MODELING EXECUTIVE PAY AS A BARRIER CALL

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Abstract

Criticism by the Administration at the height of the global financial crisis of 'excessive' company bonuses rekindles debate on the link between executive pay and firm performance. We model the relationship between realized CEO pay and an earnings-adjusted barrier call as the dependent variable. We employ both externally- and internally-derived metrics of target financial performance. Pay components are found strongly interrelated. Salary sensitivities to the dependent variable are broadly consistent with determination of a reservation wage set by the executive labor market, while annual bonuses are paid for expected above-target performance, but are also capped. Long-term incentive plans are used to mitigate noise in earnings only when above-target performance is expected. Hence, we find no evidence of 'excessive' bonuses, at least during the interval ending in fiscal 2005. Rather, we document evidence that the 'excessiveness' may in fact be present in salaries.

Keywords: executive pay, performance, barrier call model, bonuses, corporate governance

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THE PRESIDENTIAL CRITICISM OF 'SHAMEFUL' BONUSES paid to executives of companies simultaneously receiving taxpayer-funded bailouts to cover losses during the global credit crisis of early 2009 rekindles the long-running debate concerning the direction of the link between executive pay and firm performance[1, 2]. The criticism assumes that cash bonuses (being the sum of annual and long-term) are a reward only for executive effort that results in achievement of target financial performance, and not otherwise. Hence, any bonuses paid when target financial performance is not reached are assumed excessive. However, financial performance, typically inferred from earnings measures, is often influenced by factors beyond the control of executives (including the global financial crisis) and this view would deny executives any reward for their effort when target performance is not reached. We argue that this view is unduly restrictive for two reasons. First, focus on annual bonuses is potentially myopic in the sense that interactions between modes of pay (e.g., salary, annual bonus and long-term incentive benefits) are apparently overlooked. Second, the Administration's criticism implies that performance targets are set too generously set in the first place. For example, this view would reject bonus payments made as a reward for reversing or curtailing losses. In general, above-target performance is consistent with higher productivity or operating efficiency, which in turn increases the value of growth opportunities. On the other hand, below-target performance implies that growth opportunities are less valuable. Neither consideration can be adequately addressed by descriptive analysis of executive compensation data. To resolve these issues, we adapt barrier call pricing to partition payoffs according to two states: viz., when target financial performance is reached or exceeded, and when it is not. Hence, we are able to form expectations on pay levels according to which state obtains. In so doing, we address both issues simultaneously. We relate CEO pay to a one-year European barrier call on the firm's stock price adjusted for beginning-of-period earnings. The value of an up-and-in (or knock-in) call is contingent on the firm reaching or exceeding target performance, while the value of an up-and-out (or knock-out) call is contingent on target performance not being reached. Other things equal, pay sensitivities to earnings-adjusted call values are expected lower in the up-and-out state than the up-and-in state. Reversal of this inequality constitutes prima facie evidence of excessive pay. We control for concurrent grants of equity-based compensation. Applying this model to the vexed question of excessiveness of executive pay constitutes the contribution of this paper.

[1] *http://www.bloomberg.com/apps/news?pid=20601087&sid=aKvNNghfuh34&refer=home*

[2] See, for example, Jensen and Murphy (1990), Murphy (1999), Garen (1994), Hall and Murphy (2000), Hermalin and Wallace (2001), Baker and Hall (2004) and Cheng (2004) who generally report a positive relation between executive pay and concurrent firm performance.

Barrier call modeling has applied sparingly to equity valuation and executive compensation.[3] Chesney and Gibson-Asner (1999) value the equity claim as a down-and-out barrier call where shareholders avoid accepting riskier projects akin to the underinvestment problem of Myers (1977). Building on Carr (1995), Anderson and Brisley (2009) value employee stock options as an up-and-out protected barrier call. If the stock price reaches a barrier value set above the initial stock price the option is knocked out and a rebate paid to compensate for inability to exercise before vesting. Barrier call modeling has yet to be applied to executive bonuses, but Martellini and Urosevic (2005) model bonus payments as payoffs on the sum of standard and binary at-the-money calls on stock price performance at the boundary points of the incentive zone as posited by Murphy (1999), i.e., the minimum and maximum stock prices at which a bonus is payable. Annual bonuses have a one-year expiry and the long-term bonuses have a 3-6 year expiry. However, earnings performance is not linked to stock price performance so their model does not explain bonuses in relation to expected earnings, nor why cash bonuses are paid in some industries when performance targets are not reached, i.e., when shareholders consider the investment necessary to capture growth opportunities is too costly. Further, salary and grants of restricted stock are not modeled as options. While this is factually correct, we conjecture that pay and even stock grants may be structured on a year-by-year basis to mimic the payoff of a one-year call on next year's performance outcome.

Given evidence that performance targets are predominantly accounting-based (Ellig, 2007), the barrier is characterized by a hurdle stock price obtained by adjusting the current stock price by a multiplier relating the firm's current earnings/price ratio to the corresponding industry ratio. At expiry, an up-and-in barrier call has value once target performance has been reached or exceeded; else, an up-and-out barrier call has value. Prior to expiry, both have value. In general terms, CEO pay is expected higher when the performance target is reached, mimicking the pay-off structure of an up-and-in call. On the other hand, when performance targets are not reached CEO pay mimics the pay-off structure of an up-and-out call. Before next-period performance is known, CEO pay can relate to both option types. A standard call specification does not reveal these dual purposes of CEO pay. Cash bonuses are expected used to reward CEOs for reaching or exceeding target performance. The barrier-call approach simultaneously accommodates interactions among all executive pay components as well as risk differences in earnings. Our approach is far less vulnerable to earnings management designed to achieve performance targets and lock-in bonuses (Leone and Rock, 2002) because the earnings-adjusted call is valued at beginning of period.

Accordingly, we make three contributions to the empirical literature on executive bonuses. First, we link expected earnings to call pricing. This is necessary because there is ample evidence that executive rewards are determined more in relation to accounting measures of performance and less on stock price outcomes. Second, bifurcation of call value enables us to observe how pay sensitivities differ between above- and below-target financial performance. Third, our approach encompasses all components of CEO pay simultaneously, enabling us to observe whether non-option payments (such as salaries and equity-based compensation) have option payoff properties.

Murphy (2001) proposes that performance-based annual bonuses in particular should be increasing in the performance target but should not be paid if the performance target is not reached, presumably reflecting the popular viewpoint. More recently, agnostic and apologist branches of the executive compensation literature have emerged. Exemplars of the agnostic view are Bebchuk and Fried (2003, 2004) and Bertrand and Mullainathan (2001) who attribute the long-term upward trend in CEO pay to failure in corporate governance mechanisms. Further, Bizjak, Lemmon and Naveen (2008) find that CEO pay below the median pay level of their counterparts in companies of similar size and in the same industry receive pay increases that are larger in both percentage and dollar terms. Moreover, Hayes and Schaefer (2009) propose a model of the *Lake of Wobegon Effect* in which firms distort CEO pay upward in an attempt to affect market perceptions of firm value. On the other hand, Murphy and Zabojnik (2004), Oyer (2004), Baranchuk, MacDonald and Yang (2006), Gabaix and Landier (2008), Edmans, Gabaix and Landier (2008), and Kaplan and Rauh (2009) argue that CEO compensation simply reflects a market equilibrium where the Board of Directors optimally structures CEO pay to motivate and retain CEOs as required.

The present approach differs markedly from the only other empirical study that examines the interaction between executive bonuses and earnings in the context of target performance settings. Indjejikian and Nanda (2002) infer latent performance standards (in earnings terms) from the association between target and actual bonuses. Their principal finding is that executives have a high likelihood (p=0.72) of receiving above -target bonuses when receiving above -target bonuses in the prior year, with a lower likelihood (p=0.42) of receiving a below-target bonus two years in a row. These findings are interpreted as evidence of a lag in the setting of performance standards.

[3] Non-option approaches to explaining executive bonuses are also sparse; a recent example is the utility-theoretic approach of Camara (2009).

Our findings reveal a microstructure of CEO pay that mimics the value of beginning-of-period barrier calls written on the firm stock price and adjusted for concurrent earnings level.

Our main findings are summarized as follows. First, salary sensitivities are broadly consistent with determination of a reservation wage set by the executive labor market, while annual bonuses are found dedicated to above-target performance. Second, annual bonuses are found mainly capped to avoid rewarding CEOs for 'good' luck, while long-term incentive plans are used to mitigate noise in earnings only when target performance is expected to be achieved. Hence, we find no evidence of 'excessive' bonuses, at least during the interval ending in fiscal 2005. Rather, we document evidence that the 'excessiveness' may in fact be present in salaries.

The rest of the paper proceeds as follows. Section I describes the model. Section II describes the measures and data. Section III presents the quantitative results, while Section IV presents robustness tests. The model is extended to the R&D firms in Section V. We conclude in Section VI.

I. The Model

Barrier call pricing was first articulated by Reiner and Rubinstein (1991) for a single volatility.[4] A barrier call is valued as up-and-in and up-and-out. An up-and-in call is a regular call option that has value only when the underlying reaches a barrier from below, whereas an up-and-out call is a regular call option that ceases to exist when the underlying reaches the same barrier. Once the barrier is reached the up-and-in call has the same value as a straight call because the up-and-out call then has zero value. Both may have value simultaneously when the price of the underlying is below the barrier, but not above the barrier. We initially value a one-year barrier call of both types where the barrier, *H*, is a stock price determined with reference to an industry-earnings benchmark which serves as target performance. An alternative specification in which prior-year performance is substituted for an industry benchmark is tested as well. Since early-exercise is precluded a European call is specified. *H* necessarily exceeds *S* because $S < H$ implies a down-state barrier call. Down-and-in and down-and-out barrier calls where *H* is set below the current stock price (*S*) are not defined because shareholders do not rationally set $H < S$, even in a declining industry. In choosing a one-period model we assume current-period performance and reward is independent of prior-period performance and reward.

The procedure is as follows. We relate the values of up-and-in and up-and-out barrier calls to current-year financial performance, which in turn determines executive pay for the same interval. The calls, C_{ui} and C_{uo}, respectively, are written on the firm's stock at end of period, *t*, when *H* (target performance) is also set. To obtain *H*, it is necessary to link S_t with (current) earnings for the year ending at *t*. To do this, we multiply S_t by E_t/S_t to obtain an earnings figure consistent with S_t, where E_t is (current) earnings for the year ending at *t*. The base salary is set at *t* but may also incorporate convexity as an incentive device. The annual bonus is determined independently of salary at end-of-period (t+1) when E_{t+1} is realized and so is a reward, but also has an incentivizing role once negotiated at *t*. The value of the one-year barrier call is therefore determined over the same interval for which the annual bonus is determined. Salary is assumed determined by the expected marginal productivity of the CEO at *t*. To summarize, multiplying C_{ui} and C_{uo}, respectively, by E_t/S_t transforms call value to an earnings-equivalent, such that

$$ECUI_t = C_{ui,t}\left(\frac{E_t}{S_t}\right) = E_t\left(\frac{C_{ui,t}}{S_t}\right)$$

and

$$ECUO_t = C_{uo,t}\left(\frac{E_t}{S_t}\right) = E_t\left(\frac{C_{uo,t}}{S_t}\right).$$

Intuitively, *ECUI* and *ECUO* are the maximum amounts that shareholders are willing to pay at *t* for effort to secure these earnings. The barrier calls are valued at-the-money because the exercise price (*K*) represents the reinvestment needed to claim next period earnings. Following Reiner and Rubinstein (1991), the value of an up-and-in barrier call at *t* (not subscripted) is given by

$$C_{ui} = S.N(x_1)e^{-qT} - Ke^{-rT}N\left(x_1 - \sigma\sqrt{T}\right) - Se^{-qT}(H/S)^{2\lambda}[N(-y) - N(-y_1)] + Ke^{-rT}(H/S)^{2\lambda-2}\begin{bmatrix}N\left(-y+\sigma\sqrt{T}\right) - \\ N\left(-y_1+\sigma\sqrt{T}\right)\end{bmatrix}$$

and the value of an up-an-out barrier call is given by

$$C_{uo} = C - C_{ui}$$

where

$$C = Se^{-qT}N(d_1) - Ke^{-rT}N(d_2)$$

$$d_1 = \frac{ln(S/K) + (r - q - \sigma^2/2)T}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

$$\lambda = \frac{r - q + \sigma^2/2}{\sigma^2}$$

$$y = \frac{ln[H^2/(S.K)]}{\sigma\sqrt{T}} + \lambda\sigma\sqrt{T}$$

$$x_1 = \frac{ln(S/H)}{\sigma\sqrt{T}} + \lambda\sigma\sqrt{T}$$

[4] Since barrier options are path-dependent it is desirable to model a term structure of implied volatilities (Taleb, 1996), but this is considered unnecessary in the present application because annual bonuses determined annually.

$$y_1 = \frac{ln(H/S)}{\sigma\sqrt{T}} + \lambda\sigma\sqrt{T}$$

and where r is the risk-free rate, K is the exercise price, T is time to expiry (one year), q is the dividend yield, $N(d_1)$ is the cumulative normal distribution function, σ is the instantaneous standard deviation of stock returns and H is the barrier. Since executive compensation is determined from pre-dividend earnings, q is set at zero. For a given C, as H is set higher C_{ui} falls while C_{uo} rises, and vice versa. A higher H requires higher marginal CEO productivity, while lower H requires lower productivity. Thus as H rises, the probability of the hurdle being met diminishes and C_{ui} falls while C_{uo} rises. By corollary, as H falls and C_{ui} rises and C_{uo} falls. These outcomes obtain irrespective of whether H is determined with reference to externally- or internally-set benchmarks.

To obtain an estimate of the sensitivity of pay components to expected earnings in each state, *ECUO* and *ECUI* are regressed on t+1annual bonus and other pay components along with the value of equity-based grants as a control. In other words, we reveal the extent to which the components of CEO pay align with expected earnings performance conditional on the performance target being reached. As a consequence, we demonstrate the option-like properties of CEO pay. Specifically, *ECUI* and *ECUO* measure the potential at time t of firms to generate sufficient earnings to reach or not reach H, respectively. Thus, the set of pay sensitivities that aligns with *ECUI* and *ECUO* reveals the pay structure consistent with the potential to achieve or not achieve H, respectively. In other words, the pay structure associated with *ECUI* reflects the amount that shareholders are prepared to pay at the start-of-period if next-period earnings achieve H. The source of an earnings increase required to reach H is not specified, but an obvious candidate explanation is increased productivity. By corollary, the pay structure associated with *ECUO* reflects the amount that shareholders are prepared to pay at the start-of-period if next-period earnings fall short of H.

II. Measures and Data Sources

A critical factor is determination of the barrier, H. Compensation contracts alternatively specify industry-benchmarking but more commonly prior-year benchmarking (Murphy, 2001). Firms adopting internally-generated performance standards (such as budgets and prior-year performance) are found by Murphy (2001) to have less-variable bonus payouts than firms adopting externally-generated performance standards, which is likely to suit incumbent executives as pointed out by Merchant and Manzoni (1989). Bizjak, Lemmon and Naveen (2008) argue with supporting evidence that external or industry benchmarking reduces the likelihood of reward for 'good' or 'bad' luck rather than a means for extracting rents. Thus, our primary focus is on external-benchmarking, with prior-year benchmarking relegated to a robustness check. In the former case, H is set as the stock price consistent with that required for consistency with an industry price-earnings (PE) benchmark. We initially employ three commonly-used earnings definitions, consistent with Murphy (1999) and Ellig (2007): namely, earnings before interest and tax (EBIT), EBIT before depreciation and amortization expense (EBITDA) and net income (NI).[5] The stock price itself is not considered the basis of a target because Murphy (2001) reports that only 5 out of 177 contracts in his sample of the top U.S. companies use the stock price as a performance measure, and always coupled with one or more accounting measures. Murphy (1999) also notes that most firms use a single criterion.

Specifically, for firm i and its industry (*IND*) if $PE_{it} > 0, H = S_t\left(\ln(1 + \frac{PE_{it}}{PE_{INDt}})\right)$; else, $H = S_t\left(\ln(1 + \frac{|PE_{INDt} - PE_{it}|}{PE_{INDt}})\right)$. This rule has two desirable properties. First, all firms have a target (H) above their current stock price irrespective of how high their PE is relative to the industry benchmark. Second, H increases at a decreasing rate as $PE_{INDt} > PE_{it}$ but declines at a decreasing rate as $PE_{INDt} < PE_{it}$ so that extreme target values are avoided.[6]

The sample period is 1992-2006, which embraces both recession and prosperity cycles as well as introduction of the Sarbanes-Oxley Act which increased disclosure costs and imposed restrictions on executives' behavior. 2006 is the latest year for which full- and subsequent-year data are available at the time of writing. Data are collected for every CEO in the ExecuComp database as defined by the CEOANN field for each year 1992-2006. We drop firm-year observations that have (i) no reported Black-Scholes volatility (2,604), (ii) no GICS code which is needed to determine the barrier, H, (848) and (iii) no stock price quoted at fiscal year-end (t), (268). Sixteen firms that were non-operating were also deleted as were another 130 firms with sales revenue less than $10 million in any year. Since firm-level data is needed from Research Insight, some firms are not covered by both datasets and so were deleted (808). Given the requirement for realized CEO pay components for t+1 are needed, 3,711 CEO pay-year

[5] Ellig (2007) documents the four most common financial-performance criteria as (i) EPS (ii) Return on equity (iii) Return on capital and (iv) Return on assets. (i) and (ii) use a Net Income numerator, while (iii) and (iv) use an EBIT numerator; EBITDA is a variant of EBIT that steers the measure toward operating cash flow.

[6] As Garvey and Milbourn (2006) point out, benchmarking to industry also implies shareholders are relieved from bearing some systematic risk because this is transferred to the executive.

observations were deleted for having no *t*+1 data. After applying these filters the final sample comprised 15,176 firm-years. A summary of the sample construction is as follows:

ExecuComp company-year population 1992-2006		23,561
Less Company-year observations not having:		
Reported Black-Scholes volatility	2,604	
GICS code	848	
Stock price quoted at fiscal year-end (*t*)	268	3,720
		19,841
Less Companies in a given year that:		
Are non-operating or have sales revenue < $10 million	146	
Are not on *Research Insight* database	808	
Have no *t*+1 data	3,711	4,665
Final sample		15,176

Cash-based compensation includes salary (ExecuComp code: *SALARY*), bonus (*BONUS*), payments under any long-term incentive plan (*LTIP*) and other compensation (*OTHCOMP*). *SALARY*, *BONUS* and *LTIP* are cash payments, while *OTHCOMP* is predominantly so, comprising perquisites and other personal benefits, contributions to defined-benefit plans, life insurance premiums, gross-ups and other tax reimbursements and discounted share purchases.

Table I describes the impact of our target performance rule. Slightly more firms have PEs equal to or above their industry PEs (7,950) than below (7,226), but the inequality is an artefact of the sample period. For all industries, target stock price/current stock price (H/S_t) is generally lower when firm PE (PE_{it}) ≥ industry PE (PE_{INDt}) and higher when $PE_{it} < PE_{INDt}$, as expected.

Table II gives an idea of how annual bonuses/annual sales percentages vary by GICS industries according to Net Income. If the Administration is right, (cash) bonuses should only be paid when Net Income is positive and zero when Net Income is zero or below. The Table also shows the impact (if any) of the Sarbanes-Oxley Act (SOX) in the event the governance and disclosure requirements of the Act have impacted on executive compensation.[7] Years 1992-2001are pre-SOX years and 2002-2005 are post-SOX. Increased regulation and higher disclosure costs may possibly have caused executives to demand higher compensation from 2002, but alternatively may have induced a drop in compensation if SOX has made it more difficult for executives to extract rents. Two regularities are immediately evident. First, when Net Income is negative, bonuses are still observed across most industries in the post-SOX years, but less so in the pre-SOX years. Just three industries exhibit zero bonuses when Net Income is negative and bonuses when Net Income is positive across the entire sample period: namely, Transportation, Food, Beverage & Tobacco, and Real Estate. Second, with only two exceptions (Automobiles & Components and Diversified Financials) bonus/sales percentages are generally higher post-SOX than pre-SOX irrespective of Net Income levels.

[7] The provisions of the Act are evaluated by Holmstrom and Kaplan (2003).

Table I. Target Stock Price/Current Stock Price by Relative Price-Earnings Ratios

Industries are those recognized by the Global Industry Classification Standard (GICS). Price-earnings ratios (PE) are current at *t* for firms (*i)* and industries (*IND*) with earnings measured by EBITDA, as defined in ExecuComp. Industry PEs are unweighted averages. *H* is the target stock price and S_t is the current stock price.

Industry	GICS	$PE_{it} \geq PE_{INDt}$			$PE_{it} < PE_{INDt}$		
		Observ-ations	Mean H/S_t	Median H/S_t	Observ-ations	Mean H/S_t	Median H/S_t
Energy	1010	403	1.435	1.430	346	2.080	1.968
Materials	1510	592	1.468	1.489	586	2.035	1.879
Capital Goods	2010	738	1.460	1.472	694	2.110	1.962
Commercial Services & Supplies	2020	300	1.463	1.488	266	2.033	1.910
Transportation	2030	213	1.403	1.412	190	2.257	2.000
Automobiles & Components	2510	159	1.370	1.349	137	2.240	2.047
Consumer Durables & Apparel	2520	454	1.469	1.503	421	2.027	1.925
Hotels, Restaurants & Leisure	2530	332	1.432	1.440	286	2.149	1.971
Media	2540	215	1.441	1.479	198	2.087	1.880
Retailing	2550	503	1.417	1.431	437	2.168	1.973
Food & Staples Retailing	3010	123	1.441	1.440	102	2.164	1.993
Food, Beverage & Tobacco	3020	237	1.478	1.494	224	1.970	1.901
Household & Personal Products	3030	74	1.546	1.593	71	2.035	1.887
Health Care Equipment & Services	3510	480	1.419	1.430	443	2.132	2.004
Pharmaceuticals & Biotechnology	3520	303	1.403	1.414	282	2.243	1.990
Banks	4010	431	1.488	1.509	405	1.934	1.837
Diversified Financials	4020	216	1.457	1.498	179	2.219	2.045
Insurance	4030	218	1.478	1.499	190	2.056	1.905
Real Estate	4040	22	1.570	1.588	19	1.932	1.871
Software & Services	4510	487	1.398	1.416	431	2.160	1.992
Technology Hardware & Equipment	4520	573	1.410	1.424	515	2.201	1.971
Semiconductors & Semiconductor Equipment	4530	293	1.394	1.411	267	2.252	2.025
Telecommunication Services	5010	108	1.505	1.556	95	1.997	1.875
Utilities	5510	476	1.496	1.525	442	1.874	1.833
Whole sample		7,950	1.444	1.464	7,226	2.098	1.935

Table II. Median Bonus/Sales Percentages by Industry, Pre- and Post- Sarbanes-Oxley Act

Industries are those recognized by the Global Industry Classification Standard (GICS). Fiscal 1992-2001 are pre-Sarbanes-Oxley years, and fiscal 2002-2005 are post- Sarbanes-Oxley years. Net Income is dollar bottom-line earnings as defined by Compustat.

Industry	GICS	Observ-ations	Fiscal 1992-2001		Fiscal 2002-2005	
			Net Income ≤ 0	Net Income > 0	Net Income ≤ 0	Net Income > 0
Energy	1010	749	0.012	0.033	0.014	0.037
Materials	1510	1,178	0.007	0.023	0.013	0.028
Capital Goods	2010	1,432	0.005	0.026	0.011	0.038
Commercial Services & Supplies	2020	566	0.000	0.024	0.037	0.032
Transportation	2030	403	0.000	0.015	0.000	0.017
Automobiles & Components	2510	296	0.007	0.022	0.004	0.020
Consumer Durables & Apparel	2520	875	0.000	0.032	0.015	0.051
Hotels, Restaurants & Leisure	2530	618	0.000	0.041	0.021	0.052
Media	2540	413	0.000	0.029	0.067	0.031
Retailing	2550	940	0.000	0.013	0.011	0.019
Food & Staples Retailing	3010	225	0.002	0.004	0.001	0.005
Food, Beverage & Tobacco	3020	461	0.000	0.016	0.000	0.023
Household & Personal Products	3030	145	0.000	0.027	n.a.	0.034
Health Care Equipment & Services	3510	923	0.022	0.035	0.025	0.039
Pharmaceuticals & Biotechnology	3520	585	0.171	0.034	0.092	0.048
Banks	4010	836	0.000	0.032	n.a.	0.057
Diversified Financials	4020	395	0.043	0.051	0.000	0.033
Insurance	4030	408	0.005	0.017	0.009	0.027
Real Estate	4040	41	0.000	0.011	0.000	0.067
Software & Services	4510	918	0.033	0.048	0.018	0.065
Technology Hardware & Equipment	4520	1,088	0.004	0.035	0.002	0.038
Semiconductors & Semiconductor Equipment	4530	560	0.003	0.055	0.000	0.062
Telecommunication Services	5010	203	0.018	0.014	0.022	0.024
Utilities	5510	918	0.007	0.011	0.009	0.017
Whole sample		15,176	0.007	0.024	0.011	0.034

III. Analysis

We first analyze the extent to which changes in CEO pay along with grants of equity-based compensation (*EQUITY-BASED*) are associated with concurrent changes in operating income and stock volatility. Operating income is measured by EBIT because this measure is typically employed by analysts. Our only strong priors are that annual bonuses are expected to increase with operating income while the value of option grants (included in equity-based compensation) is necessarily increasing in stock volatility. The results of least-squares regressions are reported in Table III. No fixed effects are specified because we are interested only in portraying the relationships observed by analysts. As expected, first differences in annual bonuses (Δ*BONUS*) are strongly positively related to the contemporaneous first difference in EBIT (Δ*EBIT*). Salary first differences (Δ*SALARY*) are found inversely related to stock volatility, while as expected *EQUITY-BASED* is positively related. Finally, equity-based compensation appears to have been impacted negatively by SOX. If present, 'excessive' bonuses are represented in the slope coefficient of 0.287, but from this style of analysis we have no means of establishing this. A further difficult is that interactions amongst pay components are not accommodated.

Table III. Changes in CEO Pay related to Changes in EBIT for 1992-2005

Change (Δ) in a pay component is given by the first difference between pay at t and t_{+1}. Grants of equity-based compensation are for the period ending t_{+1}. All pay components are ExecuComp line-items. *EQUITY-BASED* is the sum of the value of grants of restricted stock and options as defined by ExecuComp (RSTKGRNT and OPTION_AWARDS_BLK_VALUE, respectively). *EBIT* is as defined in Compustat. *SOX* refers to the Sarbanes-Oxley Act (2002). All *t*-statistics (presented in parentheses) are robust to within-firm correlations and heteroskedasticity. ** and *** represent two-tailed significance at the 10, 5 and 1% levels, respectively.

Dependent variable: *N =15,176*	*ΔSALARY*	*ΔBONUS*	*ΔLTIP*	*ΔOTHCOMP*	*EQUITY-BASED*
ΔEBIT	0.004	0.287***	0.021	-0.016	1.705**
	(1.33)	(5.23)	(0.43)	(-0.49)	(2.13)
Stock volatility$_{t+1}$	-0.150***	0.499	0.141	-0.082	22.672***
	(-9.10)	(0.72)	(0.24)	(-0.10)	(3.67)
SOX (Post-SOX =1)	2.642	-155.267	-31.536	31.960	-937.731***
	(0.74)	(-1.26)	(-0.61)	(1.00)	(-2.96)
Constant	46.38***	19.24	19.372	61.731	18.724***
	(18.71)	(0.18)	(0.73)	(1.48)	(9.58)
R^2	0.002	0.022	0.001	0.001	0.016

The target stock price (H) used in the barrier option pricing model is benchmarked to firm characteristics in Table IV by firms with above- and below- industry PE levels. Firms with PEs above their industry PE are expected to exhibit higher profitability ratios (ROA and EBITDA/Total assets) and price ratios (Market-to-book of assets and Price/book) than firms with below-industry PEs. Firms with above- industry PEs are also expected to exhibit higher fractional CEO ownership consistent with lower agency costs (Jensen and Meckling, 1976) and have lower equity risk (Fama and French, 1992). Conformity of the data with these expectations provides broad-based support for our measure of H. Firms with above-industry PEs are also somewhat smaller than firms with below-industry PEs.

Table IV. Firm Characteristics by Relative Price-Earnings Ratios

PE is the price-earnings ratio based on EBIDTA, as defined in Compustat, and is determined both for firm i and its *Global Industry Classification Standard* (GICS) industry. Industry PEs are unweighted averages. ROA is return on assets and EBITDA is earnings before interest plus depreciation and amortization expense, both as defined in Compustat. Market-to-book of assets is the sum of the market value of equity and the face value of debt divided by total assets. Price/book is the market value of common equity divided by the corresponding book value, as defined by Compustat. Fractional CEO ownership is the percentage of CEO-owned common stock excluding options to outstanding common stock. The standard deviation of stock returns is determined over 60 months, as reported by ExecuComp. Firm size is reported as *ln*(Total assets). All firm characteristics are measured at time, t. All inter-group mean and median differences are significant at the 1% level.

	$PE_{it} \geq PE_{INDt}$		$PE_{it} < PE_{INDt}$	
	Mean	Median	Mean	Median
Observations	7,950	7,950	7,226	7,226
ROA (%)	11.2	10.0	7.7	8.1
EBITDA/Total Assets (%)	15.2	14.1	12.4	12.4
Market-to-book of assets	2.18	1.56	1.31	1.00
Price/book	4.67	2.90	2.46	1.84
Fractional CEO ownership (%)	3.29	0.37	2.52	0.28
Standard deviation of stock returns (%)	40.4	35.1	44.2	37.5
Firm size	7.37	7.21	7.49	7.29

Table V presents a test of whether our relative-PE benchmark achieves separation on standardized-measures of *ECUI*, *ECUO*, *SALARY* and *BONUS* . For the sub-sample $PE_{it} \geq PE_{INDt}$ we expect to observe higher *ECUI*/Total assets than for the sub-sample $PE_{it} < PE_{INDt}$, while *ECUO*/Total assets is expected to have more value when $PE_{it} < PE_{INDt}$. *SALARY*/Sales is expected lower for the sub-sample $PE_{it} \geq PE_{INDt}$ than the sub-sample $PE_{it} < PE_{INDt}$ because above-average performance is likely to require more convexity in CEO pay as indicated by *BONUS*/Sales.

Table V. Barrier Earnings-Call Values and CEO Pay Components by Above- and Below- Relative Price-Earnings Ratios

ECUI is the value of an up-and-in barrier call on the firm's stock price at time *t* multiplied by the earnings-price ratio also at *t* where earnings are measured by EBITDA, as defined in Compustat. *ECUO* is similarly determined for an up-and-out barrier call. *SALARY* and *BONUS* are ExecuComp line-items. All variables are measured at time, *t*. All inter-group mean and median differences are significant at the 1% level.

	Observations	Mean	Median	Standard deviation
ECUI/Total assets (%)				
$PE_{it} \geq PE_{INDt}$	7,950	2.52	1.73	2.43
$PE_{it} < PE_{INDt}$	7,226	0.37	0.55	8.61
ECUO/Total assets (%)				
$PE_{it} \geq PE_{INDt}$	7,950	0.74	0.44	0.88
$PE_{it} < PE_{INDt}$	7,226	1.54	1.36	2.67
SALARY/ Sales (%)				
$PE_{it} \geq PE_{INDt}$	7,950	0.09	0.02	0.17
$PE_{it} < PE_{INDt}$	7,226	0.10	0.04	0.25
BONUS/ Sales (%)				
$PE_{it} \geq PE_{INDt}$	7,950	0.07	0.03	0.21
$PE_{it} < PE_{INDt}$	7,226	0.06	0.02	0.23

Least-squares regressions of *ECUI* and *ECUO* on end-of-period pay components yield estimates of the loadings on earnings-adjusted barrier calls. The idealized earnings definition is EBITDA because this figure (i) has the least accounting adjustments and (ii) is before depreciation and amortization which in a single period are virtually beyond the control of mangers. We therefore expect EBITDA-based estimations to outperform EBIT- and Net Income-based estimations. [8] *SALARY*, *BONUS* and *OTHCOMP* are also represented in squared form to capture any non- increasing pay (or convexity), while a negative coefficient indicates the presence of a cap (or concavity). Equity-based compensation (*EQUITY-BASED*) and the impact of the Sarbanes-Oxley Act (2002) (*SOX*) are controls. All explanatory variables are measured at *t*+1. A fixed firm effect is specified because qualitative differences exist between firms in cross-section. A fixed time effect is not specified because fiscal years are assumed serially-independent. A random effects model is rejected by the Hausman test.

A CEO expected to reach targets is rewarded more highly than a CEO who does not. Salary sensitivity is expected more highly-positive for the *ECUI* model than the *ECUO* model, reflecting higher CEO productivity in the former case. Convexity in salaries is therefore not ruled out for the *ECUI* model but is not expected for the *ECUO* model which implies lower productivity. To the extent payoffs from reaching the performance target need to compensate for the added productivity needed to reach the performance target, shareholders reward CEOs through the annual bonus in preference to salary. Given an annual bonus, a bonus cap is necessary to limit the bonus payment in the event that higher earnings results from 'good' luck. The role of a long-term incentive plan is to transfer part of an annual bonus into a pool from which (typically, after three years) a long-term bonus is paid once random influences on earnings have been averaged out. Hence, given *H* is expected to be achieved, it is likely that next-period earnings will exceed that of two-years prior, so a smaller positive sensitivity than the annual bonus sensitivity is expected. Conversely, given *H* is not expected to be achieved, next-period earnings are unlikely to exceed that of two-years prior, so a negative sensitivity is expected. However, these expectations weaken as earnings runs occur over consecutive years, which we test later in this Section. We do not form expectations on 'other' modes of pay because items included in this category are

[8] We show later that EBITDA outperforms the other two earnings measures.

heterogeneous. These expectations are summarized in Table VI.

Both pooled and fixed-effect regressions for the whole sample are reported in Table VII. Models (1) and (3) have *ECUI* as the dependent variable, while models (2) and (4) have *ECUO* as the dependent variable. In general, the coefficients on independent variables are interpreted as sensitivities of payment modes and equity-based compensation to the value of the earnings-call. Our discussion focuses on only the fixed-effect models because these have a clearly superior fit. For model (3), the earnings call derives most value when target financial performance is exceeded, while in model (4) the call derives most value when target financial performance is not achieved. Equivalently, model (3) represents the pay structure required to obtain above-industry target performance, while model (4) represents the pay structure to achieve the industry-benchmark. For model (3), $SALARY_{t+1}$ is positive as expected, but $SALARY_{t+1}^2$ is not. Both $BONUS_{t+1}$ and $BONUS_{t+1}^2$ are correctly signed, implying that CEOs are rewarded for capturing growth opportunities but are not paid for 'good' luck. As expected, $LTIP_{t+1}$ exhibits less sensitivity (i.e., zero) than $BONUS_{t+1}$ sensitivity. In contrast, salary becomes convex on *ECUO* in model (4). Given the non-convexity of salary in model (3), this result suggests overpayment. All other sensitivities in model (4) are correctly signed. In other words, CEOs not expected to reach target performance are neither rewarded with annual bonuses nor long-term incentive payments. To the contrary, our evidence shows that cash bonuses (annual and long-term) are lower than expected because annual bonuses are capped and long-term incentive payments and not paid. If 'excessive' payments are present in the data, our evidence indicates they are more likely to reside in salaries. Finally, the SOX impact is positive in the *ECUI* model but not present in the *ECUO* model, which we interpret as evidence of shareholders collectively rewarding high-achieving CEOs but not penalizing under-performing CEOs, relative to pre-SOX pay structures.

The models tested in Table VII do not reveal the impact of positive first-order serial correlation in executive pay as documented by Indjejikian and Nanda (2002). Firms persistently performing above- (below-) target are expected to exhibit stronger (weaker) sensitivities than those reported in Table VII. In other words, we expect salary to be more (less) convex for the *ECUI* (*ECUO*) model than the corresponding model in Table VII. Likewise, for the *ECUI* model bonuses are expected less capped. We construct sub-samples where the PE of a given firm is successively above- or below- the industry PE for $2 \leq m \leq 5$ years, where the upper bound is enforced by paucity of data in the below-scenario for $m > 5$, implying that most firms continually performing below the industry-PE target have been delisted after five years. As m increases, above- and below-target performance becomes increasingly persistent.

Table VI. Expected Signs of CEO Pay Sensitivities

ECUI is the value of an up-and-in barrier call on the firm's stock price at time *t* multiplied by the earnings-price ratio also at *t* where earnings are measured by EBITDA, as defined in Compustat. *ECUO* is similarly determined for an up-and-out barrier call. *SALARY*, *BONUS* and *LTIP* are ExecuComp line-items.

Pay Component	*ECUI* model	*ECUO* model
Salary	Convexity reflecting expected higher CEO marginal productivity	Positive linear sensitivity reflecting expected lower CEO marginal productivity
Annual bonus	Positive linear sensitivity to reach or exceed target performance but capped to limit pay for 'good' luck	Zero because target performance is not expected to be reached
Long-term incentive plan	Lower positive sensitivity than for annual bonus when target performance is expected to be reached	Zero, given annual bonuse of zero

Table VII. CEO Pay Sensitivities to Earnings-Adjusted Barrier Calls

ECUI is the value of an up-and-in barrier call on the firm's stock price at time *t* multiplied by the earnings-price ratio also at *t* where earnings are measured by EBITDA, as defined in Compustat. *ECUO* is similarly determined for an up-and-out barrier call. *SALARY*, *BONUS*, *OTHCOMP* and *LTIP* are ExecuComp line-items. *EQUITY-BASED* is the sum of the value of grants of restricted stock and options as defined by ExecuComp (RSTKGRNT and OPTION_AWARDS_BLK_VALUE, respectively). *SOX* refers to the Sarbanes-Oxley Act (2002). All *t*-statistics (reported in parentheses) are robust to within-firm correlations and heteroskedasticity. *, ** and *** represent two-tailed significance at the 10, 5 and 1% levels, respectively.

	Pooled regressions		Fixed-effect regressions	
Model:	(1)	(2)	(3)	(4)
Dependent variable:	*ECUI*	*ECUO*	*ECUI*	*ECUO*
$SALARY_{t+1}$	0.0776***	0.0926***	0.0563***	0.0488**
	(7.31)	(2.70)	(4.00)	(1.97)
$SALARY_{t+1}^2$	0.0050	0.0038***	0.0023	0.0030**
	(0.91)	(2.02)	(0.34)	(2.35)
$BONUS_{t+1}$	0.0258***	0.0488***	0.0106***	0.0058
	(9.23)	(5.81)	(4.72)	(1.23)
$BONUS_{t+1}^2$	-0.0000***	-0.0000***	-0.0001***	-0.0000
	(-9.06)	(-6.61)	(-4.61)	(-0.68)
$OTHCOMP_{t+1}$	0.0026	0.0107*	0.0233	0.0089**
	(1.34)	(1.92)	(0.01)	(2.22)
$OTHCOMP_{t+1}^2$	-0.0000	-0.0000**	-0.0000	-0.0000
	(-1.48)	(-2.11)	(-0.49)	(-1.52)
$LTIP_{t+1}$	0.0084***	0.0271***	0.0019	0.0011
	(2.59)	(3.31)	(1.04)	(0.42)
$EQUITY\text{-}BASED_{t+1}$	0.0014***	0.0005**	0.0001	-0.0002
	(3.10)	(2.05)	(0.44)	(-0.65)
SOX (post-SOX = 1)	8.1629***	-17.6444***	6.8416***	2.604
	(2.78)	(-4.95)	(2.77)	(0.81)
Constant	-32.2268***	-51.6268***	0.0261	12.2407
	(-6.67)	(-4.26)	(0.004)	(1.21)
Fixed firm effect	n.a.	n.a.	Yes	Yes
Fixed year effect	n.a.	n.a.	No	No
Observations	15,176	15,176	15,176	15,176
R^2	0.179	0.173	0.796	0.876

Table VIII presents estimations of the *ECUI* and *ECUO* models only for $m = 2$ and $m = 5$ because the results for $m = 3$ and $m = 4$ exhibit similar behavior. Time is again not fixed because the pay structure is not expected to depend on a given calendar year, apart from any SOX impact. As expected, CEO salary in firms performing persistently above target (whether for 2 or 5 consecutive years) exhibit a shift towards convexity and away from linearity in the *ECUI* model, while firms performing persistently below target in the *ECUO* model exhibit a shift in the opposite direction. Annual bonuses are no longer capped in the *ECUI* model, while protection continues to be absent. Overall, the analysis in Table VIII reinforces the earlier findings reported in Table VII that any excessive payments are not present in cash bonuses, but simultaneously weaken the possibility of excessive salary payments to the extent CEOs of firms performing below-target receive a lower reservation wage.

Interestingly, when $m = 5$ (model (4)) $EQUITY\text{-}BASED_{t+1}$ has negative sensitivity, suggesting that either grants of restricted stock have not vested or stock options have lapsed unexercised. Both are a consequence of persistent below-target performance.

Table VIII. CEO Pay Sensitivities to Earnings-adjusted Barrier Calls for Above-Target Performance Runs and Below-Target Performance Runs

PE is the price-earnings ratio based on EBIDTA, as defined in Compustat, and is determined both for firm *i* and its *Global Industry Classification Standard* (GICS) industry. Industry PEs are unweighted averages. *ECUI* is the value of an up-and-in barrier call on the firm's stock price at time *t* multiplied by PE also at *t*. *ECUO* is similarly determined for an up-and-out barrier call. *SALARY*, *BONUS*, *OTHCOMP* and *LTIP* are ExecuComp line-items. *EQUITY-BASED* is the sum of the value of grants of restricted stock and options as defined by ExecuComp (RSTKGRNT and OPTION_AWARDS_BLK_VALUE, respectively). *SOX* refers to the Sarbanes-Oxley Act (2002). All *t*-statistics (reported in parentheses) are robust to within-firm correlations and heteroskedasticity. *, ** and *** represent two-tailed significance at the 10, 5 and 1% levels, respectively.

	$PE_{it} \geq PE_{INDt}$		$PE_{it} < PE_{INDt}$	
Runs:	2 years	5 years	2 years	5 years
Model:	(1)	(2)	(3)	(4)
Dependent variable:	*ECUI*	*ECUI*	*ECUO*	*ECUO*
$SALARY_{t+1}$	-0.1786***	-0.2561**	0.0694*	0.1582**
	(-2.62)	(-2.36)	(1.72)	(2.28)
$SALARY_{t+1}^2$	0.1523***	0.1652***	0.0013	-0.0003
	(4.02)	(2.84)	(1.51)	(-0.15)
$BONUS_{t+1}$	0.0105**	0.0125**	0.0115	0.0051
	(2.21)	(1.68)	(0.81)	(0.39)
$BONUS_{t+1}^2$	-0.0000	-0.0000	-0.0000	-0.0000
	(-1.38)	(-1.15)	(-0.41)	(-0.73)
$OTHCOMP_{t+1}$	0.0039	-0.0108	0.0159*	0.0171**
	(0.66)	(-0.82)	(1.70)	(2.09)
$OTHCOMP_{t+1}^2$	-0.0000	0.0000	-0.0000*	-0.0000**
	(-0.45)	(0.84)	(-1.79)	(-2.48)
$LTIP_{t+1}$	0.0025	0.0015	-0.0002	0.0008
	(0.01)	(0.45)	(-0.03)	(0.09)
$EQUITY\text{-}BASED_{t+1}$	0.0001	0.0002	-0.0004	-0.0121***
	(0.72)	(0.22)	(-0.89)	(-3.18)
SOX (post-SOX = 1)	14.1076***	19.6256***	-1.4585	-27.2128
	(2.62)	(2.27)	(-0.29)	(-1.58)
Constant	89.2177***	157.7252***	54.7441*	81.8179*
	(3.24)	(3.30)	(1.83)	(1.69)
Fixed firm effect	Yes	Yes	Yes	Yes
Fixed year effect	No	No	No	No
Observations	1,692	2,434	1,786	1,995
R^2	0.876	0.879	0.939	0.963

IV. Robustness Tests

In this section we present two sets of robustness tests. The first relates to the earnings measure. Given diversity in earnings measures used for benchmarking, we substitute EBIT and Net Income for EBITDA in the Table VII estimations retaining the same expectations as previously developed but expecting poorer fits because CEOs have less control over depreciation, interest and taxation charges. The results are reported in Table IX: Models (1) and (2) are defined on EBIT, while models (3) and (4) are defined on Net Income. In general, the regression parameters are marginally inferior for both substitute measures compared with the EBITDA-based estimations of Table VII, reinforcing our earlier preference for an EBITDA earnings measure which approximates operating cash flow. In the *ECUO* case (models (2) and (3)) the loss of sensitivity on $SALARY_{t+1}$ for both the EBIT and Net Income measures weakens the inference of excessive salary payments from Table VII. In the *ECUI* case (model (3)) based on Net Income, cash bonus sensitivity is found to transfer from the annual bonus to the long-term incentive plan. This outcome makes sense because performance targets based on Net Income are more susceptible to non-operating disturbances, i.e., more volatile. Apart from some instability of the *SOX* coefficients in the Net Income-based models (2) and (3), the pay structures identified in the fixed-effect estimations of Table VII remain essentially undisturbed. Overall, our evidence shows that the EBITDA measure of earnings explains CEO pay structures adequately.

Table IX. Robustness Tests Employing Alternative Earnings Measures

ECUI is the value of an up-and-in barrier call on the firm's stock price at time *t* multiplied by the earnings-price ratio also at *t* where earnings are measured by EBITDA, as defined in Compustat. *ECUO* is similarly determined for an up-and-out barrier call. *SALARY*, *BONUS*, *OTHCOMP* and *LTIP* are ExecuComp line-items. *EQUITY-BASED* is the sum of the value of grants of restricted stock and options as defined by ExecuComp (RSTKGRNT and OPTION_AWARDS_BLK_VALUE, respectively). *SOX* refers to the Sarbanes-Oxley Act (2002). All *t*-statistics (reported in parentheses) are robust to within-firm correlations and heteroskedasticity. ** and *** represent two-tailed significance at the 5 and 1% levels, respectively.

	EBIT	EBIT	Net Income	Net Income
Model:	(1)	(2)	(3)	(4)
Dependent variable:	*ECUI*	*ECUO*	*ECUI*	*ECUO*
$SALARY_{t+1}$	0.0447***	0.0184	0.0641**	0.0595
	(4.06)	(0.87)	(2.43)	(1.35)
$SALARY_{t+1}^2$	-0.0001	0.0030**	-0.0014	-0.0007
	(-0.33)	(2.44)	(-1.12)	(-0.29)
$BONUS_{t+1}$	0.0113***	0.0036	-0.0014	-0.0004
	(6.53)	(0.78)	(-0.21)	(-0.17)
$BONUS_{t+1}^2$	-0.0000***	-0.0000	0.0000	0.0000
	(-5.56)	(-0.29)	(0.44)	(0.74)
$OTHCOMP_{t+1}$	-0.0008	0.0080**	0.0013	0.0018
	(-0.52)	(2.08)	(0.85)	(1.12)
$OTHCOMP_{t+1}^2$	-0.0000	-0.0000	-0.0000	-0.0000
	(-0.37)	(-1.48)	(-1.22)	(-0.26)
$LTIP_{t+1}$	0.0017	0.0100	0.0023**	0.0013
	(1.20)	(0.35)	(2.49)	(0.66)
$EQUITY\text{-}BASED_{t+1}$	0.0001	-0.0003	0.0002	-0.0001
	(0.70)	(-1.12)	(1.25)	(-0.10)
SOX (post-SOX = 1)	-0.7781	8.1137***	-8.3728**	4.0103
	(-0.29)	(3.49)	(-1.99)	(1.55)
Constant	5.5068	7.4434	-13.2750	-21.1637
	(0.94)	(0.85)	(-1.32)	(-1.27)
Fixed firm effect	Yes	Yes	Yes	Yes
Fixed year effect	No	No	No	No
Observations	15,147	15,147	15,018	15,018
R^2	0.785	0.841	0.294	0.655

The second robustness test relates to substitution of prior-period earnings performance for current-period industry-benchmarked PE in accord with the common observation that companies set performance targets in relation to internally-benchmarked performance rather than external benchmarks. For the present purpose we specify prior-year earnings as the substitute performance benchmark. Earnings are EBITDA-based and the metric is constructed as follows.

Firm *H* is given by the rule: For firm *i* if $E_{it-1} > E_{it}, H = S_{it}\left(\ln(1+\frac{E_{it-1}-E_{it}}{|E_{it}|})\right)$; else, $H = S_{it}\left(\ln(1+\frac{E_{it}-E_{it-1}}{|E_{it}|})\right)$. This rule adjusts the stock price at *t* upwards whatever the earnings outcome for [*t*-1, *t*]. Table X shows that firm H/S_t is lower and also less volatile than the corresponding industry H/S_t. This outcome is consistent with prior-year benchmarking locking in inefficiencies which otherwise would be exposed through external benchmarking.

Table X. Robustness Tests Employing Alternative Earnings Measures

Industry H is given by the rule: If; $PE_{it} > 0$, $H = S_t[\ln(1+ PE_{it}/PE_{INDt})]$; else, $H = S_t[\ln(1+|PE_{INDt} - PE_{it}|/PE_{INDt})]$, where E is EBITDA-based earnings. Firm H is given by the rule: If $E_{t-1}>E_t$, $H = S_t\ S_t[\ln(1+(E_{it-1} - E_{it}/|E_{it}|)]$; else $H = S_t[\ln(1+(E_{it} - E_{it-1}/|E_{it}|)]$. All inter-group mean and median differences are significant at the 1% level.

	Industry H/S_t	Firm H/S_t
Mean	1.73	1.28
Median	1.67	1.16
Standard deviation	0.48	0.45

Prior-period benchmarking is expected to overall deliver a less sensitive pay structure for both models given a lower hurdle than that determined by current-period industry-benchmarked performance. Table XI reports the results of the two regressions for the two models. As expected, all pay sensitivities in both models disappear save for $SALARY_{t+1,}$ which in the *ECUI* model is positively signed. The implication is that as the performance target is lowered $SALARY_{t+1}$ declines to the reservation wage. Despite losing more than 2,000 observations from the first year in the sample period, these results indicate that an externally-benchmarked performance target outperforms an internally-benchmarked performance target.

Table XI. Robustness Test Employing Prior-Year Performance Benchmark

ECUI is the value of an up-and-in barrier call on the firm's stock price at time *t* multiplied by the earnings-price ratio also at *t* where earnings are measured by EBITDA, as defined in Compustat. *ECUO* is similarly determined for an up-and-out barrier call. *SALARY*, *BONUS*, *OTHCOMP* and *LTIP* are ExecuComp line-items. *EQUITY-BASED* is the sum of the value of grants of restricted stock and options as defined by ExecuComp (RSTKGRNT and OPTION_AWARDS_BLK_VALUE, respectively). *SOX* refers to the Sarbanes-Oxley Act (2002). All *t*-statistics (reported in parentheses) are robust to within-firm correlations and heteroskedasticity. ** and *** represent two-tailed significance at the 5 and 1% levels, respectively.

Model:	(1)	(2)
Dependent variable:	*ECUI*	*ECUO*
$SALARY_{t+1}$	0.1208**	-0.0088
	(2.27)	(-0.60)
$SALARY_{t+1}^2$	0.0025	0.0008
	(1.16)	(1.23)
$BONUS_{t+1}$	0.0094	0.0024
	(1.20)	(1.79)
$BONUS_{t+1}^2$	-0.0000	-0.0000
	(-1.01)	(-1.73)
$OTHCOMP_{t+1}$	0.0059	0.0022
	(1.06)	(1.19)
$OTHCOMP_{t+1}^2$	-0.0000	-0.0000
	(-0.90)	(-1.27)
$LTIP_{t+1}$	0.0026	0.0041
	(0.77)	(0.04)
$EQUITY\text{-}BASED_{t+1}$	-0.0006	0.0001
	(-1.44)	(0.83)
SOX (post-SOX = 1)	12.5202**	-1.3462
	(2.20)	(-0.82)
Constant	13.6980	4.4244
	(0.85)	(0.67)
Fixed firm effect	Yes	Yes
Fixed year effect	No	No
Observations	13,160	13,160
R^2	0.891	0.420

V. Extension to Research & Development

We now extend the barrier call approach to scenarios where extra risk-taking is required in order to secure growth opportunities, as exemplified by Research & Development-intensive (RD) industries. Increased risk-taking for RD firms enters through higher stock volatility and hence higher barrier call valuation. RD firms are described by the *ECUI* model, while non-RD firms are described by the *ECUO* model. Hence, RD firms are expected to exhibit pay structures similar to model (3) but not to model (4) reported in Table VII, with the added proviso that the sensitivities are higher due to the extra risk taking. By corollary, non-RD firms are expected to exhibit pay structures similar to model (4) but not to model (3) reported in Table VII. Since non-RD firms engage in less risk-taking than RD firms, we expect to observe lower pay sensitivities than model (4) of Table VII.

To test these propositions, sub-samples of RD and non-RD firms are established. RD firms are firms belonging to the four most RD-active GICS industries and subject to RD expenditure being positive in a given year. Non-RD firms are firms belonging to the four least RD-active GICS industries and subject to RD expenditure being zero in a given year. Applying these filters generates sub-samples 2,629 RD firms and 806 non-RD firms.

Table XII. Extension of Barrier Call Model to Research & Development

Research & Development-intensive (RD) firms are those classified in industries having a GICS# of 3520 (Pharmaceuticals & Biotechnology), 4510 (Software & Services), 4520 (Technology Hardware & Equipment) or 4530 (Semiconductors & Semiconductor Equipment) and having RD expenditure > 0. Non-RD firms are those with a GICS# of 2550 (Retailing), 3010 (Food & Staples Retailing), 3020 (Food, Beverage & Tobacco) or 3030 (Household & Personal Products) and having RD expenditure = 0. These industry clusters exhibited the highest and lowest RD expenditures/Total Assets, respectively. *ECUI* is the value of an up-and-in barrier call on the firm's stock price at time *t* multiplied by the earnings-price ratio also at *t* where earnings are measured by EBITDA, as defined in Compustat. *ECUO* is similarly determined for an up-and-out barrier call. *SALARY*, *BONUS*, *OTHCOMP* and *LTIP* are ExecuComp line-items. *EQUITY-BASED* is the sum of the value of grants of restricted stock and options as defined by ExecuComp (RSTKGRNT and OPTION_AWARDS_BLK_VALUE, respectively). *SOX* refers to the Sarbanes-Oxley Act (2002). All *t*-statistics (reported in parentheses) are robust to within-firm correlations and heteroskedasticity. ** and *** represent two-tailed significance at the 5 and 1% levels, respectively.

	RD firms		Non-RD firms	
Model:	(1)	(2)	(3)	(4)
Dependent variable:	*ECUI*	*ECUO*	*ECUI*	*ECUO*
$SALARY_{t+1}$	0.1861**	0.1630***	0.0716	0.2030***
	(2.17)	(2.68)	(0.28)	(2.65)
$SALARY_{t+1}^2$	-0.0040	0.0171	-0.0011	0.1660***
	(-0.26)	(0.17)	(0.82)	(3.16)
$BONUS_{t+1}$	0.0510***	0.0119	0.0220**	-0.0271
	(5.00)	(1.01)	(2.18)	(-1.36)
$BONUS_{t+1}^2$	-0.0002***	0.0000	0.0000	0.0060
	(-3.06)	(0.18)	(0.19)	(1.56)
$OTHCOMP_{t+1}$	-0.0103	0.0266	0.0003	-0.0006
	(-1.06)	(1.25)	(0.17)	(-0.22)
$OTHCOMP_{t+1}^2$	0.0002*	-0.0001	-0.0000	0.0000
	(1.78)	(-0.74)	(-0.82)	(1.42)
$LTIP_{t+1}$	0.0201***	0.0321	-0.0184	0.0109
	(3.03)	(1.17)	(-0.98)	(0.47)
$EQUITY\text{-}BASED_{t+1}$	0.0000*	0.0501	0.0010	-0.0009
	(1.71)	(0.59)	(1.02)	(-1.18)
SOX (post-SOX = 1)	10.2551	-4.2581	3.6845	11.6576
	(1.26)	(-0.43)	(0.58)	(1.41)
Constant	0.1572	-71.8232***	1.5871	82.0664***
	(0.01)	(-4.16)	(0.07)	(3.20)
Fixed firm effect	Yes	Yes	Yes	Yes
Fixed year effect	No	No	No	No
Observations	2,629	2,629	806	806
R^2	0.860	0.860	0.882	0.777

The results of panel regressions of *ECUI* and *ECUO* on the standard set of compensation variables are reported in Table XII for both sub-samples. For RD firms the *ECUI* model better explains outperforms the *ECUO* model. The pay structure revealed in model (1) conforms to that previously observed in model (3) of Table VII except for positive sensitivity on $LTIP_{t+1}$, but this outcome is expected given the higher risk inherent in RD firms. As expected, the *ECUO* model describes pay structures of non-RD firms more satisfactorily than the corresponding *ECUI* model.

However, the estimation of model (4) has much higher positive salary sensitivities than those obtained in model (4) of Table VII. Given the prior selection of low risk-taking non-RD firms, it is difficult not to infer excessive salaries in this subsample.[9] Thus, we encounter an indication of excessive salary payments for a second time. Nor do we observe any suggestion of excessive bonuses. The absence of a *SOX* effect suggests the Act impacted industries not represented by RD and non-RD firms.

VI. Summary and Conclusion

We devise a new technique to reveal the ex ante structure of CEO pay which is not revealed through conventional ex post analysis. Broadly, we find that most components of CEO pay are positively-related to the payoff on a one-year earnings adjusted barrier call option. The *ECUI* model successfully describes pay structures where target financial performance is expected to be reached or exceeded, while the *ECUO* model successfully describes pay structures for scenarios in which target performance is not reached. Salary sensitivities are more convex for the *ECUO* model than the *ECUI* model, suggesting excessive payments. This finding is reinforced for non-RD firms in low-RD industries. Our evidence suggests that annual bonuses are paid and capped when target performance is likely to be reached in order to reward above-target performance, but not otherwise. Long-term incentive payments tend to be reserved for high risk-taking firms. Importantly, and contrary to the Administration's viewpoint, no evidence of excessive bonuses is uncovered at least for the interval ending in fiscal 2005. A clear direction for future research is to replicate the study on years around emergence of the global financial crisis. Policy-wise, it is equally clear from our analysis that bonuses cannot be considered in isolation from other modes of CEO pay. Further examination of 'other' modes of pay is also warranted given sporadic significance on this item.

[9] Further analysis (not reported here) traces the 'excessive' salaries to GICS 4010, or Banks.

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