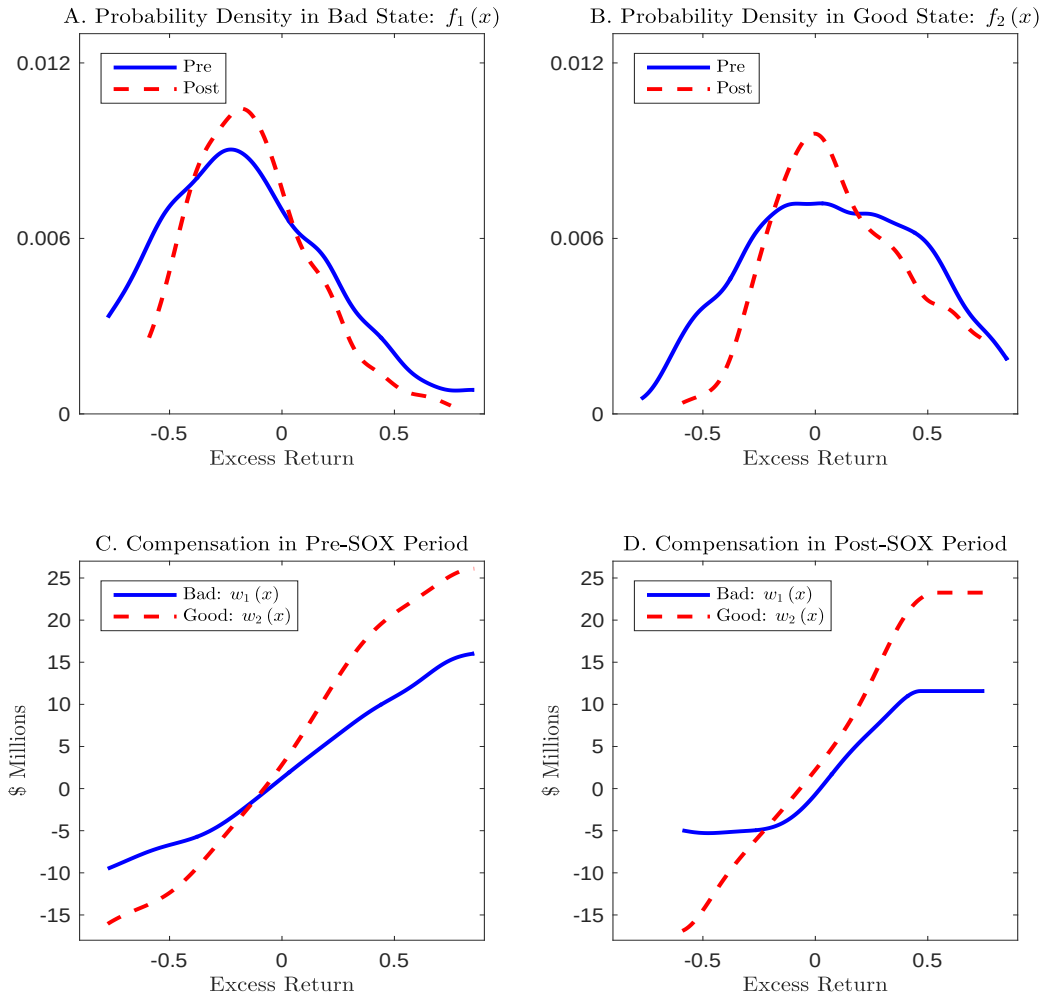
October
2002
10/9/2002
NASDAQ submits its proposed rules (2nd round) to the SEC.

.....

November
2003
11/4/2003
SEC approves NASDAQ and NYSE proposals.

Note: From Chhaochharia and Grinstein [2007].

FIGURE 2: EMPIRICAL COMPENSATION SCHEDULE AND EXCESS RETURN DENSITY



Note: The plots present the non-parametrically estimated density of excess returns and the optimal compensation of firms with large size and high leverage in the Primary sector. "Pre" and "Post" indicating the pre- and post- SOX eras. The compensation of both periods is anchored at bond prices equal to 16.5 (b_t) and 16.4 (b_{t+1}).

FIGURE 3: WELFARE COSTS SUMMARY

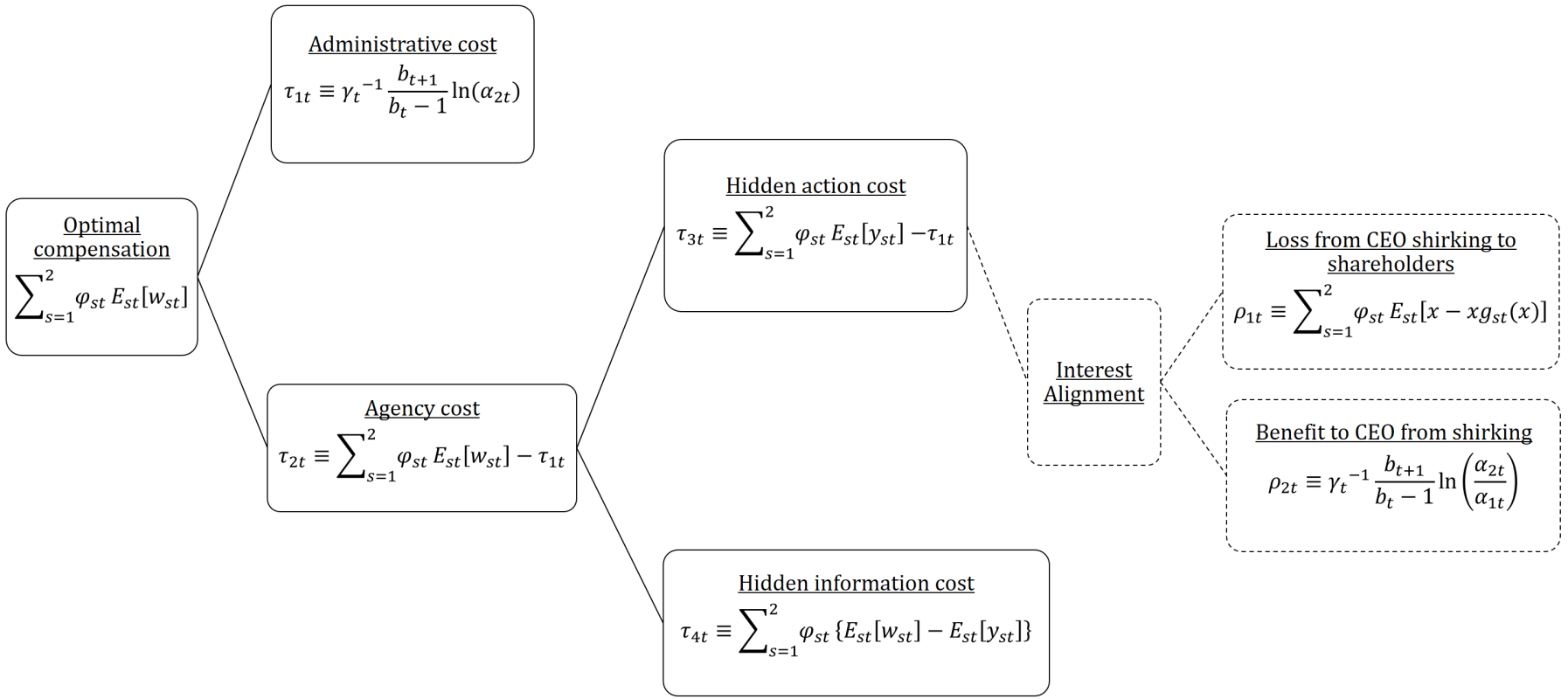
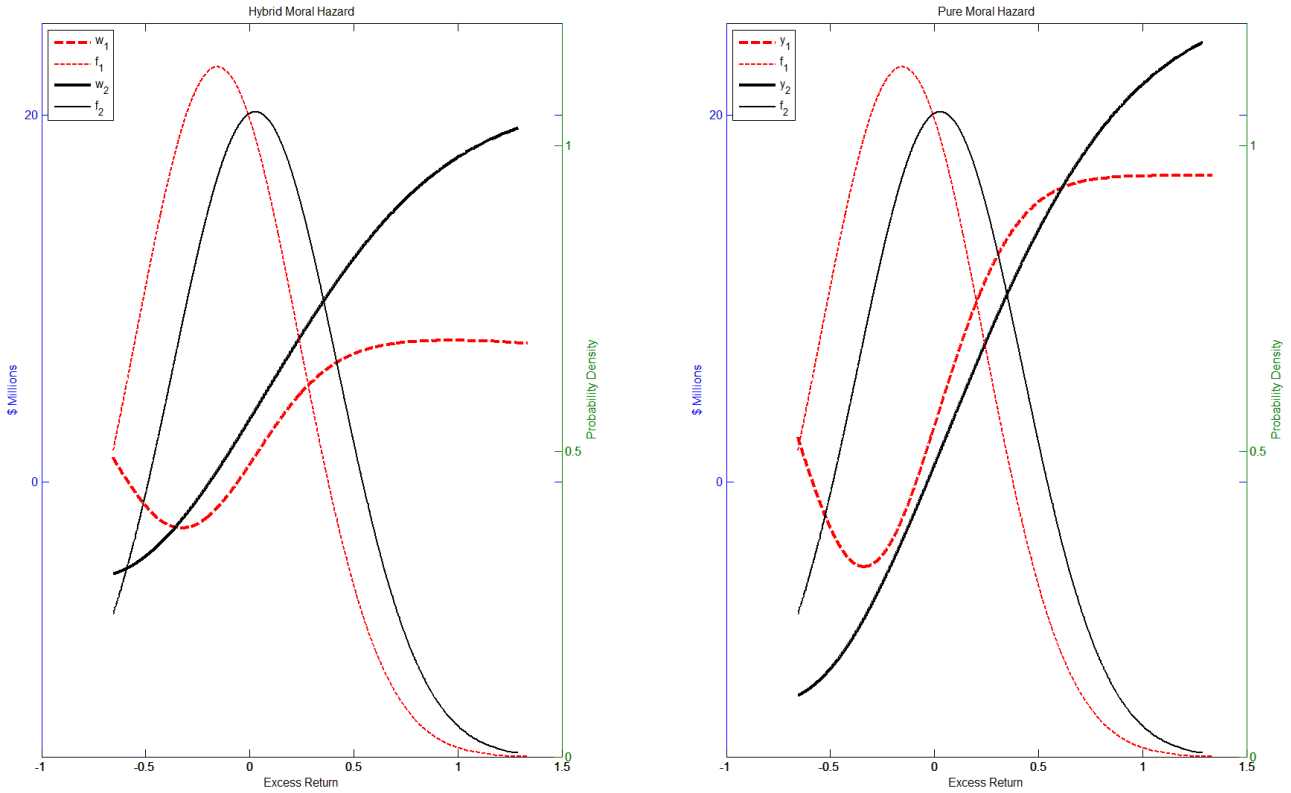


Figure 4: Optimal Compensation Schedules



Note: The plots use the return and optimal compensation of firms with small size and low leverage in the Primary sector in the pre-SOX period. The risk aversion parameter γ equals 0.08. The cost of shirking (α_1) equals 0.96 and the effort cost of working (α_2) equals 1.20. Bond prices are 16.5 (b_t) and 16.4 (b_{t+1}). The excess return is approximated by a one-side truncated normal distribution $TN(a,\mu,\sigma)$ with truncated point on the left (a), mean (μ), and standard deviation (σ) as follows. Working in bad state: $TN(-0.66,-0.16,0.39)$. Working in good state: $TN(-0.66,0.03,0.39)$. Shirking in bad state: $TN(-0.66,-0.25,0.27)$. Shirking in good state: $TN(-0.66,-0.11,0.36)$. The probability of the bad state is 0.54 and the probability of the good state is 0.46.