

# Empirics of Executive Compensation: What Determines CEO Pay?

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# Introduction: What We Do

- Adverse selection model of executive compensation
- Principal screens for talent using available measures for performance
- Structure of pay depends on the volatility of managerial productivity inside and outside the firm
- Talent as the manager's ability to handle idiosyncratic and aggregate shocks
- Empirical specification of CEO pay based on internal and external performance measures
- Factors that may influence the sensitivity of pay to performance

# Introduction: Modelling CEO Pay as Moral Hazard

- Holmstrom (1979)
  - First order approach versus the cost minimization of Grossman and Hart (1983)
  - Distribution conditional of modelling lower effort affects compensation through incentive compatibility, but it is difficult to recover from the data
- Holmstrom and Milgrom (1987)'s Brownian Model
  - Widely used in the executive pay literature: e.g., Gibbons and Murphy (1990), Aggarwal and Samwick (1999 JF, JPE), Jin (1999), Garvey and Milbourn (2003), Baker and Hall (2004)
  - Wages are linear in performance, but this is not a feature of CEO pay (stock options)
- Himmelberg and Hubbard (2000)
  - Non-linear wages derived by solving a second order Taylor approximation of the model

- Pay-Performance Sensitivity

- CEO wealth increases by \$3.25 for every \$1,000 increase in shareholder wealth (Jensen and Murphy [1990])
- Higher estimates by Hall and Liebman [1998] and Aggarwal and Samwick [1999])
- Pay-performance sensitivity has grown in the 1990s, but has decreased in late 2000s (Murphy [2013])

# Introduction: CEO Pay Puzzles (continued)

- Relative Performance Evaluation (Holmstrom [1982])
  - Little if any evidence
    - Antle and Smith (1986), Lambert and Larcker (1987), Gibbons and Murphy (1990), Barro and Barro (1990), Janakiraman, Lambert and Larcker (1992), Garen (1994), Joh (1999), Jo (2002), Aggarwal and Samwick (1999 JF, JPE)
  - Possible explanations:
    - CEO's ability to hedge against systematic risk (Feltham and Xie [1994], Maug [2000], Jin [2002], Garvey and Milbourn [2003])
    - Softening competition in imperfectly competitive product markets (Salas Fumas [1992], Aggarwal and Samwick [1999a])
    - Common shocks to marginal return of effort (Celentani and Loveira [2006])
    - Common shocks to reservation wages (Himmelberg and Hubbard [2000], Oyer [2004], Rajgopal, Shevlin and Zamora [2006])
    - Using the wrong benchmark (Bizjak, Lemmon and Naveen [2008], Albuquerque [2009], Faulkender and Yang [2010])
    - Rent extraction under captured boards of directors (Bertrand and Mullainathan [2001], Bebchuk and Fried [2003]).

- Role of CEO Age
  - Career concerns (Gibbons and Murphy [1992], Holmstrom [1999])
  - Proxy for CEO's ability to hedge against market risk (Garvey and Milbourn [2003])
- One-Dollar CEOs (in salaries)
  - Steve Jobs (Apple, 2009), Larry Ellison (Oracle, 2011), Mark Zuckerberg (Facebook, 2013)

- We consider an adverse selection model
- The principal seeks managers with extraordinary talent
- Talent,  $\tau$ , is related to the ability of the manager to handle productivity shocks
  - firm-specific shocks
  - aggregate shocks
- Manager's reservation wage increases in talent

## Model (continued)

- In particular, a risk-neutral principal minimizes the expected cost of hiring the most talented manager (with talent  $\bar{\tau}$ ):

$$\min_w E\{w|\bar{\tau}\} \text{ s.t.}$$

$$E\{u(w)|\bar{\tau}\} \geq u(\underline{w}(\bar{\tau})) \quad (1)$$

$$E\{u(w)|\tau\} \leq u(\underline{w}(\tau)), \forall \tau \leq \bar{\tau}, \quad (2)$$

where  $u$  is manager's utility,  $\underline{w}$  is the manager's reservation wage, and the wage  $w$  maps some measure of firm's performance  $v$  to  $\mathbb{R}$ .

$\min_w \int w(v)f(v|\bar{\tau})dv$  s.t.

$$\int u(w(v))f(v|\bar{\tau})dv \geq u(\underline{w}(\bar{\tau})) \quad (3)$$

$$\int u(w(v))f(v|\tau)dv \leq u(\underline{w}(\tau)), \forall \tau < \bar{\tau} \quad (4)$$

where  $f(v|\tau)$  is the density of performance  $v$  conditional on talent  $\tau$ .

- Talent as first-order stochastic dominance
- Focus on two types only
- Manager is risk-averse
- Strong monotonicity of the likelihood ratio, so monotone pay

**Proposition 1.** If  $|\underline{w}(\bar{\tau}) - \underline{w}(\underline{\tau})| \rightarrow 0$ , then the optimal wage becomes a constant

**Proposition 2.** If the principal can screen by another measure like sales, she will use it

**Proposition 3.** If the variance of the shock is big, then  $\beta$  is small [*under some assumptions*]

## Nature of the Shock

$$\theta = \prod_{i=1}^3 \theta_i, \text{ where}$$

$\theta_1$  is a firm-specific shock

$\theta_2$  is a sector shock

$\theta_3$  is an economy-wide shock

## Decomposing talent

$$\tau = \prod_{i=1}^3 \tau_i, \text{ where}$$

$\tau_1$  is talent for firm-specific innovation

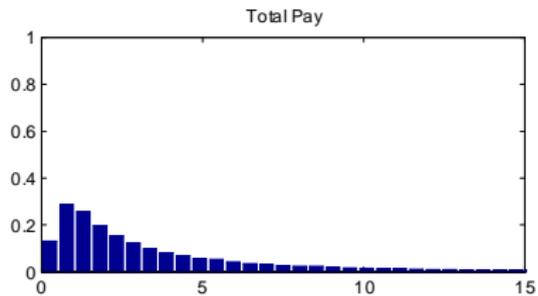
$\tau_2$  is talent for sector innovation

$\tau_3$  is talent for economy-wide innovation

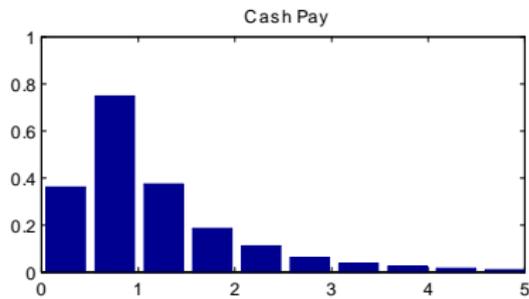
- CEO data from ExecuComp (October 2010):
  - S&P Composite 1500 (S&P 500, S&P Midcap 400, and S&P SmallCap 600)
  - June 1992 - August 2010
  - 5,789 CEOs from 3,068 companies for a total of 29,749 CEO-year matches
  - CEOs who are in office for at least two thirds of the fiscal year
- Balance Sheet data from Compustat
- Returns and market capitalizations from CRSP
- Inflation from Bureau of Labor Statistics: 2005 constant prices

- Levels
  - CEO total compensation measured at grant-date value
  - Cash Pay = Salary + Bonus
  - Equity-Based Pay = Stock + Stock Options (at Black-Scholes value)
- Ratio
  - Equity-Based Pay Ratio = Equity-Based Pay / (Cash Pay + Equity-Based Pay)
- Changes
  - $\log(\text{Total Pay at } t / \text{Total Pay at } t - 1)$
  - $\log(\text{Cash Pay at } t / \text{Cash Pay at } t - 1)$
  - $\log(\text{Equity-Based Pay at } t / \text{Equity-Based Pay at } t - 1)$

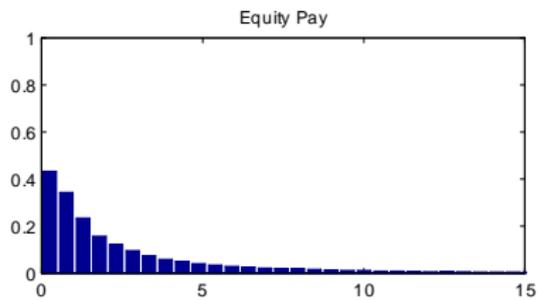
## Total CEO Pay



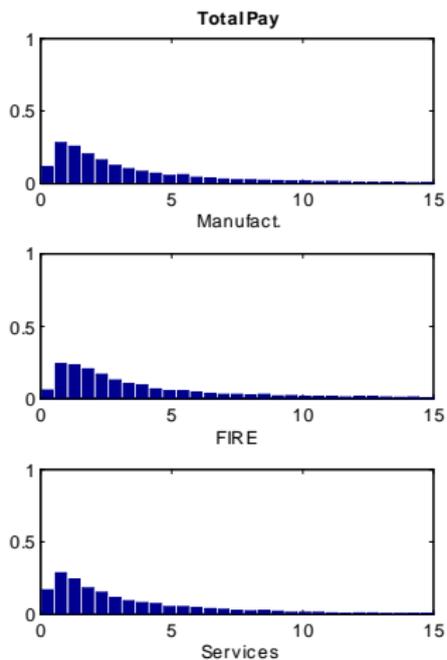
## Cash Pay



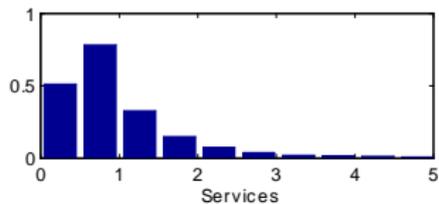
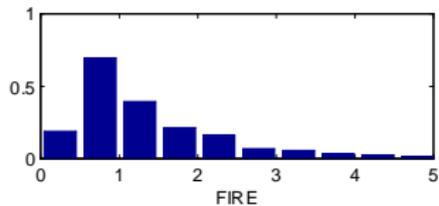
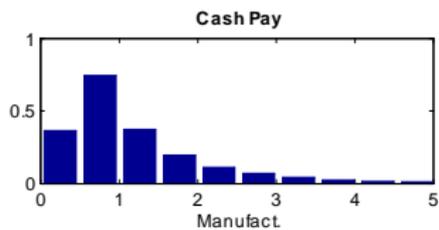
## Equity-Based Pay



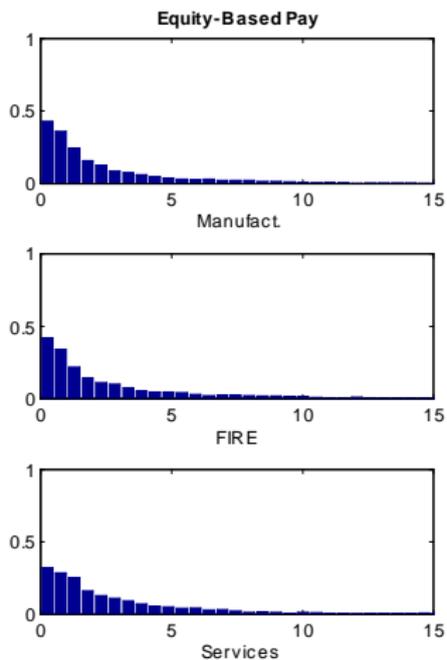
## Total CEO Pay for Selected Industries



## Cash Pay for Selected Industries



## Equity-Based Pay for Selected Industries

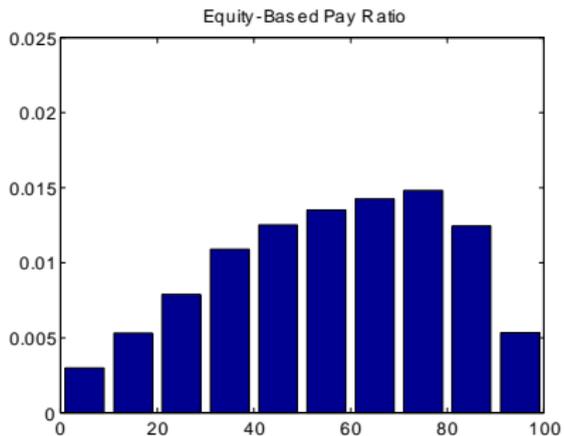


# CEO Pay and its Components across Industries

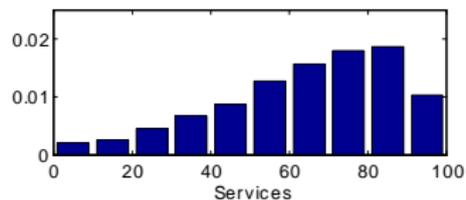
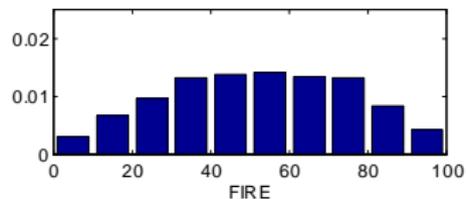
## CEO PAY

	Mining	Constr	Manuf	Transp	Whsale	Retail	FIRE	Services	ALL
<b>TOTAL PAY</b>									
mean	5,185	6,902	4,533	4,687	3,270	4,084	5,653	5,382	4,775
median	2,393	3,313	2,393	1,986	1,994	2,280	2,836	2,364	2,359
min	25	160	0	0	86	3	29	0	0
max	128,834	65,190	675,002	224,872	188,564	144,061	258,193	775,812	775,812
st.dev.	10,342	8,945	10,014	10,675	6,812	6,893	9,633	17,536	11,053
N	1,177	294	12,070	2,965	1,111	2,226	4,089	4,046	28,921
<b>CASH PAY</b>									
mean	1,519	2,835	1,277	1,275	1,087	1,241	1,864	1,123	1,344
median	903	1,130	919	916	892	943	1,108	780	917
min	0	155	0	0	86	0	31	0	0
max	72,393	32,433	47,660	22,152	9,316	10,073	126,155	19,070	126,155
st.dev.	3,818	4,313	1,323	1,580	752	1,003	3,266	1,290	1,927
N	1,193	301	12,298	2,996	1,138	2,265	4,151	4,156	29,578
<b>EQUITY PAY</b>									
mean	3,507	3,857	3,317	3,523	2,362	3,203	3,768	5,177	3,647
median	1,325	1,678	1,398	1,189	1,073	1,584	1,505	1,920	1,452
min	9	62	0	0	0	0	0	0	0
max	98,052	45,218	675,002	211,569	179,610	140,655	235,811	770,325	770,325
st.dev.	7,667	5,773	10,307	10,561	7,029	6,356	8,125	19,711	11,331
N	1,005	225	9,735	2,185	835	1,606	3,242	3,011	22,341

## Equity-Based Pay Ratio



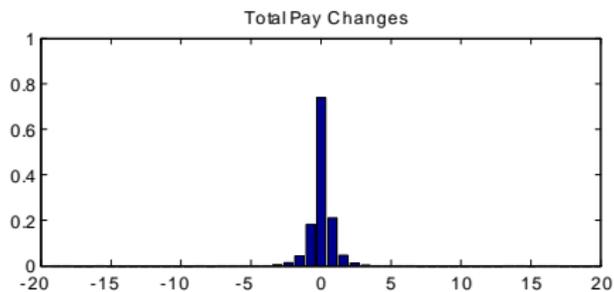
## Equity-Based Pay Ratio for Selected Industries



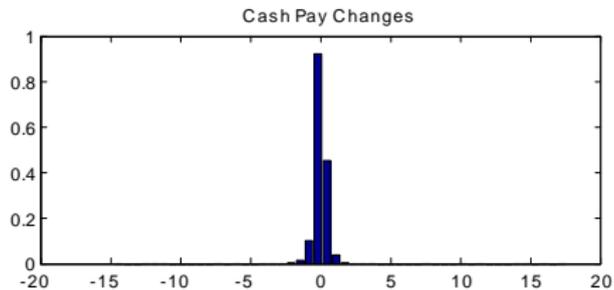
### EQUITY PAY RATIO

	Mining	Constr	Manuf	Transp	Whlsale	Retail	Finance	Services	ALL
<b>mean</b>	0.5574	0.5241	0.5581	0.5126	0.5184	0.5523	0.5198	0.6424	0.5583
<b>median</b>	0.5623	0.5438	0.5770	0.5183	0.5230	0.5733	0.5251	0.6806	0.5772
<b>min</b>	0.0130	0.0259	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
<b>max</b>	0.9870	0.9490	1.0000	1.0000	0.9944	0.9881	0.9988	1.0000	1.0000
<b>st.dev.</b>	0.2152	0.2321	0.2311	0.2520	0.2216	0.2353	0.2312	0.2243	0.2353
<b>N</b>	1002	225	9714	2171	835	1602	3222	2999	22267

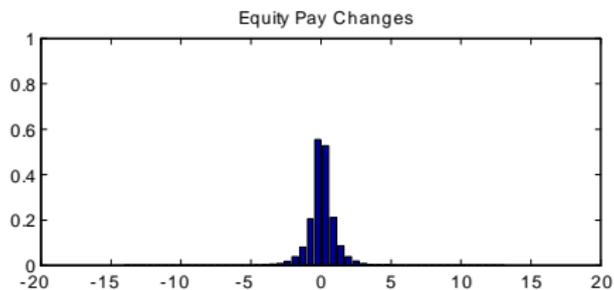
## Annual Change in CEO Total Pay



## Annual Change in Cash Pay



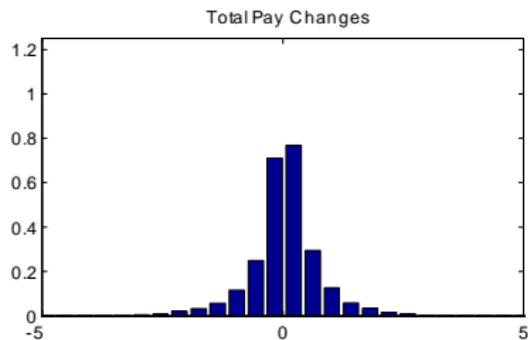
## Annual Change in Equity-Based Pay



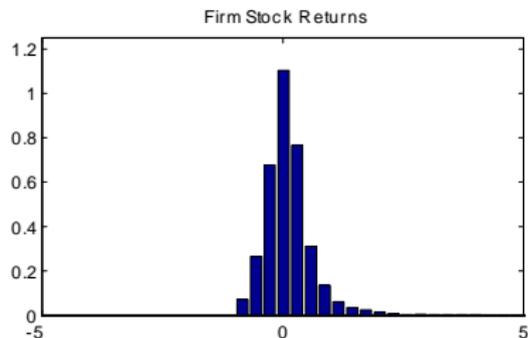
### PAY CHANGES

	Mining	Constr	Manuf	Transp	Whlsale	Retail	Finance	Services	All Sectors
<b>TOTAL PAY</b>									
mean	0.0916	0.0229	0.0351	0.0835	0.0423	0.0238	0.0240	0.0482	0.0439
median	0.0881	0.0784	0.0404	0.0678	0.0448	0.0238	0.0576	0.0344	0.0476
min	-3.3363	-3.1554	-18.1547	-6.2902	-3.8153	-7.2635	-6.8139	-19.3344	-19.3344
max	2.6220	3.3196	20.1791	16.0357	3.3114	3.2935	4.7048	16.9433	20.1791
st.dev.	0.6363	0.7774	0.7775	0.8123	0.6907	0.7453	0.6920	1.1807	0.8318
N	970	248	9770	2388	901	1811	3313	3219	23001
<b>CASH PAY</b>									
mean	0.0497	-0.0356	0.0134	0.0200	0.0134	-0.0084	-0.0027	0.0166	0.0120
median	0.0482	0.0646	0.0258	0.0333	0.0251	0.0019	0.0291	0.0255	0.0259
min	-3.3090	-3.7505	-14.6577	-3.8400	-1.8744	-11.4939	-6.3237	-14.7482	-14.7482
max	3.3249	2.0124	17.5624	2.4459	2.2729	2.3720	3.7649	14.0200	17.5624
st.dev.	0.3977	0.6549	0.6525	0.4078	0.3963	0.4670	0.4840	0.6532	0.5737
N	990	255	10055	2438	938	1864	3397	3362	23776
<b>EQUITY PAY</b>									
mean	0.1240	0.0862	0.0389	0.0773	0.0986	0.0146	0.0879	0.0230	0.0539
median	0.0956	-0.0088	0.0371	0.0692	0.0853	0.0138	0.0705	0.0254	0.0485
min	-4.3299	-2.5756	-14.1374	-12.1740	-11.6707	-11.8344	-6.9720	-13.3271	-14.1374
max	4.5282	2.6188	13.1514	5.1521	9.9727	12.6167	10.3401	7.3366	13.1514
st.dev.	0.8799	0.8699	1.0525	1.1111	1.1517	1.2035	0.9386	1.1524	1.0676
N	750	170	7087	1559	582	1117	2385	2018	15779

## Annual Change in CEO Total Pay



## Firm's Annual Stock Return



# Empirical Specification

## Internal and External Measures

- Internal measures
  - Idiosyncratic return
  - Firm's share in market sales
  
- External measures
  - Systematic return
  - Average CEO pay

$$\log\left(\frac{w_{i,t}}{w_{i,t-1}}\right) = a_0 + a_1 * \text{idiosyncratic log-return}_{i,t} + a_2 * \text{systematic log-return}_{i,t} + a_3 \log\left(\frac{\bar{w}_{i,t}}{\bar{w}_{i,t-1}}\right) + a_4 \log\left(\frac{s_{i,t}}{s_{i,t-1}}\right) + e_{t,i},$$

where  $w_{i,t}$  is CEO's pay,  $\bar{w}_{i,t}$  is the average CEO pay (excluding  $w_{i,t}$ ), and  $s_{i,t}$  is the market share of the firm

# Empirical Specification

## Results for Total Pay

	Panel A				Panel B			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Constant	-0.15 (0.182)	-0.19 (0.188)	-0.17 (0.165)	-0.21 (0.169)	-0.24 (0.212)	-0.26 (0.216)	-0.28 (0.203)	-0.28 (0.204)
Idiosyncratic return	0.30*** (0.015)	0.31*** (0.015)	0.28*** (0.015)	0.29*** (0.015)	0.33*** (0.015)	0.33*** (0.015)	0.31*** (0.016)	0.31*** (0.016)
Systematic return	0.19*** (0.029)	0.16*** (0.029)	0.18*** (0.030)	0.15*** (0.030)	0.26*** (0.054)	0.26*** (0.054)	0.24*** (0.055)	0.24*** (0.055)
Average CEO pay		0.20*** (0.025)		0.20*** (0.025)		0.05* (0.031)		0.06* (0.031)
Market share			0.23*** (0.027)	0.22*** (0.027)			0.21*** (0.027)	0.21*** (0.027)
N	21981	21943	21729	21698	21981	21943	21729	21698
R <sup>2</sup>	0.03	0.04	0.04	0.04	0.04	0.04	0.05	0.05
Adjusted R <sup>2</sup>	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04

# Empirical Specification

## Year Regressions for Total Pay

Fiscal Year	1993	1994	1995	1996	1997	1998	1999	2000	2001
Constant	0.06 (0.105)	0.31*** (0.099)	0.16*** (0.052)	0.21*** (0.073)	-0.05 (0.150)	0.22*** (0.047)	-0.09 (0.636)	-0.15 (0.213)	0.37** (0.170)
Idiosyncratic return	0.37*** (0.093)	0.41*** (0.087)	0.42*** (0.067)	0.46*** (0.076)	0.44*** (0.077)	0.31*** (0.054)	0.39*** (0.061)	0.34*** (0.05)	0.27*** (0.081)
Systematic return	1.29 (0.810)	-0.03 (0.469)	0.32* (0.167)	0.58*** (0.216)	0.65*** (0.191)	0.11 (0.19)	0.51* (0.284)	0.80* (0.437)	-0.01 (0.298)
Average CEO pay	-0.37 (0.429)	-0.19 (0.253)	-1.03*** (0.297)	0.04 (0.112)	0.02 (0.112)	0.12 (0.073)	0.07 (0.117)	0.00 (0.088)	-0.07 (0.074)
Market share	0.50*** (0.110)	0.13 (0.123)	0.13 (0.082)	0.05 (0.079)	0.20* (0.111)	0.09 (0.103)	0.46*** (0.115)	0.04 (0.101)	0.15* (0.088)
N	837	1111	1129	1201	1211	1272	1317	1251	1233
R <sup>2</sup>	0.15	0.13	0.10	0.11	0.11	0.10	0.14	0.08	0.09
Adjusted R <sup>2</sup>	0.08	0.08	0.04	0.05	0.05	0.05	0.10	0.03	0.04
Fiscal Year	2002	2003	2004	2005	2006	2007	2008	2009	
Constant	-0.02 (0.161)	-0.28** (0.125)	0.25 (0.163)	-0.46*** (0.177)	0.31** (0.153)	-0.29*** (0.039)	-0.06 (0.213)	-0.41*** (0.046)	
Idiosyncratic return	0.35*** (0.074)	0.33*** (0.090)	0.35*** (0.092)	0.41*** (0.069)	0.64*** (0.077)	0.31*** (0.056)	0.10*** (0.033)	0.18*** (0.057)	
Systematic return	0.52 (0.338)	0.22 (0.251)	0.93* (0.499)	-0.30 (0.414)	0.29 (0.241)	0.36 (0.285)	0.09 (0.121)	-0.01 (0.076)	
Average CEO pay	-0.10 (0.105)	0.12 (0.187)	-0.21 (0.159)	-0.38* (0.214)	-0.24 (0.254)	0.02 (0.210)	0.18 (0.311)	0.23 (0.180)	
Market share	0.25*** (0.094)	0.17 (0.129)	0.13 (0.126)	0.29** (0.118)	-0.17* (0.085)	0.04 (0.108)	0.25* (0.139)	0.35*** (0.086)	
N	1357	1370	1446	1358	1307	1362	1438	1445	
R <sup>2</sup>	0.07	0.04	0.05	0.11	0.10	0.11	0.07	0.14	
Adjusted R <sup>2</sup>	0.02	0.00	0.01	0.06	0.05	0.06	0.02	0.10	

# Empirical Specification

## Results for Cash Pay

	Panel A				Panel B			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Constant	-0.15 (0.176)	-0.17 (0.183)	-0.16 (0.155)	-0.18 (0.163)	-0.18 (0.181)	-0.15 (0.180)	-0.16 (0.160)	-0.16 (0.161)
Idiosyncratic return	0.21*** (0.010)	0.22*** (0.010)	0.20*** (0.010)	0.20*** (0.011)	0.22*** (0.010)	0.22*** (0.010)	0.20*** (0.011)	0.20*** (0.011)
Systematic return	0.07*** (0.019)	0.05*** (0.019)	0.07*** (0.020)	0.05** (0.019)	0.08** (0.037)	0.08** (0.037)	0.07* (0.038)	0.07* (0.038)
Average CEO pay		0.13*** (0.020)		0.12*** (0.020)		0.04* (0.025)		0.04* (0.025)
Market share			0.13*** (0.017)	0.13*** (0.017)			0.12*** (0.017)	0.12*** (0.017)
N	22589	22391	22321	22134	22589	22391	22321	22134
R <sup>2</sup>	0.03	0.03	0.03	0.04	0.08	0.08	0.08	0.08
Adjusted R <sup>2</sup>	0.03	0.03	0.03	0.03	0.07	0.07	0.08	0.08

# Empirical Specification

## Results for Equity-Based Pay

	Panel A				Panel B			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Constant	0.16*** (0.028)	0.12*** (0.028)	0.06* (0.031)	0.02 (0.031)	-0.01 (0.182)	-0.03 (0.188)	-0.12 (0.165)	-0.12 (0.169)
Idiosyncratic return	0.27*** (0.024)	0.28*** (0.024)	0.24*** (0.024)	0.25*** (0.024)	0.31*** (0.015)	0.31*** (0.015)	0.28*** (0.015)	0.28*** (0.015)
Systematic return	0.15*** (0.035)	0.10*** (0.035)	0.14*** (0.035)	0.09*** (0.035)	0.14** (0.029)	0.14** (0.029)	0.12* (0.030)	0.11* (0.030)
Average CEO pay		0.35*** (0.035)		0.34*** (0.035)		0.08** (0.025)		0.09** (0.025)
Market share			0.31*** (0.038)	0.31*** (0.037)			0.29*** (0.027)	0.29*** (0.027)
N	15354	15337	15207	15196	15354	15337	15207	15196
R <sup>2</sup>	0.02	0.02	0.02	0.03	0.04	0.04	0.04	0.05
Adjusted R <sup>2</sup>	0.01	0.02	0.02	0.03	0.03	0.03	0.04	0.04

# Empirical Specification

## Comment

- Equity-based pay is more sensitive to all four measures
- Static model of pay as a reasonable approximation

- Using dynamic bins: bottom 25 percent and top 25 percent
- Factors
  - Volatility measured as the standard deviation in firm's stock market returns
  - Size measured as total assets (alternatively, market cap, total sales, number of employees)
  - Technology
    - new-economy versus old-economy firms
    - R&D intensity (the ratio of R&D expense to net sales)
  - CEO age

# Factors

Volatility: Difference in Means

## VOLATILITY BINS

Year	TOTAL PAY (logged)					EQUITY-BASED PAY RATIO				
	mean		st. dev.		$\Delta$ in means	mean		st. dev.		$\Delta$ in means
	top 25%	bottom 25%	top 25%	bottom 25%		top 25%	bottom 25%	top 25%	bottom 25%	
1994	7.5100	7.5721	1.0121	0.9688	-0.0621	0.5067	0.3756	0.2011	0.2034	0.1311
1997	7.5008	7.9300	1.1118	0.9875	-0.4292	0.5726	0.4310	0.2389	0.2141	0.1416
2000	7.7387	8.2034	1.2521	1.0459	-0.4647	0.6218	0.5067	0.2438	0.2229	0.1151
2003	7.5201	7.9935	1.1761	0.9480	-0.4734	0.5839	0.4861	0.2230	0.1941	0.0978
2006	7.7534	8.1893	0.9989	1.3536	-0.4360	0.6483	0.6664	0.2321	0.2170	-0.0182
2009	7.6522	8.2581	0.9486	0.9730	-0.6059	0.5476	0.6715	0.2390	0.1902	-0.1239
<b>POOLED</b>	7.6038	8.0151	1.0919	1.0506	-0.4113	0.5830	0.5110	0.2336	0.2350	0.0720

# Factors

## Volatility: Regressions in Bins

	Panel A					Panel B				
	Bottom 25%	Top 25%	Difference	Two-Tailed	One-Tailed	Bottom 25%	Top 25%	Difference	Two-Tailed	One-Tailed
Constant	0.09 (0.075)	-0.21 (0.062)	-0.31 (0.097)			-0.04 (0.121)	-0.53*** (0.077)	-0.49 (0.144)	**	**
Idiosyncratic return	0.37*** (0.024)	0.28*** (0.039)	-0.09 (0.046)	**	**	0.42*** (0.024)	0.30*** (0.044)	-0.12 (0.050)	***	***
Systematic return	0.24*** (0.039)	0.15*** (0.051)	-0.10 (0.065)		*	0.31*** (0.067)	0.27*** (0.104)	-0.03 (0.124)		
Average CEO pay	0.22*** (0.047)	0.30*** (0.075)	0.08 (0.088)			0.06 (0.058)	0.07 (0.114)	0.01 (0.128)		
Market share	0.14*** (0.041)	0.23*** (0.065)	0.09 (0.076)		*	0.14*** (0.040)	0.18*** (0.065)	0.04 (0.076)		
N	5593	5109				5593	5109			
R <sup>2</sup>	0.05	0.05				0.06	0.07			
Adjusted R <sup>2</sup>	0.04	0.04				0.05	0.05			

- Smaller mean total compensation for high-volatility firms
- Higher equity-based pay ratio for high-volatility firms
- Sensitivity of CEO pay to firm's idiosyncratic return is significantly higher for low-volatility firms than for high-volatility firms
- Aggarwal and Samwick (1999b): trade-off between providing incentives and minimizing agent's exposure to risk.
- Holmstrom (1979): the compensation weight of a performance measure is positively related to its signal-to-noise ratio (e.g., Lambert and Larcker [1987])

# Factors

Size: Difference in Means

## SIZE BINS

Year	TOTAL PAY (logged)					EQUITY PAY RATIO				
	mean		st. dev.		$\Delta$ in means	mean		st. dev.		$\Delta$ in means
	top 25%	bottom 25%	top 25%	bottom 25%		top 25%	bottom 25%	top 25%	bottom 25%	
1994	8.1768	6.9359	0.8915	0.8088	1.2409	0.4587	0.4851	0.1889	0.2476	-0.0264
1997	8.5754	7.0351	0.9771	1.0159	1.5402	0.5290	0.5633	0.2220	0.2498	-0.0343
2000	8.8378	7.1900	1.4301	1.1019	1.6479	0.6485	0.5713	0.1901	0.2579	0.0772
2003	8.7361	7.0805	1.2623	0.9605	1.6555	0.5810	0.4951	0.1867	0.2401	0.0858
2006	8.8693	7.2593	1.3077	0.7544	1.6099	0.7483	0.5858	0.1799	0.2235	0.1625
2009	8.5743	7.1631	1.0219	0.7822	1.4113	0.7172	0.5467	0.1927	0.2104	0.1705
<b>POOL</b>	8.5914	7.0781	1.2922	0.9144	1.5134	0.6005	0.5402	0.2234	0.2390	0.0603

# Factors

## Size: Regressions in Bins

	Bottom 25%	Top 25%	Difference	Two-Tailed	One-Tailed	Bottom 25%	Top 25%	Difference	Two-Tailed	One-Tailed
Constant	-0.39*** (0.173)	0.14** (0.175)	0.53 (0.246)	***	***	-0.53*** (0.165)	0.02 (0.185)	0.55 (0.248)	**	***
Idiosyncratic return	0.27*** (0.035)	0.31*** (0.026)	0.05 (0.043)			0.28*** (0.039)	0.33*** (0.026)	0.05 (0.047)		
Systematic return	0.14*** (0.049)	0.20*** (0.053)	0.05 (0.072)			0.28*** (0.106)	0.36*** (0.095)	0.08 (0.142)		
Average CEO pay	0.20*** (0.042)	0.41*** (0.054)	0.21 (0.068)	**	***	0.07 (0.064)	0.30*** (0.063)	0.22 (0.090)	*	**
Market share	0.26*** (0.049)	0.11* (0.042)	-0.14 (0.065)	*	**	0.23*** (0.049)	0.11 (0.040)	-0.12 (0.064)		*
N	4790	5802				4790	5802			
R <sup>2</sup>	0.07	0.04				0.09	0.05			
Adjusted R <sup>2</sup>	0.06	0.03				0.07	0.03			

- Mean CEO pay is higher in big firms
- Equity-based pay ratio is higher in big firms
- Big firms, unlike small firms, set compensation that is more sensitive to average wages and less sensitive to firm's market share.
- Size and talent: Gabaix and Landier (2008)

# Factors

## New Economy: Difference in Means

	TOTAL PAY (logged)		EQUITY-BASED PAY RATIO	
	Old-Econ	New-Econ	Old-Econ	New-Econ
mean	7.8224	7.8157	0.5476	0.6864
median	7.7859	7.7848	0.5620	0.7278
st.dev.	1.0984	1.4279	0.2288	0.2105
N	12585	2737	10171	2106
$\Delta$ in means	0.0067		-0.1388	

# Factors

## New Economy: Regressions

	Panel A					Panel B				
	Old-Econ	New-Econ	Difference	Two-Tailed	One-Tailed	Old-Econ	New-Econ	Difference	Two-Tailed	One-Tailed
Constant	0.08 (0.056)	0.04 (0.039)	-0.04 (0.068)			0.16* (0.095)	-0.35 (0.419)	-0.52 (0.430)		
Idiosyncratic return	0.26*** (0.020)	0.34*** (0.052)	0.08 (0.056)		*	0.29*** (0.021)	0.37*** (0.053)	0.08 (0.057)		*
Systematic return	0.12*** (0.031)	0.28*** (0.096)	0.16 (0.101)		*	0.21*** (0.057)	0.46*** (0.165)	0.26 (0.174)		*
Average CEO pay	0.19*** (0.035)	0.36*** (0.086)	0.17 (0.093)	*	**	0.04 (0.043)	0.20** (0.101)	0.17 (0.110)		*
Market share	0.24*** (0.034)	0.20** (0.094)	-0.04 (0.100)			0.22*** (0.033)	0.13 (0.086)	-0.09 (0.092)		
N	9855	2041				9855	2041			
R <sup>2</sup>	0.05	0.05				0.06	0.07			
Adjusted R <sup>2</sup>	0.04	0.05				0.05	0.06			

# Factors

## New Economy: Results

- Equity-based pay ratio is higher in new-economy firms
- The pay of the CEOs in new-economy firms is more sensitive to systematic returns and especially market-average pay than the compensation of CEOs in old economy firms.

# Factors

## Technology: Difference in Means

### TECHNOLOGY BINS

Year	TOTAL PAY (logged)					EQUITY-BASED PAY RATIO				
	mean		st. dev.		$\Delta$ in means	mean		st. dev.		$\Delta$ in means
	top 25%	bottom 25%	top 25%	bottom 25%		top 25%	bottom 25%	top 25%	bottom 25%	
1994	7.4139	7.7392	1.0090	0.8296	-0.3252	0.5755	0.4555	0.1969	0.2027	0.1199
1997	7.4410	7.9642	1.1586	0.9353	-0.5232	0.6838	0.4759	0.1984	0.2226	0.2080
2000	7.9232	8.1138	1.5655	1.0800	-0.1906	0.7525	0.5570	0.2139	0.2325	0.1955
2003	7.7027	8.0276	1.1600	0.9818	-0.3249	0.6864	0.4987	0.1939	0.2035	0.1877
2006	7.8848	8.3054	1.1462	0.8854	-0.4206	0.7394	0.6573	0.1717	0.2080	0.0822
2009	7.8041	8.2385	1.0840	0.8928	-0.4343	0.6756	0.6625	0.2022	0.2060	0.0131
<b>POOLED</b>	7.6999	8.0140	1.2477	0.9552	-0.3141	0.6846	0.5299	0.1993	0.2282	0.1547

# Factors

## Technology: Regressions in Bins

	Panel A					Panel B				
	Bottom 25%	Top 25%	Difference	Two-Tailed	One-Tailed	Bottom 25%	Top 25%	Difference	Two-Tailed	One-Tailed
Constant	0.19*** (0.046)	-0.31* (0.188)	-0.5 (0.194)	***	***	0.15 (0.101)	-0.45** (0.199)	-0.61 (0.223)	***	***
Idiosyncratic return	0.25*** (0.037)	0.32*** (0.048)	0.07 (0.06)			0.27*** (0.037)	0.32*** (0.047)	0.05 (0.060)		
Systematic return	0.18*** (0.052)	0.24*** (0.08)	0.07 (0.096)			0.22*** (0.081)	0.43*** (0.142)	0.22 (0.163)		*
Average CEO pay	0.14*** (0.053)	0.23** (0.090)	0.09 (0.105)			0.03 (0.058)	-0.01 (0.110)	-0.04 (0.124)		
Market share	0.29*** (0.075)	0.18*** (0.056)	-0.12 (0.094)			0.26*** (0.078)	0.14** (0.055)	-0.12 (0.096)		*
N	2306	2095				2306	2095			
R <sup>2</sup>	0.08	0.06				0.10	0.08			
Adjusted R <sup>2</sup>	0.06	0.05				0.07	0.07			

- Mean CEO pay is lower in high-technology firms
- Equity-based pay ratio is higher in high-technology firms
- Sensitivites differ along the lines of new-economy vs. old-economy firm, but differences are insignificant

# Factors

## CEO Age: Difference in Means

### CEO AGE BINS

Year	TOTAL PAY (logged)					EQUITY-BASED PAY RATIO				
	mean		st. dev.		$\Delta$ in means	mean		st. dev.		$\Delta$ in means
	top 25%	bottom 25%	top 25%	bottom 25%		top 25%	bottom 25%	top 25%	bottom 25%	
1994	7.8728	7.4409	0.8725	0.9335	0.4318	0.4034	0.4884	0.1980	0.2167	-0.0850
1997	7.9798	7.6894	1.0525	1.1016	0.2905	0.4750	0.5233	0.2206	0.2314	-0.0483
2000	8.0932	7.7959	1.2645	1.3123	0.2974	0.5313	0.6227	0.2304	0.2523	-0.0914
2003	8.0679	7.7606	1.1324	1.1902	0.3072	0.5091	0.5718	0.2165	0.2118	-0.0627
2006	8.0002	8.0331	1.4094	1.1027	-0.0329	0.6367	0.6973	0.2223	0.1894	-0.0606
2009	7.9138	7.7945	1.0700	0.9191	0.1194	0.6165	0.6409	0.2257	0.1894	-0.0245
<b>POOLED</b>	7.9975	7.7706	1.1554	1.1610	0.2269	0.5469	0.5974	0.2286	0.2273	-0.0505

# Factors

## CEO Age: Regressions in Bins (Idiosyncratic and systematic return)

	Panel A					Panel B				
	Bottom 25%	Top 25%	Difference	Two-Tailed	One-Tailed	Bottom 25%	Top 25%	Difference	Two-Tailed	One-Tailed
Constant	-0.34*	-0.12	0.22			-0.47**	-0.34	0.13		
	(0.197)	(0.228)	(0.301)			(0.203)	(0.232)	(0.308)		
Idiosyncratic return	0.29***	0.26***	-0.03			0.30***	0.28***	-0.03		
	(0.038)	(0.023)	(0.045)			(0.039)	(0.024)	(0.045)		
Systematic return	0.06	0.15***	0.09			0.09	0.22***	0.13		
	(0.076)	(0.037)	(0.084)			(0.134)	(0.073)	(0.152)		
Average CEO pay	0.29***	0.14***	-0.15	*	**	0.08	0.00	-0.08		
	(0.081)	(0.034)	(0.088)			(0.098)	(0.041)	(0.107)		
Market share	0.32***	0.18***	-0.14	*	**	0.28***	0.17***	-0.11		*
	(0.067)	(0.043)	(0.080)			(0.065)	(0.042)	(0.077)		
N	3769	7339				3769	7339			
R <sup>2</sup>	0.05	0.04				0.06	0.05			
Adjusted R <sup>2</sup>	0.03	0.03				0.04	0.04			

- Mean CEO pay is higher for older executives
- Equity-based pay ratio is lower for older executives
- The pay of younger CEOs is more sensitive to market share and market average pay than the pay of older CEOs.
- Garvey and Milbourn (2003)
- Gibbons and Murphy (1992)

# Robustness: Simpler Return Decomposition

- Alternative, simpler decomposition of firm's stock return:
  - relative return = firm's return less market return
  - market return
- This specification circumvents estimating idiosyncratic and systematic return components by setting each company's beta equal to 1

$$\log\left(\frac{w_{i,t}}{w_{i,t-1}}\right) = b_0 + b_1 * (\text{firm's log-return}_{i,t} - \text{market log-return}) + b_2 * \text{market log-return}_t + b_3 \log\left(\frac{\bar{w}_{-i,t}}{\bar{w}_{-i,t-1}}\right) + b_4 \log\left(\frac{s_{i,t}}{s_{i,t-1}}\right) + \epsilon_{t,i}$$

	Panel A				Panel B			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Constant	-0.22 (0.184)	-0.22 (0.174)	-0.24 (0.185)	-0.23 (0.175)	-0.28 (0.207)	-0.29 (0.209)	-0.31 (0.213)	-0.31 (0.210)
Firm less market return	0.30*** (0.015)	0.31*** (0.015)	0.28*** (0.015)	0.28*** (0.015)	0.32*** (0.016)	0.32*** (0.016)	0.30*** (0.016)	0.30*** (0.016)
Market return	0.18*** (0.028)	0.12*** (0.028)	0.18*** (0.028)	0.12*** (0.028)	0.24** (0.103)	0.20** (0.101)	0.23** (0.102)	0.20** (0.099)
Average CEO pay		0.23*** (0.026)		0.21*** (0.025)		0.07** (0.030)		0.07** (0.030)
Market share			0.24*** (0.027)	0.23*** (0.027)			0.21*** (0.027)	0.21*** (0.027)
N	22459	22420	22193	22161	22459	22420	22193	22161
R <sup>2</sup>	0.03	0.04	0.04	0.04	0.04	0.04	0.05	0.05
Adjusted R <sup>2</sup>	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04

# Robustness: Simpler Return Decomposition

- Note that the specification can be derived in a setting where the CEO is paid for both relative and absolute performance

$$\log\left(\frac{w_{i,t}}{w_{i,t-1}}\right) = c_0 + c_1 * (\text{firm's log-return}_{i,t} - \text{market log-return}_t) + c_2 * \text{firm's log-return}_{i,t} + c_3 \log\left(\frac{\bar{w}_{i,t}}{\bar{w}_{i,t-1}}\right) + c_4 \log\left(\frac{s_{i,t}}{s_{i,t-1}}\right) + \varepsilon_{t,i},$$

Just take  $c_1 = b_1 - b_2$  and  $c_2 = b_2$ .

# Robustness: Industry Share and Industry Average CEO Pay

## Total Pay

	Panel A				Panel B			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Constant	-0.15 (0.182)	-0.34*** (0.076)	0.05 (0.041)	0.03 (0.053)	-0.24 (0.212)	-0.31 (0.365)	-0.02 (0.115)	0.05 (0.358)
Idiosyncratic return	0.30*** (0.015)	0.28*** (0.018)	0.29*** (0.016)	0.27*** (0.018)	0.33*** (0.015)	0.30*** (0.019)	0.32*** (0.016)	0.29*** (0.019)
Systematic return	0.19*** (0.029)	0.16*** (0.033)	0.20*** (0.028)	0.16*** (0.033)	0.26*** (0.054)	0.27*** (0.068)	0.28*** (0.052)	0.25*** (0.069)
Industry average CEO pay		0.17*** (0.024)		0.16*** (0.025)		0.07*** (0.027)		0.07*** (0.027)
Industry share			0.11*** (0.019)	0.11*** (0.025)			0.09*** (0.019)	0.09*** (0.025)
N	21981	14801	19831	14357	21981	14801	19831	14357
R <sup>2</sup>	0.03	0.04	0.04	0.04	0.04	0.05	0.05	0.05
Adjusted R <sup>2</sup>	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04

- Estimates are similar to our main specification
- The sensitivity to the average CEO pay in the sector remains significant at 0.01 when we add year dummies

# Robustness: Cash Pay (Broader Measure)

	Panel A				Panel B			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Constant	0.02	0.01	0.00	-0.01	0.26	0.25	0.24	0.24
Idiosyncratic return	0.26***	0.26***	0.24***	0.25***	0.26***	0.26***	0.25***	0.25***
Systematic return	0.21***	0.20***	0.20***	0.20***	0.22***	0.22***	0.21***	0.21***
Average CEO pay		0.04***		0.04**		0.01		0.01
Market share			0.14***	0.14***			0.13***	0.13***
N	22562	22364	22293	22106	22562	22364	22293	22106
R <sup>2</sup>	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06
Adjusted R <sup>2</sup>	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06

# Robustness: Equity-Based Pay (Raised by \$1,000)

	Panel A				Panel B			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Constant	-0.66	-0.74	-0.70	-0.78	-1.24	-1.29	-1.32	-1.33
Idiosyncratic return	0.44***	0.45***	0.41***	0.42***	0.51***	0.51***	0.48***	0.49***
Systematic return	0.09	0.03	0.07	0.01	0.29*	0.29*	0.25*	0.25*
Average CEO pay		0.44***		0.44***		0.04		0.05
Market share			0.34***	0.33***			0.28***	0.28***
N	22030	21992	21777	21746	22030	21992	21777	21746
R <sup>2</sup>	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Adjusted R <sup>2</sup>	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01

# Robustness: Return on CEO's Firm-Related Wealth

	Panel A				Panel B			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Constant	-0.17	-0.14	0.04	0.07	0.21	0.22	0.44**	0.44**
Idiosyncratic return	0.96***	0.95***	1.00***	0.99***	0.93***	0.93***	0.98***	0.98***
Systematic return	0.93***	0.96***	0.96***	0.98***	1.06***	1.06***	1.12***	1.12***
Average CEO pay		-0.20***		-0.19***		0.00		0.00
Market share			-0.43***	-0.43***			-0.42***	-0.42***
N	16426	16420	16244	16244	16426	16420	16244	16244
R <sup>2</sup>	0.28	0.28	0.30	0.30	0.35	0.35	0.36	0.36
Adjusted R <sup>2</sup>	0.28	0.28	0.29	0.30	0.34	0.34	0.36	0.36

# Robustness: Percentage Change in Compensation

	Panel A				Panel B			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Constant	2.14	2.94	6.75	7.38	5.75	6.93	11.65	11.71
Idiosyncratic return	26.99***	26.91***	28.14***	28.06***	26.75***	26.77***	27.98***	27.99***
Systematic return	22.90***	23.56***	23.25***	23.79***	23.29***	23.53***	24.30***	24.51***
Average CEO pay		-4.50***		-3.77**		-2.81		-2.29
Market share			-11.71***	-11.58***			-11.48***	-11.47***
N	16584	16578	16399	16399	16584	16578	16399	16399
R <sup>2</sup>	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Adjusted R <sup>2</sup>	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07

# Robustness. Differences between Regression Coefficients (Dropping factor outliers when forming bins)

- Consider excluding the top and bottom 1 percent as follows
  - if, for example, we consider top and bottom 25 percent bins, say, for CEO age:
    - the top bin contains CEOs with age between the 75 and 99th percentile
    - the bottom bin contains CEOs with age between the 1 and 25th percentile

# Factors. Differences between Regression Coefficients (Dropping factor outliers when forming bins)

Top 25% and Bottom 25% Bins

**Top 25% Bin Regression Coefficient LESS Bottom 25% Bin Regression Coefficient**  
**Top 1% Excluded from the Top Bin, Bottom 1% Excluded from the Bottom Bin**

	Panel A					Panel B				
	Volat	Size	New Less Old Econ	Tech	Age	Volat	Size	New Less Old Econ	Tech	Age
Constant	-0.33	0.53***	-0.04	-0.01	0.22	-0.49*	0.58***	-0.52	-0.04	0.17
Idiosyncratic return	-0.09**	0.05	0.08	0.05	-0.02	-0.11**	0.06	0.08	0.01	-0.02
Systematic return	-0.12	0.07	0.16	0.08	0.11	-0.08	0.10	0.26	0.24	0.15
Average CEO Pay	0.07	0.19**	0.17*	0.07	-0.15	-0.01	0.22*	0.17	-0.05	-0.07
Market Share	0.08	-0.15*	-0.04	-0.03	-0.17**	0.03	-0.13*	-0.09	-0.05	-0.14*

# Empirical Specification: Sub-Period Regressions

## Total Pay

TABLE 6. TOTAL PAY REGRESSIONS FOR SUBPERIODS

	1992-1999	2000-2005	2006-2010	ALL YEARS
constant	0.08***	0.01	0.00	0.04***
idiosyncratic return	0.36***	0.31***	0.20***	0.29***
systematic return	0.26***	0.20***	0.03	0.16***
outside option	0.13***	0.13***	0.22**	0.20***
market share	0.20***	0.22***	0.22***	0.23***
N	8078	8015	5605	21698
R2	0.0561	0.0363	0.0238	0.0402
Adj. R2	0.0556	0.0359	0.0231	0.0400

	1992-2005	2006-2010	ALL YEARS
constant	0.04***	0.00	0.04***
idiosyncratic return	0.32***	0.20***	0.29***
systematic return	0.29***	0.03	0.16***
outside option	0.16***	0.22**	0.20***
market share	0.22***	0.22***	0.23***
N	16093	5605	21698
R2	0.0456	0.0238	0.0402
Adj. R2	0.0453	0.0231	0.0400

\*\*\*, \*\*, \* significance at 0.01, 0.05, 0.10. Using robust standard errors clustered by firm. No sector dummies.

- Adverse selection model of executive compensation
- The structure of pay depends on the uncertainty about firm's productivity and manager's reservation wage
- Decomposing productivity shocks and talent into idiosyncratic and aggregate components suggests the use of alternative measures of firm's performance
- In the empirical part, we consider internal measures such as idiosyncratic return and change in firm's market share based on sales, and external measures such as systematic return and changes in average CEO pay.
- We consider factors such as firm's volatility, size, technology and CEO age and confirm the predictions of the model