Hidden Information and Moral Hazard

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Structural Econometrics

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- 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.

- Through what channels and to what extent did SOX affect CEO compensation?
- We address these issues with:

  1. A **model capturing how SOX affects CEO compensation** practice:
     - 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. A mapping relating variables in **model to data**:
     - shareholder performance measures
     - CEO compensation for
     - data on CEO reporting to shareholders

  3. Econometric techniques
     - for **identifying** what a large data set can explain
     - consistent estimators accounting for **sample error**

- This paper:
  - **derives** the measures from a dynamic principal-agent model of moral hazard and hidden information.
  - **attributes** SOX effect to changes in agency costs versus administrative costs driven by changes in primitives.
  - **estimates and compares** the contribution of each channel.
- Our empirical results results thow that SOX reduced:
  - **shareholders' potential loss due to CEO shirking** by 1%–16% of firm value (average S&P 1500 firms' market cap is $18 billion).
  - **CEO's benefit from shirking** by up to $7.7 millions.
- SOX also increased:
  - **administrative costs** in one CEO's compensation in the primary sector by $2.2–$4.6 millions though reduced in the service sector by $0.1–$4 millions.
  - **agency costs** of CEO's compensation in most types of firms by up to $1.8 millions.

Literature on SOX

- 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.

Data
Categorizing firms, regimes and compliance

- 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 size** (total assets, A): large L, and small S.
    - 2 levels of **capital structure** (debt/equity ratio, C): large L, and small S.

- We also partitioned a subsample 12 ways by:
  - sector (primary,consumer, services)
  - size (total assets, L or S)
  - **compliant** or not on pieces of SOX legislation prior to implementation.

- Prior to SOX legislation firms in the compliant group 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.*

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

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

where:

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

- Firm performance measure is gross abormal return:

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

where:

- $\widetilde{x}_{nt}$ 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 optimal CEO compensation

Data
Key Variables: compensation and (bond) prices

- w_{nt} is estimated from:

$$w_t\left(x_n|Z, s, b_t\right) = \frac{\sum_{m=1}^{N} \widetilde{w}_{mt} I\{Z_m=Z, s_m=s\} K\left(\frac{x_{mt}-x_{nt}}{h_x}\right) K\left(\frac{b_m-b_t}{h_b}\right)}{\sum_{m=1}^{N} I\{Z_m=Z, s_m=s\} K\left(\frac{x_{mt}-x_{nt}}{h_x}\right) K\left(\frac{b_m-b_t}{h_b}\right)}$$

  - $\widetilde{w}_{nt}$ is measures **total compensation** (ExecuComp items + change in wealth from holding of firm denominated securities
  - b_t (bond price) = the present value of an annuity of \$1 Treasury Bill paid for 30 years.

Did Structural Change Occur?
Nonparametric Tests (Table 1 in paper)

- 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.
- We reject the hypothesis of no change in almost every category and regime.

A: Test on PDF of Gross Abnormal Returns						
Sector	Primary		Consumer		Service	
(Size, D/E)	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	Primary		Consumer		Service	
(Size, D/E)	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

Note: The critical value for these one-sided tests at the 5% confidence level is 1.64.

Did Structural Change Occur?

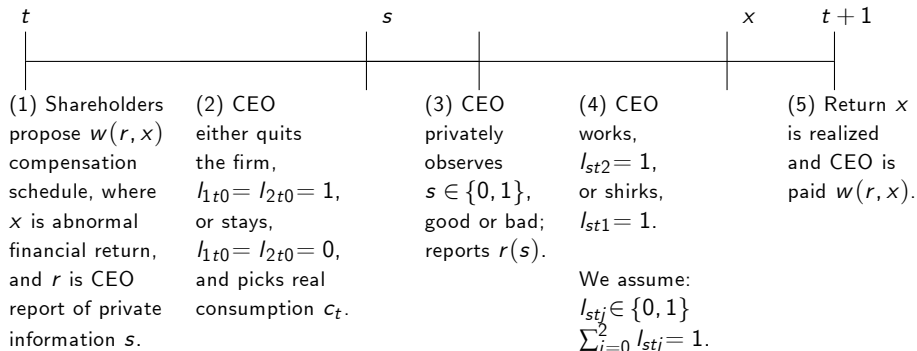Illustrating nonparametrically estimated returns density and compensation schedule
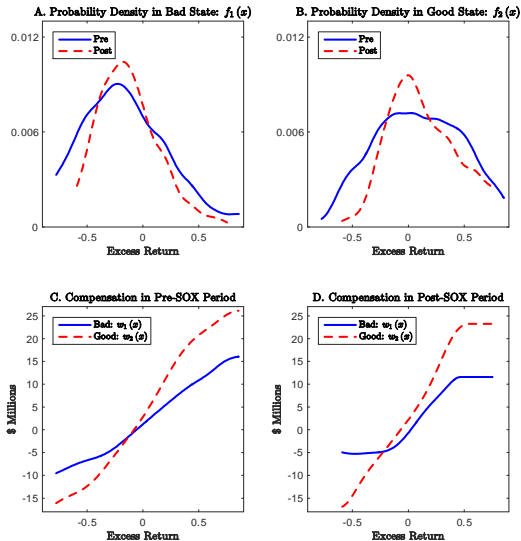
Note: The plots depict small firms with low leverage in the consumer sector.

- We model hidden information as a one-sided information problem where shareholders can directly verify the good state, but not the bad:
  - 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.

t		s			x	$t+1$
(1) Shareholders propose $w(r,x)$ compensation schedule, where x is abnormal financial return, and r is CEO report of private information s.	(2) CEO either quits the firm, $l_{1t0} = l_{2t0} = 1$, or stays, $l_{1t0} = l_{2t0} = 0$, and picks real consumption c_t.		(3) CEO privately observes $s \in \{0,1\}$, good or bad; reports $r(s)$.	(4) CEO works, $l_{st2} = 1$, or shirks, $l_{st1} = 1$. We assume: $l_{stj} \in \{0,1\}$ $\sum_{j=0}^{2} l_{stj} = 1$.		(5) Return x is realized and CEO is paid $w(r,x)$.

Model
CEO utility and annuity value of indirect expected utility

- The lifetime expected utility of the CEO is:

$$-\sum_{t=0}^{\infty}\sum_{j=0}^{2}\beta^t\alpha_j I_{stj}\exp\left(-\gamma c_t\right)$$

  - β: subjective discount factor
  - α_j: utility factor for effort choice $j\in\{1(shirk),2(work)\}$
  - γ: coefficient of absolute risk aversion

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

$$U\left(s,r,j\right)\equiv\begin{cases}-1 & \text{if } reject\\-\alpha_2^{\frac{1}{b_t-1}}\int_{-\infty}^{\infty}\exp\left(-\frac{\gamma w_{r,t}(x)}{b_{t+1}}\right)f_s(x)dx & \text{if } work\\-\alpha_1^{\frac{1}{b_t-1}}\int_{-\infty}^{\infty}\exp\left(-\frac{\gamma w_{r,t}(x)}{b_{t+1}}\right)g_s(x)f_s(x)dx & \text{if } shirk\end{cases}$$

  - $f_s(x)$: 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 $\alpha_1<\alpha_2$ but:

$$\int_{-\infty}^{\infty}xf_s\left(x\right)dx > \int_{-\infty}^{\infty}xg_s(x)f_s\left(x\right)dx$$

Model

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

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

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

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

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

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

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

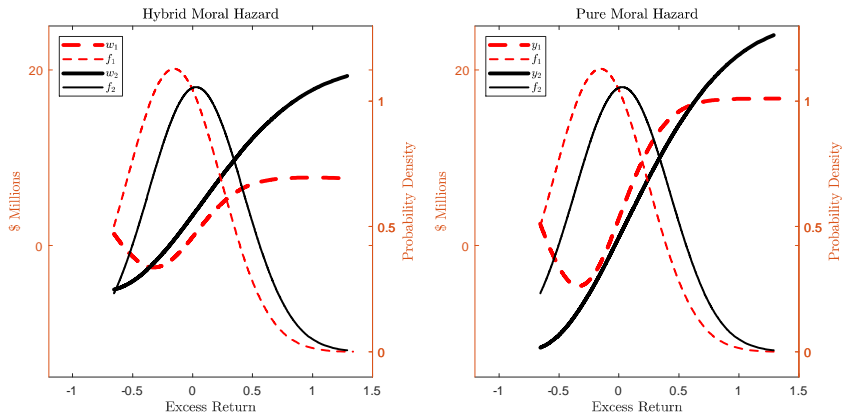 $$U\left(2, r = 2, j = 2\right) \geq U\left(2, r = 1, j = 1\right)$$

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

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

- Maximize expected return by liquidating or indirectly selecting CEO tasks subject to appropriate constraints.
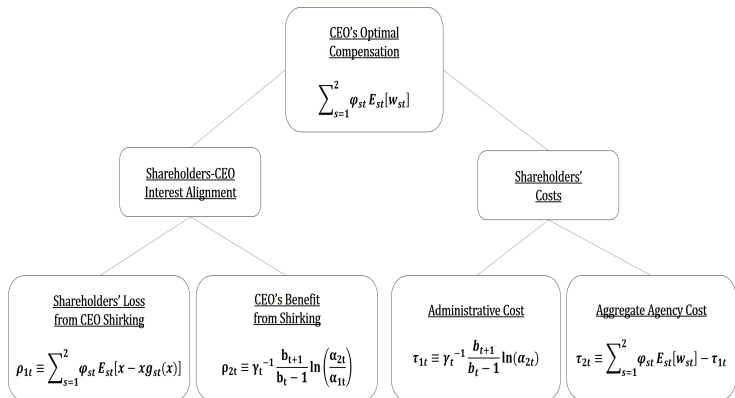
Model

Optimal Compensation for pure and hybrid models of moral hazard

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

CEO's Optimal
Compensation

$$\sum_{s=1}^{2} \varphi_{st} E_{st}[w_{st}]$$

Shareholders-CEO
Interest Alignment

Shareholders'
Costs

Shareholders' Loss
from CEO Shirking

$$\rho_{1t} \equiv \sum_{s=1}^{2} \varphi_{st} E_{st}[x - x g_{st}(x)]$$

CEO's Benefit
from Shirking

$$\rho_{2t} \equiv \gamma_t^{-1} \frac{b_{t+1}}{b_t - 1} \ln\left(\frac{\alpha_{2t}}{\alpha_{1t}}\right)$$

Administrative Cost

$$\tau_{1t} \equiv \gamma_t^{-1} \frac{b_{t+1}}{b_t - 1} \ln(\alpha_{2t})$$

Aggregate Agency Cost

$$\tau_{2t} \equiv \sum_{s=1}^{2} \varphi_{st} E_{st}[w_{st}] - \tau_{1t}$$

- Data on excess returns x, firm state s and compensation $w_s(x)$ when:
  - CEO works (otherwise compensation does not depend on x)
  - CEO is truthful (implied by optimal contracting)
- Hence $f_s(x)$ is trivially identified.
- To identify the remaining parameters γ and:

$$\theta(x) \equiv (\alpha_1, \alpha_2, g_1(x), g_2(x))$$

  1. Concentrate parameter space to risk aversion parameter γ:
     - use first order conditions, binding participation and incentive compatibility constraints to derive mapping $\theta(x, \gamma)$
     - if γ^* is true value then $\theta^*(x, \gamma)$ that are implied by the data generating process
  2. Derive maximal (tight and) sharp set for γ 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 2)

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

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)	Pre	Post - Pre
	(S,S)	(11.09, 11.31)	(-2.69, -1.96)
Primary	(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)
	(S,S)	(15.65, 16.28)	(-9.16, -8.72)
Consumer	(S,L)	(9.13, 13.15)	(2.12, 12.21)
Goods	(L,S)	(6.60, 9.13)	(-0.40, 1.54)
	(L,L)	(5.46, 7.58)	(-2.68, -2.11)
	(S,S)	(19.64, 20.25)	(-8.93, -6.34)
Service	(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)

$$\rho_2 \equiv b_{t+1} \left[(b_t - 1)\, \gamma \right]^{-1} \ln \left(\alpha_{2,pre} / \alpha_{1,pre} \right)$$

Sector	Size	Compliant		Noncompliant		DID
		(1)	(2)	(3)	(4)	(4) - (2)
		Pre	Post - Pre	Pre	Post - Pre	$\Delta\rho_2^{NC} - \Delta\rho_2^{C}$
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)

- The benefit from shirking became less differentiated across firm types.
- This is most evident when comparing noncompliant versus compliant firms.

How did SOX affect the Expected Cost of Compensation?
Administrative costs (in thousands of 2006 US$, Table 4)

$$\tau_1 \equiv \gamma^{-1} \frac{b_{t+1}}{b_t - 1} \ln \alpha_{2,pre}$$

Sector	Size	Compliant		Noncompliant		DID
		(1)	(2)	(3)	(4)	(4) - (2)
		Pre	Post - Pre	Pre	Post - Pre	$\Delta\tau_1^{NC} - \Delta\tau_1^{C}$
Primary	S	(2988, 3060)	(1917, 2095)	(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)

- In 5 out of 6 cases noncompliant firms benefited less or increased costs more than compliant firms when implementing SOX.

How did SOX affect the Expected Cost of Compensation?

Agency costs (in thousands of 2006 US$, Table 5)

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

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

SOX increased agency costs in 10 out of 12 categories.

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

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

- Controls
  - We (checked and) find no evidence the estimated risk aversion parameter changed.
  - We control 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 the treatment group.

- Limitations
  - CARA + "complete markets" aside from "market for effort" explicitly motivated by "optimal contracting"
    $\implies$ no role for CEO wealth + bond prices are "sufficient statistics" for economy aggregates
  - from "no accumulated learning from past performance" + complete markets assumption
    $\implies$ "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.)*