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ARE CEOS REALLY PAID LIKE BUREAUCRATS?*

BRIAN J. HALL AND JEFFREY B. LIEBMAN

A common view is that there is little correlation between firm performance and CEO pay. Using a new fifteen-year panel data set of CEOs in the largest, publicly traded U. S. companies, we document a strong relationship between firm performance and CEO compensation. This relationship is generated almost entirely by changes in the value of CEO holdings of stock and stock options. In addition, we show that both the level of CEO compensation and the sensitivity of compensation to firm performance have risen dramatically since 1980, largely because of increases in stock option grants.

I. INTRODUCTION

A common view of CEO compensation is that CEOs are paid like bureaucrats. There is said to be a weak link between the performance of large public companies and the compensation of their CEOs. For example, Jensen and Murphy [1990a] argue that in "most publicly held companies, the compensation of top executives is virtually independent of performance . . . on average, corporate America pays its most important leaders like bureaucrats." Jensen and Murphy's [1990b] argument is based on their widely cited finding that, on average, CEOs receive only $3.25 for

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every $1000 increase in shareholder wealth. Rosen [1992] surveys the large empirical literature on CEO compensation and concludes that "evidence from several independent studies and samples leaves us fairly secure that the effect of stock returns on log compensation is in the 0.10–0.15 range." An elasticity of 0.10 implies that a CEO whose work produced annual rates of return of 20 percent would be paid only 1 percent more than a CEO whose work produced annual rates of return of 10 percent.[1]

The design of performance incentives for managers in large companies is an enormously important issue. Aligning the incentives of executives with those of owners is the most direct way to mitigate the agency problem. If there is no meaningful link between CEO pay and company performance, it is doubtful that the trillions of dollars of assets in public corporations are being managed efficiently. As Jensen and Murphy [1990a] argue, if CEOs are paid like bureaucrats, "is it any wonder then that so many CEOs act like bureaucrats rather than the value-maximizing entrepreneurs companies need to enhance their standing in world markets?"

In this paper we argue that CEOs are not paid like bureaucrats. We use a new fifteen-year panel data set of CEOs in the largest, publicly traded U. S. firms. Because our data contain detailed information on CEO holdings of stock and stock options, we are able to produce precise and comprehensive measures of the relationship between firm performance and CEO pay and to document the large increase in CEO holdings of stock and stock options that occurred between 1980 and 1994. In measuring the responsiveness of pay to performance, we focus on a broad measure of compensation, which includes changes in the value of stock and stock options.[2] We report a variety of measures of the relationship between pay and performance and find a strong link between the fortunes of CEOs and the fortunes of the companies they manage. We find that virtually all of the pay to performance sensitivity is attributable to changes in the value of CEO holdings of stock and stock options.

Our main empirical finding is that CEO wealth often changes by millions of dollars for *typical* changes in firm value. For example, the median total compensation for CEOs is about $1 million if their firm's stock has a thirtieth percentile annual

1. The view that there is little correlation between firm performance and CEO pay is often echoed in the popular press and by CEO compensation critics such as Crystal [1992].

2. Jensen and Murphy [1990b] also use a broad measure of CEO compensation. We discuss why our conclusions differ from theirs shortly.

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return (−7.0 percent) and is $5 million if the firm's stock has a seventieth percentile annual return (20.5 percent). Thus, there is a difference of about $4 million dollars in compensation for achieving a moderately above average performance relative to a moderately below average performance. The difference in compensation between a tenth percentile firm performance and a ninetieth percentile performance is more than $9 million.[3]

In addition, we show that both the level of CEO compensation and the responsiveness of CEO compensation to firm performance have risen dramatically over the past fifteen years. Between 1980 and 1994 the direct compensation (salary, bonus, and the value of annual stock option grants) of CEOs increased by 136 percent at the median and 209 percent at the mean in real terms. Moreover, because most of this pay increase was in the form of stock options, the relationship between CEO pay and firm performance has increased substantially. As one example, the median elasticity of CEO compensation with respect to firm market value more than tripled from 1.2 to 3.9 between 1980 and 1994. This total compensation elasticity for 1994 is about 30 times larger than previously reported salary and bonus elasticities, which ignore sensitivity generated by stock and stock option revaluation.

It is worth stating from the outset why our results differ from previous findings. With regard to the large literature that indicates that salary and bonus elasticities are small, our findings differ simply because previous estimates ignored changes in the value of stock and stock options, which account for virtually all of the sensitivity. Indeed, for a given change in firm value, we find that changes in CEO wealth due to stock and stock option revaluations are more than 50 times larger than wealth increases due to salary and bonus changes.

Our conclusion differs from that of Jensen and Murphy's for two reasons. First, Jensen and Murphy's estimates of the relationship between pay and performance rely on data from a period (1969–1983) that predates the explosion in stock option issuance that occurred during the 1980s and 1990s.[4] Indeed, the increase in

3. Estimates using mean changes in compensation are many times larger. But, as we will argue later, these are misleading since they are heavily influenced by outliers. Thus, throughout the paper we focus on medians.

4. Although their data predate the explosion in stock options, they find that the vast majority of sensitivity is the result of CEO stock holdings. Our 1980 estimate of the total change in CEO wealth for a $1000 change in firm value is $3.11 (when we adjust our number in a few minor ways to make it comparable to theirs), which is very close to their estimate of $3.25.

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pay to performance sensitivity during the last fifteen years is consistent with the prescription called for by Jensen and Murphy.

Second, Jensen and Murphy focus exclusively on how CEO wealth varies relative to changes in firm value. Although an important measure, the Jensen and Murphy statistic in isolation can present a misleading picture of pay to performance relationships because the denominator—the change in firm value—is so large. A several million dollar change in CEO wealth appears very small when divided by the annual change in the market value of a Fortune 500 company, and firm size matters a lot in interpreting their measure of pay to performance sensitivity.

The main goal of this paper is to provide a broader perspective on the relationship between CEO pay and firm performance. Thus, in addition to the Jensen and Murphy statistic, we report a variety of other pay to performance measures. We show that CEO pay varies by millions of dollars in response to typical changes in firm performance. However, we do not argue that current CEO contracts are efficient. Such a statement would require us to make strong assumptions about many parameter values that are not easily measured. Indeed, our findings suggest that there are some potentially serious flaws in the contracts of CEOs. We do, however, believe that our results contradict he claim that there is little or no link between firm performance and CEO pay. By extension, our findings also contradict the claim that current contracts are necessarily inefficient simply because pay to performance sensitivities are too low.

II. Motivating CEOs

One of the key challenges of effective corporate governance is solving the agency problem [Jensen and Meckling 1976]. CEOs have goals that often conflict with the interests of shareholders. The most direct solution to this agency problem is to align the incentives of executives with the interests of shareholders by granting (or selling) stock and stock options to the CEOs. For risk-neutral CEOs the optimal contract is a one-to-one correspondence between firm value and CEO pay. This contract essentially sells the firm to the CEO. With a "sharing rate" of one, CEOs have the correct incentives on every margin, including effort, perquisites, and project choice.[5]

5. This argument applies to all workers in the firm. To completely eliminate the agency problem, a firm must design compensation packages so that the compensation of every worker with decision-making power varies dollar-for-dollar with changes in firm value.

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While a one-to-one benchmark may be reasonable for small firms, it is not appropriate for the large, publicly traded companies we are studying. There are two main reasons for this. First, most CEOs simply do not have enough wealth to purchase all, or even a substantial fraction, of the largest companies. The median size of the companies in our sample for 1994 is $2.2 billion, and the mean is $4.6 billion. Even if the typical CEO had $20 million in wealth—which is almost fourteen times annual total compensation at the median—the CEO could purchase only about 0.9 percent of the firm. This represents a substantial "financing constraint." For the largest public corporations, a reasonable upper bound for the amount of stock that typical CEOs could purchase is 1 percent, which implies a sharing rate that is two orders of magnitude below the one-to-one relationship that is sometimes used as a benchmark.[6]

The second reason why the one-to-one benchmark is not reasonable for very large firms is CEO risk aversion [Garen 1994; Haubrich 1994]. The optimal contract represents a trade-off between incentives and risk-sharing [Fama and Jensen 1983]. If a very high sharing rate induces large swings in CEO pay, CEOs will need to be rewarded for taking such risks. Since typical changes in firm value are so large in the largest publicly traded companies—the median standard deviation of annual changes in firm value in our sample is 32 percent or about $700 million (many of the largest firms have annual standard deviations in the billions)—paying CEOs to accept such variations in pay would be prohibitively costly.[7] Perhaps more importantly, CEO risk aversion coupled with even moderately high sharing rates in large companies will cause CEOs to avoid some high-risk, positive NPV projects that are optimal from the perspective of diversified shareholders. Because risk-averse CEOs will price idiosyncratic risk, high sharing rates coupled with large annual swings in firm value will substantially distort CEO incentives.[8]

6. This financing constraint implies an upper bound on the Jensen and Murphy statistic of a $10 increase in CEO wealth per $1000 increase in firm value.

7. To further explore this issue, we conducted simulations using a power utility function and various estimates of risk aversion. The analysis and results are presented in Hall and Liebman [1997]. Under reasonable assumptions regarding risk aversion, putting nearly all of a CEO's wealth in company stock substantially reduces the CEO's utility.

8. As a simple example, suppose that the CEO of a $10 billion company is deciding on a project that will raise firm value, in expectation, by $500 million. Project success (increasing firm value by $1.5 billion) and failure (decreasing value by $0.5 billion) are equally likely. A risk-averse CEO with a sharing rate of one would almost certainly reject such a project. A much smaller sharing rate, say 0.01, would therefore improve incentives.

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This analysis suggests that measuring the sharing rate, b, in isolation, gives an incomplete picture of the optimality of CEO incentive contracts. The importance of financing constraints and CEO risk aversion is directly related to dollar changes in CEO wealth, which equal $b\Delta V$, where ΔV is defined to be the change in firm value.

Small sharing rates (b) in very large companies are the result of the infeasibility (due to financing constraints) and nonoptimality (because of risk aversion) of having CEO wealth vary one for one with changes in firm value. However, the resulting large swings in CEO wealth ($b\Delta V$) for typical changes in firm value will often lead CEOs to make correct decisions, especially with regard to large, discrete projects or major strategic goals. For example, consider two projects with differing expected payoffs and private benefits. Project A has expected returns that are $350 million more than the expected returns of project B, but project B yields private benefits that the CEO values at $1 million. In this case, the CEO needs to be paid only $1 million more (plus a dollar) for choosing project A. In this case, even if the CEO receives only $3.25 per $1000 of added market value, the CEO will choose the correct project.

This is only one example. For many other decisions a small sharing rate will not be sufficient to induce value-maximizing decisions: with a sharing rate of 0.01, a CEO can purchase a corporate jet at a 99 percent discount (absent effective monitoring). But the example illustrates the importance of measuring dollar changes in CEO wealth that occur in response to typical changes in firm value. It is these changes in wealth that need to be compared with the value of empire building and other private benefits to determine whether compensation-based incentives are sufficient to produce value-maximizing behavior by the CEO. The example also demonstrates that because changes in firm market value are often extremely large, even small sharing rates lead to very large dollar rewards and punishments for CEOs.

III. Data Description and Means

Our data set covers the years from 1980 to 1994, and combines CEO compensation information from corporate proxies and 10-K filings with stock price and stock return information from CRSP and with accounting data from Compustat. In addi-

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tion, some compensation data from the 1970s were collected in order to construct measures of the value of stock options held by CEOs in the first years of the sample. The data for the 1984 to 1991 period were provided to us by David Yermack, and these data are described in Yermack [1995]. We randomly selected half of Yermack's 792 companies and extended his sample up to 1994 and back to 1980. Our data set consists of information on 478 companies for the period 1980 to 1994.[9]

The Yermack firms are essentially the largest publicly traded companies in the United States. Each year, *Forbes* creates four lists of the largest U. S. companies, ranked on the basis of sales, profits, assets, and market value. In order to be in the sample, a firm must be included in one of the four *Forbes* 500 lists at least four times between 1984 and 1991. In order to have a sample of firms that is representative of large firms at the end of our sample, we added 50 percent of the firms that met the large-firm requirement since 1991 (40 additional firms).[10] If a firm qualifies, the firm is in the sample in all years during which it was publicly traded, even if the firm did not make any of the lists for that year. In some cases, when the data from the proxy statements and 10-K forms were vague or incomplete, data were collected from firms' Annual Reports, *Forbes* magazine's annual CEO surveys, press reports, or direct correspondence with the companies.

Most of the CEO literature uses the compensation data provided by the *Forbes* survey. The main problem with the *Forbes* data set is that it has limited information on stock and stock option awards. The information reported on stock options includes only the value of stock options exercised during the year, which reflects past, not current, compensation. In contrast, our proxy data include detailed information on the amount of stock options granted during the year, as well as the exercise prices and durations of the options. Although there are a few exceptions, we

9. Not all firms are present in every year, and some firms split into more than one firm. After splits, we treat the new firms as two additional firms in the data set.

10. Because firms must have existed during four years in the 1984–1994 period to be in our sample, our sample does not include large firms from the early 1980s that had shrunk or gone out of business by the mid-1980s. The median annual growth rate between 1980 and 1984 of firms in our sample was approximately 20 percent, about 4 percent a year greater than the growth rate of the S&P 500. To the extent that this produces a bias, it will understate the increases in sensitivity between 1980 and 1994 to the extent that the poor-performing firms that are underrepresented in our sample are also low sensitivity firms.

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find that the vast majority of options are issued at-the-money with a ten-year duration. The options then become vested over time. For example, a typical option grant becomes vested 25 percent per year over four years.

We use the details about option grants and the Black-Scholes formula in order to value stock option grants and holdings. The distinguishing feature of our data set is that with our panel of yearly proxy data on option grants, option gains, and total options held, we are able to calculate the value of all stock options held by the CEO at a given point of time. More importantly, since we have the details about the stock options held (number, exercise price, time to maturity, etc.), we can precisely calculate the change in the value of a CEO's stock option holdings for a given change in firm value. The methodology for making these calculations is described in Appendix 1.

Some summary statistics for our data for fiscal year 1994 are presented in Table I. The median CEO in our sample is 58 years old, has held the job of CEO for 6 years, and has been employed by

TABLE I
DATA SUMMARY STATISTICS (1994)

Variable	Mean	Median	Standard deviation	Minimum	Maximum
Age of CEO	57.6	58.0	6.6	36.0	82.0
Years as CEO	8.4	6.0	7.3	1.0	38.0
Years employed by company	22.0	22.0	13.3	1.0	59.0
Founder of company (dummy)	0.09	0	0.29	0	1
Percent of firm stock owned by CEO	2.15%	0.14%	6.65%	0%	53%
Salary and bonus	$1,292,290	$1,050,000	$1,163,920	$52,000	$16,000,000
Value of option grants	$1,213,180	$ 324,989	$2,874,280	$ 0	$28,849,350
Value of restricted stock grants	$ 201,736	$ 0	$ 757,127	$ 0	$ 9,737,770
Other compensation	$ 319,014	$ 69,000	$ 961,007	$ 0	$11,154,000

n = 368. Summary statistics are for the last year of 1980–1994 panel data set.

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TABLE IIa
MEAN CEO COMPENSATION (1994 DOLLARS)

Year	Mean salary and bonus	Mean value of stock option grants	Mean direct compensation[a]	Mean total wealth increase[b]
1980	654,935	155,037	809,973	5,493,312
1981	676,912	211,014	887,926	2,032,343
1982	675,441	235,571	911,011	4,481,189
1983	732,029	266,388	998,417	10,383,767
1984	770,878	258,402	1,029,280	1,852,328
1985	830,365	431,333	1,261,698	8,122,815
1986	931,056	375,738	1,306,793	10,439,932
1987	960,839	543,886	1,504,725	3,964,999
1988	1,057,791	530,653	1,588,444	3,782,151
1989	1,062,148	574,162	1,636,309	13,357,133
1990	1,005,860	751,477	1,757,336	907,567
1991	994,470	780,604	1,775,074	17,546,181
1992	1,061,370	959,791	2,021,161	14,852,845
1993	1,175,870	891,843	2,067,715	12,774,561
1994	1,292,290	1,213,180	2,505,469	9,168,990
% Change 1980–1994	97.3	682.5	209.3	—

Annual sample sizes vary from 365 to 432.
a. Direct compensation is salary and bonus plus value of stock option grants.
b. Total wealth increase is the increase in the value of the CEO's holdings of firm stock and stock options plus direct compensation. The increase in the value of stock and stock option holdings is calculated using each firm's actual stock market returns during the firm's fiscal year.

the company for 22 years. Nine percent of the CEOs in our sample founded their companies. The mean (median) CEO owned 2.2 percent (0.14 percent) of the firm's stock. The mean (median) CEO received $1.3 million ($1.1 million) in salary and bonus, stock options worth $1.2 million ($325,000), restricted stock worth $202,000 ($0), and other compensation totaling $319,000 ($69,000).

IV. TRENDS IN CEO COMPENSATION

In this section we document how CEO compensation has increased over time and relative to the compensation of other workers.[11] Tables IIa and IIb report the means and medians of

11. The increase in CEO compensation, and stock option grants in particular, has been widely reported in the business press, in annual compensation surveys, and by Crystal [1992]. Murphy [1998] provides a comprehensive survey of trends in CEO compensation.

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TABLE IIb
MEDIAN CEO COMPENSATION (1994 DOLLARS)

Year	Median salary and bonus	Median value of stock option grants	Median direct compensation[a]	Median total wealth increase[b]
1980	566,541	0	622,777	1,025,342
1981	604,050	0	650,515	818,455
1982	572,067	0	669,588	1,119,251
1983	641,307	0	760,926	1,842,217
1984	677,527	0	784,504	915,421
1985	705,190	6,257	853,985	2,044,776
1986	809,962	64,274	964,111	1,586,680
1987	846,671	89,190	1,083,832	964,806
1988	929,539	44,651	1,120,047	1,569,690
1989	938,202	42,410	1,152,117	2,358,251
1990	857,791	71,646	1,098,947	483,799
1991	857,427	141,852	1,179,344	3,033,961
1992	860,891	236,296	1,250,785	2,318,349
1993	945,608	271,091	1,309,698	2,002,501
1994	1,050,000	324,989	1,472,202	1,046,897
% Change 1980–1994	85.3	NA	136.4	–

Annual sample sizes vary from 365 to 432.
a. Direct compensation is salary and bonus plus value of stock option grants.
b. Total wealth increase is the increase in the value of the CEO's holdings of firm stock and stock options plus direct compensation. The increase in the value of stock and stock option holdings is calculated using each firm's actual stock market returns during the firm's fiscal year.

CEO compensation from 1980 to 1994 in real 1994 dollars.[12] Column 1 of each table shows that mean salary and bonus has risen by 97 percent over the past fifteen years, from $655,000 to $1.3 million, and median salary and bonus has risen by 85 percent. The rise in the value of stock option grants has been even more dramatic. Between 1980 and 1994 the mean value of stock option grants rose by 683 percent from $155,000 to $1.2 million. The median value of stock option grants rose from $0 to $325,000. The sum of all direct compensation rose by 209 percent at the mean and 136 percent at the median.[13]

12. Throughout the paper we use the consumer price index to adjust for inflation. Our choice of a deflator does not matter much since the CPI and the personal consumption expenditure deflator both grew at a annualized rate of 4.27 percent from 1980 to 1994.

13. Note that the direct compensation measure used in this table excludes components of compensation such as restricted stock grants and other compensation for which it is impossible to construct consistent time series. As Table I shows, these other components are small relative to the included ones.

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The fourth column of each table shows the broader measure of CEO compensation: the total increase in wealth, which includes all direct compensation plus changes in the value of stock and stock option holdings. Changes in total wealth are quite volatile, reflecting the large variation in year-to-year returns in the stock market. Nevertheless, the same basic pattern emerges. Changes in total wealth in the early 1980s are generally much smaller than those in the late 1980s and 1990s.

The remarkable growth in stock option awards can be seen in Figure I. The percentage of CEOs receiving stock option awards during the year increased from 30 percent in 1980 to nearly 70 percent in 1994. Likewise, the percentage of CEOs holding any stock options (including past grants) increased from 57 percent to about 87 percent over the same period. The increase in stock option awards explains much of the increase in CEO pay over the past fifteen years and will be shown later to be the main factor responsible for the large increase in pay to performance sensitivities that we find.

Table III documents the real growth of CEO compensation over time relative to the growth of pay of other workers. Between 1982 and 1994, mean CEO pay increased by 175 percent or about 8.8 percent per year. The median growth rates are 120 percent and 6.8 percent, respectively. The third row shows the growth rate of total compensation for all wage and salary workers, based on the Employment Cost Index. As is well-known, average compensation for all workers was almost flat during this period, rising by 0.6 percent a year from $30,400 to $32,600. Our proxy for bureaucrats is state and local government workers, excluding teachers. Their total compensation has grown slowly as well, at a rate of 0.9 percent a year. Professors have also seen little growth in their real compensation during this period.

The sixth row of Table IV contains a measure of the increase in incomes of the very rich.[14] The incomes of individuals at the top one-half of 1 percent of the income distribution increased by about 55 percent during the period, far more than the growth rate of average workers but only one-third as high as the mean CEO compensation growth rate. The next two rows include compensation data on two groups of superstars, Major League Baseball

14. Specifically, this is the income level that excludes the top 0.5 percent of adjusted gross income earners, as reported on tax returns. See Feenberg and Poterba [1993] who report this "high income threshold" up to 1990. We thank Daniel Feenberg for updating these numbers for us.

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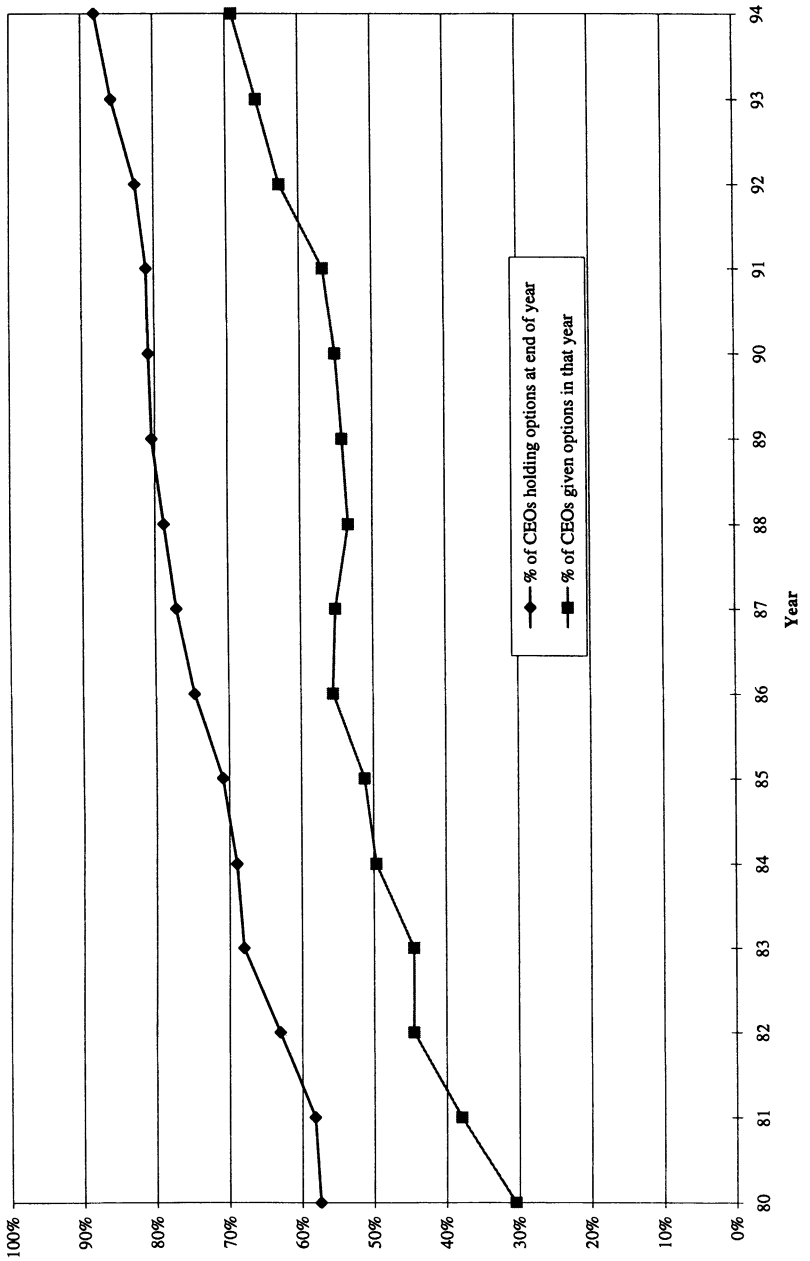

FIGURE I
CEO Compensation with Stock Options (1980–1994)

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TABLE III
COMPENSATION GROWTH: CEOs RELATIVE TO OTHER WORKERS (1994 DOLLARS)[a]

Group	1982	1994	% Change 1982–1994	Annualized % change 1982–1994
CEO direct compensation (mean values)[b]	$ 911,011	$2,505,469	175.0	8.8
CEO direct compensation (median values)[b]	$ 669,588	$1,472,202	119.9	6.8
All workers[c]	$ 30,400	$ 32,600	7.2	0.6
State and local government (excluding education)[c]	—	—	11.9	0.9
Professors[d]	$ 40,700	$ 47,900	17.7	1.4
Top 0.5% of AGI[e]	$ 180,900	$ 281,100	55.4	3.7
MLB players[f]	$ 376,300	$1,154,500	206.8	9.8
NBA players[f]	$ 325,600	$1,558,000	378.5	13.9
CEO total wealth increase assuming median performance (mean values)[g]	$1,904,056	$7,039,669	269.7	11.5
CEO total wealth increase assuming median performance (median values)[g]	$1,030,428	$2,476,637	140.4	7.6

a. Comparisons are between 1982 and 1994 because the employment cost index is not available before 1982. The data are converted to real dollars using the CPI.

b. CEO direct compensation is salary and bonus plus the value of stock option grants.

c. All workers and state and local government are total compensation from the employment cost index [Bureau of Labor Statistics]. Compensation levels for all workers are calculated by dividing NIPA total compensation of all employees by the total number of employees in the economy.

d. Professors is total salary (*Source*. ACADEME [March–April 1996].

e. Top 0.5% of AGI is the cutoff point for being in the top 0.5% of AGI (an updated version of the series in Feenberg and Poterba [1993]).

f. MLB and NBA Players are mean salaries and were provided to us by NBA and MLB Commissioner's Offices.

g. CEO total wealth increase assuming median performance is the increase in wealth from holdings of firm stock plus increase in wealth from holdings of stock options plus direct compensation assuming that every firm in the sample had a 5.9 percent increase in market value.

(MLB) players and National Basketball Association (NBA) players, which have had remarkable compensation growth of 207 percent and 379 percent, respectively. However, these very high growth rates in sports leagues are distorted by complicated changes in rules governing free agency and salary caps.

In the last two rows we show how the total wealth increase of CEOs (including increases in the value of stock and stock option holdings) has increased during this period. Because the endpoint values of this time series are driven by the overall market return during the particular years, we have standardized the compensation levels by assuming that all firms (in both years) had an

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TABLE IV
RESPONSIVENESS OF SALARY AND BONUS AND OPTION GRANTS TO FIRM PERFORMANCE

Independent variable	Dependent variable					
	ln (salary and bonus)			ln (direct compensation)		
	1	2	3	4	5	6
Firm return in current year	0.1630	0.1887		0.2799	0.3230	
	(0.0116)	(0.0132)		(0.0224)	(0.0254)	
Firm return in previous year	0.0596	0.0487		−0.0156	−0.0348	
	(0.0105)	(0.0110)		(0.0236)	(0.0253)	
S&P 500 return in current year		−0.1884			−0.3059	
		(0.0342)			(0.0710)	
S&P 500 return in previous year		0.0182			0.0413	
		(0.0341)			(0.0710)	
Firm return in current year × (80 ≤ year ≤ 86)			0.1214			0.2189
			(0.0222)			(0.0342)
Firm return in current year × (87 ≤ year ≤ 94)			0.2278			0.3896
			(0.0164)			(0.0363)
Firm return in previous year × (80 ≤ year ≤ 86)			0.0471			0.0271
			(0.0166)			(0.0254)
Firm return in previous year × (87 ≤ year ≤ 94)			0.0444			−0.0790
			(0.0144)			(0.0374)
S&P 500 return in current year × (80 ≤ year ≤ 86)			−0.0814			−0.1126
			(0.0415)			(0.0817)
S&P 500 return in current year × (87 ≤ year ≤ 94)			−0.2555			−0.4548
			(0.0419)			(0.0888)
S&P 500 return in previous year × (80 ≤ year ≤ 86)			−0.0067			−0.0977
			(0.0418)			(0.0781)
S&P 500 return in previous year × (87 ≤ year ≤ 94)			0.0512			0.1667
			(0.0405)			(0.0867)
Number of observations	5773	5773	5773	5680	5680	5680
R^2	0.06	0.07	0.07	0.05	0.05	0.05

The numbers in parentheses are Huber-White robust standard errors that allow for correlation in the errors among observations for each CEO. Rates of return are calculated as changes in firm market value over the firm's fiscal year. S&P 500 returns also correspond to each firm's fiscal year. Direct compensation is salary and bonus plus value of stock option grants, but does not include revaluations.

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increase in firm value of 5.9 percent (the median annual change in market value of the largest 500 firms between 1970 and 1995) during the year. Using this normalization, the broad measure of CEO compensation increased by 270 percent at the mean and 140 percent at the median.

In sum, our data confirm the general impression that CEOs have enjoyed large gains in compensation, both in absolute terms and relative to most other highly paid groups. Periods of large increases in CEO pay relative to other workers have not been common historically. Jensen and Murphy [1990b] report that the level of CEO pay actually *decreased* in real terms between the 1934–1938 and the 1974–1986 periods. We are aware of only one other period in history with increases in CEO wealth that were similar to those in the 1980s and 1990s. Lewellen [1968] shows that between 1945 and 1955, CEO wealth increased by 133 percent, while average earnings of production workers rose by only 78 percent. These wealth increases in the immediate postwar period were largely due to the introduction of stock option plans.[15]

V. Measures of the Relationship between CEO Pay and Firm Performance

In Section II we discussed how single measures of the pay to performance relation can be misleading when taken in isolation. In this section we therefore present a variety of measures of the relationship between CEO compensation and firm performance. Our emphasis is on how the stock and stock option holdings of CEOs affect this relationship since, as we will show, performance-related changes in the value of stock and stock option holdings are much larger than changes in components of direct pay.

We report four basic measures of the relationship between CEO pay and firm performance. The first two show how CEO wealth changes for "typical" changes in firm performance, which we define as moving from fiftieth percentile performance to seventieth percentile performance. We present dollar changes in CEO wealth from such performance improvements as well as percent increases in CEO compensation in response to such performance. Our third measure is an elasticity—the percentage

15. Lewellen's wealth measure smoothes ex post gains from stock option holdings. Lewellen shows that over the longer 1940 to 1963 period, CEO compensation actually fell by 25 percent while real earnings of production workers increased by 62 percent.

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increase in CEO compensation for a 1 percent increase in firm value. Since virtually all previous studies of the pay to performance relationship report salary and bonus elasticities, we estimate the total compensation elasticity to highlight the fact that including stock and stock option revaluations increases compensation elasticities by a factor of about 30. Finally, our fourth measure is the Jensen and Murphy statistic—the dollar change in CEO wealth per $1000 change in firm market value.

A. Salary and Bonus Sensitivity

We begin by exploring the relationship between salary and bonus and firm performance. A large number of authors have limited their measure of CEO compensation to salary and bonus. These studies typically find that the elasticity of CEO compensation with respect to changes in firm value is quite small, in the range of 0.10 to 0.15.[16] Although we find that this elasticity has approximately doubled since the early 1980s, we basically corroborate earlier findings that salary and bonus elasticities are small.

In order to calculate salary and bonus elasticities, the log difference of salary and bonus is regressed on the percentage change in firm value during the firm's fiscal year.[17] The bonus part of pay is usually determined at the end of the fiscal year and typically reflects performance during the year. In contrast, salaries are typically set at the beginning of the fiscal year, and therefore respond to performance from the previous year. To account for both of these components of pay, our regressions include the firm's rate of return during both the current fiscal year and the previous fiscal year. In addition, following Gibbons and Murphy [1990] and Antle and Smith [1986], we investigate whether there is a relative component of CEO pay. Therefore, we add current and lagged values of the return to the S&P 500 as

16. A sampling of examples include Murphy [1985, 1986]; Coughlin and Schmidt [1985]; Gibbons and Murphy [1990]; Barro and Barro [1990]; Joskow, Rose, and Shepard [1993]; and Kaplan [1994].

17. We run OLS regressions to retain comparability with previous estimates of these elasticities. We have also run median regressions as well as robust regressions (using the STATA version 5 rreg command [Hamilton 1991]). The median regressions and robust regressions give results that are quite similar to each other and produce elasticities that are generally 20 to 30 percent smaller (closer to zero) than the results presented in Table IV. We have also investigated specifications in which the change in salary and bonus is regressed on the change in firm market value. These Jensen and Murphy statistic regressions are more sensitive to outliers. We find estimates of the increase in salary and bonus for a $1000 increase in firm market value that vary from 11 cents to 42 cents depending on the regression technique used.

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independent variables. We regress

$$(1)\quad \ln(SB_{t,i}/SB_{t-1,i}) = \beta + \gamma^1 r_{t,i} + \gamma^2 r_{t-1,i} + \theta^1 r_{t,i}^{SP500} + \theta^2 r_{t-1,i}^{SP500} + \epsilon_{t,i},$$

where SB_t and $SB_{t\text{-}1}$ are the salary and bonus received by the CEO during the current and previous fiscal years, r_t and $r_{t\text{-}1}$ are the firm's rates of return during the current and previous fiscal year, and r_t^{SP500} and r_{t-1}^{SP500} are the S&P 500 rate of return during the current and previous fiscal year of the firm. The results are shown in the first two columns of Table IV. The first column shows that the elasticity of salary and bonus with respect to changes in firm value is about 0.16, which is similar to previous estimates. The lagged value is smaller at about 0.06, suggesting that the salary component of compensation has a weaker link to performance than the bonus component.

The second column shows that there is an operational relative pay component. Salary and bonus responds negatively to changes in the market as a whole, as indicated by the coefficient of −0.19 on the contemporaneous market return. Although the overall evidence on "Relative Performance Evaluation" has been mixed, our findings are consistent with those of Gibbons and Murphy [1990], who find that CEOs are paid in part on the basis of relative performance.[18]

We also tested to see whether sensitivity has risen over time by interacting each of these variables with time dummies for the early 1980s (1980–1986) and the more recent period (1987–1994). The coefficients are larger for the later period, suggesting that sensitivity has increased since the early 1980s. For example, the salary and bonus elasticity with respect to contemporaneous returns has approximately doubled from 0.12 to 0.23.[19]

This analysis is repeated in the next three columns, with direct compensation (salary and bonus plus stock option grants, but *not* the revaluation of stock and stock option holdings) substituted for salary and bonus.[20] The estimates, although a bit

18. Gibbons and Murphy [1990] find evidence supporting relative performance evaluation. Antle and Smith [1986] find only weak evidence of RPE, and Barro and Barro [1990] find no evidence of RPE. Rosen [1992] surveys this literature.

19. Gibbons and Murphy [1992] and Joskow, Rose, and Shepard [1993] also find an increase in the salary and bonus elasticity over time.

20. Stock options grants are the dollar value of stock options given during the year, valued with the Black-Scholes formula. This should not be confused with the change in the value of the CEO's existing stock option holdings, which (along with changes in the value of stock holdings) is the main source of the large elasticities estimated later in this paper.

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larger, are similar. The sensitivity comes mostly from contemporaneous performance, suggesting that bonuses and end-of-year stock option grants are the driving forces behind the pay to performance relationship. There is some evidence of relative pay, and again sensitivity seems to have risen since the early 1980s.

The key implication of these results is that the pay to performance sensitivity from direct compensation is tiny in comparison to the sensitivity generated by holdings of stock and stock options. For example, the 0.22 elasticity of salary and bonus (adding the coefficients on contemporaneous and lagged performance) implies that a 10 percent increase in firm performance will increase salary and bonus by 2.2 percent or about $23,400 (evaluated at the median CEO salary and bonus in 1994). As we will show, this same 10 percent increase in firm value increases the value of the median CEO's stock and stock options by about $1.25 million, which is 53 times larger.

B. The Pay to Performance Relationship from Stock and Stock Option Revaluations

We now turn to estimating the relationship between total CEO compensation and changes in firm value. Our measure of total compensation includes salary and bonus, stock option grants, restricted stock grants, other compensation, changes in the value of stock holdings, and changes in the value of stock option holdings. In order to highlight the importance of stock and stock option holdings, we hold constant all of the other components of compensation, and examine the change in CEO wealth that are the result of changes in the value of stock and stock options holdings. We ignore sensitivity based on changes in salary and bonus and the other components of direct compensation since such changes are essentially in the rounding error of changes in the value of stock and stock options. While including changes in the value of stock and stock options represents a broad measure of compensation, it is the right measure in terms of monetary incentives. CEOs presumably care about changes in their wealth emanating from all sources, not just salary and bonus. Indeed, increasing the responsiveness of pay to performance is perhaps the main reason why boards give CEOs stock and stock options,

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both of which typically have restrictions that force CEOs to hold the stock and stock options.[21]

Because our data contain detailed information on CEO stock and stock option holdings, we are able to calculate the change in each CEO's wealth that occurs in response to various changes in his firm's market value. We begin by creating a distribution of annual stock returns for large firms by pooling the annual returns for the period 1970 to 1994 of the 500 firms in each year that had the largest market values at the end of the previous year.[22] The nine decile cutoffs of *annual* firm returns are shown at the top of Table V. For example, the return at the tenth percentile is negative 27.6 percent, the median return is 5.9 percent, and the ninetieth percentile return is 47.9 percent.

From the proxy data we construct entire compensation packages for each CEO in our sample for 1994 using the panel to build up the stock of stock options that the CEO holds at each point in time. Then, we simulate nine levels of total compensation for each CEO, which correspond to the nine decile cutoffs of the distribution of stock returns. Thus, the first column of the top half of the table shows the mean compensation of *all CEOs* under the assumption that each firm performed at the tenth percentile rate of return. The first four rows show the mean compensation from salary and bonus, option grants, other compensation, and restricted stock grants. These components of compensation are assumed to be invariant to firm performance, and therefore have identical values across columns.

The next two rows display the change in the value of stock options and stock holdings at the various firm performance levels. These columns show dramatic changes in the level of compensation. For example, assuming a tenth percentile performance, the average CEO in our sample loses $2.4 million in the value of stock option holdings and nearly $15 million in the value of their stock holdings. These losses swamp the amount of direct compensation

21. CEOs often continue to hold stock and stock options even after the restrictions have lapsed because of both explicit and implicit restrictions on the selling of stock. Many companies have explicit guidelines that indicate how much stock CEOs must hold. In many other companies, implicit guidelines are in place since boards and stockholders do not like CEOs to unload their stockholdings, in part because selling sends a bad signal to the market.

22. These returns exclude dividends since option holders do not receive dividends. But we do include the value of dividends received by the CEO in the component of compensation that reflects the increase in the value of stock holdings.

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TABLE V
COMPOSITION OF 1994 CEO COMPENSATION ($1000S), ASSUMING STOCK PRICE PERFORMANCE AT EACH DECILE[a]

Deciles	10	20	30	40	50	60	70	80	90
A: % Change in stock price[b]	−27.6	−15.3	−7.0	−.01	5.9	12.8	20.5	30.5	47.9
B: Mean compensation									
salary and bonus	1,292	1,292	1,292	1,292	1,292	1,292	1,292	1,292	1,292
option grants	1,213	1,213	1,213	1,213	1,213	1,213	1,213	1,213	1,213
other comp.	325	325	325	325	325	325	325	325	325
restricted stock grant	204	204	204	204	204	204	204	204	204
Increase in value of:									
options	(2,448)	(1,414)	(662)	(1)	569	1,251	2,028	3,054	4,886
stock	(14,659)	(7,812)	(3,183)	727	4,009	7,858	12,147	17,707	27,422
Total compensation	(14,073)	(6,193)	(811)	3,760	7,611	12,143	17,209	23,794	35,342
C: Median compensation									
salary and bonus	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050
option grants	325	325	325	325	325	325	325	325	325
other comp.	70	70	70	70	70	70	70	70	70
restricted stock grant	0	0	0	0	0	0	0	0	0
Increase in value of:									
options	(1,283)	(772)	(367)	(0.5)	329	729	1,191	1,779	2,854
stocks	(1,037)	(512)	(155)	96	358	691	1,023	1,460	2,233
Total compensation[c]	(435)	441	1,014	2,196	3,026	4,042	5,111	6,385	8,598

a. Salary, bonus, option grants, other compensation, and restricted stock grants are all assumed to be invariant to firm performance.
b. The stock price distribution comes from the annual returns (excluding dividends) for the 500 largest firms for each year between 1970 and 1995. In this table these annual returns are used to calculate compensation under 1994 CEO compensation plans at different percentiles of firm performance.
c. This is the median of the sum which does not equal the sum of the medians.

gains to the CEO, so that on net CEOs lose an average of about $14 million when their firms perform this poorly. These losses contrast with net gains of $7.6 million for a median performance and an astounding $35 million gain for a ninetieth percentile performance.

This extreme variation of pay, however, is misleading because the large swings in the value of stock are driven by a few outliers

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such as Bill Gates, who owns about one-quarter of Microsoft, one of America's largest companies. Thus, in the bottom half of the table, the analysis is repeated for median rather than mean compensation. While slightly less dramatic, the results still indicate very large changes in CEO wealth in response to changes in firm performance. For example, with a tenth percentile performance, our median CEO loses about $435,000; losses in the value of stock and stock option holdings more than offset the amount of direct pay. This contrasts with total compensation of about $3 million for the typical CEO with a median stock performance, and $8.6 million for a ninetieth percentile performance. For the median CEO in our sample, there is a $9 million difference in CEO wealth in moving from a tenth percentile firm performance to a ninetieth percentile performance.[23] It is hard to reconcile these results with the view that CEO compensation has little correlation with firm performance. Holdings of stock and stock options create a strong link between firm performance and changes in CEO wealth.

C. Distributions of Pay to Performance Measures

The separate roles of holdings of stock and stock options in creating a relationship between pay and performance can be seen in Table VI, where we show distributions of four measures of pay to performance. In all cases, we assume that direct pay is held constant, allowing only variation resulting from stock and stock option revaluation.

The entries in the first row of this table indicate the dollar amount (in millions) by which CEO total compensation changes if the firm's stock price increases from a median performance (5.9 percent) to a seventieth percentile performance (20.5 percent). This 14.6 percent change in firm value represents a typical change in firm value since the median standard deviation of annual changes in firm value is about 32 percent for our firms. The mean change is shown in the first column, and the next nine columns indicate the decile cutoffs of percent changes, ranked from the

23. When we repeat this analysis for a five-year period, the results are even more dramatic. We again assume salary and bonus to be invariant to firm performance and use overlapping five-year periods from 1965 to 1994 to calculate and rank firm returns. A tenth percentile five-year performance represents a negative 45.5 percent total return. A ninetieth percentile performance represents a 160.7 percent total return. Under these assumptions, the median CEO receives about $4.6 million over five years for a tenth percentile performance but nearly $34 million for a ninetieth percentile performance.

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TABLE VI

FOUR MEASURES OF THE PAY TO PERFORMANCE RELATIONSHIP FOR 1994 IF FIRM MOVES FROM 50TH PERCENTILE TO 70TH PERCENTILE PERFORMANCE (FROM A 5.9% RETURN TO A 20.5% RETURN)

Deciles	Mean change	Smallest change 10	20	30	40	50	60	70	Largest change 80	90
One-year dollar change in compensation					*Dollar change (millions)*					
—50th to 70th, no stock[a]	1.46	0.00	0.05	0.30	0.54	0.85	1.09	1.43	1.95	3.06
—50th to 70th, with stock[b]	9.58	0.15	0.65	0.96	1.34	1.82	2.42	3.42	6.08	13.24
One-year percent change in compensation					*Percent change*					
—50th to 70th, no stock[a]	37.8	0.0	4.6	13.6	24.6	33.2	40.2	50.0	60.1	81.6
—50th to 70th, with stock[b]	70.8	15.0	25.9	38.2	48.9	57.6	68.0	81.2	111.3	149.5
Percent change in compensation divided by percent change in market value					*Elasticity*					
—50th to 70th, no stock[a]	2.59	0.00	0.32	0.93	1.68	2.27	2.75	3.42	4.11	5.59
—50th to 70th, with stock[b]	4.85	1.03	1.77	2.61	3.35	3.94	4.66	5.56	7.62	10.23
Dollar change in compensation for $1000 change in market value					*Jensen and Murphy statistic*					
—50th to 70th, no stock[a]	3.66	0.00	0.21	0.70	1.27	2.15	3.07	4.39	5.65	9.30
—50th to 70th, with stock[b]	25.11	0.54	1.30	2.50	3.58	5.29	6.78	10.31	16.43	44.82

Compensation is calculated using actual 1994 compensation contracts and assuming 50th and 70th percentile rates of return for all firms.

a. Assumes that CEOs hold no stock (but that they do hold stock options).

b. Allows for changes in the value of both stock and stock options.

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smallest to the largest. The first row indicates these changes under the (counterfactual) assumption that CEOs have no stock holdings. This row highlights the sensitivity created by holdings of stock options.

The table shows that moving firm performance from a median performance to a seventieth percentile performance increases CEO wealth by a substantial $1.5 million at the mean and $0.85 million at the median, assuming no stock holdings. The zero change at the tenth percentile reflects that fact that slightly more than 10 percent of the CEOs hold no stock options at all. At the ninetieth percentile CEO wealth increases by about $3 million.

The next row reports the same calculations, including CEO holdings of stock in their firms. The changes are, as expected, much larger. The mean change from moving from the fiftieth percentile performance to the seventieth percentile performance is an increase in CEO pay of $9.6 million. The median increase is about $1.8 million. Note that this implies that a ten percentage point increase in firm value increases CEO wealth by about $1.25 million, which is 53 times larger than our estimated $23,400 increase in salary and bonus for the same change in firm value.

The second panel of the table repeats the analysis with percent changes in compensation replacing dollar changes. For example, the median increase in CEO pay in moving from a median to a seventieth percentile performance is 58 percent. This number ranges from only 15 percent at the tenth percentile to 150 percent at the ninetieth percentile. Taken together, the findings again indicate that even modest changes in firm performance increase CEO compensation by a substantial amount, and that both the holdings of stock and stock options contribute to this relationship.

We also calculate the elasticity of total compensation. Compensation is again defined to be the CEO's annual *change* in wealth, which includes all direct pay and stock and stock option revaluations. Salary and bonus is again assumed to be invariant to firm performance. We then evaluate elasticities of total compensation at the median firm performance. That is, we mechanically calculate total compensation for each CEO at the fiftieth percentile, and at the seventieth percentile.[24] The elasticity is the percentage change in total compensation divided by the percentage change in

24. Since annual compensation is sometimes negative, it is not possible to estimate these elasticities econometrically, which is why we evaluate them at a particular point (compensation at the median firm performance).

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firm value.[25] The mean elasticity and the distribution of elasticities, from smallest to largest, are shown in the third panel of the table. The first row shows the distribution of elasticities (from smallest to largest) under the assumption that CEOs hold no stock. The mean elasticity is 2.6, and the median elasticity is 2.3. Adding in the impact of stock holdings raises the elasticities substantially. The distribution of elasticities has a mean of about 4.9 and a median of 3.9. Moreover, the tenth percentile of CEO elasticities is about one, and the ninetieth percentile of elasticity is a strikingly large ten.

Finally, we show how much CEO wealth changes relative to $1000 changes in firm value. We find that a $1000 increase in firm value increases CEO wealth by about $25 at the mean and $5.29 at the median.[26] Our $5.29 median estimate of the Jensen and Murphy statistic represents only sensitivity from stock and stock option revaluation. In order to make this estimate comparable to the $3.25 estimate of Jensen and Murphy, we need to make a few adjustments reflecting (current and future) changes in salary and bonus as well as sensitivity from the probability of being fired. After making these adjustments, our median estimate of the Jensen and Murphy statistic rises to $6.00 for 1994.[27]

This increase, however, substantially underestimates the size-adjusted increase in sensitivity over time. There is a dramatic negative correlation between the Jensen and Murphy measure and the size of the firm. For example, the largest firms in our sample (market value over $10 billion) have a median Jensen and Murphy statistic that is more than an order of magnitude smaller than the smallest firms in our sample (market value less than $500 million). Since most of the firms in our sample increased their market value during the fifteen-year period we are studying, there is a natural tendency for their Jensen-Murphy statistics to fall over time. Using our data, the size-adjusted Jensen and Murphy sensitivities increased fourfold (rather than

25. The elasticity is the one-year percent change in compensation between the fiftieth and seventieth percentiles divided by 14.6 percent, the difference between the rates of return at the two percentiles. It is important to note that this is not a CEO wealth elasticity since we do not know total CEO wealth.

26. The means and medians are quite different because stock ownership percentages and firm market values have highly skewed distributions.

27. We add 11 cents per $1000 for current salary and bonus sensitivity, based on our Table IV regression estimates. Because we do not have estimates of sensitivity from future salary and bonus changes or from the possibility of dismissal, we also add 60 cents based on estimates from Jensen and Murphy [1990b].

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the almost doubling from $3.25 to $6.00) between 1980 and 1994.[28]

D. Regression Estimates of the Pay to Performance Relationship

Most of our calculations so far have used our detailed data on the 1994 compensation contracts of CEOs to simulate compensation under different assumptions about firm performance. This method enables us to ask well-defined questions such as how much the median CEO gains if performance changes by a certain amount. Nevertheless, as a robustness check, it is useful to estimate the pay to performance relationship with regression analysis.

We run the simplest possible specification (given the constraint that we cannot log total compensation since this number is sometimes negative). We regress total compensation on the firm's contemporaneous return for that fiscal year. Because the resulting estimates are influenced by outliers, we run robust regressions, which lower the weight on observations with large residuals.[29]

The results are shown in Table VII. The coefficient is 0.043 and is highly significant.[30] This coefficient implies that a one percentage point increase in the firm's return increases the CEO's wealth by $43,000. The results of Table VI, which show the pay to performance relationship for 1994, indicate that this measure is less than half of the median measure reported there, which is about $125,000 for every 1 percent increase in firm value ($1.82 million divided by 14.6 percent).

However, note that this is an average over the entire fifteen-year period, and is much less than the estimate for the last year in our sample, 1994. Therefore, in column (2) we interact returns with each year to see how the pay to performance measurement has changed over time. As expected, it rises steadily over time. The measure in 1994 is almost nine times larger than that of

28. We calculated the size-adjusted increase by dividing our firms into five groups based on size (market value). We then took a weighted average of the within-group increases in the Jensen and Murphy statistic.

29. We use the STATA version 5 rreg command which uses Huber weight iterations followed by biweight iterations. See Hamilton [1991] for details.

30. Simple OLS regressions result in estimates that are almost ten times higher, and less precisely estimated. We have also run regressions to estimate the Jensen and Murphy statistic (dollar change in CEO wealth on dollar change in firm wealth). OLS versions of this regression produce a Jensen and Murphy statistic of 54 dollars per thousand, while robust regressions produce a Jensen and Murphy statistic of $16 per thousand. However, simple plots of the data suggest that there is not a visible linear relationship between the two variables.

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TABLE VII
PAY TO PERFORMANCE REGRESSIONS

	Dependent variable Total wealth CEO change (millions)	
Independent variable	(1)	(2)
Annual return (percent)	0.043	
	(0.001)	
Annual return * 1980		0.014
		(0.007)
Annual return * 1981		0.026
		(0.002)
Annual return * 1982		0.031
		(0.002)
Annual return * 1983		0.025
		(0.002)
Annual return * 1984		0.037
		(0.003)
Annual return * 1985		0.026
		(0.003)
Annual return * 1986		0.036
		(0.003)
Annual return * 1987		0.049
		(0.003)
Annual return * 1988		0.038
		(0.003)
Annual return * 1989		0.052
		(0.003)
Annual return * 1990		0.046
		(0.003)
Annual return * 1991		0.033
		(0.002)
Annual return * 1992		0.066
		(0.002)
Annual return * 1993		0.085
		(0.003)
Annual return * 1994		0.124
		(0.003)

Regressions are robust regressions and include a full set of year dummies. Rates of return are calculated as changes in firm market value over the firm's fiscal year. N = 5672.

1980. The coefficient for 1994 is 0.124, which implies that a one percentage point increase in firm value leads to a $124,000 increase in CEO wealth. This estimate is almost identical to the $125,000 estimate based on our earlier results, giving us confidence in our earlier calculations. We now turn to describing more

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precisely how the pay to performance relationship has changed over time.

VI. How Has Pay to Performance Changed over Time?

The dramatic rise in CEO compensation has been driven to a large extent by increases in annual stock option grants, which have produced a large buildup in total CEO holdings of stock options. Moreover, although the holding of direct stock relative to total firm value has remained constant or fallen a bit since the early 1980s, the dollar value of stock held by CEOs has risen sharply since the early 1980s due to the stellar performance of the stock market. The median value of stock holdings of CEOs rose from $1.2 million in 1980 to $4.4 million in 1994 (in 1994 dollars). Taken together, these factors have dramatically increased the relationship between pay and performance during the last fifteen years.[31]

In Table VIII we show how four measures of the pay to performance relationship have changed over time. The measures are (1) the median elasticity, (2) the median change in CEO wealth for a $1000 change in firm value, (3) the median dollar difference in CEO wealth from a dramatic improvement—moving from a tenth percentile performance to a ninetieth percentile performance—and (4) the median dollar difference in CEO wealth from a modest improvement—moving from a fiftieth percentile performance to a seventieth percentile performance. Again, we focus only on that part of the pay to performance relationship that results from stock and stock option revaluations. That is, the measures are calculated with the same assumptions we made to create Tables V and VI.

The increase in the pay to performance relationship is evident in all of the measures. For example, between 1980 and 1994 the median elasticity more than tripled from 1.2 to 3.9. The median wealth change per thousand dollar firm value change more than doubled from $2.5 to $5.3.[32] And the CEO wealth change for a dramatic firm performance change increased by a factor of almost seven—from $1.4 million to more than $9 million. The median

31. Since CEO holdings of firm stock are often the result of exercising stock options, some of the increased sensitivity that shows up as due to stock holdings actually originated in stock option grants.

32. Recall from the previous section that the size-adjusted Jensen and Murphy statistic increased by a factor of four rather than two.

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TABLE VIII
CHANGE IN FOUR PAY TO PERFORMANCE MEASURES OVER TIME MEASURES ARE BASED ON CHANGES IN THE VALUE OF HOLDINGS OF STOCK AND STOCK OPTIONS ONLY

Year	Median elasticity (1)	Median change in CEO wealth per $1000 change in firm value (2)	Median 10th to 90th dollar change (millions of dollars) (3)	Median 50th to 70th dollar change (millions of dollars) (4)
1980	1.17	2.51	1.396	0.281
1981	1.40	2.70	1.631	0.323
1982	1.50	2.86	1.676	0.334
1983	1.71	3.35	2.097	0.415
1984	2.02	3.21	2.671	0.523
1985	1.91	3.46	2.881	0.569
1986	2.26	3.84	3.318	0.654
1987	2.42	3.97	3.885	0.761
1988	2.33	3.63	3.931	0.770
1989	2.81	4.11	4.517	0.887
1990	3.10	3.64	5.297	1.034
1991	2.68	4.22	4.424	0.873
1992	3.61	4.63	6.773	1.333
1993	3.99	5.30	7.929	1.560
1994	3.94	5.29	9.237	1.823

Columns (3) and (4) are in 1994 dollars. Pay to performance measures are calculated using actual CEO compensation arrangements for each year, under various assumptions about firm performance. The elasticity in column (1) is the percent change in CEO compensation divided by the percent change in market value from moving between a 50th and a 70th percentile performance.

wealth change for a modest improvement in firm performance increased from $281,000 to $1.8 million. The increase in these pay to performance measures would be even larger, although only modestly so, if we allowed for the slight increase in direct pay sensitivity, which was documented in Table IV. The key point is that, regardless of which measure is used, there has been a dramatic increase in responsiveness of CEO pay to firm performance during the last fifteen years.

VII. DO CEOS EVER LOSE MONEY?

An important issue in the pay to performance debate is whether CEOs are punished sufficiently for poor performance. Our analysis suggests that CEOs can actually lose money, since the losses in stock and stock option holdings can more than offset

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TABLE IX
DO CEOS EVER LOSE MONEY?

Years	S&P 500 stock return	Percent of CEO sample with decline in wealth	Median stock return for firms with decline in wealth	Mean wealth loss of CEOs with a decline in wealth (millions of dollars)	Median wealth loss of CEOs with a decline in wealth (millions of dollars)
1994	0.020	24.0	−0.181	12.82	3.10
1993 through 1994	0.126	15.0	−0.192	47.75	4.96
1992 through 1994	0.226	10.0	−0.326	74.30	14.63
1991 through 1994	0.564	3.5	−0.347	23.83	27.41
1990 through 1994	0.551	5.0	−0.273	64.27	29.89

Sample consists of the 200 CEOs in our data set who were CEO for all five years from 1990 to 1994. This table indicates the frequency and magnitude of actual CEO wealth declines over the periods indicated. A wealth decline occurs if the sum of salary and bonus, restricted stock grants, option grants, other compensation, and stock and stock option revaluations is negative during the period.

gains from direct compensation. However, it is an empirical question as to whether this actually happens, and if so, to what degree.

In order to investigate this issue, we calculated the percentage of CEOs who actually suffered a loss in wealth during the last year (1994) of our sample, the last two years (1993 to 1994), and so on up to the last five years (1990 to 1994). For these calculations we used the 200 CEOs in our sample who were CEO for all five years from 1990 to 1994. The results are shown in Table IX. The first column shows the S&P 500 stock return for each of the periods. The next column shows the percent of CEOs in our sample who suffered an actual decline in wealth during the period. The third column shows the median stock return for the firms whose CEOs had their wealth decline during that year. The fourth and fifth columns show the mean and median wealth losses for those CEOs who experience wealth declines.

The numbers indicate that CEOs do in fact experience wealth declines and that the declines are both frequent and large. For example, in 1994, which was a flat year for the stock market, about 24 percent of the CEOs in our sample actually lost money during the year. Moreover, the mean and median losses for those who experience wealth declines was $13 million and $3 million, respectively. Even over a three-year period, 10 percent of CEOs

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lost an average (median) of $74 million ($15 million). For the five-year period, 5 percent of the CEOs lost an average (median) of $64 million ($30 million).

These results are consistent with the general theme of this paper, which is that the relationship between pay and performance is much larger than has previously been recognized, and that this includes both gains and losses in CEO wealth.[33] Note also that all of our pay to performance measures ignore the possibility that CEOs may get fired if their firm performs poorly [Gilson and Vetsuypens 1993; Warner, Watts, and Wruck 1988; Weisbach 1988]. The prospect of being fired clearly raises the sensitivity of CEO pay to performance, especially since CEO stock and stock option grants sometimes contain provisions that nullify the awards if a CEO is fired before the restrictions elapse. However, given the existence of generous CEO buyouts (golden parachutes), it is not clear how much CEOs lose, on net, when they are fired.

VIII. Implications

The results of this study have a number of important implications that make us think differently about the incentives facing CEOs and the direction of future research on CEO compensation.

A. The Importance of Equity-Based Pay Relative to Salary and Bonus

One important implication follows from the fact that changes in the value of stock and stock options completely swamp changes in salary and bonus. The large literature that measures pay to performance with salary and bonus elasticities should be interpreted with the important caveat that, for a given change in firm value, the incentive effects of salary and bonus changes are 53 times smaller than those from stock and stock option revaluations.

Why do salary and bonus vary so little? In principle, bonuses could approximate the variability inherent in stock and stock option revaluations. However, corporate board members are often reluctant to reduce CEO pay even in response to poor performance, and bonuses the size of stock option gains are likely to

33. Hall [1997] analyzes the downside and upside sensitivity of CEO stock option holdings in greater detail.

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generate unwanted media attention. The result is that salary and bonus have a weak relationship with firm performance, a result that seems to hold in the other major industrialized countries as well [Kaplan 1998]. The fact that it is hard in practice to use salary and bonus to reward and penalize CEOs has the important implication that equity-based pay may be the only feasible way to create high-powered incentives that align CEO pay with shareholder objectives.

B. The Lack of Relative Pay

A related and disturbing implication of our results is that Relative Pay Evaluation (RPE) is not a significant component of CEO compensation packages. Our results indicate that RPE via direct pay is trivial relative to the sensitivity generated from movements in the value of stock and stock option holdings, which do not have a relative component. One principle of efficient compensation is that managers should be rewarded for outcomes over which they have control, while being insulated from economywide or industrywide shocks.[34] This implies that CEOs should be paid, at least in part, relative to some market or industry index. Consistent with Gibbons and Murphy [1990], we find a statistically significant RPE component: CEO salary and bonus changes are positively related to own firm returns and negatively related to market returns. Likewise, we also find a relative pay component with regard to direct pay. However, our findings suggest that changes in direct pay, which do have a relative pay component, are tiny when compared with changes in the value of stock and stock option holdings, which do not have a relative pay component.

One way to introduce relative pay would be to issue options with an exercise price that moves with a market or industry index.[35] Such an option contract would introduce relative pay, which is lacking in current contracts. While more research is needed, we suspect that this would represent a substantial improvement over current contracts.

34. See Holmstrom [1979]. There is an important caveat to this argument, however. To the extent that managers can take actions to reduce their exposure to industry or economywide shocks, which is typically the case, then completely insulating them from such shocks is not optimal [Baker, Jensen, and Murphy 1988]. Nevertheless, the near complete absence of relative pay seems to be a puzzle.

35. According to CEO pay consultants whom we interviewed, the main reasons why such contracts are rarely used is that stock options with moving exercise prices have "bad accounting." That is, unlike at the money options with a fixed exercise price, which do not reduce current earnings, options with an unknown exercise price must be expensed against current earnings.

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C. Why the Increasing Use of Stock Options?

Why has the use of stock options (and therefore the relationship between pay and performance) increased so dramatically over the past fifteen years? There are at least two theories, which are not mutually exclusive. First, the increase in the use of stock options may reflect a desire by boards to increase the relationship between pay and performance. Boards may have been influenced by practitioners (e.g. LBO specialists such as Henry Kravis)[36] and academics (e.g., Jensen and Murphy) that pay to performance is central to inducing CEOs to raise shareholder value. Boards of directors (as well as increasingly powerful institutional investors) may not want their CEOs to be paid like bureaucrats and have therefore responded with higher-powered incentive contracts.

Our results are at least suggestive that this is the case. For example, our finding that salary and bonus sensitivity has increased over time is consistent with the view that boards are attempting to increase pay to performance. While salary and bonus sensitivities are only the tip of the iceberg in terms of overall sensitivity, they may reveal important information about the iceberg.

A second possible explanation for the increased use of stock options is that boards have wanted to increase CEO pay (either to compete for executive talent or because the boards are beholden to their CEOs) and option grants are a less visible vehicle for paying CEOs than salary and bonus is. Finding a less visible way to pay CEOs is important because public opposition to high pay levels appears to have increased as levels of pay have risen.[37]

Even if CEOs are receiving stock options in order to mask the rise in the level of CEO pay, the options still generate the benefits of high-powered pay to performance contracts. In this case, boards may have improved the incentive structures of CEO contracts for the wrong reason. Nevertheless, a high priority for future research is understanding why CEO stock options grants have grown so dramatically over the past fifteen years.

36. See a persuasive paper by Kaplan [1997] who argues that "we are all Henry Kravis now."

37. Dial and Murphy [1995, p. 285] report an interesting example of this involving executives at General Dynamics. There was a huge public outcry when they were given large bonuses for raising the company's stock price. This outcry basically ended when the bonus plan was replaced with a stock option plan "even though the payouts under the two plans were virtually identical." Likewise, we interviewed compensation consultants at seven leading firms. Many reported that there would be huge public resistance to giving bonuses that are as large as annual stock option gains.

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It is also worth noting that the dramatic increases in CEO pay over the past fifteen years are not very large relative to the market value of firms in our sample or to their number of employees.[38] If annual CEO direct compensation were reduced to 42 percent of its current level (essentially back to 1980 levels) and the annual savings were returned to shareholders, shareholders in the median firm in our sample would receive an extra .04 percentage points of return on their shares. If the savings were spread equally among the firm's workers, the median per worker gain in our sample of firms would be $63 per year.

IX. Summary and Conclusion

Are CEOs paid like bureaucrats? Our evidence suggests that the answer is no. We use a new data set that enables us to precisely measure how the value of CEO stock and stock options changes when a firm's stock market value changes. Taking into account the revaluation of CEO stock and stock option holdings, CEO compensation is highly responsive to firm performance. The median CEO in our sample loses $435,000 for a tenth percentile firm performance and increases his wealth by about $8.6 million for a ninetieth percentile performance. More typical changes in firm value increases CEO wealth by millions of dollars at the median.

The relationship between pay and performance is almost entirely driven by changes in the value of stock and stock options. For example, we find that stock and stock option revaluations increase median CEO wealth by about $1.25 million dollars in response to a 10 percent increase in firm value. This is 53 times larger than our estimated $23,400 increase in salary and bonus emanating from the same change in firm value, suggesting that stock and stock option revaluation account for about 98 percent of the relationship between pay and performance. Moreover, our estimate of the CEO pay to performance elasticity is 3.9, which is 30 times larger than previous estimates that rely on salary and bonus changes alone.

We find that both the level of CEO compensation and the sensitivity of CEO compensation to performance has increased sharply over the past fifteen years. Mean (median) direct CEO

38. The median market value for firms in our sample is $2.2 billion. The median number of employees is 14,000.

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compensation increased by 209 percent (136 percent) in real terms during the past fifteen years, and the large increase in stock option awards and in the value of stock holdings during this period has dramatically increased responsiveness of CEO pay to firm performance. For example, the elasticity of CEO compensation to firm market value more than tripled from 1.2 to 3.9 between 1980 and 1994. During the same period, the dollar change from moving the firm from a median to a seventieth percentile performance increased by a factor of seven, from $280,000 to $1.82 million.

We do not claim the current relationship between CEO pay and firm performance is sufficiently strong or that current contracts are efficient. Indeed, our findings point to some potentially serious deficiencies in current CEO compensation packages. However, we believe that our findings do contradict the claim that CEO contracts are wildly inefficient because there is little correlation between performance and pay. The fortunes of CEOs are strongly related to the fortunes of the companies they manage.

Appendix 1: Measuring and Valuing Total Stock Option Holdings

We measure value stock options based on the Black-Scholes formula for valuing European call options, as modified by Merton [1973].[39] The value of options is

$$V_{options} = N[Pe^{-dT}\Phi(Z) - Ee^{-rT}\Phi(Z - \sigma\sqrt{T})], \tag{2}$$

where

$$Z = \frac{\ln(P/E) + T(r - d + \sigma^2/2)}{\sigma\sqrt{T}}, \tag{3}$$

N = number of shares
P = price of underlying stock
E = exercise price of the option
T = time to expiration
r = risk-free interest rate (bond rate)
d = expected dividend rate
σ = expected standard deviation of stock return
Φ = cumulative probability function for normal distribution.

39. See Carpenter [1998] for a more elaborate model of executive stock option valuation.

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To construct a measure of the total stock option holdings of each CEO at a given point in time, we use proxy data on stock option grants, gains from exercising stock options, and the total number of stock options held by the CEO.

Annual proxies contain information on options granted during the preceding fiscal year, including the number, duration, and exercise price of the options. In order to construct a CEO's total holdings of stock options, we go back to the first year in which the CEO was the CEO and use the annual data on option grants to build up the stock of stock options held by the CEO, including the exercise price and remaining duration of each option.[40] Each year, we reduce the remaining duration of options granted in the previous year, add the options granted in that year, and subtract options sold.

There are three characteristics of the data that complicate this procedure. First, CEOs often hold options that they received before they became CEO. Second, the exercise price is sometimes missing. Third, the proxies report option gains as a dollar value, so it is impossible to determine exactly which options were sold in a given year. We are helped, however, by the fact that proxies sometimes contain information on the total number of options held by the CEO (or alternatively the total number of vested options held by the CEO). This information on total options allows us to test the accuracy of our algorithm for building up the stock of stock options holdings and to adjust for cases in which our algorithm produces an inaccurate count of stock options.

Initial Conditions

CEOs often hold options that they were granted before they became CEO. In many cases, we can obtain a measure of the total number of these previous options from the proxy for the year before the CEO became CEO (proxies contain information on option holdings of other top executives). When this measure is not available, we use the maximum of the total number of vested options held by the CEO before becoming CEO and a variable that we call *backcount*. *Backcount* is a measure of the total options held

40. In constructing the stock of stock options for 1980, the first year in our data set, we go back only to 1971. Since most stock options have a duration of ten years, and since only 32 CEOs in our sample both were CEOs in 1970 and held stock options in 1971, we are losing little information by not going back further. Moreover, in those few cases, we use our regular procedure for handling initial conditions (see below) in order to calculate the number of stock options held at the end of 1970.

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by the CEO that is constructed by taking the earliest year of data for which total options held by the CEO is available in the proxy and then going backward in time, subtracting the number of options granted and adding the number of options sold. We assume that these initial options have a remaining duration of seven and that the exercise price is the median price from three years before. None of our results are sensitive to reasonable changes in these values.

Missing Exercise Prices

The exercise price is missing for 3.7 percent of options grants in our 1980–1994 sample. It is missing in 20.6 percent of the cases in the 1970 data used to construct the 1980 stock of stock options. Since nearly all options are granted at the money, we assume that the exercise price is the end-of-year stock price for the fiscal year in cases in which it is missing.[41]

Accounting for Gains from Selling Stock Options

Annual proxy statements report the dollar value of gains from options sold during the fiscal year. This is not sufficient information to tell how many options were sold or exactly which options were sold. In order to subtract options sold, we make two assumptions. First, we assume that the options were sold at the median stock price during the year. Second, we assume that CEOs sell their oldest options first. This is a reasonable assumption since basic option theory tells us that CEOs should not exercise options early (ignoring dividend issues) and because some firms have rules that require CEOs to exercise the earliest options first. Most importantly, in a rising stock market the earliest options will be the most in the money. Therefore, our assumption that CEOs sold these options is a conservative one in that it minimizes our estimates of the pay to performance sensitivity. In a very small number of cases, the median price during the year in which the options were sold is less than the exercise price of the option. In

41. Repricing of existing options appears to be a minor problem. Yermack [1995] found that only 1.5 percent of firms changed the terms of previously awarded stock options in a given year. This is consistent with a U. S. SEC report [1993] that also found a very low incidence of repricings in a survey of 1000 companies. In addition, Chance, Kumar, and Todd [1997] look at a sample of about 4000 publicly traded firms over ten years and found 73 repricing events from 40 firms. Moreover, we randomly checked 50 of our proxy statements and found no instances in which past options were repriced.

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this case, we assume that the exercise price was incorrect, and arbitrarily reduce it by 50 percent.

Adjusting the Option Stock to be Consistent with the Total Number of Options Held by the CEO

In years in which the proxies contain a measure of the total number of options held by the CEO, we can compare the option holdings produced by our algorithm with the proxy total. The simple correlation between the two measures is .79. A regression of our total option measure on the proxy measure has a coefficient of 1.003, suggesting that our measure is unbiased. The ratio of the error variance to the true variance is .64. It is important to note that since we rely mostly on medians in our estimation, our results are not very sensitive to this (apparently white noise) measurement error.

For observations for which the proxy measure of total options is available, we rescale our options holdings to coincide with the proxy measure. When the proxy measure of options is below our measure, we subtract the oldest options from our stock of stock options until the two measures coincide. When the proxy measure of total options (or vested options) is above our measure, we first assume that we sold too many options in accounting for the previous year's gains, and add back in the options until we reach the correct number of total options. If this number is still too low, we rescale option holdings to coincide with the proxy total.

Data on total stock options held are available for most firms from 1980–1983 and from 1993–1995, so our measures of stock options holdings are likely to be more accurate in those years. Fortunately, this period contains the beginning and end of our sample period and is therefore the focus of our attention.

Adjusting for Stock Splits

Finally, in building up the stock of stock options held by a CEO, it is necessary to adjust the number and exercise price of stock options to account for stock splits. We obtain information on stock splits from CRSP. First, we take all stock splits identified in the CRSP event file. We identify additional stock splits by comparing daily stock returns with daily price changes.[42] To adjust the stock options, we needed to determine whether option

42. If the stock price changed by more than 20 percent and the daily return was substantially smaller, we assumed that a split had occurred.

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grants in a given year occurred before or after the stock split. In cases in which the exercise price was known, it was usually obvious whether the options were granted before or after the split. In cases in which the exercise price was not given, we assume that they were granted after the split because in 96 percent of the cases in which the exercise price was known, the options were granted after the split.

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