

Lower Salaries and No Options? On the Optimal Structure of Executive Pay

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The Question

- CEO pay consists of stock, options, base salary, bonus, and other contributions
- What is the optimal structure of executive pay?
- Should CEOs receive options as part of their compensation?

Some Practitioners are Sceptical

"We don't give options because it would be a lottery ticket."

Warren Buffet, Berkshire Hathaway

"There will be no new stock option grants from Microsoft. Instead, we will award actual stock to our employees."

Steve Ballmer, Microsoft

Are Options Cheap or Expensive?

Perspective 1

- Generate incentives with options
 - How does CEO utility change with firm value?

$$UPPS = \frac{\partial}{\partial P_0} E[U(W_T)]$$

- Results (Hall and Murphy, 2000):
 - CEOs get leveraged instrument
 - Incentives generated by 1\$ of cash outlay are always larger with options than with stock
 - Options are *cheap*!

Are Options Cheap or Expensive?

Perspective 2

- Compensate CEOs with options
- Compute certainty equivalent values of options

$$U(W_0 + V) = E[U(W_0 + n_o \max[P_T - K, 0])]$$

- Results (Lambert, Larcker und Verrecchia, 1991):
 - CEOs value options much less than market
 - Typically 60%-80% discount relative to Black-Scholes Price
 - Options are *expensive!*

Options: Cheap or Expensive?

A Simple Example

	Stock	Options
Market Value	\$100	\$95
Subjective Value	\$40	\$25
Risk Premium	\$60	\$70

- Options are a "cheap" form of providing incentives: (\$100 > \$95)
 - Relevant in model with rigid base salaries
- Options are an "expensive" form of compensation
 - \$60 < \$70: relevant if salaries can be reduced

Research Strategy

- Formulate principal-agent model
 - CRRA-utility, lognormal prices
 - Contracts with base salary, stock, options
- Calibrate model to actual data on 598 US CEOs
 - Estimate wealth and representative option
 - Grid on relative risk aversion
- Compute optimal contract numerically
 - Analyze deviations from actual (observed) contracts

Main Results

- Optimal Contracts almost *never* include options
 - But 96.5% of the sample CEOs have some options!
 - Use stock instead to provide incentives
- Model implies lower base salaries
 - ...and negative base salaries in many plausible cases
 - CEOs need to invest private wealth in their companies
- What does this mean?
 - Either the world is inefficient
 - ...or the model is incorrect

Literature

The "conventional model"

- CRRA-lognormal models are widely used in applications (optimal strike price, repricing, reloading, indexing):
 - Lambert, Larcker, Verrecchia (1991)
 - Hall and Murphy (2001), (2002)
 - Hall and Knox (2002)
 - Jenter (2001)
 - Huddart (1994, binomial)
 - Carpenter (1998, binomial)
 - Tian (2001, geometric Brownian motion)
 - Johnson and Tian (2000a, 2000b, geom. Brown. m.)

Outline of the Talk

- (1) Introduction
- (2) Model and its empirical implementation
- (3) Dataset and model calibration
- (4) Optimal non-concave contracts
- (5) Optimal unrestricted contracts
- (6) Alternative explanations
- (7) Conclusions

The Model: Setup

- Stock Prices are log-normal:

$$P_T = P_0(e) \exp\left\{\left(r_f - \frac{\sigma^2}{2}\right)T + u\sigma\sqrt{T}\right\}, \quad u \sim N(0,1)$$

- Permissible contracts: (ϕ, n_S, n_O)

$$W_T = (\phi + W_0) \exp\{r_f T\} + n_S P_T + n_O \max(P_T - K, 0)$$

- Separable preferences:

$$U(W_T, e) = \frac{W_T^{1-\gamma}}{1-\gamma} - C(e)$$

The Model: Risk-neutral pricing

- Assume risk-neutral pricing

$$P_T = P_0(e) \exp\left\{\left(r_f - \frac{\sigma^2}{2}\right)T + u\sigma\sqrt{T}\right\}, \quad u \sim N(0,1)$$

- More realistic: expected return is $\mu > r_f$
- But then CEO must be able to invest in market
 - otherwise CEO will overvalue own stock
 - incoherent results
- Modelling the market requires additional r.v.
 - extreme numerical complication

The Model: Two-stage solution

- Two-stage solution (Grossman-Hart, 1983), minimize:

$$\pi_0 = \exp(-r_f T) E(\pi_T) = \phi + n_s P_0 + n_o BS$$

s. t. :

- IC constraint
 - PC constraint
- We only need the first stage

The Model: IC constraint

- Replace IC constraint with first-order condition
 - Need to check that this is ok later.

$$\frac{\partial}{\partial e} E[U(W_T, e^*)] = E \left[\underbrace{\left[\frac{\partial U}{\partial P_T} \right] \frac{\partial P_T}{\partial P_0} \frac{\partial P_0}{\partial e}}_{\text{UPPS}} - \frac{\partial C(e^*)}{\partial e} \right] = 0$$

- Define utility-adjusted pay for performance sensitivity:

$$UPPS = \frac{\partial}{\partial P_0} E[U(W_T, e^*)] = k(e^*)$$

The final program

- Hence, we need to solve this program numerically:

$$\text{Min}_{(\phi, n_S, n_O)} \phi + n_S P_0 + n_O BS$$

$$\text{s.t. } E[V(W_T(\phi, n_S, n_O); \gamma)] = E[V(W_T(\phi^d, n_S^d, n_O^d); \gamma)]$$

$$UPPS(W_T(\phi, n_S, n_O); \gamma) = UPPS(W_T(\phi^d, n_S^d, n_O^d); \gamma)$$

$$0 \leq n_S \leq 1, \quad n_O \geq 0, \quad \phi \geq -W_0$$

- Can we find a cheaper contract, that
 - provides the same incentives, and
 - provides the same utility to the CEO?

Data

- Use CompuStat ExecuComp
 - Generated from Proxy Statements
 - 1.696 CEOs in 2000
 - Require 5 years of continuous history
 - Estimate wealth from previous years' income
 - Reconstruct approximate option portfolios
 - Aggregate into „representative option“
- We are left with 598 CEOs

The Sample

Variable	Symbol	Mean	Median	Std. Dev.	Minimum	Maximum
Age of CEO		57	57	7	36	84
Base Salary (\$ '000)	ϕ	2,037	1,261	2,570	97	22,109
Stock (%)	n_S	2.29%	0.29%	6.00%	0.00%	46.34%
Options (%)	n_O	1.29%	0.84%	1.82%	0.00%	24.32%
Wealth (\$ mil.)	W_0	34.60	6.86	234.79	0.03	5,431.72
Option Delta	$N(d_1)$	0.834	0.856	0.126	0.001	1.000
Maturity (years)	T	5.89	5.54	1.96	1.20	22.18
Market Value (\$ mil.)	P_0	9,857	1,668	27,845	7	280,114
Stock Price Volatility	σ	0.377	0.335	0.196	0.136	3.487

Result 1

Option and Stock Holdings in Optimal Contracts

Risk aversion	Option holdings		Fraction with options > 0	Stock holdings	
	Mean	Median		Mean	Median
0.5	0.069%	0.000%	17.45%	3.186%	1.035%
1	0.041%	0.000%	11.39%	3.089%	0.987%
2	0.013%	0.000%	5.18%	2.897%	0.829%
3	0.003%	0.000%	1.34%	2.746%	0.724%
4	0.001%	0.000%	0.33%	2.639%	0.640%
5	0.000%	0.000%	0.00%	2.563%	0.570%
6	0.000%	0.000%	0.00%	2.508%	0.513%
8	0.000%	0.000%	0.00%	2.438%	0.441%
10	0.000%	0.000%	0.00%	2.396%	0.414%
observed	1.294%	0.840%	96.49%	2.291%	0.294%

Result 2

Base Salaries and Investment in Stock

Risk aversion	Base salary ϕ		Fraction with base salary < 0	Wealth that must be invested (mean)	
	Mean	Median		in \$'000	% of wealth
0.5	-5,593	-1,959	78.69%	5,830	38.50%
1	-4,659	-1,406	72.53%	4,956	31.43%
2	-2,997	-380	61.04%	3,435	18.74%
3	-1,652	92	46.99%	2,258	10.51%
4	-651	321	35.28%	1,432	5.42%
5	44	491	25.42%	926	2.92%
6	519	625	18.39%	614	1.63%
8	1,091	803	10.03%	287	0.59%
10	1,402	941	5.52%	155	0.26%
observed	2,037	1,261	0.00%	0	0.00%

Result 3

Savings from Switching to Optimal Contracts

Risk aversion	Savings (\$ '000)		Savings as percentage of total pay		Savings as percentage of firm value	
	Mean	Median	Mean	Median	Mean	Median
0.5	673	197	1.73%	1.02%	0.04%	0.01%
1	2,229	567	4.93%	3.25%	0.10%	0.03%
2	7,156	1,513	12.77%	9.42%	0.23%	0.08%
3	12,278	2,449	19.58%	15.58%	0.34%	0.14%
4	16,156	3,297	24.54%	20.50%	0.42%	0.19%
5	19,013	3,884	28.11%	24.74%	0.47%	0.22%
6	21,121	4,395	30.76%	28.32%	0.52%	0.25%
8	23,850	4,925	34.30%	32.76%	0.57%	0.29%
10	25,493	5,234	36.49%	35.46%	0.60%	0.31%

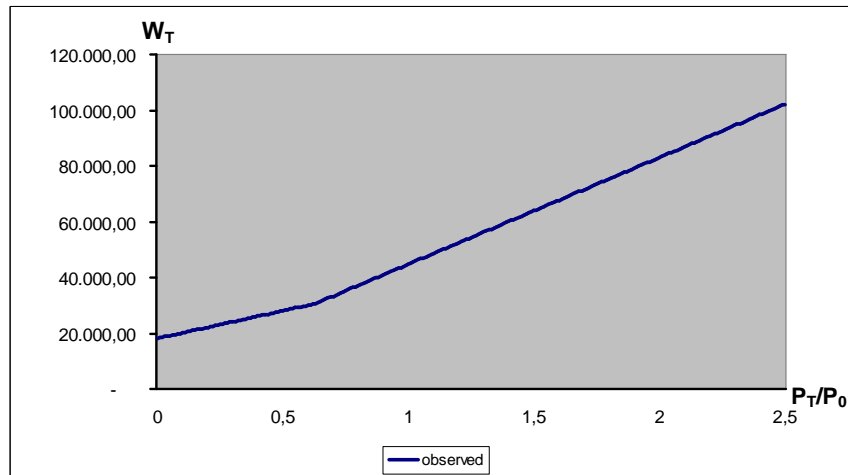
Robustness Checks

- Results are robust to ...
 - the introduction of tax effects
 - variations in the CEO's wealth
 - Gamma distributed stock prices
 - distinguishing between firm-specific and market risk

Allowing for Concave Pay Functions

- Contract with a long position in options is non-concave.
- Result: Linearity is preferable to convexity.
 - corner solution: what if we allow concave contracts?
- Extensions:
 - (1) Allow short positions in options.
 - (2) Determine theoretical shape of pay function and estimate its parameters.

Allowing short positions in options Results for a Representative CEO

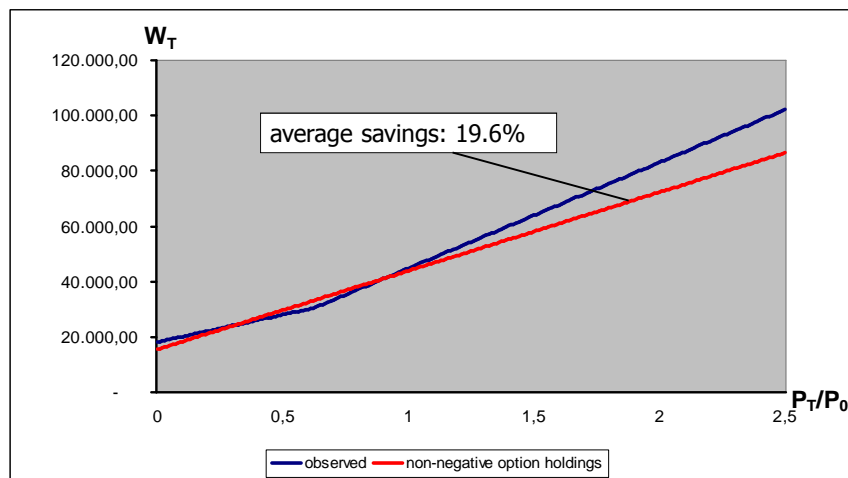


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Allowing short positions in options Results for a Representative CEO

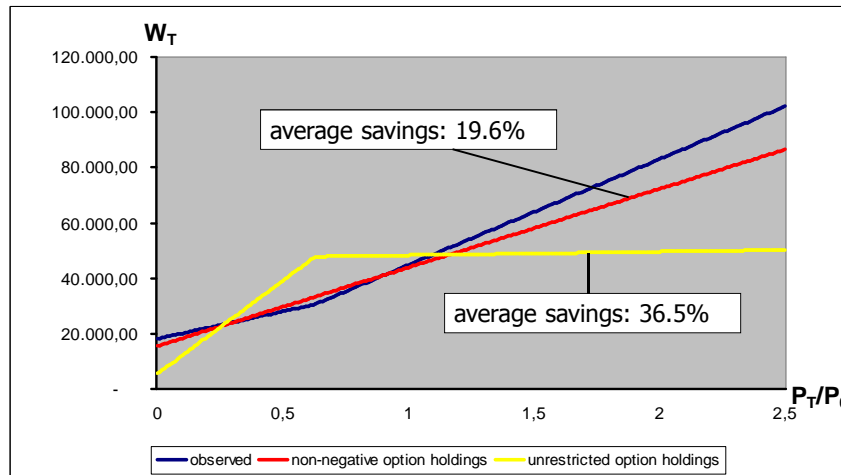


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Allowing short positions in options Results for a Representative CEO

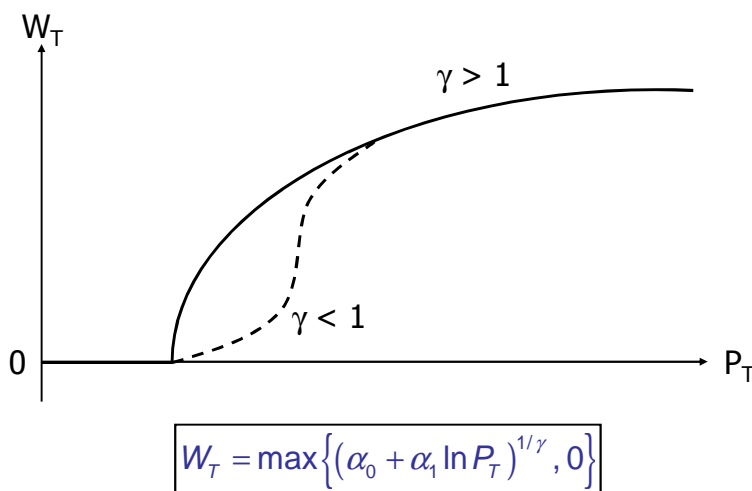


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Theoretical Solution Derived from Holmström (1979)

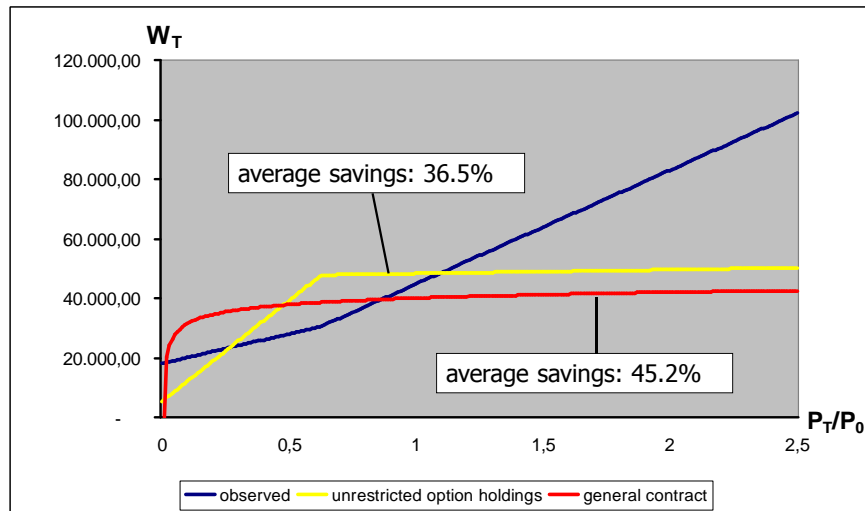


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The optimal general contract Results for a Representative CEO



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Alternative Explanations: Investment Incentives

- CEOs receive options to "make them risk-neutral"
- Our analysis shows:
 - Concave contracts reduce investment incentives substantially.
 - Linear contracts ("no options") reduce investment incentives only slightly.
- Investment incentives can explain why contracts are not concave.
- They appear unable explain why the contract is convex.
 - may be part of a more complex explanation

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Further Alternative Explanations

- Further alternative explanations
 - Sticky base salary
 - Inefficient contracts
- ... do not appear convincing.

Conclusions

- Most CEO compensation contracts feature stock options
 - ...but the standard model cannot generate these
 - Lower salaries and more stock instead
- Extensions of the model unlikely to solve the problem:
 - Robust to mistakes in estimating wealth, risk
 - Dynamic trading, investment incentives, liquidity, taxes
 - Potentially a governance problem: further checks
- Alternative modeling approaches required