

# CEMMAP Lectures on Contracts & Market Microstructure

## *7. Moral Hazard with Hidden Information*

Robert A. Miller

Carnegie Mellon University

September 2022

# Introduction

## The Sarbanes-Oxley Act of 2002 (SOX)

- SOX was a legislative response to **corporate governance** failures at many prominent companies:
  - The most **extensive** regulation of the securities markets since the 1933 Securities Act and the 1934 Securities Exchange Act (Ball, 2009).
  - Regulating contracts within firms is **controversial** (Hart, 2009).
- SOX affects CEO compensation:
  - directly . . . by prohibiting option backdating and perks.
  - indirectly . . . by enhancing the board independence, internal control, and disclosure quality.
- This is because CEO actions that were:
  - **formerly incentivized** by compensation contracts and contractual arrangements
  - are now **governed** by SOX's legal provisions.

- How, and to what extent, did SOX affect CEO compensation?
- To address these issues we:
  - 1 **model how SOX affects CEO compensation:**
    - embedding conflict between shareholders and managers  
(*otherwise no governance problem*)
    - making CEO more informed than shareholders  
(*otherwise SOX redundant*)
    - providing welfare measures to evaluate SOX
  - 2 **map its equilibrium into the data generating process (DGP):**
    - shareholder performance measures
    - CEO compensation function
    - data on CEO reporting to shareholders
  - 3 **develop econometric methods for:**
    - **identifying** what a large data set can explain
    - **estimating** parameter sets accounting for sample error

# Introduction

## Brief summary of empirical results

- **SOX reduced shareholders' potential loss due to CEO shirking:**
  - by between 1% and 16% of firm value.
  - The average S&P 1500 firm market cap was \$18 billion (US 2006).
- **SOX also reduced CEO's benefit from shirking:**
  - by up to \$7.7 million (US 2006).
- **Administrative costs** attributable to CEO's compensation:
  - increased by \$2.2 – \$4.6 million in the primary sector.
  - fell by \$0.1 – \$4 million in the service sector.
- **Agency costs** of CEO's compensation increased:
  - in most types of firms by up to \$1.8 million.
- In a sense SOX addressed the excesses of **rogue management**:
  - in this model a probability zero event of management shirking.

- Firm behavior:
  - earnings management methods (Cohen et al 2008)
  - investment (Bargeron et al. 2010, Cohen et al. 2007, Kang et al. 2010)
  - delisting (Engel et al. 2006, Leuz et al. 2007)
- Stock market reaction:
  - Zhang 2007, Jain and Rezaee 2006, Leuz 2007, Dey 2010, Livtak 2007, Hochberg et al. 2009
- CEO compensation practice:
  - Carter et al. (2009) finds increased weight on positive earnings changes in CEO bonus contracts after SOX and lower weight on salary.
  - 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, increased bonus, and no significant decrease in compensation.
  - Chhaochharia and Grinstein (2009) find CEO compensation fell when boards previously had less than a majority of independent directors.
  - Guthrie et al. (2012) find the compensation committee independence requirement increased CEO compensation after SOX.

- Observations  $(n, t)$  are on S&P1500 firms, 1993 to 2005,
- Data extracted from ExecuComp, CRSP, Compustat, and RiskMetrics.
- Sample (subsample) split into two regimes:
  - pre SOX 1993 -2001 and post SOX 2004 -2006
- Firms partitioned into 12 categories, denoted by  $z_{nt} \in Z$ :
  - 3 sectors based on GICS code:
    - **primary** (energy, materials, industrials, utilities)
    - **consumer goods** (consumer discretionary, consumer staples)
    - **services** (health care, financial, information technology, telecommunication services)
  - 2 levels of **firm total assets** (size): large L, small S.
  - 2 levels of **capital structure** (D/E): large L, small S.

- We also partitioned a subsample 12 ways by:
  - sector (primary, consumer, services)
  - size (total assets, L or S)
  - largely **compliant** or not with SOX legislation **prior** to implementation.
- Prior to SOX legislation, compliant firms had :
  - majority board independence
  - entire audit committee independence
  - entire compensation committee independence
- We conducted a structural DID test that uses:
  - compliant firms as the **control group**
  - noncompliant firms as the **treatment group**.
- *Since SOX affects CEO compensation through changing board structures, noncompliant firms might experience more changes after SOX than the compliant firms.*

# Data

## Key Variables: Accounting and financial returns

- CEOs privately observe and report on  $s_{nt} \in \{1, 2\}$ :

$$s_{nt} \equiv \begin{cases} 1 \text{ (bad)} & \text{if } acc\_ret_{nt} < mean(acc\_ret \mid z_{nt}) \\ 2 \text{ (good)} & \text{otherwise} \end{cases}$$

where:

$$acc\_ret_{nt} \equiv \frac{Assets_{nt} - Debt_{nt} + Dividend_{nt}}{Assets_{n,t-1} - Debt_{n,t-1}}$$

- Firm performance measure is gross abnormal return:

$$x_{nt} \equiv \tilde{x}_{nt} + w_{nt} / V_{n,t-1}$$

where:

- $\tilde{x}_{nt}$  is abnormal financial return (over stock market index) to  $n$  in  $t$
- $V_{n,t-1}$  is value of the firm in period  $t - 1$
- $w_{nt}$  is CEO compensation



- Let  $b_t$  denote the bond price in  $t$ :
  - the present value of an annuity of \$1 Treasury Bill paid for 30 years.
- We could estimate compensation:

$$w_{nt} \equiv w(x_{nt}, s_{nt}, z_n, b_t) = E [\tilde{w}_{nt} | x_{nt}, s_{nt}, z_n, b_t]$$

with the Kernel estimator:

$$\hat{w}(x_{nt}, s_{nt}, z_n, b_t) = \frac{\sum_{m=1}^N \tilde{w}_{mt} I\{z_{mt}=z_{nt}, s_{mt}=s_{nt}\} K\left(\frac{x_{mt}-x_{nt}}{h_x}\right)}{\sum_{m=1}^N I\{z_{mt}=z_{nt}, s_{mt}=s_{nt}\} K\left(\frac{x_{mt}-x_{nt}}{h_x}\right)}$$

where  $\tilde{w}_{nt} \equiv w_{nt} + \varepsilon_{nt}$  measures **total compensation**:

- comprising ExecuComp items + change in wealth from holding of firm denominated securities
- and  $\varepsilon_{nt}$  is assume to be measured an *iid* disturbance (such as measurement error).

# Did Structural Change Occur?

Nonparametric Tests (Table 2 in GLM 2022)

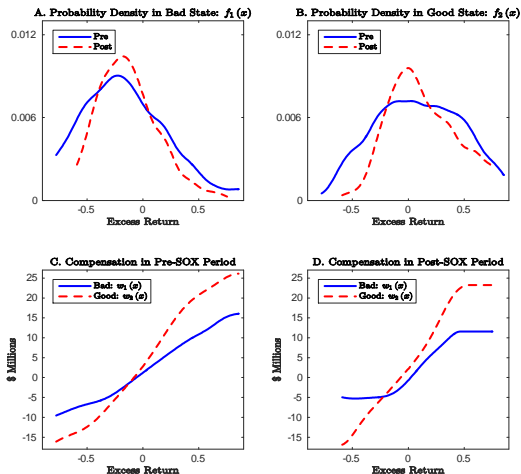
- A structural change occurs when SOX is implemented if:
  - (A) the probability distribution of gross abnormal returns changes
  - (B) the mapping from abnormal returns to CEO compensation changes.
- The critical value for these one-sided tests at the 5% confidence level is 1.64:

A: Test on PDF of Gross Abnormal Returns						
Sector (Size, D/E)	Primary		Consumer		Service	
	Bad	Good	Bad	Good	Bad	Good
(S,S)	18.05	10.34	12.51	12.39	14.25	14.55
(S,L)	5.88	5.02	1.26	2.27	14.70	5.29
(L,S)	3.29	4.16	3.74	2.03	9.01	19.69
(L,L)	29.46	8.57	9.03	8.68	71.68	29.56

B: Test of Contract Shape						
Sector (Size, D/E)	Primary		Consumer		Service	
	Bad	Good	Bad	Good	Bad	Good
(S,S)	10.06	1.58	2.89	1.09	1.54	1.47
(S,L)	6.82	6.45	3.30	1.71	4.08	6.85
(L,S)	19.67	7.34	5.51	3.52	5.66	8.74
(L,L)	10.32	23.38	3.69	6.74	7.37	10.65

# Did Structural Change Occur?

Illustrating nonparametrically estimated returns density and compensation schedule

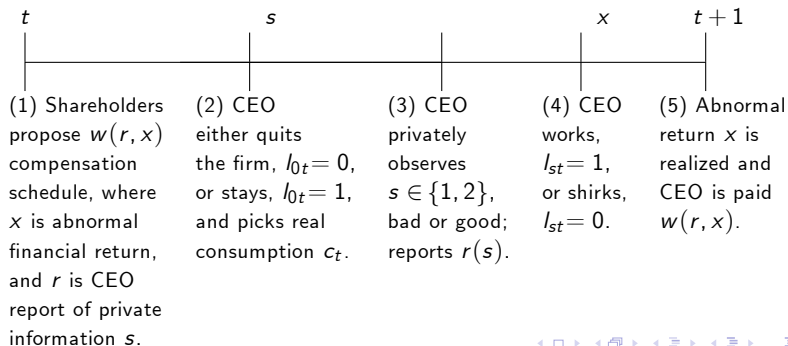


Note: The plots depict small firms with low leverage in the consumer sector.

# Model

## Timeline

- We model hidden information as a one-sided information problem where shareholders can directly verify the good state, but not the bad one:
  - SOX exposed CEOs to legal jeopardy from overstating their private information about good news.
  - A primary intention of SOX legislation was to stop CEOs from lying when they privately receive bad news.



# Model

## CEO utility and annuity value of indirect expected utility

- The realized lifetime utility of the CEO is:

$$-\sum_{t=0}^{\infty} \delta^t \exp(-\gamma c_t) [l_{0t} + \alpha l_{st} + \beta (1 - l_{st})]$$

$\delta$ : subjective discount factor     $\gamma$ : coefficient of absolute risk aversion

$\alpha$ : utility factor for working     $\beta$ : utility factor for shirking

- It is useful to focus on the expected annuitized utility markup:

$$U(s, r, j) \equiv \begin{cases} -1 & \text{if } j=0 \text{ (reject offer)} \\ -\beta \frac{1}{b_t-1} \int_{-\infty}^{\infty} \exp\left(-\frac{\gamma w_t(r,x)}{b_{t+1}}\right) g_s(x) f_s(x) dx & \text{if } j=1 \text{ (shirk)} \\ -\alpha \frac{1}{b_t-1} \int_{-\infty}^{\infty} \exp\left(-\frac{\gamma w_t(r,x)}{b_{t+1}}\right) f_s(x) dx & \text{if } j=2 \text{ (work)} \end{cases}$$

- $f_s(x)$ : density of  $x$  from working when state is  $s$
  - $f_s(x)g_s(x)$ : density of  $x$  from shirking in state  $s$
  - $b_t$ : bond price for consumption unit paid each period from  $t$  onwards.
- There is a conflict of interest because  $\beta < \alpha$  but for each  $s \in \{1,2\}$ :

$$\int_{-\infty}^{\infty} x f_s(x) dx > \int_{-\infty}^{\infty} x g_s(x) f_s(x) dx$$

# Model

## Optimal contract for expected cost minimization and task choice

- Minimize expected compensation for honest working subject to:
  - overall participation constraint, where  $\varphi_s$  is probability of  $s$  occurring:

$$\sum_{s=1}^2 \varphi_s U(s, r = s, j = 2) \geq -1$$

- incentive compatibility constraint for each state  $s \in \{1, 2\}$ :

$$U(s, r = s, j = 2) \geq U(s, r = s, j = 1)$$

- truth-telling constraint in the good state  $s = 2$ :

$$U(2, r = 2, j = 2) \geq U(2, r = 1, j = 2)$$

- sincerity constraint in the good state  $s = 2$ :

$$U(2, r = 2, j = 2) \geq U(2, r = 1, j = 1)$$

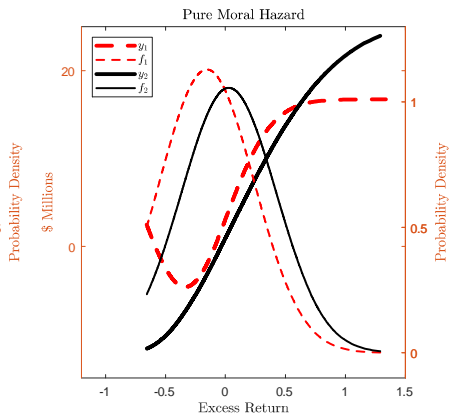
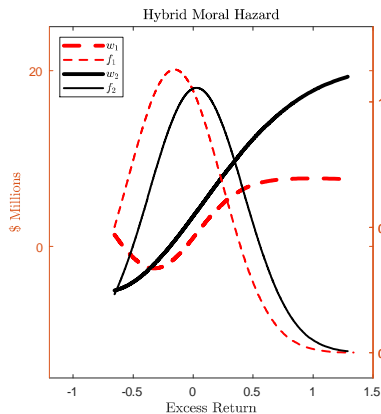
- Minimize compensation for shirking for each  $s \in \{1, 2\}$ , subject to:

$$U(s, r = s, j = 1) \geq -1$$

- Maximize expected return by liquidating or indirectly selecting CEO tasks.

# Model

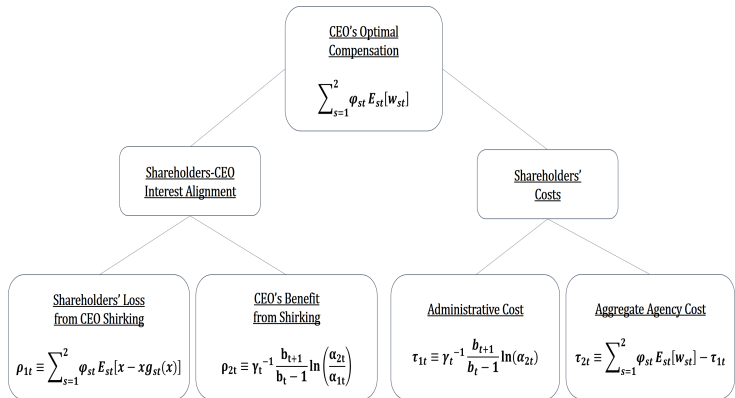
## Optimal Compensation for pure and hybrid models of moral hazard



Note: The excess return is approximated by one-side truncated normal distribution.

# Model

## Assessing conflict of interest and agency costs





# Identification (follows Gayle and Miller 2015)

## 2 step identification procedure

- Data on excess returns  $x$ , firm state  $s$  and compensation  $w_t(s, x)$  when:
  - CEO works (otherwise compensation does not depend on  $x$ )
  - CEO is truthful so  $r = s$  (implied by optimal contracting)
- Hence  $f_s(x)$  is trivially identified.
- To identify the remaining parameters  $\gamma$  and  $(\alpha, \beta, g_1(x), g_2(x))$ 
  - 1 Concentrate parameter space to risk aversion parameter  $\gamma$ :
    - use first order conditions, binding participation and incentive compatibility constraints to derive mappings from  $\gamma$  to  $\alpha, \beta, g_1(x)$  and  $g_2(x)$ .
    - if  $\gamma^*$  is true value of  $\gamma$  then  $\alpha(\gamma^*), \beta(\gamma^*), g_1(x; \gamma^*),$  and  $g_2(x; \gamma^*)$  must be true values of  $\alpha, \beta, g_1(x)$  and  $g_2(x)$  respectively.
  - 2 Derive maximal (tight and) sharp set for  $\gamma$  using remaining model restrictions to construct a criterion function  $Q(\gamma)$  such that:

$$\Gamma \equiv \{\gamma > 0 : Q(\gamma) = 0\}$$

# How did SOX affect the Conflict of Interest?

Shareholder loss from CEO shirking (in percentages, Table 3, GLM 2022)

$$\rho_1 \equiv \sum_{s=1}^2 \varphi_{s,pre} E_{s,pre} \left\{ x[1 - g_{s,pre}(x)] \right\} \quad \Delta\rho_1 \equiv \sum_{s=1}^2 \varphi_{s,post} E_{s,post} \dots - \rho_1$$

SOX reduced the loss shareholders would incur from a CEO who shirks.

Compared to compliant firms, losses to noncompliant firms were greater and declined more.

Sector	(Size,D/E)	$\rho_1$	$\Delta\rho_1$
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 Goods	(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)
Service	(L,L)	(5.46, 7.58)	(-2.68, -2.11)
	(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)

# How did SOX affect the Expected Cost of Compensation?

Administrative costs (in thousands of 2006 US\$, Table 5, GLM 2022)

$$\tau_1 \equiv \gamma^{-1} \frac{b_{t+1}}{b_{t-1}} \ln \alpha_{pre} \quad \Delta \tau_1 \equiv \gamma^{-1} \frac{b_{t+1}}{b_{t-1}} (\ln \alpha_{post} - \ln \alpha_{pre})$$

	(Size, D/E)	$\tau_1$	$\Delta \tau_1$
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)

- Administrative costs rose in every category of the primary sector and fell in every other category.

# How did SOX affect the Expected Cost of Compensation?

Agency costs (in thousands of 2006 US\$, Table 6, GLM 2022)

$$\tau_2 \equiv \sum_{s=1}^2 \varphi_{s,pre} E_{s,pre} [w_{s,pre}(x)] - \tau_1$$

Agency costs are much lower than losses firms incur from a CEO shirking.

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)

SOX increased agency costs in 10 out of 12 categories.

Consumer Goods	(S,S)	(222, 1783)	(-527, -59)
	(S,L)	(65, 542)	(21, 156)
	(L,S)	(302, 2395)	(182, 1812)
	(L,L)	(290, 2323)	(81, 459)

Costs in primary and consumer (service) sectors increased less (more) in noncompliant firms.

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)

# Concluding Remarks

## Controls and limitations

- Controls

- There is no evidence the risk aversion parameter changed.
- It controls for aggregate shocks by anchoring the welfare calculations to the same bond prices in pre- and post-SOX eras.
- To account for other trends in governance, our DID framing uses compliant firms as a control group and noncompliant firms as the treatment group.

- Limitations

- CARA + "complete markets" aside from "market for effort" explicitly motivated by "optimal contracting"  
⇒ no role for CEO wealth + bond prices are "sufficient statistics" for economy aggregates
- from "no accumulated learning from past performance" + complete markets assumption  
⇒ "short term contracts" + no role for "granting" versus "vesting"
- crude partitioning of firms (following literature and industry codes)

# Concluding Remarks

Summarizing the main findings

- Broadly speaking our findings suggest:
  - ① SOX **improved the interest alignment** between shareholders and CEOs, most notably in noncompliant firms.
  - ② Noncompliant firms benefited less, or incurred **higher administrative costs**, than compliant firms.
  - ③ **Some firm types might have benefited.** (*SOX obligated taxpayers to subsidize governance.*)
  - ④ **Agency costs increased** in most sectors. (*SOX made truthfully reporting good news more expensive.*)