1-18-2007

Historical Trends in Executive Compensation 1936-2005

Carola Frydman

Raven E. Saks

Historical Trends in Executive Compensation 1936-2005

Carola Frydman* and Raven E. Saks**

January 18, 2007

Abstract

We analyze the long-run trends in executive compensation using a new panel dataset of top executives in large publicly-held firms from 1936 to 2005, collected from historical corporate reports. This historical perspective reveals three surprising new facts. First, the median real value of pay was remarkably flat from the end of World War II to the mid-1970s. This stability signals a change in the relationship between compensation and firm size over our sample period: whereas recent decades have witnessed rapid increases in both the size of firms and the level of pay, this correlation was much weaker in the past. Additionally, our data reveal an important transformation in the composition of managerial pay, as stock options and other forms of incentive pay have been a growing share of compensation since the 1950s. Finally, the sensitivity of changes in an executive's wealth to the performance of the firm was considerable for most of our sample period. Although this correlation was strongest in the 1990s, its magnitude throughout most of our sample period was in line with the relationship between wealth and performance in the 1980s.

* M.I.T. Sloan School of Management. frydman@mit.edu
** Federal Reserve Board of Governors. raven.e.saks@frb.gov.
We would like to thank George Baker, Edward Glaeser, Claudia Goldin, Caroline Hoxby, Lawrence Katz, and Robert Margo for their advice and encouragement throughout this project. Helpful comments have also been received from seminar participants at the NBER Summer Institute, AEA meetings, EHA meetings, and Rutgers University. We would also like to thank the staff at the Historical Collections and Danielle Barney of Baker Library for making the data collection possible and Brian Hall and Jeff Liebman for providing us with their data. Yoon Chang, Yao Huang, Michele McAteer, Timothy Schwuchow, James Sigel, and Athanasios Vorvis provided outstanding research assistance. We gratefully acknowledge financial support from the Economic History Association, the Multidisciplinary Program in Inequality & Social Policy at Harvard University, and the National Science Foundation's Dissertation Completion Fellowship. This paper does not reflect official views of the Federal Reserve Board or its staff.

1. Introduction

The real value of CEO compensation in the S&P 500 increased by more than 5 percent per year from 1980 to 1996, stimulating considerable interest in the determinants of managerial pay (Murphy 1999). However, very little is known about the compensation arrangements of corporate officers prior to this period. This paper adds a historical perspective to the recent run-up in executive compensation by setting forth and analyzing the trends in the level and composition of executive pay from the 1930s to the present.

Although prior studies have reported information on managerial pay for earlier time periods, these data cannot provide a consistent description of the long-run evolution of executive compensation because they are based on short time periods with different sample designs and employ different methodologies to value the components of pay.[1] We document these trends by constructing a comprehensive panel dataset on the compensation of individual executives that extends from 1936 to 2005. This information is collected from proxy statements and 10-K reports of publicly-held firms, which have been required to disclose the remuneration of their top officers ever since the Securities and Exchange Commission (SEC) was established in 1934.

The availability of consistently-measured data that extend over the past eight decades allows us to address several key issues that have surfaced regarding the recent surge in executive compensation. Rapid increases in the level of pay over the past 30 years have been linked to a strong upward trend in the market value of firms (Hall and Murphy 2003, Jensen and Murphy 2004, Bebchuk and Grinstein 2005, Gabaix and Landier 2006), but a historical perspective provides more fluctuations in aggregate

[1] A few examples include Baker (1938), Roberts (1959), Lewellen (1968), Wattel et al. (1978), and Murphy (1985).

economic conditions to examine this relationship. Another important topic raised by modern data has been the correlation between changes in an executive's wealth and the performance of the firm he manages. The recent boom in stock option use led to a marked increase in the sensitivity of managerial wealth to firm performance during the 1990s (Hall and Liebman 1998), but prior research has been unable to assess this relationship in earlier decades in a consistent manner.

We begin by presenting the central facts on the longer run trends in executive compensation over the past seventy years. After a sharp decline in the real value of pay during World War II, compensation grew at a sluggish rate of 0.8 percent per year during the following 30 years. The rate of increase in the level of pay began to pick up during the 1970s and rose at a faster rate in each subsequent decade, reaching an average growth rate of more than 10 percent per year from 1995 to 1999. The composition of pay also underwent a marked transformation over our sample period, as stock option grants and other forms of incentive pay have been growing shares of total compensation ever since the 1950s. These trends characterize the patterns in compensation for most of the executives in our sample, and are broadly characteristic of the largest 200 to 300 publicly-traded firms in the economy.

The stability of pay during the 1950s and 1960s is particularly surprising in view of the large increases in firm size during those years. We study how the relationship between the level of pay and firm size has changed over time, paying particular attention to the distinction between the effect of a firm's relative position in the cross-sectional distribution of firm size within a year, and the effect of shifts in the aggregate distribution of firm size over time. The cross-sectional relationship has remained relatively stable

over the past seventy years, but upward and downward shifts in the distribution of firm size over time have become more strongly correlated with executive pay since the 1970s. However, the results for the recent period may be biased by high degrees of serial correlation in the market value of firms and the level of pay, casting doubt on whether increases in firm size can explain the recent run-up in executive compensation.

Weak growth in the level of executive pay during the 1950s and 1960s does not necessarily imply a low correlation between firm performance and managerial incentives, because executives should be influenced by any change in their wealth. Top officers have held equity and stock options in the firm that they manage throughout our sample period, so changes in the value of executives' holdings of stock and stock options must be taken into account in order to present a consistent picture of the evolution of managerial incentives over time. We find that the correlation of executive wealth with firm performance (often called "pay-to-performance") was higher in the 1990s than in any other decade of our sample period. However, the increase from the 1980s to the 1990s is not part of a long-run upward trend in pay-to-performance. In most of the decades of our sample period, this correlation was similar to its magnitude in the 1980s. Therefore, recent decades were not the first period in which the structure of compensation arrangements generated a strong link between the wealth of top executives and the value of the firm.

Although we cast our findings in terms of managerial incentives, it is important to keep in mind that we simply document changes in the correlation between executive wealth and the market value of firms. The evolution of pay-to-performance may reflect changes in the optimal incentive contract between managers and shareholders, but it may

also be an unintentional byproduct of other factors that have altered the structure of executive pay.[2]

2. Executive compensation data

Our data on executive compensation are obtained from historical proxy statements and 10-K reports. The SEC has required firms to report information on the remuneration of their highest-paid officers in these documents since its inception in the 1930s.[3] Because SEC disclosure requirements have not meaningfully changed over time, corporate reports provide a valuable resource for tracking pay over the longer run.[4] These documents report information on salaries, bonus payments, stock options, and equity holdings. Moreover, detailed descriptions of compensation plans allow each component of pay to be measured consistently over time. Using consistent methods to value pay is particularly important when considering stock options, which were measured differently in research conducted from the 1950s to the 1970s than the common practice today.

Our sample includes the compensation of individual officers in the largest 50 publicly-traded corporations in 1940, 1960 and 1990, which amounts to a total of 101 firms. We identify the largest firms in 1960 and 1990 by ranking corporations in Standard & Poor's Compustat database according to their total value of sales. Compustat's data do not extend back to 1940, so for that year we rank firms in the Center

[2] Examples of these other possible factors include changes in corporate governance of firms (Bebchuk and Fried 2004, Bertrand and Mullainathan 2001), tax advantages of certain instruments of pay (Hall and Liebman 2000), regulation (Rose and Wolfram 2000), product market competition (Cuñat and Guadalupe 2006), and changes in the demand for managers (Himmelberg and Hubbard 2000).

[3] While corporations were required to disclose the compensation of top officers in 10-K reports starting in 1934, many firms were reluctant to do so in the early years. By 1936 most of the firms included data on remuneration in these reports, and so we start our sample in that year.

[4] Examples of studies that have used proxy statements to study executive compensation (although over shorter time periods than our sample) include Roberts (1959), Lewellen (1968), Yermack (1995), and Hall and Liebman (1998).

for Research in Security Prices (CRSP) database according to their market value. For each firm among the largest 50, we include annual data for as many years as our sources allow from 1936 to 2005. When a firm in our sample merges with a firm outside of the sample, we continue to follow the executives in the merged firm if the new firm retains the same name or if the industrial classification of the new firm is the same (see Appendix Section 1.1 for details). Thus, the resulting dataset is an unbalanced panel dataset as companies enter and leave the sample over time.[5] Because the dataset includes firms that were large at different points in time, our sample reflects some of the structural changes that were experienced by the economy over this 70-year period. Although this sample is not representative of the economy as a whole, it comprises about at least 20 percent of the market value of the S&P 500 in every decade of our sample period, and more than 40 percent prior to 1970 (see Appendix Table A1). Because the sample includes all of the available years for each of the selected firms, it reflects a broader segment of the economy than only the largest 50 publicly-traded firms. We discuss the representativeness of our sample in Section 3 of the Appendix, and conclude that it is representative of the largest 200 to 300 publicly-traded corporations. On the other hand, the sample does not reflect the compensation practices of smaller or private companies.

About ¾ of the firms in our sample are in manufacturing industries, including a large fraction of automobile producers, airplane manufacturers and oil companies. Our sample also contains communications, public utilities, and retail companies. Appendix

[5] Firms enter the sample when they go public or when corporate records become available in the collection at the Baker Library of Harvard Business School (our main source of corporate reports). Companies exit the sample as they go bankrupt, become private, or are acquired by a foreign company, among other reasons.

Table A2 shows the distribution of firms by 2-digit SIC code and Appendix Table A3 gives a complete list of the firms in our sample.

We hand-collect compensation data for the years 1936 to 1991 from proxy statements and 10-K reports, and obtain data for 1992 to 2005 from Compustat's Executive Compensation database.[6] Compustat's source data come from proxy statements, so the data are comparable over time. Table 1 reports basic descriptive statistics of our main sample, which includes the three highest-paid officers in each firm. There are more than 15,800 executive-year observations between the years 1936 to 2005, for a total of 2,862 individuals. Roughly 28 percent of these executives are CEOs.[7] Although we collected data on the five highest-paid officers in each firm whenever possible, corporate reports consistently listed only the three highest-paid officers prior to 1978. We limit our analysis to the top three officers in order to maintain a consistent group of individuals over time, but the results are robust to including the 4th and 5th highest-paid executives.

The job titles held by the executives in our sample suggest that these officers were the main decision-makers in the firm (see Table 2). More than 47 percent of these managers held the title "CEO," "president," or "chairman of the board." Other frequently

[6] As of January 2007, not all firms had reported compensation for the fiscal year 2005 in Compustat. Our current sample is missing 1 out of the 59 firms sampled in this year.

[7] Restricting the analysis to CEOs is useful for comparing our sample to previous research, which has mainly focused on chief executive officers. Because the title "CEO" was not frequently used until the 1970s, identifying the top decision-maker of the firm is not always straightforward. Previous studies suggest that this person was most often the president of the company, so we identify the president as the chief executive where the CEO is not explicitly mentioned (Mace 1971). In cases where we observe neither a CEO nor a president, we identify the chairman of the board as the CEO (about 2% of the observations).

observed job categories are "executive vice-president" and "vice-president."[8] Another indication of the importance of the individuals in our sample is that more than 8 out of 10 officers also served on the board of directors.

3. Long-Run Trends in Compensation

3.1 Trends in total compensation

Figure 1 shows the median real value of total compensation from 1936 to 2005.[9] We define total compensation as the sum of salaries, bonuses, long-term incentive payments, and the Black-Scholes value of stock option grants. The figure reveals three distinct phases that form a J-shaped pattern over the course of our sample period. During the first 15 years, the real value of compensation fell from about $0.9 million to $0.75 million. Although this decline was concentrated during World War II, executive pay continued to move down from the end of the war until the early 1950s. This period of deterioration was followed by 30 years of moderate growth, averaging about 1.3 percent per year from 1950 to 1980. Since 1980, the level of executive pay has climbed at an increasing rate. The median value of compensation rose at an annual rate of 5.9 percent from 1980 to 1990 and 9.2 percent from 1990 to 2000. Although compensation dipped briefly from 2001 to 2003, it resumed a growth rate of 7 percent per year during the last two years of our sample. Therefore, rapid increases in the level of pay do not appear to have ended

[8] There have been important changes in the job titles assigned to top officers over time. In addition to the expanding use of he title "CEO" since the 1970s (see footnote 7), other titles that became more prevalent over time are "CFO" and "COO."

[9] Throughout the paper, real values are measured in year 2000 dollars using the Consumer Price Index.

with the collapse of the stock market boom of the late 1990s, but rather indicate that the rapid increases in pay of the past 20 years are part of a secular trend.

The J-shaped trend in the long-run evolution of executive pay becomes even more pronounced when comparing compensation to the earnings of a typical worker in the US economy (see the dashed-line in Figure 1). We calculate relative executive pay by dividing median compensation in our sample by average earnings per full-time equivalent worker from the National Income and Product Accounts. The real value of average earnings in the economy increased during the early years of our sample even as the level of executive pay declined, leading to a sharp contraction in the gap between these two groups from 1940 to 1944. Relative executive pay declined further from 1944 until 1970, at which time executive earnings began to rise faster than those of the average worker. By 1990, relative executive pay had recovered its Depression-era level. The gap between executives and workers continued to expand during the last 15 years of our sample, and by 2005 the median executive in our sample earned 110 times average worker earnings—about twice the corresponding ratio prior to World War II.

More than 95 percent of the individuals in our sample fall above the 99.9th percentile of the national distribution of wage and salary income documented by Piketty and Saez (2003), so our data are comparable to the wage share they calculate for the top 0.1 percent. Despite the differences in the underlying source data between our sample and the income tax records used by Piketty and Saez,[10] the two measures of earnings inequality reveal similar patterns in the long-run evolution of income inequality.[11]

[10] Piketty and Saez use data based on income tax records to estimate shares of aggregate wage and salary income for the highest 10 percent of the income distribution. Although their measure of earnings inequality is similar to ours, earnings data from income tax records are biased by changes in the use and tax treatment of options over time. One disadvantage of income tax records is that they only contain information on the

3.2 The structure of executive compensation

Figure 2 decomposes the real value of total compensation into its three main components. The short dashed line shows the median value of salaries plus any bonus that was both awarded and paid out within the same year, which we refer to as a *current* bonus.[12] These bonuses were generally paid in cash, but some were also paid in the form of company stock. The long-dashed line adds the amount paid to each executive as part of a deferred bonus or long-term incentive payment.[13] The solid line, which replicates the real value of total compensation shown in Figure 1, adds the Black-Scholes value of stock option grants.

During the first twenty years of our sample, the vast majority of compensation was composed of salaries and current bonuses.[14] Although long-term bonuses were

---

gains from exercised options, rather than the value of stock option grants. Grants reflect the value of compensation at the time of the award more accurately, and are not affected by subsequent movements in the firm's share price or by the executive's decision when (or if) to exercise the options. Moreover, the vast majority of stock options granted to corporate officers during the 1950s and 1960s were taxed as capital gains, and so would not have been reported on income tax returns at all.

[11] The fact that relative executive pay and the top 0.1 percent wage share have followed a similar pattern over time does not necessarily imply that changes in executive compensation have driven the observed changes in wage inequality. For example, Kaplan and Rauh (2006) find that the five highest-paid executives in public corporations represent a very small fraction of top income brackets (top executives of non-financial companies account for less than 8 percent of the top 0.1 adjusted gross income distribution).

[12] Because bonuses payments are frequently related to a measure of firm performance, it would be useful to separate salaries from current bonus payments. However, many firms reported only the sum of salary and bonuses prior to 1992. In firms that did report these payments separately between 1950 and 1970 (about 25 percent of the sample), the value of current bonus payments ranged between 15 and 20 percent of current compensation, with no obvious trend. Therefore, it is likely that the share of current bonuses did not increase dramatically during this period, even as the use of long-term bonuses was expanding.

[13] We measure bonuses as the amount *received* during the year rather than the amount awarded (to be paid in the future) for consistency, because Compustat and some earlier proxy statements do not report information on the value of bonus *awarded*.

[14] The 1950s were not the first period when incentive compensation mechanisms were a part of managerial pay. Historical accounts suggest that both current and deferred forms of incentive compensation were almost negligible prior to WWI but became commonly used during the 1920s (Taussig and Barker 1925, Baker and Crum 1935, Baker 1938, Roberts 1959). However, hard evidence concerning the magnitude of these payments is difficult to find because firms were reluctant to divulge the details of managerial compensation. With the onset of the Depression and large declines in firm profits, many bonus plans were abandoned or suspended (Baker 1938).

awarded to some executives as early as the 1940s, they were not common enough to make a noticeable impact on median compensation until the 1960s. A common scheme was to award bonuses based on the firm's profits or net income, and then to distribute the payment (in cash or stock) in equal installments over a certain number of years.[15] These bonuses became a greater share of total compensation over time, reaching more than 35 percent of total compensation by 2005.

Stock option grants have also become a larger fraction of median compensation over the course of the century. This increase is largely attributable to an upward trend in the frequency of option grants during our sample period. Among executives receiving an option award, the median value of grants has been at least 15 percent of total compensation since the mid-1950s. This share fluctuated between 15 and 30 percent until the mid-1980s, not much less than its median value of 37 percent during the option boom of the late 1990s. Stock options became a more noticeable component of the compensation of the median executive in our sample as grants were awarded with greater frequency over time.

Options were granted very infrequently to the executives in our sample during the 1930s and 1940s. In 1950, tax reform legislation introduced the restricted stock option, a special type of employee stock option that was taxed as a capital gain instead of as labor income. Consequently, executives paid a marginal tax rate on these options of only 25 percent instead of the 70 to 90 percent marginal rate they faced on labor income. More than 40 percent of the firms in our sample instituted a restricted stock option plan in the 5

[15] These bonuses are awarded in the forms of cash and stock, and sometime both. The deferral period was generally around 5 years, although individual plans varied from 2 to 10 years.

years following this reform, suggesting that this tax policy had a significant impact on executive pay.

Despite the proliferation of restricted stock option plans during this period, grants were sporadic at first and they were usually only awarded to the highest-paid officers in the firm. Throughout the 1950s, only about 16 percent of the executives in our sample were awarded an option in any given year. The frequency of stock option grants has increased steadily since then. Concurrently, the value of stock options became a larger share of total pay. By the 1990s, the fraction of executives receiving an option had reached 82 percent (see Figure 3).

Prior research on executive pay has found a lower frequency of option grants during the 1970s and 1980s than we find in our sample (Hall and Liebman 1998, Jensen and Murphy 2004 and Murphy 1999). These studies have concluded that option use was negligible from 1970 to 1985 and did not begin to expand rapidly until the late 1980s. Part of the discrepancy between our results and prior research can be explained by firm size. Our sample is more heavily weighted towards large firms than other samples, and large firms tend to grant options more frequently than small firms. However, several measurement issues are more important in explaining these discrepancies. First, prior research on option use in the 1970s has relied on data on the gains from exercising options rather than direct evidence on option grants. We find that the probability of being granted an option was 16 percentage points higher than the probability of exercising an option during the 1970s, possibly due to unexpectedly poor stock market performance during this period that would have reduced the desirability of exercising options.[16]

[16] The downturn in the market made the repricing of options a common practice during the 1970s. We exclude repriced options from our estimates of grants whenever it is possible to identify them.

Another central explanation for the high frequency of stock option grants in our sample is our treatment of multi-year reporting of options. It was common for proxy statements issued from the late 1960s to the late 1980s to report option grants and exercises as 3- or 5-year cumulative totals, making it difficult to ascertain the number granted or exercised in each year. Section 2.2 of the Appendix describes how we handle this issue, and Section 3.2 of the Appendix discusses the differences between option use in our sample and prior research in more detail. While our treatment of multi-year reporting biases the *frequency* of grants upwards, the average and median *values* of options in our sample are unbiased.

Although only a few studies have examined the use of employee stock options during the 1950s and 1960s, our data present a different view of option use during this period as well. The most well-known research is Lewellen (1968), who calculates a much higher value of stock options in a sample of 50 large manufacturing firms. This disparity can be explained by differences in our methodologies of valuing options. Whereas we use the Black-Scholes formula to value options in the year they are granted, Lewellen calculates the difference between an option's exercise price and the market price of the company's stock at the end of each fiscal year, and then spreads these potential gains from stock appreciation over the duration of the option. Because gains from exercising options were significantly higher than the value of grants during this period, this ex-post valuation method overstates the value of option grants.[17] More importantly, Lewellen's statistics greatly overstate the value of options because he reports

[17] A potential concern is that investors did not have access to the Black-Scholes formula prior to 1973. However, this does not imply that investors did not have an understanding of derivative pricing. For example, Moore and Juh (2006) find that investors were able to determine the fair value of warrants traded in the Johannesburg Stock Exchange in the early twentieth century.

a "before-tax equivalent value," which he defines as the before-tax value of cash salary that an executive would need to receive in order to achieve an after-tax level of pay equivalent to the potential gains from exercising his stock options.[18] Because options were taxed at a much lower rate than cash compensation, this valuation is substantially larger than the simple (before-tax) value of options granted that we use in our analysis.

In summary, the rise in executive compensation that began in the mid-1970s was fueled by an increase in the use of incentive pay, both in the form of stock options and in bonus awards tied to firm performance. Consistently-measured estimates of stock option grants over the past 70 years reveal that this form of pay has been on a steady upward trajectory since the 1950s. But the importance of other components of pay can not be ignored. The level of cash salaries increased considerably during the past 25 years, rising at a relatively steady rate of 3 percent per year from 1980 to 2005.

3.3 Other forms of compensation

Our analysis does not include information on two other components of pay: pensions and perquisites. Although proxy statements provide descriptions of pension plans, we are unable to estimate the value of these benefits because many plans were based on an age-tenure profile of the managers and we lack information on employment tenure and personal characteristics for most of the executives in the sample. Perquisites are

[18] Lewellen also reports the after-tax value of stock options, which is generally lower than after-tax gains from exercising options in our data but significantly higher than the average after-tax Black-Scholes value of option grants.

excluded because firms were not required to report any information on this type of pay until the late 1970s.[19]

The omission of pensions and perks may bias estimates of the long-run trend in the level of total compensation because they are not subject to personal income taxes at the time they are awarded. Therefore, these methods of pay may have been more common during periods like the 1950s and 1960s when income tax rates were high. Thus, the growth rate in *total* pay (including both observed and unobserved forms of compensation) may have been faster during these earlier decades than in later years when the tax advantage of pensions, perks, and other non-taxable benefits was smaller.

However, evidence from Lewellen (1968) suggests that pensions cannot account for the low rate of growth in compensation observed during the 1950s and 1960s. He reports that the after-tax value of retirement benefits declined from 26 percent of after-tax total pay in the 1940s to 15 percent in the period 1950-1963. Because pensions were taxed at a lower rate than current cash compensation, the pre-tax value of pensions relative to total pay was even lower than 15 percent. By contrast, Sundaram and Yermack (2006) find increases in the actuarial value of pensions to be about 10 percent of total CEO pay from 1996 to 2002, and Bebchuk and Jackson (2005) report the ratio of executives' retirement benefits to total pay received during their entire service as CEO to be about 34 percent in 2004. Thus, it does not appear that pensions could have been a

[19] Regulation introduced in December, 1978 required firms to disclose the total amount of remuneration distributed or accrued in the form of securities or property, insurance benefits or reimbursement, and personal benefits. It was not until 1993 that proxy statements perquisites and other personal benefits (above a minimum threshold) had been separately reported. In any case, the transparency and accuracy of data on perks is limited, and so research on this topic has mainly focused on whether a certain perk was offered rather than on the value of perquisites (Rajan and Wulf 2006, Yermack 2006)

larger fraction of total compensation in the 1950s or 1960s than they are today, despite the larger incentive to grant pensions in the past.

Furthermore, the following back-of-the-envelope calculation suggests that the combined value of pensions, perquisites and other untaxed benefits would need to have been implausibly large to account for the low rate of growth in compensation observed during the 1950s and 1960s. For the observable types of compensation in our dataset, median pay increased from $0.74 million in 1950 to $0.82 million in 1970, which works out to an annual average growth rate of 0.5 percent. By contrast, median compensation in our data increased by a factor of 4.4 from 1980 to 2000. If unobserved forms of pay grew at a similar rate to the observed components during this later period (compared with earlier decades, changes in personal income tax rates at the top of the income distribution were relatively minor during these years, so there would be no reason to think otherwise) then *total* compensation should also have risen by a factor of 4.4 from 1970 to 2000. If we assume that the value of unobserved benefits was zero in 1950, these forms of pay would need to have amounted to $2.4 million in 1970 in order to achieve a rate of increase in *total* compensation similar to the 1980 to 2000 period ($0.74*4.4-$0.82=$2.4 million). This amount is almost three times higher than the median level of salaries, bonuses and stock options at that time (which was $0.82 million) and strikes us as implausibly large. Moreover, this value underestimates the value of non-taxable benefits in 1970 if the actual level of unobserved benefits was greater than zero in 1950.

In sum, while pensions and perks may partly explain the slow growth rate of pay documented during the 1950s and 1960s, it is doubtful that including these benefits

would alter our finding of a much lower rate of increase in total pay during this period compared with later decades.

3.4 Differences among executives

Table 3 shows total compensation at the 10th, 25th, 50th, 75th and 90th percentiles of our sample. The general pattern over time is similar across all groups, with relatively slow growth from the 1950s to the 1970s followed by larger increases in the past 25 years. One exception to these similarities is the decline in real compensation that occurred during the 1940s, which was experienced only by executives at the higher end of the distribution. Thus, this period was marked by a sharp compression in the income distribution of executives, suggesting that the "Great Compression" (Goldin and Margo 1992) occurred even among some of the highest-paid individuals in the nation.

A second notable exception to the similarities across groups is that growth in compensation was faster for higher-paid executives during the last 20 years of our sample. Whereas the ratio of compensation at the 90th to the 50th percentile hovered between 1.8 and 2.4 from 1936 to 1986, by 2005 this gap had risen to more than 3.5. This trend has coincided with an increase in the returns to holding the job title of "CEO." We estimate this return by calculating the ratio of CEO compensation to average compensation of the other two highest-paid officers in each firm.[20] The median of this ratio across firms ranged between 1.1 and 1.6 for most of our sample, but it began drifting upward during the mid-1980s and was greater than 2.6 by 2005 (see Figure 4). On the other hand, increases in levels of pay for both CEOs and non-CEOs were larger

[20] We identify the CEO as the president of the company in firms where the title "CEO" is not used (see footnote 7). Results are similar if the chairman of the board is used instead.

than the increase in the gap between the two groups. Therefore, the patterns documented in this paper are not specific to CEOs, but characterize the compensation paid to top management more generally.

3.5 Representativeness of the sample

The trends in pay that we have documented thus-far are similar for all of the executives in our sample, but the question remains how well they reflect more general patterns in the compensation of corporate officers in the US economy. The individuals in our sample were employed mainly in the very largest publicly-traded firms. Because pay is highly correlated with firm size (Roberts 1959, Kostiuk 1990, Rosen 1992, Gabaix and Landier 2006) it is not obvious whether our data will reflect compensation practices in smaller firms. An added consideration is how to interpret our data at points in time that are not close to 1940, 1960, or 1990—the years in which the firms in our sample were selected to be among the largest in the economy. We evaluate the representativeness of our sample in Section 2 of the Appendix, and highlight the main results of that analysis here.

A simple graph of median compensation in firms of different sizes shows that the trends in total compensation are similar in both the larger and smaller firms in our sample (see Figure 5). It is true that individuals working in larger firms were paid more, but compensation increased markedly in all firm-size categories during the last 25 years of our sample period. From 1980 to 2005, the average annual growth rate of compensation was 7.0 percent for firms ranked among the largest 100, 5.7 percent for firms ranked between 100 and 200, and 4.7 percent for firms smaller than the top 200. Similarly, compensation stagnated from 1950 to 1980 in firms of all sizes in our sample. In Section

3 of the Appendix we evaluate the representativeness of our sample by assigning a weight to each firm that is inversely proportional to its probability of being selected among all publicly-held firms. Thus, smaller firms are given larger weights as we expand the universe of firms that the sample is meant to reflect. In most decades, the median level of compensation in our unweighted sample closely matches the weighted median of the largest 300 firms in the economy. The trend in compensation is even similar to the weighted median of the largest 500 firms, although at a somewhat lower level.

In addition to paying a different level of compensation, large firms may be more likely to award a higher share of compensation in stock options or other forms of incentive pay. Somewhat surprisingly, we do not find a strong correlation between firm size and the composition of pay in our data. Hall and Liebman (1998) find a stronger positive relationship between option use and firm size in a sample that is more representative of all publicly-traded firms in the S&P 500 from 1980 to 1994. We attribute this result to the fact that the smaller firms in our sample are not representative of the typical small firm in the economy. Indeed, these firms are only included in our sample if they were large earlier in the sample, if they will grow larger later in the sample, or if they are experiencing a temporary negative shock. It may well be that the compensation practices in these firms are not similar to those in firms that are never among the very largest in the economy. In Appendix Section 3.3, we calculate the relationship between option grants and firm size in the Hall-Liebman data and assume it holds for the firms in our sample as well. This exercise does not alter our conclusions about the long-run evolution of the level of executive pay.

4. The relationship between the level of executive compensation and firm size

A historical perspective on executive compensation reveals that the level of pay has behaved differently over time. Recent decades have been characterized by large increases in both the level of pay and the value of publicly-traded firms. However, the relationship between compensation and the market value of firms has not always been as strong. As measured by the S&P 500 index, aggregate market capitalization increased considerably during the 1950s and 1960s, but with little change in the level of executive pay (see Figure 6).[21]

The correlation between executive compensation and the market value of firms is particularly interesting because several studies have concluded that firm size can explain much of the increase in executive pay in recent decades (Bebchuk and Grinstein 2005, Gabaix and Landier 2006). Moreover, a vast number of studies have documented that CEO pay tends to increase by 0.3 percent for a 1 percent increase in firm size, a result that is robust to using a range of different measures firm size (Roberts 1956, Kostiuk 1990, Rosen 1992). Recent data provide little variation to study the effect of firm size on pay as both the level of compensation and the size of firms have trended upwards since the 1980s. By contrast, our long-run data on executive pay provide more fluctuations in aggregate economic conditions to study this relationship.

The observed relationship between firm size and pay could be the result of many factors. One plausible explanation is that it may be driven by competition among firms for scarce managerial talent if the returns to talent are increasing in firm size (Rosen 1981, Rosen 1982). Consequently, larger firms should pay their CEOs more than

[21] Prior studies of executive pay relied on the gains from exercising options to value options prior to 1980, but these values are mechanically correlated with the market value of firms. Because we calculate the value of stock options granted using the Black-Scholes formula for the entire sample, our measures of total pay are not subject to this concern.

smaller firms in any given year. In addition, compensation should rise over time if the aggregate size of the market increases (Gabaix and Landier 2006, Tervio 2007). These models suggest that executive pay may respond differently to changes in individual versus aggregate firm size.

Table 4 decomposes the relationship between firm size and the level of pay into three main components: average firm size in each year (reflecting the size of a typical firm in the market), average size of each firm across all years (reflecting firm-specific factors), and the difference of firm size in each year from these year-specific and firm-specific averages (reflecting transitory changes in firm size that are unrelated to market fluctuations). We estimate the correlation between each of these factors and the compensation of each executive in our sample from the following OLS regression:

$$Ln(Compensation_{ijt}) = \beta_0 + \beta_1 Ln(\overline{S_t}) + \beta_2 Ln(\overline{S_j}) + \beta_3 Ln(S_{jt} - \overline{S_t} - \overline{S_j}) + \varepsilon_{ijt} \qquad [1]$$

where S_{jt} is firm size in a given year, $\overline{S_t}$ is the average size across all firms in our sample, and $\overline{S_j}$ is the average size of each firm across all years.[22] We measure firm size using the firm's market value and break the sample into two periods in order to examine how these effects have changed over time.[23] During the later years of our sample (1976 to 2005), the relationship between executive pay and average firm size in the market is roughly 1-for-1 (col. 3). The coefficients on the firm-specific and idiosyncratic

[22] We calculate average size for each firm using only the years included the regression sample period.

[23] We use the average market value or average sales of the firms in our sample to represent aggregate market size because these measures correspond to a simple decomposition of firm size into its three main components. However, our results are robust to using a variety of other measure of aggregate firm size including the median market value in our sample, average and median market value in the top 500 firms, and the S&P index relative to the CPI.

components of firm size are both around 0.3, significantly greater than zero but smaller than the aggregate size effect.[24]

In contrast to recent decades, the relationship between the level of compensation and average firm size was much weaker in the past. During the first 40 years of our sample, we estimate a coefficient of 0.1 on the annual average market value of the firms in our sample (col. 1). This result cannot be explained by unusual behavior of compensation during the Depression or World War II, as we find a similarly small coefficient over the period 1946 to 1975 (col. 2). The coefficients on the firm-specific and idiosyncratic components of firm size did not change noticeably during our sample period, as they are only a bit smaller in the early years than in the later period.[25]

The pattern of these coefficients is similar when we use the value of sales as an alternative measure of firm size (see cols. 3 and 4 of Table 4). Although the magnitudes of these coefficients suggest that compensation is two or three times more sensitive to aggregate sales than to aggregate market capitalization, these two variables have different distributions. The values in brackets report the fraction of the variance of compensation that can be accounted for each of the independent variables, and show similar results for both measures of firm size.[26] The firm-specific component can explain between 10 and 20 percent of this variation in any period, and idiosyncratic shocks to firm size account for another 3 to 4 percent. While aggregate firm size can explain somewhere between 1/4

[24] These results are in line with the effects reported by Gabaix and Landier (2006), who use the much larger sample of firms from Compustat's Executive Compensation database from 1992 to 2004.

[25] These results also cannot be explained by an asymmetric response of pay to increases and decreases in firm size. When we interact the average firm size in the market with a dummy variable to indicate years when this variable is smaller than it was in the previous year, the estimated coefficient on the interaction term is zero in both periods and the coefficients on average firm size remain unchanged.

[26] These results are based on an ANOVA decomposition for each sample period. The fraction of the variance explained by each independent variable is the sum of squared residuals explained by that variable relative to the total sum of squared residuals of ln(compensation).

and 1/3 of the variation in compensation from 1976 to 2005, it only accounts for about 2 percent in the first half of our sample. The second panel of the table replaces the average size of each firm with a firm fixed effect, providing a more flexible way to control for firm-specific factors. Not surprisingly, the estimated coefficients on the other two variables are unchanged. Overall, it seems that the cross-sectional relationship between firm size and executive compensation has remained relatively stable over the past seventy years, while upward and downward shifts in the distribution of firm size have a different implication for executive pay in recent years than they did in the past.[27]

One potential explanation for the rise in the coefficient on average firm size is that the dynamics of compensation arrangements may have changed over time. For example, the level of compensation may now be more tied to current firm size, while it was more responsive to lagged measures of size in the past.[28] In this case, a smaller coefficient on the contemporaneous value of firms in early years would be offset by a larger effect of lagged market value during this period. However, panel 3 of Table 4 shows little support for this conjecture. Although the average market value in the previous year had a larger effect on compensation than the current value from 1946 to 1975, the sum of these two coefficients is still considerably smaller than the corresponding sum in recent decades.

So far, we have focused on the pre-tax level of pay. This measure of compensation reflects the cost to the firm, but the value to the executive will depend on the tax structure. If the relevant measure of compensation to the executive is the after-tax

[27] In Appendix Table A7, we decompose the variance in the logarithm of compensation by decade. The portions explained by firm-specific and idiosyncratic changes in size have been stable since the 1960s at around 20 percent and 1½ percent, respectively. Average market value in each year explained 8 percent in the 1980s and 13 percent in the 1990s, but less than 1 percent in all other decades.

[28] In fact, a switch from incentive pay based on accounting measures of performance to market-based measures could explain such a pattern over time.

value, the different correlation between aggregate firm size and pay over time could be related to the substantial change in the structure of income tax rates over the twentieth century. We calculate after-tax compensation by assuming each executive in our sample is married, files jointly and has no income other than the compensation earned at his firm. Based on the income tax schedule in each year, we reduce the salary and bonus compensation of each executive in our sample by his marginal income tax rate.[29] Unless we have information on whether or not option grants qualify to be taxed as capital gains, we assume that grants made prior to 1980 are taxed at the capital gains tax rate and that grants in later years are taxed at the marginal income tax rate. While the correlation between average firm size and after-tax pay is stronger for the 1945-1975 period than the correlation with pre-tax compensation, it is still markedly weaker than the correlation in later decades (panel 4 of Table 4).[30]

It is tempting to conclude that aggregate firm size has become an important determinant of executive pay during the past thirty years. However, these coefficients are only correlations and do not necessarily reflect a causal relationship. Furthermore, the estimates may be biased by spurious upward trends in firm size and the level of compensation. Indeed, adding a quadratic time trend to the regression reduces the coefficient on average market value a bit, while the coefficient on average sales becomes negative (panel 5 of Table 4). To investigate further, the final panel of the table estimates the relationship between changes in compensation and changes in firm size, which

[29] This method will underestimate the marginal tax rate of executives with other sources of income if this extra income pushes them into a higher tax bracket. On the other hand, it will overestimate the total amount of taxes paid since the average tax rate is lower than the marginal rate, we do not account for deductions to an individual's income, and savvy executives may find ways to reduce their tax burden.

[30] Alternatively, high personal income tax rates may affect the estimated coefficients if firms responded by increasing components of pay that we do not observe, as pensions and perks. However, it is unlikely that these components alone explain the significant difference in the correlation between aggregate market size and the level of pay (see Section 3.3 for a more detailed discussion of perquisites and retirement plans).

mitigates the potential problem brought about by non-stationarity in both the dependent and independent variables. The estimated effects of both the average size of the market and the idiosyncratic component of firm size are notably smaller in this specification, but the coefficients on average firm size are reduced by more.[31] These results suggest that the bias may be more severe for the average firm size. Thus, the seemingly-strong correlation between average firm size and the level of pay of the past several decades may be driven by spurious correlation between the two variables.

In sum, the relationship between firm size and executive pay has changed over time. Relative to average market capitalization or sales in a given year, the effect of a firm's position in the distribution of firm size accounts for about 20 percent of the variation in compensation, and this fraction has remained relatively stable over time. Shifts in the distribution of firm size over time may have become more strongly correlated with executive pay since the 1970s, although the magnitude of the correlation is hard to determine. To the extent that recent increases in the level of pay are consistent with a model of competitive matching for managerial talent (Gabaix and Landier 2006, Tervio 2007), the smaller correlation between pay and average firm size in earlier decades suggests that there have been important changes in the labor market over the twentieth century. However, the coefficient estimates we have discussed are only correlations, and do not identify a causal link between firm size and executive pay. Therefore, one should be wary of using these results to make inferences to either confirm or reject any given model of executive compensation.

[31] Evidence from Hall and Liebman's 1980-1994 sample of CEOs confirms this result. Using their data, we find that the elasticity of compensation with respect to average firm market value is 0.85 and the elasticity with respect to the idiosyncratic component of firm size is 0.32. These coefficients are -0.04 and 0.31 respectively when a time trend is included in the regression, and -0.10 and 0.28 respectively when the regression is estimated in changes.

5. Estimating changes in pay-for-performance over time

By tying changes in an executive's wealth to the firm's outcomes, stock options and other forms of incentive pay can help to correct the agency problem between managers and shareholders. Therefore, the transformation of the structure of executive compensation in the second half of the 20th century may have important implications for the relationship between managerial wealth and firm performance.

A large increase in the correlation between pay and performance during the past twenty years has brought agency problems to the forefront of research in executive compensation (Murphy 1985, Jensen and Murphy 1990, Gibbons and Murphy 1990, Aggarwall and Samwick 1999, Bertrand and Mullainathan 2001, Bebchuk and Fried 2004). Although the recent surge in attention may lead to an impression that agency problems were not important in earlier times, this topic has been a concern ever since the separation of corporate ownership from corporate control during the late nineteenth century (Baker and Crum 1935, Berle and Means 1932, Chandler 1977). However, despite a longstanding interest in the subject, a scarcity of data from earlier time periods has limited empirical studies of how managerial incentives have evolved over the course of the century.[32] Because we value stock options consistently over time, our dataset provides new evidence on how pay-to-performance has changed from 1936 to 2005.

5.1 Defining the appropriate measure of executive pay

[32] We are only aware of one study that measures pay-to-performance using a long-term series. Boschen and Smith (1995) estimate correlations from 1948 to 1990, but their sample may be unreliable because it is based on only 16 firms and does not include executives' holdings of stock and stock options.

Recent studies have emphasized that it is not simply compensation that should influence a manager's decision-making, but also any other change in his wealth that is related to the performance of the firm (Jensen and Murphy 1990, Hall and Liebman 1998). Corporate executives often own shares of equity or stock options in the company they manage, and the value of these assets also depends on the performance of the firm. Therefore, a comprehensive analysis of pay-to-performance should include revaluations of stock and stock option holdings in addition to annual compensation awards.[33]

Table 5 presents the mean and median of compensation and other components of executives' firm-related wealth.[34] We calculate changes in the value of stock and stock option holdings based on the number of shares held at the end of the previous year and firm's stock market return during the fiscal year (adjusted for stock splits and dividends).

A key advantage of our dataset is that we are able to estimate the portfolio of stock options held by each executive in each year, and we value these options using a consistent method for the entire sample period. Changes in the value of stock option holdings account for a considerable portion of the increase in pay-to-performance during the 1990s, so including this type of wealth is fundamental to obtaining an accurate assessment of long-run changes in this correlation (Hall and Liebman 1998). Although the fraction of executives *receiving* stock options prior to the 1980s was relatively modest compared with more recent decades, the fraction of individuals *holding* options was sizeable. For example, only about 28 percent of the executives in our sample were granted an option in any given year between 1960 and 1969, but more than 64 percent of

[33] Even though we consider a broader measure of changes in wealth than executive pay, we keep in line with the literature by referring to this correlation as pay-to-performance.

[34] A limitation of our data is the lack of information on forms of wealth and earnings that are not related to compensation, such as dividends, capital gains, and non-firm related wealth. Unless otherwise specified, we use the term "wealth" throughout the paper to refer to firm-related wealth.

these officers held options during this period (see Figure 3). This difference can be attributed to the way stock options were granted during the 1950s and 1960s. At that time, it was common for an executive to receive options only once every few years, but these options vested slowly over a period of years. Most top executives received stock options at some point in their career, leading to a substantial number of people holding options even though they had not received a grant in that year. By contrast, most executives today receive options annually, so both the fraction of officers receiving options and the fraction holding stock options are high.[35] The fraction of executives holding stock options in the 1960s was not much lower than its value in the 1990s, suggesting that pay-for-performance may also have been considerable in earlier decades.

Another important asset tying an executive's wealth to firm performance is his holdings of firm equity (Hall and Liebman 1998). Top executives' holdings of stock relative to total shares outstanding have declined over the century, with a more pronounced contraction among executives at the upper end of the income distribution (see Figure 7).[36] By 2005, median holdings of stock relative to total shares outstanding were about 1/3 of their pre-war value.[37] Despite the decline in fractional holdings,

[35] The standard duration of a grant was also longer in the past (10 years prior to 1963, compared with 3-7 years today), providing another reason for a larger number of executives to own options than would be implied by the frequency of grants.

[36] We collect information on equity holdings after 1942 from proxy statements. For the 1935-41 period, we construct stock holdings from an initial report on holdings in 1935 and bi-monthly reports on the transactions of each officer. These reports list the equity purchases and sales of every officer in publicly-held corporations and public utilities. The use of transactions data means that our measure of stock holdings may be biased, but we do not find evidence of the bias being large. See the Appendix Section 2.4 for further details.

[37] Holderness, Kroszner and Sheehan (1999) find that stock ownership of *all top officers and directors* was higher in 1995 than in 1935. There are two main explanations for the difference between their findings and our results. First, they do not find an increase in fractional shareholdings among the largest publicly-held firms, which are more comparable to our sample of companies. More importantly, their findings do not hold when restricting the sample to the executives at the very top of the corporate hierarchy. For example, they find that the stock holdings of the median CEO declined from 0.09 percent of shares outstanding in 1935 to 0.06 percent in 1995 (holdings for the average CEO were about 1.25 percent in both years).

changes in the dollar value of an executive's stock holdings have remained about as large as the value of cash salaries and bonuses. Consequently, this form of wealth may also have had a considerable influence on pay-to-performance for most of the century.

5.2 Defining measures of pay-to-performance

The empirical literature on executive compensation has used a wide range of specifications to measure the correlation between pay and firm performance.[38] Common alternatives have been the dollar change in executive wealth per dollar change in firm value (or the Jensen-Murphy statistic), and the dollar amount of wealth that an executive has at risk for a 1 percent change in the firm's value (or the value of equity at stake). Studies that focus solely on compensation instead of changes in all forms of wealth usually report the percentage change in compensation for a 1 percent change in firm value (the elasticity of pay-to-performance). However, because changes in the value of stock and stock options are sometimes negative and we do not observe the level of an executive's total wealth but only firm-related wealth, it is not possible to estimate the elasticity of pay-to-performance when pay is defined to include changes in wealth.[39] Therefore, we focus on estimating the Jensen-Murphy statistic and the value of equity at

---

Similarly, the median (mean) holdings of CEOs in our sample declined from 0.25 (0.76) percent in 1936 to 0.06 (0.42) percent in 1995. Thus, the fractional holdings of stock among the very top officers appear to have declined over time while those of other officers and directors increased over the century.

[38] For further discussion of the advantages and disadvantages of each of these different methodologies, see Jensen and Murphy (1990), Joskow and Rose (1994), Garen (1994), Hall and Liebman (1998), Murphy (1999), Aggarwall and Samwick (1999), Baker and Hall (2004).

[39] Negative changes in wealth preclude us from running a regression with ln(change in wealth). An alternative way of computing the elasticity would be to use the percentage change in wealth. This approach would require knowing the *total* level of wealth for the denominator of the dependent variable. Because we do not observe executives' non-firm-related wealth and these assets may have trended upward or downward over the century, ignoring these forms of wealth may lead to a systematic bias over time.

stake. We discuss the implications of these estimates for a measure similar to the elasticity in Section 5.5.

Both the Jensen-Murphy statistic and the value of equity at stake give an empirical measure of the correlation between pay and firm performance. However, each of these correlations is an appropriate measure of the degree of managerial incentives for a different type of managerial decision.[40] Baker and Hall (2004) interpret these two statistics in the context of a simple agency model that allows for variations in the marginal product of managerial effort with the value (or size) of the firm, *V*. The optimal level of effort in their framework corresponds to the strength of managerial incentives, and it depends on the form of the relationship between the marginal product of managerial effort and the size of the firm. If the marginal product of effort changes proportionally with firm size, the optimal strength of incentives is proportional to the dollar value of executive wealth at stake (i.e., fractional shareholdings of the executive multiplied by the value of the firm *V*). By contrast, if managerial actions have the same dollar effect independent of the size of the firm, then the appropriate measure of incentives is the Jensen-Murphy statistic (i.e., fractional shareholdings). Thus, the proper metric of incentives depends on the type of CEO activity being considered. While the Jensen-Murphy statistic is the correct measure for activities whose dollar impact is the same regardless of the size of the firm (like buying a corporate jet), the value of equity at stake is appropriate for actions whose value scales with firm size (like restructuring the firm). Because executives likely engage in both tasks that have a dollar-effect and tasks that have a percentage-effect on firm value, we report estimates of both measures.

[40] While a higher pay-to-performance correlation will likely influence managerial actions, it is not clear that this correlation is caused by firms' desire to provide incentives. Pay-to-performance correlations can be the result of a bargaining or fairness model (Blanchflower, Oswald, and Sanfey 1996, Benjamin 2005).

5.3 Estimating pay-to-performance correlations

The value of equity at stake is the dollar value of wealth that an executive has at risk for a 1 percent change in the firm's value. Thus, we estimate this statistic from the following regression:

$$\Delta(Exec.\ Wealth)_{ijt} = \alpha_t^{ES} + \beta_t^{ES} r_{jt} + \varepsilon_{ijt} \qquad [2]$$

where the firm's j (real) rate of return during fiscal year t, r_{jt}, measures the percentage change in firm market value.[41] Changes in the coefficient β_t over time provide evidence on the evolution of the value of equity at stake over the century. We assess changes in β_t by estimating the regression separately for each of the following time periods: 1937-40, 1941-1949 (excluding 1946), 1950-59, 1960-69, 1970-1979, 1980-1989 and 1990-1999, and 2000-2005.[42] The dependent variable is the change in the real value of all types of an executive's firm-related wealth, which we calculate as the sum of total compensation (salaries, bonuses, long-term incentive payments and stock option grants), changes in the value of stock option holdings, and changes in the value of company stock holdings.

We use a similar regression to estimate the Jensen-Murphy statistic, where the firm's rate of return is replaced by the change in the market value of the firm:

$$\Delta(Exec.\ \text{Wealth})_{ijt} = \alpha_t^{JM} + \beta_t^{JM}\ \Delta(Shareholder\ Value)_{jt} + \varepsilon_{ijt} \qquad [3]$$

[41] The percentage change in firm value may be approximated by the rate of return since we ignore issues of repurchases of shares during the fiscal year.

[42] The distribution of rates of return in our sample of firms is unusually low and highly skewed in 1946, possibly due to the end of war contracts. Therefore we exclude this year from all regressions. When this year is included, the Jensen-Murphy statistic estimated over the 1944-1948 period falls from \$0.44 to \$0.24, and the value of equity at stake goes from \$8,664 to \$7,822. Therefore, our finding of an unusually low pay-to-performance correlation in the 1940s would only be strengthened by including 1946.

We measure the dollar change in shareholder value as $r_{jt}V_{j,t-1}$, firm's j rate of return during fiscal year t multiplied by firm's j market value in the previous year.

Because the distributions of compensation and wealth are highly skewed, simple OLS regressions will not provide an accurate picture of the pay-to-performance sensitivity facing the typical executive in our sample.[43] This problem is exacerbated for the estimates of the Jensen-Murphy statistic, as the distribution of dollar-changes in market value are also extremely heteroskedastic. Therefore, we estimate equations [2] and [3] using a quantile regression to fit the conditional medians of the data.[44]

Table 6 reports coefficient estimates and standard errors for the Jensen-Murphy statistic and the value of equity at stake.[45] With the exception of the first and last decades of the sample, the magnitude of the standard errors suggests that the coefficients are significantly different from one another.[46] In accordance with prior research, both measures show a large increase in pay-to-performance during the 1980s and 1990s (Hall and Liebman 1998, Murphy 1999).[47] However, a historical perspective reveals a more

[43] For example, Aggarwall and Samwick (1999) find that OLS estimates of pay-performance sensitivities are between 2 to 7 times larger than those obtained from median regression.

[44] As alternative strategies, we computed a robust regression that uses Huber and biweight iterations to down-weight large outliers (the rreg command in Stata), and estimated an OLS regression after trimming the highest and lowest percentiles from the distribution of changes in wealth. These methods yielded similar results.

[45] We calculate the standard errors using a bootstrap technique that accounts for correlation of observations within the same firm.

[46] The estimates for the 1930s do not appear to be significantly different from the 1940s, and similarly the 2000s may not be different from the 1990s. We attribute the larger standard errors in these decades to smaller sample sizes in these periods. Extreme heteroskedasticity prevents estimation of the entire sample in one regression to directly test the significance of the changes in the coefficients over time.

[47] Our estimates of the value of equity at stake are consistent with the measures reported by Hall and Liebman (1998). Although our estimates of the Jensen-Murphy statistic are smaller than those found in previous studies, this discrepancy is partly due to the larger size of the firms in our sample. When we limit our sample to CEOs between 1993 and 1995, we obtain an estimate of $1.11 for a $1000 increase in firm value for executives in firms ranked among the top 100 of the S&P 500, $2.62 for executives in firms ranked from 100 to 200, and $3.37 for the smallest firms in our sample (75% of which are among the largest 500). Hall and Liebman report a sensitivity of $5.29 for 1994, which is based on a random sample of 500 firms listed in the Forbes 500 surveys between 1984 and 1994.

nuanced picture of the longer-run trends. The value of equity at stake trended upward over time, while the Jensen-Murphy statistic is more U-shaped. Thus, whereas the value of equity stakes in the 1930s was less than one tenth of its level by the end of the 1990s, the Jensen-Murphy statistic was higher prior to World War II than at any other period.

The correlation between pay and performance has been driven by changes in the value of the holdings of stock and stock options (see Table 7). Total compensation itself has played only a minor role in this correlation. Prior to the 1970s, equity holdings were the main factor linking executive wealth to firm performance. Pay-to-performance has strengthened over time as the number of options held by executives has risen. Thus, stock option holdings have become the most important type of wealth tying pay to performance in recent decades. However, options are not solely responsible for the recent increases in this correlation, as the correlation of equity holdings with firm performance has also risen over time.

5.4 Accounting for changes in the size of firms over time

A possible explanation for the diverging trends in our two measures of pay-to-performance prior to the 1970s is the growth in the size of firms over time. While the Jensen-Murphy statistic is negatively correlated with firm size, the value of equity at stake is higher for larger firms.[48] The average market value of the firms in our sample increased by more than a factor of 3½ from 1936 to 1970. Therefore, it is not surprising

[48] There are several reasons for the well-known negative correlation between the Jensen-Murphy statistic and firm size. First of all, executives are wealth-constrained and risk averse. Because of wealth-constraints, it would only be feasible to acquire a small portion of a large corporation even for risk-neutral executives. Moreover, big firms would have to pay excessively high salaries in order to compensate risk-averse executives for large swings in firm value. See Hall and Liebman (1998) and Baker and Hall (2004) for a more detailed explanation.

to find that the value of equity at stake increased while the Jensen-Murphy statistic declined over this period. On the other hand, both measures rose from the 1970s to the 2000s despite another 3½-fold increase in firm size. Thus, the strengthening of pay-to-performance during the past thirty years was large enough to offset the natural downward trajectory of the Jensen-Murphy statistic.

Because the long-run trends in our measures of pay-to-performance are influenced by a secular increase in firm size, we use a regression-based method to estimate how these correlations would have changed if firm size had remained the same over the course of our sample period. The basic idea of our strategy is to estimate pay-to-performance correlations for firms in specific size categories in each decade, and then to compare estimates for a given firm size from one decade to the next. We provide a detailed description of this methodology in Appendix Section 4.1. Since our firm-size adjustments are formed by comparing pay-to-performance correlations in subsequent decades, they do not provide estimates of the magnitude of these correlations but only estimates of how these correlations have changed over time. Therefore, we index both the Jensen-Murphy statistic and the value of equity at stake to equal 1 in the 1930s and use size-adjusted growth rates in pay-to-performance to obtain a new index value in each successive decade (see Figure 8).[49] For comparison, the solid lines in Figure 8 show indexes based on growth in the unadjusted Jensen-Murphy statistic and value of equity at stake.[50]

[49] The size-adjusted measures were calculated using the average across firms in each decade.
[50] The size-adjusted trends fall within the bounds of the unadjusted-estimates, illustrating that controlling for firm size brings the Jensen-Murphy statistic and the value of equity at stake more in line with one another.

Adjusted for firm size, pay-to-performance followed a W-shaped pattern over our sample period. The magnitude of this correlation was about the same in the 1930s, the 1950s, the 1960s and the 1980s, and was unusually low in the 1940s and the 1970s. The correlation in the 1990s was higher than in any other decade of our sample. The small sample size for the 2000-2005 period makes it difficult to tell whether this increase reflects a transitory spike in pay-to-performance or whether the strengthening of this correlation will be longer-lasting.[51] The W-shaped pattern is largely related to the value of equity holdings, but increases in the past 25 years have been magnified by an upward trend in the correlation of firm performance with stock option wealth.

Figure 8 reveals that pay-to-performance in many previous decades was as strong as it was in the 1980s. It is not clear why this correlation was unusually low in the 1940s or the 1970s, as the most obvious potential explanations are not supported by our data. It is plausible that the unusually low correlation during the 1940s was related to World War II, but relatively weak managerial incentives were characteristic of the 1946 to 1949 period as well. In addition, we find a similar pattern over time when estimating pay-to-performance with only positive changes in firm outcomes. Thus, neither the downturn of pay-to-performance in the 1940s nor the downturn in the 1970s can be explained by a prevalence of negative shocks in those decades. Moreover, it is unlikely that the lower degree of pay-to-performance in the 1970s is the result of constraints imposed by public and private political forces, as suggested by Jensen and Murphy (1990). If that were the case, one would expect to find even lower correlations in the 1950s and 1960s as well.

[51] The documented pattern in pay-to-performance also does not appear to be solely driven by CEOs, as the long-run trends in our estimates are similar for both CEOs and other top executives.

5.5 Quantifying the size of the pay-to-performance correlation

The optimal degree of managerial incentives obtained from standard principal-agent models is based on a range of factors such as the agents' risk aversion and the cost of managerial effort. However, it is difficult to link these predictions to empirical pay-to-performance correlations because many of the models' inputs are unobservable. Although it is not possible to relate our estimates directly to model-based measures of the optimal incentive contract, we can gauge the strength of incentives by calculating an executive's monetary return for a meaningful improvement in firm performance. If the magnitude of this return is substantial, it would suggest that executives have a strong incentive to undertake actions that improve the market value of the firm. Following Hall and Liebman (1998), we define a meaningful improvement in firm performance as the change in firm value from the median to the 70th percentile.

For both the Jensen-Murphy statistic and the value of equity at stake, we calculate a measure of wealth at stake by multiplying the appropriate improvement in firm performance in each decade (a change in market value for the Jensen-Murphy statistic and a change in the rate of return for the value of equity at stake) by the corresponding coefficient estimate from Table 6. According to this measure, an executive's reward for moving from the median to the 70th percentile of firm performance has been in a range of $170,000 to $2 million in every decade except the 1940s and 1970s (see cols. 1 and 3 of Table 8). These estimates strike us as being at least moderately sizeable, especially for the measure based on the value of equity at stake.

A natural way to evaluate the strength of managerial incentives would be to compare the dollar-values of wealth at stake to the size of an executive's total wealth

portfolio. This measure would be related to the elasticity of pay-to-performance, with the same drawback that it is difficult to calculate in practice because we do not observe the executive's total wealth holdings but only his firm-related wealth.[52] Nevertheless, we estimate this quasi-elasticity by comparing the dollar-value of wealth at stake to the total value of wealth that we do observe: cash compensation, equity in the firm and stock option holdings. The estimates range from 2 percent (lower bound of the Jensen-Murphy statistic) to 20 percent (upper bound of the value of equity at stake). It is important to keep in mind, however, that these estimates are biased upward by the absence of information on non-firm-related assets. Moreover, the magnitude of this bias may change over time if these assets have become a larger or smaller fraction of total wealth. Nevertheless, to paraphrase Hall and Liebman, it appears that for most of the 20th century managerial incentives have not been "wildly inefficient."

6. Conclusion

In this paper, we document important changes in the level and the structure of pay from 1936 to 2005. The real level of total compensation followed a J-shaped pattern over our sample period. After a sharp decline during World War II, the level of pay increased at a modest rate from the mid-1940s to the mid-1970s, and then rose at an accelerating rate from the 1970s to the present. The composition of executive compensation also changed considerably from 1950 to 2005, as both stock options and other forms of incentive pay became larger fractions of total compensation over time.

[52] While the elasticity measures the percentage increase in wealth for a 1 percent change in firm performance, this measure attempts to estimate the percentage change in wealth associated with an improvement from the 50th to the 70th percentile of in firm performance.

The relative stagnation of the level of compensation during the 1950s and 1960s is surprising because it suggests that executive pay did not keep pace with the size of firms during this period. By contrast, pay and firm size have been more strongly correlated in recent decades. Decomposing the relationship between executive compensation and firm size into its cross-sectional and time series components, we find that the cross-sectional relationship has remained relatively stable over the past seventy years. On the other hand, while the level of pay moved almost one-to-one with the average market value of firms in the economy over the past 30 years, this correlation was one-tenth to one-third as large in the 1946-1975 period. Moreover, the results for the recent period may be biased upward by spurious correlation in the market value of firms and the level of pay.

The transformation in the structure of executive compensation over the past fifty years has important implications for managerial incentives because these instruments tie changes in an executive's wealth to the performance of the firm. Using a broad measure of executive wealth that includes compensation, stock options and equity, we find that the magnitude of pay-to-performance correlations were considerable in most decades except the 1940s and the 1970s. Thus, compensation arrangements have served to tie the wealth of managers to the performance of firms — and perhaps to align managerial incentives with those of shareholders — for most of the twentieth century.

The long-run trends in executive compensation force us to reassess some common explanations for changes in the level and structure of pay over the past several decades. The level of compensation has not always been as highly correlated with the average market value of firms as it has been in recent years, possibly signaling a shift in the

market for managers towards a model of competitive matching for managerial talent. On the other hand, our pay-to-performance estimates suggest that managerial incentives in the 1930s, 1950s and 1960s were not significantly weaker than they were in the 1980s, suggesting that other aspects of the market for executives in the past may resemble recent years. It is unlikely that any single factor can accommodate the variety of trends described in this paper. However, we hope that a more thorough understanding of these trends will advance our understanding of recent developments in the market for corporate executives.

References

Aggarwal, Rajesh K., and Andrew A. Samwick. 1999. "The Other Side of the Trade-Off: The Impact of Risk on Executive Compensation," *Journal of Political Economy*, Vol. 107, No.1: 65-105

Baker, George and Brian Hall. 2004. "CEO Incentives and Firm Size," *Journal of Labor Economics*, Vol. 22, Issue 2: 767-798.

Baker, John Calhoun, and William L. Crum. 1935. "Compensation of Corporation Executives: The 1928-1932 Record." *Harvard Business Review* (Spring): 321-333.

Baker, John Calhoun. 1938. *Executive Salaries and Bonus Plans*. New York: McGraw-Hill Book Company.

Bebchuk, Lucian A., and Jesse M. Fried. 2004. *Pay without Performance: The Unfulfilled Promise of Executive Compensation*. Cambridge: Harvard University Press

Bebchuk, Lucian Arye and Robert J. Jackson. 2005. "Executive Pensions," Journal of Corporation Law, Vol. 30, No. 4: 823-855

Bebchuk, Lucian Arye, and Yaniv Grinstein. 2005. "The Growth of Executive Pay." NBER Working Paper # 11443

Benjamin, Daniel J. 2005. "A Theory of Fairness in Labor Markets," Harvard University mimeo, November

Berle, Adolf A. and Gardiner C. Means. 1932. The Modern Corporation and Private Property. New Brunswick, NJ: Transaction Publishers.

Bertrand, Marianne, and Sendhil Mullainathan. 2001. "Are CEOs Rewarded for Luck? The Ones Without Principals Are." *Quarterly Journal of Economics* 116(3): 901-32.

Blanchflower, David G., Andrew Oswald and Peter Sanfey, 1996. "Wages, profits and rent sharing," *Quarterly Journal of Economics*, Vol. 111, Issue 1: 227-251

Boschen, John F and Kimberly J. Smith. 1995. "You Can Pay Me Now and You Can Pay Me Later: The Dynamic Response of Executive Compensation to Firm Performance," *Journal of Business,* Vol. 68 (4): 577-608.

Chandler Jr., Alfred D. 1977. The Visible Hand. The Managerial Revolution in American Business. Cambridge, MA: Harvard University Press

Cunat, Vicente and Maria Guadalupe. 2006. "Globalization and the Provision of Incentives Inside the Firm: The Effect of Foreign Competition," Working Paper.

Gabaix, Xavier and Agustin Landier. 2006. "Why Has CEO Pay Increased So Much?," NBER Working Paper 12365

Garen, John E. 1994. "Executive Compensation and Principal-Agent Theory," *Journal of Political Economy*, Vol. 102: 1175-1199

Gibbons, Robert, and Kevin J. Murphy. 1990. "Relative Performance Evaluation for Chief Executive Officers", *Industrial and Labor Relations Review*, Vol. 43, No. 3

Goldin, Claudia and Robert A. Margo. 1992. "The Great Compression: The Wage Structure in the United States at Mid-Century." *Quarterly Journal of Economics* 107 (February): 1-34.

Hall, Brian J. and Jeffrey B. Liebman. 1998. "Are CEOs Really Paid like Bureaucrats?" *Quarterly Journal of Economics* 113 (August): 653-691.

Hall, Brian J. and Jeffrey B. Liebman. 2000. "The Taxation of Executive Compensation." In *Tax Policy and the Economy*, vol. 14, edited by James Poterba. Cambridge, MA: MIT Press.

Hall, Brian J. and Kevin J. Murphy. 2003. "The Trouble with Stock Options." *Journal of Economic Perspectives* 17 (Summer): 49-70.

Himmelberg, Charles P. and R. Glenn Hubbard. 2000. "Incentive Pay and the Market for CEOs: An Analysis of Pay-for-Performance Sensitivity," Columbia University mimeo.

Holderness, Clifford G., Randall S. Kroszner and Dennis P. Sheehan. 1999. "Were the Good Old Days That Good? Changes in Managerial Stock Ownership Since the Great Depression," *Journal of Finance,* Vol. 54 (2): 435-469

Jensen, Michael and Kevin J. Murphy. 1990. "Performance Pay and Top-Management Incentives," *Journal of Political Economy*, 98(2).

Jensen, Michael C. and Kevin J. Murphy. 2004. "Remuneration: Where We've Been, How We Got to Here, What are the Problems, and How to Fix Them." *ECGI Working Paper Series in Finance 44* (July).

Joskow, Paul L. and Rose, Nancy L. 1994. "CEO Pay and Firm Performance: Dynamics, Asymmetries, and Alternative Performance Measures," NBER Working Paper No. W4976

Kaplan, Steven N. and Joshua Rauh. 2006. "Wall Street and Main Street: What Contributed to the Rise in the Highest Incomes?," Working Paper

Kostiuk, Peter. 1990. "Firm Size and Executive Compensation," *Journal of Human Resources* 25: 90-105.

Kothari, S.P., Jay Shanken and Richard G. Sloan. 1995. "Another Look at the Cross-section of Expected Stock Returns." *Journal of Finance* 50: 185-224.

Lewellen, Willbur G. 1968. *Executive Compensation in Large Industrial Corporations*. New York: National Bureau of Economic Research.

Mace, Myles L. 1971. *Directors, Myth and Reality*. Boston, MA: Harvard Business School Press.

Moore, Lyndon and Steve Juh. 2006. "Derivative Pricing 60 Years before Black-Scholes: Evidence from the Johannesburg Stock Exchange," Journal of Finance Vol. 61 No. 6: 3069-3098

Murphy, Kevin J. 1985. "Corporate Performance and Managerial Remuneration: An Empirical Analysis." *Journal of Accounting and Economics* 7: 11-42.

Murphy, Kevin J. 1999. "Executive Compensation." In *Handbook of Labor Economics*, vol. 3B, edited by Orley Ashenfelter and David Card. Amsterdam, New York: North Holland.

Piketty, Thomas and Emmanuel Saez. 2003. "Income Inequality in the United States: 1913-1998." *Quarterly Journal of Economics* 118: 1-39.

Rajan, Raghuram G and Julie Wulf. 2006. "Are Perks Purely Managerial Excess?," *Journal of Financial Economics*, 79: 1-33

Rose, Nancy L., and Catherine Wolfram. 2000. "Has the "Million-Dollar Cap" Affected CEO Pay?," *American Economic Review*, Papers and Proceedings, Vol. 90 No. 2: 197-202

Roberts, David. 1956. "A General Theory of Executive Compensation Based on Statistically Tested Propositions," *Quarterly Journal of Economics*, 70: 270-294

Roberts, David. 1959. *Executive Compensation.* Glencoe, IL: The Free Press.

Rosen, Sherwin. 1981. "The Economics of Superstars," *American Economic Review*, 71: 845-858

Rosen, Sherwin. 1982. "Authority, Control and the Distribution of Earnings," *Bell Journal of Economics*, 13: 311-323

Rosen, Sherwin. 1992. "Contracts and the Market for Executives." In *Contract Economics*, edited by Lars Werin and Hans Wijkander. Cambridge, MA: Blackwell Publishers.

Smith, Clifford W. Jr. and Jerold L. Zimmerman. 1976. "Valuing Employee Stock Option Plans Using Option Pricing Models," *Journal of Accounting Research* 14: 357-364

Sundaram, Rangarajan K. and David Yermack. 2005. "Pay Me Later: Inside Debt and its Role in Managerial Compensation," NYU, Law and Economics Research Paper No. 05-08

Taussig, F. W. and W. S. Barker. 1925. "American Corporations and Their Executives: A Statistical Inquiry." *Quarterly Journal of Economics* 40 (November): 1-51.

Tervio, Marko. 2007. "The Difference That CEOs Make: An Assignment Model Approach," Working Paper

Wattel, Harold L. 1978. *Chief Executive Officer Compensation.* New York: Hofstra University.

Yermack, David. 1995. "Do Corporations Award CEO Stock Options Effectively?" *Journal of Financial Economics* 39: 237-269.

Yermack, David. 2006. "Flights of Fancy: Corporate Jets, CEO Perquisites, and Inferior Shareholder Returns," *Journal of Financial Economics* 80: 211-242

Data Appendix

Outline:

1. Sample Selection

1.1 Selecting Firms

Our sample includes data on executives working in the largest 50 firms in 1940, 1960 and 1990. For 1960 and 1990, we measure firm size by the total value of sales and obtain company rankings from the Compustat database. Compustat's coverage was expanded in 1978 from 2700 to 6000 firms, so firms that were listed prior to 1978 are less likely to be included in the sample.[53] Therefore, we crosscheck the 1960 ranking with rankings published by *Fortune* magazine and add firms that are missing from Compustat.[54] For 1940, a rank ordering of firms by the value of total sales was not available from either Compustat or any other published surveys such as *Forbes* or *Fortune*. Therefore, we rank firms by total market value using the CRSP database. In 1951 (the first year with a reliably large number of firms reporting sales in Compustat), the correlation between a firm's rank by sales and its rank by market value is 0.76 (based on 423 firms).

We obtain information on executive compensation from historical proxy statements and 10-K reports from the collection at Harvard Business School's Baker Library (one of the largest collections of corporate reports in the world). To facilitate the data collection we limit our sample to firms for which the Baker Library has proxy statements for a large number of years. To be specific, for the largest firms according to the 1940 ranking we only use firms for which we can find information for at least 20 years between 1936-66, for the 1960 ranking we select firms with proxy statements available for at least 20 years between 1943-73, and for the 1990 ranking we select firms with proxy statements available for at least 20 years between 1970 and 2000. Moreover,

[53] See Kothari, Shanken and Sloan (1995) for a more detailed description of survivorship bias in Compustat.

[54] We find 3 firms that are listed in Fortune's ranking but do not appear in Compustat. We base our ranking on Compustat instead of the Fortune rankings because Fortune only includes manufacturing firms.

we also require that annual data must be available for at least 3 blocks of 5 consecutive years. This requirement is useful because only consecutive data on stock option grants and exercises can allow us to reliably estimate an individual's holdings of unexercised stock options, and because it allows us to calculate changes in executive compensation and wealth.[55] If a firm does not meet these criteria, we replace it with the next largest firm on the list. In this manner, we move down the rankings until we have a total of 50 firms for each year. Because the ranking of firms is fairly consistent over time, our final sample includes a total of 101 firms. For each firm that meets our selection criteria, we collect annual data for all of the years for which proxy statements or 10-Ks are available. Appendix Table A3 lists the firms in our sample, the years they appear and their industrial classification.

Another issue related to the selection of the firms in our sample is how to treat mergers. Our intent is to keep a post-merger company in the sample if the new firm is similar to the original company. Thus, we continue to follow a company for as long as the firm maintains the same permanent company identification number (PERMNO) in the CRSP database. We also include a post-merger firm with a different permanent number if either (1) all or part of the name of the old company is retained in the new company's name, or (2) the 2-digit SIC code of the new and the old company are the same. Out of the 101 firms in our sample, there are 7 cases where a firm's identification number changes but it retains the name of the original firm, and 25 cases where the identification number and name changes but the industrial classification remains the same. There are 11 cases where we stop following a firm after a merger because the new firm takes on an entirely new name and operates in a different industry. There are also another 14 cases where we cease to follow a firm because it becomes foreign-owned (and therefore not subject to SEC reporting requirements) or because the firm has gone out of business.

We measure the market value of each firm in our sample as the number of shares outstanding multiplied by the end-of-fiscal year market price, both of which are reported in CRSP. The total value of sales in each firm is from Compustat (data12), which is available for most companies from 1950 to the present. For years prior to 1950, we collected data on total sales from various editions of *Moody's Industrial Manual*, *Moody's Transportation Manual,* and *Moody's Public Utility Manual*.

1.2 Selecting Executives in Each Firm

During the 1930s, the SEC required firms to report remuneration for each of their 3 highest paid officers. From 1943 to 1978, this requirement was extended to include any additional officers who earned above a nominal cutoff (this amount was increased over time).[56] From 1978 to the present, the disclosure requirements extended to the 5 most highly compensated officers whose remuneration exceeded a certain amount.[57] Whenever possible, we collected information on the 5-highest paid officers in each firm. However, including the 4th and 5th highest-paid executives may bias our sample because only firms with higher average pay report the remuneration of these officers prior to 1978. Therefore, we limit most of our analysis to the three highest paid officers in each

[55] Moreover, sampling a different firm in each year would be an extremely time-consuming data collection process given the way in which the information is archived at Baker Library.
[56] This level was initially $20,000. It was raised to $25,000 in 1948, $30,000 in 1954, and $40,000 in 1974.
[57] This amount increased from $50,000 in 1978, to $60,000 in 1983, and $100,000 in 1993.

company.[58] We also exclude executives that entered the sample or retired mid-way through the year. Appendix Table A2 shows the distribution of job titles in our sample. When multiple job titles are reported, we record all of them. For example, an executive vice president who also serves as treasurer is counted in both categories.

2. Measuring Executive Compensation

2.1 Collecting Information from Proxy Statements

Our data on executive compensation were obtained from corporate reports that were filed with the Securities and Exchange Commission (SEC). In 1934, the SEC began to require firms to disclose information on executive compensation in 10-K reports. These documents list the name, job title, and aggregate remuneration (normally defined as cash salary and bonuses) paid to each of the 3 highest-paid officers in the firm. Recognizing that the information reported in the 10-Ks was not very detailed, the SEC introduced executive compensation as an item in proxy statements when it revised proxy rules in 1942.[59] Ever since that time, proxy statements have contained detailed quantitative and descriptive information on several major components of compensation for the highest paid officers in the firm. Therefore, we collect data from proxy statements between 1943 and 1992 (thus for compensation pertaining to 1942 to 1991), and extend our sample to back to 1936 using 10-K reports.[60] Although some firms did not disclose executive compensation in their 10-K reports and the collection of 10-Ks at Baker Library is not as extensive as their collection of proxy statements, we found information pertaining to the 1936-42 period for 63 out of the 85 firms in our sample that were in business at that time. From 1992 to 2005, we use information on executive compensation from Computstat's Executive Compensation database. These data are also originally collected from proxy statements, and so are comparable to the data we collected.

The information on executive compensation contained in the proxy statements comes from several parts of the document. As required by the SEC, each proxy statement contains a table listing the remuneration of the highest paid officers in the firm. This table provides data on cash remuneration, long-term bonuses and, frequently, job titles. Information on the number of stock options granted and exercised generally follows this table. Many proxy statements also include a description of any incentive compensation or stock option plans that were in effect at the time. These descriptions include information on the characteristics of stock option and bonus awards (for example, the vesting structure of options and deferred bonuses, the tax status of stock options, and the method used to calculate incentive compensation). Another useful section of the proxy statement is a table that lists all of the nominees for director and their holdings of company stock. This table allows us to record the equity holdings of most officers who

[58] We select the highest-paid officers according to total cash remuneration (i.e. total cash and bonus payments, but not the value stock or stock option grants), which is same measure firms use to determine which individuals to include in their proxy statements.

[59] At that time, it was the Commission's perception that "more extensive information [had to] be given on the compensation and dealings of corporate managers." Securities Act of 1933, Release No. 2887, December 18th, 1942.

[60] The collection of 10-Ks at Baker Library includes fewer companies in the early years. We begin our sample with 10-Ks pertaining to 1936 because this is the first year that provides us with a large enough sample size. Moreover, many firms refused to disclose information of compensation in 1934 and 1935.

were also directors, which comprises more than 80 percent of the executives in our sample.

2.2 Measurement of salary and bonus payments

Salary and current bonus payments: Salary plus any bonus both awarded and paid out in the same year. These bonuses are generally in the form of cash, although some were given in stock. Stock bonuses are valued using the stock price on the day the stock was given to the executive. When the stock price on the award day is missing, we use the stock price at the end of the fiscal year. Ideally we would like to be able to separate straight salaries from bonuses, but in many cases only total cash remuneration is reported. In about 5 percent of the sample, these amounts include payments from long-term incentive awards as well as current-year bonuses.

Long-term incentive payments: Payments made to the executive as compensation for bonuses awarded in prior years. Many long-term incentive plans were structured to pay bonuses in equal installments during the 4 to 5 years after they are awarded. Although we would prefer to attribute all bonus awards to the year in which they are granted, the majority of firms only report the cash amounts paid to the executive in each year. In cases where the firm reports the amount awarded instead of the amount paid out, we convert the award into future payments using the structure of the bonus plan to estimate the amount paid out each year. In earlier decades, the majority of these bonuses were paid in cash, but a few are awarded in stock. Bonuses awarded in stock became more common over time as restricted stock grants became more prevalent. Stock bonuses are valued using the stock price at the end of the year that the individual receives the stock. Since the realization of performance measures for contingent awards are usually not observable, contingent bonuses are only included when the amounts paid out are reported.

2.3 Measurement of stock options

Options granted: We value options on the day they are granted using the following Black-Scholes formula:

$$\text{Award value} = N[Pe^{dT}\Phi(Z) - Ee^{rT}\Phi(Z - \sigma\sqrt{T})]$$

$$Z = \frac{\ln\left(\frac{P}{E}\right) + T(r - d - \frac{1}{2}\sigma^2)}{\sigma\sqrt{T}}$$

N = number of shares awarded

P = stock price on the date of the award. We assume this price is equal to the exercise price of the stock (see below for details).

E = exercise price of the stock option.

d = monthly dividend rate = 1/12*ln(1+D/S) where D is the total amount of dividends paid in the previous year and S is the average stock price in the previous year.

T = time to expiration of the option, measured in months.

r = monthly yield on US treasury securities. We use the 3-year constant maturity interest rate from Global Insight's DRI-WEFA Basic Economic Database.

Σ = standard deviation of monthly stock returns. Monthly stock returns are obtained from the CRSP database and are corrected for stock splits and dividend payments. The

standard deviation in each year is calculated from the previous 3 years of monthly stock returns.

$\Phi(Z)$ = cumulative probability function for the normal distribution

Except for the dividend rate, interest rate and standard deviation of stock returns, the proxy statements generally contain all of the information necessary to implement the Black-Scholes formula. Before 1964, the typical stock option plan granted options that expired after 10 years and had an exercise price ranging from 95 to 100% of the market price of the stock on the day it was granted. These characteristics are fairly standard because, under the 1950 Revenue Act, capital gains tax rates applied to an option with these characteristic instead of income tax rates. When the 1964 Revenue Act replaced "restricted" with "qualified" stock options, these requirements were changed to an exercise price of 100% and duration of 5 years. The majority of the firms in our sample changed their stock option plans in order to conform to these new rules. As the tax incentive to grant stock options diminished during the 1970s, firms began granting a larger number of non-qualified options that lengthened the duration back to 10 years. Therefore, when information on the duration of an option is missing, we assume that it is 10 years if the option was granted prior to 1964 or after 1974, and 5 years if it was granted between 1964 and 1973. This imputation is made for 16% of the sample prior to 1992, and the missing information is more common during the 1970s and 1980s. Compustat does not report the duration of option grants, so we assume a horizon of 7 years for all options granted after 1992.[61] Because the vast majority of the options granted after 1950 had an exercise price equal to the stock price on the day of the grant, we assume that the stock price on the day of the award is equal to the exercise price for all options grants after this year.[62] For years prior to 1950, a much larger number of options were granted in-the-money. However, we frequently do not know the exact grant date of these options so we are unable to calculate their value on the day they were granted. Instead, we value these options as if the market price on the grant date were equal to the end-of-fiscal year market price.

One final complication to valuing stock option grants and exercises is that from the late 1960s to the late 1980s, many firms began reporting the amounts of stock options awarded and gains from exercising options as a total for each executive during the previous 3 or 5 years. Wherever possible, we combine this information with information on annual grants and exercises from previous proxy statements to estimate the amounts granted and exercised for each executive in an individual year (we are able to back out annual information for about 8 percent of the cases where only multi-year totals are reported). However, this imputation cannot be made for executives who do not appear in all of the previous 3 or 5 proxy statements, or if the proxy statement for an intervening year is missing. Because roughly 27 percent of the firms in the 1970s and 20 percent of the firms in the 1980s reported options in this manner, excluding this information would severely bias downward our estimates of stock option grants and exercises. Instead, when we can not impute the grants and exercises for a given year, we assume that 1/5 of the 5-year totals were granted in each of the past 5 years, or 1/3 of the 3-year totals in

[61] We assume 7 years instead of 10 year both to be consistent with prior research (for example, Hall and Liebman 1998) and to be consistent with the assumptions made by Compustat.

[62] See Smith and Zimmerman (1976) and Murphy (1985) for further evidence that firms fix the exercise price equal to the current stock price.

each of the past 3 years. We assume that the exercise price of these options was equal to the stock price at the end of the fiscal year, and that the duration was 5 years for options granted prior to 1974 and 10 years after 1974. Similarly, we assume that 1/5 of the gains from exercising options were realized in each of the past 5 years, or 1/3 over the past 3 years when 3-year totals are reported.

Appendix Figure A1 shows the frequency of stock option grants both including and excluding imputed values. Our imputation procedure has the largest impact during the 1970s and 1980s, when including imputed values raises the probability of receiving an option by 20 to 30 percentage points. Including the imputations also alters the trend in grants during this period, moving up the era of the most rapid increases in option grants from the mid-1980s to the mid-1960s. Despite its clear impact on our assessment of the long-run trend in option grants, it is important to keep in mind that the imputations during the 1970s are derived from 5-year summaries, making it difficult to ascertain how the timing of option grants correlates with the performance of firms during this period. For example, it is possible that many of the grants we attribute to the mid-1970s were actually granted in the late 1960s or early 1970s, which were times when firms were earning higher rates of return. Although the imputations raise our estimates of the fraction of executives who are granted stock options in each year, the effect on the median value of total compensation is not as large (see Appendix Figure A2). These imputations raise the median real value of total compensation by less than $0.1 million for most of our sample, and do not appreciably alter the long-run trend.

Options exercised: Proxy statements issued during the 1950s, 1960s and 1970s generally report the number of options exercised, the exercise price (adjusted for stock splits) and the market value of the stock on the date of purchase. Using this information, we value options exercised as the difference between the exercise price and the average stock price on the day the option was exercised. The exercise price is missing for only about 1½ percent of the observations on stock option exercises, and so these exercises are not included in the analysis. Proxy statements issued during the 1980s and 1990s generally report the total gains from exercising options directly. In these cases, we assume the executive exercised his oldest options first and calculate the number of options exercised needed to achieve the gains reported in the proxy statement.

Analogous to the reporting of option grants, the number of options exercised were also reported in 3- and 5-year totals during the 1970s and 1980s. We impute exercises from these totals using a procedure similar to the one used for option grants. Appendix Figure A3 shows the frequency of option exercises including and excluding these imputations. In this case, the biggest effect of our imputations is from the late 1960s to the late 1970s. Whereas the non-imputed statistics suggest that option exercises fell off during the late 1960s and early 1970s, our calculations suggest that option exercises rose throughout the 1960s and maintained a frequency between 45 and 50 percent throughout the 1970s and 1980s.

Stock option holdings: We calculate the number of options held by an executive as the number he held the previous year plus the number granted, less the number exercised and the number that expire. In order to calculate the value of these holdings using the Black-Scholes formula, we need to know the exercise price and remaining duration of the

different options held at each point in time. These statistics are not generally reported directly in proxy statements, so we gather this information by following an executive over time and observing the exercise price and duration of the options he receives and exercises in each year. In cases for which information on the exercise price or remaining duration of an option grant is missing, we assume that the exercise price is the closing price at the end of the fiscal year of the grant year and that options granted before 1964 or after 1974 have a duration of 10 years, while options granted between 1964 and 1974 have a duration of 5 years. This method may underestimate an executive's total stock option holdings because many executives are likely to have been granted stock options before we observe them in our data. This bias is likely to be less severe in the 1950s because the majority of firms did not grant stock options before 1950. Starting in the 1970s, firms also began to report the total number of options held by each executive. Following Hall and Liebman (1998), we adjust our calculated holdings to match the reported totals. About one third of our estimates match the reported totals exactly. Our estimates do not appear to be significantly biased, as the average difference between our estimates and the reported totals is 586 shares (0.2 percent of the average number of options held for executives with positive holdings) and the median difference is zero. In cases where our estimates are greater than the reported totals, we assume that the oldest options in the portfolio were exercised first. In cases where we calculate fewer option holdings than reported, we assume that the missing options were granted in the year prior to the first year the executive was observed.

2.4 Equity holdings

Equity holdings are valued with the stock price at the end of the fiscal year. We include shares that are held by family members and associates because an executive's incentives may be influenced by changes in overall family wealth. Equity holdings were only listed in proxy statements for officers who were also directors and occasionally they were only reported for directors who are up for re-election. We are able to observe stock holdings for 88 percent of our sample of the three highest-paid executives in each firm from 1942-2005. Because 10-K reports did not list the equity held by officers and directors, stock holdings for the 1935-41 period are based on the bi-monthly reports of the SEC, *Official Summary of Security Transactions and Holdings*. These reports record the equity purchases and sales of every officer and director in publicly-traded corporations and public utilities. At the time of a transaction, an officer's total holdings of company stock are also reported. Using these reports, we collected information on the holdings of company stock of any officer who made a transaction during a year. We assume that officers who do not appear in any reports for a given year did not make any transactions during the year, and so we assume they own the same amount of stock as in the previous year. We obtain an initial estimate of stock holdings in 1935 from the *Official Summary of Holdings of Officers, Directors and Principal Stockholders*, which reports the holdings of all officers in each firm for that year. If an individual was not an officer or director in 1935, we will not observe his equity holdings until the first year in which he makes a transaction. If officers with less tenure in the company tend to hold smaller shares of stock, our estimates of stock holdings during the 1936-41 period will be biased upward. However, the fraction of officers with stock holding information ranked at first-, second- or third- highest paid is the same for our 1936-41 sample as it is in 1942-49. Therefore,

the magnitude of this bias is likely to be small. Furthermore, proxy statements issued in the 1936-41 period sometimes reported officers' equity holdings, so for these cases we are able to compare our estimated stock holdings to the reported totals. Our estimates match the proxy statements about 50 percent of the time, but they do not appear to be biased, as the average difference between our estimates and the reported totals is 2000 shares (equivalent to 20 percent of the average number of shares held) and the median difference is 50 shares (equivalent to 3 percent of the median number of shares held).

3. Evaluating the Representativeness of our Sample

3.1 Salary and Bonus

Although our sample-selection procedure is heavily weighted towards executives working in large firms, the sample also includes executives in smaller firms that will either become large in future years or that were large in the past. Appendix Table A1 shows the distribution of the firms in our sample ranked by their market value. To calculate these rankings, we define the universe of firms as those listed in Compustat as being traded on the S&P, NYSE, ASE or NASDAQ. For the years prior to 1951, we use all firms listed in CRSP. The fraction of firms ranked among the largest in the economy declines over time, but our sample still comprises close to 25 percent of the entire market value of the S&P 500 by the end of our sample period.

Due to our sample design, our sample should be fairly representative of the trends in compensation among the largest publicly-traded firms in the economy. In Figure 5 we showed that the trends in compensation are similar in the smaller firms in our dataset, suggesting that our sample may be representative of a wider group of firms. We can evaluate this possibility by comparing our data to a different dataset with broader coverage than our own: Hall & Liebman's (1998) study that provides information on CEO compensation in 500 companies from 1980 to 1994.[63] As far as we are aware, no nationally-representative studies were done prior to the 1970s that would provide us with a comparison group in earlier periods.

Appendix Table A4 shows the median real value of the salaries and bonuses paid to CEOs in our sample compared with the Hall & Liebman data. Hall and Liebman analyze a random sample of 478 firms listed in the Forbes 500 rankings for the period 1980 to 1994, so their data are likely to be representative of compensation in the largest 500 publicly-traded firms. They separately identify salary and bonus and restricted stock awards, but do not include other deferred bonuses. Thus, Table A4 compares their measure of "salary and bonus" (which does not include restricted stock) with our measure of "salary and current bonus." The median value of this form of compensation is higher in our dataset than in the Hall-Liebman sample, but this result is because the firms in our sample are larger. If we restrict the samples to CEOs in the same group of firms or examine medians by firm size, the differences between the two samples largely disappear. Thus, as long as the median values within each size category are similarly

[63] Hall and Liebman (1998) expanded on a sample of 792 originally constructed by Yermack (1995) for the period 1984-1991. Alternatively, we could assess our findings using the Forbes's survey of the 800 largest publicly-traded corporations from 1970 to the present. A drawback of the Forbes data is that stock options are measured as the gains from exercising options, and so its value is mechanically correlated with the performance of the stock market.

representative for earlier time periods, we can calculate national trends in cash compensation by reweighting firms to achieve a more nationally-representative distribution of firm sizes.

Appendix Figure A4 shows the trends in median compensation—again defined only as current salary and bonus payments—where each firm is assigned a weight inversely proportional to its probability of being in our sample. We calculate these probabilities by grouping the firms into 5 major size categories according to their market value: the largest 50, firms ranked 50-100, firms ranked 100-200, firms ranked 200-300 and firms ranked 300-500. For each size category, the probability of being included in our sample is the fraction of firms in our sample out of the total number of firms in the group. For example, in 1950 we have 38 firms ranked among the largest 50, so any firm ranked between 1 and 50 given a weight inversely proportional to 38/50. Because we only have a few firms in the smallest group in earlier years and these firms are least likely to be representative of other firms of a similar size, we also consider weights scaled to be representative of only the largest 300 publicly-traded firms.

For most of the century, the median of our unweighted sample is similar to the median of the top 300 firms in the economy. Exceptions to this result are in the 1930s and the 1950s, when our unweighted statistics are about 10-20 percent higher than would be expected in the largest 300 publicly-traded firms. Using weights to represent the largest 500 firms lowers the level of compensation throughout our sample period. This reduction is greater in earlier years, leading to a slightly higher growth rate in the level of compensation in the weighted data. Despite these differences, the long-run trends are broadly similar in all three data series, and we conclude that our data on salaries and bonuses are broadly representative of the largest 300 firms in the economy.

3.2 Stock Options

In contrast to the amount of stock option grants we showed in Appendix Figure A3, Hall and Liebman report a much lower incidence of these grants during the 1980s. Whereas 47 percent of the CEOs in their sample were granted an option during any given year between 1980 and 1989, the analogous figure for the CEOs in our sample is close to 75 percent. This discrepancy cannot be explained by disparities in firm size between the two samples because substantial differences remain even when we restrict both samples to include the same set of firms. In the 45 firms that appear in both datasets, we calculate a frequency of option grants of 77 percent for CEOs between 1980 and 1989, while Hall and Liebman's data show a frequency of 65 percent. This difference can be attributed to our imputation of option grants from the 3- and 5-year summaries reported in the proxy statements (see section 2.3 of the Appendix). The imputation is not necessary in the Hall-Liebman sample because firms reporting multi-year summaries were contacted by mail to provide annual information on option grants. Correspondence with David Yermack, who collected the data on which the Hall-Liebman sample is based, indicates that the response rate of firms was high, leaving few cases where annual option grants were unknown. Therefore, the incidence of stock option grants in the Hall-Liebman data is likely to be more accurate than in our estimates. On the other hand, their data may be biased downward somewhat since firms that did not grant options may have been more likely to respond to the mail questionnaire.

In truth, option grants were probably lumpier than our calculations suggest, so our estimates of the frequency of option grants are likely biased upward. On the other hand, the value of these grants will be biased downward, leaving the aggregate value of grants over several years about right. Indeed, we find an average value of option grants to CEOs from 1980 to 1989 of $0.42 million, compared with $0.40 million for the same set of firms in the Hall-Liebman data.

Another source of bias in our statistics on option use is that the smaller firms in our sample may not be representative of they typical publicly-traded firm of a similar size. We suspect this bias because, unlike the Hall-Liebman sample, we do not find that option grants were less frequent in smaller firms. Appendix Table A5 compares option grants in the two samples for firms belonging to different size categories. In Hall and Liebman's sample, there is a strong correlation of option grants with firm size, as firms with higher market values are both more likely to grant options and pay a larger fraction of total compensation in the form of options. By contrast, we find similar propensities to grant options in small and large firms, whether or not imputed options are included. We attribute this result to the fact that the small firms in our sample were not randomly selected, but rather are included in the sample either because they were large in the past, because they will be large in the future, or because are experiencing a transitory negative shock to their market value. These firms may have compensation practices more similar to larger firms than the typical small firm in the economy. Thus, the composition of pay in our sample may be more heavily weighted towards options than the typical publicly-traded firm in the economy.

3.3 Total Compensation

We have established the representativeness of our sample using an alternative data source from 1980 to 1994, but it is more difficult to assess how well the firms in our sample reflect the typical firm in earlier periods. One concern is that many of the firms in the early years of our sample were included because they are big in later years, and thus may experience higher growth rates in compensation than the typical large firm. However, the trends in compensation in our data do not appear to vary systematically with the year in which the firm was among the largest fifty in the economy. Appendix Figure A5 shows the trends in median compensation in each of the three different types of firms in our sample: those that were selected because they were large in 1940, those that were large in 1960, and those that were large in 1990.[64] The trends are broadly similar for all three groups, suggesting that the long-run evolution of executive compensation was similar in firms no matter whether they were big at the beginning, the middle or the end of our sample.

Despite the similarities, two key differences are worth noting. First, the decline in compensation coinciding with World War II (which mostly occurred in 1942 and 1943) is most prominent in firms from the 1940 sample. Median compensation also falls in the 1960 sample around this time, but the decline is not as pronounced. In addition, the wartime drop in compensation in these firms may be exaggerated by an anomalously high level of compensation in the pre-war period. While the market value of these firms was not meaningfully different from the firms in the 1990 sample prior to World War II,

[64] Firms that were among the top 50 in more than one time period are included in every sample for which they qualify.

compensation was about 15-20 percent higher in the 1960 sample. This differential fell to about 5 percent by the end of the war—a gap more in line with the differences in firm size among these two groups—and remained around this magnitude for the next 15 years. For the firms in the 1990 sample, there was no significant wartime decline after abstracting from a transitory upward spike in 1938 and 1939.[65] Thus, the typical firm in the economy may not have experienced as large a drop in compensation during World War II as implied by the median firm in our sample. The second notable difference among these three samples appears in the last ten years of our data, as compensation in the 1940 sample increased more slowly during this period compared with the other two samples. By contrast, executives in this sample did not experience the same contraction in compensation from 2000 to 2003 that occurred in the samples of larger firms. Thus, we find that both the decline in the level of compensation during World War II and the increase in compensation during the late 1990s were more exaggerated in the largest firms in the economy. On the other hand, we find no evidence that including firms that are likely to have better performance than average has biased our sample in any meaningful way.[66]

Appendix Table A6 presents median total compensation by decade, using various weighting schemes to reflect different groups of publicly-traded firms:

A. Entire unweighted sample.
B. Firms ranked among the largest 100 according to total sales, unweighted.
C. Firms ranked among the largest 100 according to market value, unweighted.
D. Firms ranked among the largest 100 according to market value, weighted inversely proportional to a firm's probability of being selected. The probabilities are calculated from the fraction of firms in our sample falling in categories of rank by market value (see Section 3.1 for details).
E. Firms ranked among the largest 100 according to market value, weighted inversely proportional to their market value. This weighting scheme would be appropriate if the probability of being selected were proportional to a firm's market share.
F. Firms ranked among the largest 300 according to market value, weighted inversely proportional to a firm's probability of being selected.
G. Firms ranked among the largest 300 according to market value, weighted inversely proportional to their market value.
H. Firms ranked among the largest 500 according to market value, weighted inversely proportional to a firm's probability of being selected.
I. Firms ranked among the largest 500 according to market value, weighted inversely proportional to their market value.

Not surprisingly, the level of compensation was higher in groups representing larger firms. The trends are similar, with the exception that the decline in compensation from the 1930s to the 1940s was limited to larger firms and the increases in compensation

[65] It is worth noting that we were able to find compensation data for almost half of the firms in our 1990 sample during this period, despite the fact that these firms were selected based on a criteria 50 years in the future.

[66] This conjecture is confirmed by calculating median compensation in a sample that excludes firms in the years prior to the year in which they were selected (i.e. only the 1940 sample from 1940-1959, the 1940 and 1960 samples from 1960-1989 and the entire sample from 1990-2005). The trend in median compensation in this sample is no different from our entire sample.

during the past 15 years were greater in larger firms. We do not find that using different weighting schemes or using sales instead of market value to measure firm size has a meaningful effect on the long-run trends in compensation. Our unweighted sample is most similar to the top 300 firms weighted by the probability of being selected (sample F) from the 1960s onward, and lies somewhere between the top 100 and top 300 during the early decades of our sample. Therefore, we conclude that the unweighted statistics we show in the text of our paper are fairly well representative of the largest 200-300 firms in the economy.

As we showed in the previous two sections, the level of salaries and bonuses in our sample is fairly representative of the level of pay within categories of firm size, but the frequency of option grants may be overstated in the smaller firms in our sample. Using Hall and Liebman's data from 1980 to 1994, we find that the median value of option grants relative to total compensation is 0.23 for firms ranked from 1 to 100, 0.16 for firms ranked 100 to 200, 0.11 for firms ranked 200 to 300, 0.09 for firms ranked 300 to 500, and 0 for firms ranked lower than 500 (where the ranks are determined by market value). Although these values increased from 1980 to 1994, the relative distribution by firm size did not (i.e. the value of options granted relative to cash compensation was always about 30 percent lower in firms ranted 100 to 200 than in the largest 100 firms). Therefore, we use the relative proportions of option grants by firm size to estimate an alternative value of option grants for firms ranked below the largest 100 in our sample. For example, for firms ranked between 100 and 200, we assume that the value of option grants is 0.16/0.23=70 percent of the average value of option grants in firms ranked in the top 100 in each year. It is unlikely that the value of option grants is truly zero for all firms in the smallest size category, so we assume that option grants in this category are 10 percent of the average in the top 100 firms.

The bottom rows of the Table A6 show median compensation using these alternative stock option grants in our unweighted sample, the sample weighted to reflect the top 300 firms (sample F) and the sample weighted to reflect the top 500 firms (sample H). The stock option adjustment has a larger effect in the sample that gives smaller firms more weight, but in no sample is median compensation meaningfully different prior to the 1960s. The adjustment has a greater effect with each successive decade, and by the end of the sample, median compensation is 21 to 25 percent below our estimates based on actual stock option grants. One caveat to this analysis is that the Hall-Liebman data end in 1994. To the extent that stock option grants may have spread to smaller firms during the 1990s, our calculations will understate the value of option grants in small firms.

To summarize, Figure A6 shows median compensation by year in our unweighted sample and the top 500 firms (sample H) using alternative assumptions for stock option grants. Although the top 500 reflects the broadest group of firms we show, there is still may be a concern that the smallest firms in our sample are not representative. Therefore the figure also shows the top 300 firms (sample F) using alternative assumptions for stock option grants. The level of compensation is lower in the other samples, but the long-run trends are the same. The real value of total compensation declined during the 1940s, increased only very slowly for the next several decades, and has risen at an increasing rate since the 1970s. It is worth noting that high growth rates in total compensation have persisted through 2005; the large increases in compensation of the 1990s appear to be part of a long-run secular increase in pay.

4. Correcting pay-to-performance estimates for growth in firm size

An accurate description of pay-to-performance needs to account for the scale of firms because the Jensen-Murphy statistic and the value of equity at stake are both correlated with firm size. This concern is particularly important for understanding the long-run trends in pay-to-performance since the median firm in our sample expanded by more than a factor of 7 over the past seventy years. We use a regression-based method to correct our pay-to-performance estimates for changes in the size of firms. The basic idea of this strategy is to estimate pay-to-performance correlations for firms in specific size categories in each decade, and then to compare estimates for a given firm size from one decade to the next.

To adjust the Jensen-Murphy statistic we interact the change in market value in equation [3] with a spline function based on quintiles of the firm-size distribution, as follows:

$$\Delta(Exec.Wealth)_{ijt} = \alpha_t^{JM} + \beta_t^{JM}\Delta(Shareholder\,Value)_{jt} + \\ + \sum_s \beta_t^{JM,s}\Delta(Shareholder\,Value)_{jt} I_s + \sum_s \theta_t^s I_{st} + \varepsilon_{ijt}$$

where I_s are dummy variables for quintiles of the distribution of firm size in each decade. We measure firm size as the average market value of the firm during the previous three years. For each firm in our sample, we predict a Jensen-Murphy statistic as the fitted value from this regression. We also predict an alternative Jensen-Murphy statistic for each firm using the coefficient estimates and the distribution of firm size from the previous decade. The difference between these two estimates reflects the change in the Jensen-Murphy statistic for each firm of a given size.

For example, a firm with a market value of $3.1 billion in the 1960s falls in the 24th percentile for that decade, and so it would have a predicted Jensen-Murphy statistic of $\beta_{60}^{JM} + \beta_{60}^{JM,16-25}$. The same firm would have fallen in the 57th percentile of the 1950 distribution of firm size, and so its predicted Jensen-Murphy statistic for prior decade would be $\beta_{50}^{JM} + \beta_{50}^{JM,56-65}$. The difference between these two statistics reflects the change in pay-for-performance from the 1950s to the 1960s for firms of this size.

This methodology generates a range of estimates of changes in pay-to-performance based on the distribution of firm sizes in our data. Appendix Table 8 reports the mean and median change in pay-to-performance across all of the firms in our sample, along with the predicted change in pay-to-performance at the median firm size in each decade. All three statistics provide a similar picture of the evolution of pay-to-performance over time.[67] The index shown in Figure 8 of the text is based on the average across firms, because we believe the average provides the best estimate of the typical change in pay-to-performance in our sample.[68] We follow a similar technique to adjust the value of equity at stake for changes in firm size.[69]

[67] The only exception is that the median percent change in the Jensen-Murphy statistic appears to be lower in the 2000s than in the 1990s, while it is higher for all the other statistics of pay-to-performance.

[68] The median change in pay-to-performance may not be representative of a typical firm since it may occur in a firm that is unusually large or unusually small for that decade. We prefer the average change to the

Table A1
Distribution of Firms by Size

	1936-1939	1940-1949	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2005
Fraction of Firms Ranked by Market Value								
Rank<=50	.51	.54	.43	.41	.33	.34	.31	.30
50<Rank<=100	.22	.22	.27	.19	.17	.20	.14	.13
100<Rank<=200	.16	.13	.17	.23	.21	.20	.25	.13
200<Rank<=500	.09	.11	.12	.16	.21	.17	.20	.27
500<Rank	.01	.00	.01	.01	.08	.08	.09	.17
Fraction of Firms Ranked by Total Sales								
Rank<=50	--	--	.62	.53	.40	.39	.33	.26
50<Rank<=100	--	--	.23	.25	.26	.27	.24	.16
100<Rank<=200	--	--	.11	.14	.21	.19	.18	.24
200<Rank<=500	--	--	.04	.07	.11	.12	.21	.21
500<Rank	--	--	0	.00	.03	.02	.04	.13
Average Market Share of Entire Sample in S&P 500								
	.39	.51	.49	.42	.37	.30	.24	.23

Rankings by market value are based on all firms appearing in the CRSP database, which includes all publicly-traded firms in the NYSE, AMEX and NASDAQ stock markets. Rankings by sales are based on all firms appearing in Compustat, which does not have data prior to 1950.

change at the median firm size because the former uses information across the entire distribution of firm sizes, rather than only at a single point.

[69] An alternative methodology would be to compare the pay-for-performance estimates in two successive decades using a subsample of firms of similar size. One problem with this method is that the type of firms that appear in the upper part of the distribution in one decade may be systematically different from small firms in the subsequent decade. In any case, results are similar when we follow this strategy.

Table A2
Distribution of Sampled Firms by Industry

Industry	Percent of Firms
Mining	0.9
Manufacturing	
Food and kindred products	10.5
Tobacco	4.0
Lumber/wood products	0.8
Paper and allied products	2.2
Chemicals and allied products	7.0
Petroleum and coal products	10.8
Rubber and misc. plastics products	3.1
Stone, clay, glass, concrete products	0.8
Primary metal industries	8.6
Fabricated metal products	2.0
Industrial machinery and equipment	4.3
Electronic equipment	4.8
Transportation equipment	
Motor vehicles and equipment	5.0
Aircraft and parts	5.4
Ship and boat building	1.0
Instruments and related products	1.7
Transportation	2.7
Communications	2.3
Utilities	6.0
Wholesale trade	0.6
Retail trade	
General merchandise stores	5.8
Food stores	2.6
Other retail	1.0
Finance, Insurance and Real Estate	6.2

Note. Based on the largest 50 firms in 1940, 1960 and 1990. Industry definitions are the modal 2-digit SIC code from CRSP.

Table A3
Firms Included in the Sample

Company Name	First Year in Sample	Last Year in Sample	Rank in 1940	Rank in 1960	Rank in 1990	Industry
AETNA LIFE & CASUALTY CO	1964	2005	--	--	48	Insurance carriers
ALLIED CHEMICAL CORP	1936	2005	16	65	82	Chemical mfg
AMERICAN CAN CO	1936	2005	34	42	200	Fabricated metal products
AMERICAN EXPRESS CO	1977	2005	--	--	36	Depository institutions
AMERICAN INTERNATIONAL GROUP INC	1970	2005	--	--	59	Holding and other investment offices
AMERICAN MOTORS CORP	1937	1986	302	43	--	Motor vehicles
AMERICAN STORES CO	1936	1998	263	48	39	Food stores
AMERICAN TELEPHONE & TELEG CO	1942	2005	1	3	10	Communications
AMERICAN TOB CO	1936	2005	36	71	146	Tobacco mfg
ANACONDA COPPER MNG CO	1936	1975	31	82	--	Primary metals
ARMCO INC	1937	2005	212	55	534	Primary metals
ARMOUR & CO	1936	1969	228	22	--	Food mfg
ATLANTIC RICHFIELD CO	1936	1999	104	90	52	Petroleum mfg
BELLSOUTH CORP	1984	2005	--	--	66	Holding and other investment offices
BETHLEHEM STEEL CORP	1936	2000	25	15	246	Primary metals
BOEING CO	1936	2005	234	26	32	Motor vehicles
BORDEN CO	1936	1992	84	53	163	Food mfg
C I G N A CORP	1982	2005	--	--	51	Holding and other investment offices
C I T FINANCIAL CORP	1938	1976	62	198	--	Nondepository credit institutions
C P C INTERNATIONAL INC	1936	1999	63	74	215	Food mfg
CHASE MANHATTAN CORP	1972	2005	--	--	67	Depository institutions
CHESAPEAKE & OHIO RAILWAY CO	1938	2005	19	--	149	Transportation
CHRYSLER CORP	1936	1997	21	10	29	Motor vehicles
CITICORP	1971	1997	--	--	20	Depository institutions
CITIES SERVICE CO	1939	1981	--	50	--	Petroleum mfg
COCA COLA CO	1936	2005	10	104	114	Food mfg
COMMONWEALTH EDISON CO	1938	1999	14	110	236	Electric, Gas, Sanitary
CONAGRA INC	1972	2004	--	--	46	Food mfg
CONSOLIDATED EDISON CO NY INC	1938	2005	28	79	217	Electric, Gas, Sanitary
CONTINENTAL CAN INC	1936	1983	68	41	--	Fabricated metal products
DAYTON HUDSON CORP	1970	2005	--	--	64	General merchandise stores
DETROIT EDISON CO	1938	2005	52	181	331	Electric, Gas, Sanitary
DIGITAL EQUIPMENT CORP	1971	1997	--	--	75	Industrial machinery
DOW CHEMICAL CO	1936	2005	45	60	45	Chemical mfg
DU PONT E I DE NEMOURS & CO	1937	2005	3	16	18	Chemical mfg
EASTMAN KODAK CO	1936	2005	18	54	49	Instruments
ENRON CORP	1970	2000	--	--	71	Electric, Gas, Sanitary
FIRESTONE TIRE & RUBBER CO	1936	1987	162	35	--	Rubber
FORD MOTOR CO DEL	1955	2005	--	5	4	Motor vehicles
GENERAL DYNAMICS CORP	1951	2005	--	18	117	Motor vehicles
GENERAL ELECTRIC CO	1942	2005	4	6	9	Electronic equipment

GENERAL FOODS CORP	1937	1984	39	40	--	Food mfg
GENERAL MOTORS CORP	1936	2005	2	1	2	Motor vehicles
GENERAL TEL & ELECTRS CORP	1941	2005	277	37	50	Communications
GEORGIA PACIFIC CORP	1951	2004	--	220	79	Lumber/wood mfg
GOODYEAR TIRE & RUBR CO	1936	2005	185	27	99	Rubber
GULF OIL CORP	1946	1982	--	12	--	Petroleum mfg
HEWLETT PACKARD CO	1970	2005	--	--	70	Instruments
INLAND STEEL CO	1936	2005	49	69	290	Primary metals
INTERNATIONAL BUSINESS MACHS COR	1936	2005	50	32	5	Industrial machinery
INTERNATIONAL HARVESTER CO	1936	2004**	35	23	292	Industrial machinery
INTERNATIONAL PAPER CO	1936	2005	191	47	74	Paper
INTERNATIONAL TEL & TELEG CORP	1936	2005	326	61	42	Electronic equipment
KENNECOTT COPPER CORP	1936	1979	12	106	--	Primary metals
KRESGE S S CO	1936	2005	56	126	25	General merchandise stores
KROGER COMPANY	1970	2005	126	20	44	Food stores
LIGGETT & MYERS TOB CO	1937	1989	37	161	777	Tobacco mfg
LOCKHEED AIRCRAFT CORP	1936	2005	187	33	120	Motor vehicles
MCDONNELL DOUGLAS CORP	1936	1996	168	39	58	Motor vehicles
MINNESOTA MINING & MFG CO	1950	2005	--	94	73	Paper
MONTGOMERY WARD & CO	1936	1975	40	--	--	General merchandise stores
NATIONAL DAIRY PRODS CORP	1936	1987	86	24	--	Food mfg
NORFOLK & WESTERN RAILWAY CO	1938	2005	23	--	412	Transportation
OCCIDENTAL PETROLEUM CORP	1970	2005	--	--	40	Oil and gas extraction
OWENS ILLINOIS GLASS CO	1936	1985	60	88	--	Stone, clay, glass, concrete
PACIFIC GAS & ELEC CO	1938	2005	44	80	126	Electric, gas, sanitary
PACIFIC TELEPHONE & TELEG CO	1938	1980	33	--	--	Communications
PENNEY J C CO INC	1936	2005	30	30	55	Apparel and accessory stores
PENNSYLVANIA RAILROAD CO	1939	2004	22	--	473	Transportation
PEPSICO INC	1936	2005	198	274	53	Food stores
PHELPS DODGE CORP	1937	2005	42	177	400	Primary metals
PHILIP MORRIS INC	1936	2005	97	153	17	Tobacco mfg
PHILLIPS PETROLEUM CO	1936	2005	41	36	68	Petroleum mfg
PROCTER & GAMBLE CO	1936	2004	15	31	37	Chemical mfg
RADIO CORP AMER	1936	1984	102	29	--	Electronic equipment
REPUBLIC STEEL CORP	1936	1986	59	44	202	Primary metals
REYNOLDS R J TOBACCO CO	1936	1999	24	62	64*	Tobacco mfg
ROCKWELL INTERNATIONAL CORP	1940	2005	155	52	81	Motor vehicles
SAFEWAY STORES INC	1937	2005	196	13	62	Food stores
SALOMON INC	1970	1996	--	308	21	Primary metals
SEARS ROEBUCK & CO	1970	2004	9	7	11	General merchandise stores
SHELL OIL CO	1936	1984	47	21	--	Petroleum mfg
SINCLAIR OIL CORP	1936	1967	89	34	--	Petroleum mfg
SOCONY VACUUM OIL INC	1936	1998	27	9	8	Petroleum mfg
SPERRY RAND CORP	1941	2005	492	38	119	Industrial machinery
STANDARD OIL CO CALIFORNIA	1936	2005	29	25	19	Petroleum mfg
STANDARD OIL CO IND	1937	1997	13	17	30	Petroleum mfg

STANDARD OIL CO N J	1936	2005	5	2	3	Petroleum mfg
SWIFT & CO	1937	1984	57	14	--	Food mfg
TENNECO INC	1955	2005	--	91	65	Electric, gas, sanitary
TEXACO INC	1970	2000	8	11	17	Petroleum mfg
UNION CARBIDE CORP	1938	1999	6	28	64	Chemical mfg
UNITED AIRCRAFT CORP	1936	2005	79	49	41	Motor vehicles
UNITED FRUIT CO	1938	2005	38	166	270	Food mfg
UNITED STATES RUBBER CO	1936	1985	152	51	--	Rubber
UNITED STATES STEEL CORP	1941	2005	7	8	47	Primary metals
WAL MART STORES INC	1973	2005	--	--	24	General merchandise stores
WARNER LAMBERT CO	1936	2005	48	237	254	Chemical mfg
WESTINGHOUSE ELECTRIC CORP	1936	1999	26	19	76	Electronic equipment
WOOLWORTH F W CO	1938	2005	20	45	124	General merchandise stores
WRIGLEY WILLIAM JR CO	1936	2005	46	360	712	Food mfg

Note. Rank in 1940 is defined according to market value and ranks in 1960 and 1990 are defined according to total sales. Company names refer to the name most frequently used throughout the entire time period. * indicates rank in 1991 instead of 1990 because the company was not public in 1990. Industry definitions are the modal 2-digit SIC code reported in CRSP.

**As of Oct. 2006, Execucomp had not yet included compensation for Navistar International Corp. (formerly International Harvester) for its fiscal year 2005 (which ends in October).

Table A4
Median Salary and Bonus for CEOs in Our Sample and Hall & Liebman's Sample
(Millions of $2000)

	1980-89		1990-1994	
	Our Sample	H&L	Our Sample	H&L
Entire sample	1.26	0.83	1.72	1.05
Same firms in both samples	1.31	1.41	1.67	1.65
By firm size:				
Rank<=50	1.49	1.62	1.97	1.94
50<Rank<=100	1.32	1.34	1.92	1.82
100<Rank<=200	1.23	1.17	1.77	1.47
200<Rank<=300	1.22	1.10	1.30	1.24
300<Rank<=500	1.04	0.87	1.24	1.13
500<Rank	0.75	0.62	0.70	0.79

Note: Salary and bonus defined as the amount received in salaries and current bonuses granted in stock and in cash. Our sample is based on the CEOs of the largest 50 firms in 1940, 1960, and 1990. The Hall and Liebman sample is based on a random sample of 478 firms from Forbes's top 500 rankings (see Hall and Liebman 1998 for details). A total of 45 firms appear in both samples. Rankings by size are determined by market value based on all firms appearing in the CRSP database, which includes all publicly-traded firms in the NYSE, AMEX and NASDAQ stock markets.

Table A5
Frequency of Stock Option Grants for CEOs 1980-1989

	Our Sample				Hall and Liebman Sample		
	# Obs.	% CEOs granted options (excl. imputed)	% CEOs granted options (incl. imputed)	Median value option grants / total comp. (incl. imputed options)	# Obs.	% CEOs granted options	Median value option grants / total comp.
Entire sample	813	53.9	74.9	.142	3974	47.2	0
Same firms in both samples	409	57.5	76.8	.219	409	64.5	.191
By firm size:							
Rank<=50	280	57.1	80.0	.222	201	70.6	.195
50<Rank<=100	164	54.9	74.4	.155	239	63.2	.181
100<Rank<=200	155	52.6	76.8	.172	410	56.6	.135
200<Rank<=300	72	55.6	68.1	.129	361	49.6	0
300<Rank<=500	68	54.4	83.8	.162	794	48.1	0
500<Rank	68	42.6	52.9	.044	1567	40.9	0

Note: Our sample is based on the CEOs of the largest 50 firms in 1940, 1960, and 1990. The Hall and Liebman sample is based on a random sample of 478 firms from Forbes's top 500 rankings (see Hall and Liebman 1998 for details). A total of 45 firms appear in both samples. Rankings by size are determined by market value based on all firms appearing in the CRSP database, which includes all publicly-traded firms in the NYSE, AMEX and NASDAQ stock markets. Total compensation is the sum of salaries, bonuses, long-term bonus payments, and the Black-Scholes value of stock option grants. Annual stock option grants are imputed for cases when only the cumulative number of options granted over a multi-year period are disclosed in proxy statements. See Appendix Section 2.3 for a detailed description of the imputation procedure.

Table A6
Median Compensation, Weighted to Reflect Different Groups
(Millions of $2000)

	1936 - 1939	1940 - 1949	1950 - 1959	1960 - 1969	1970 - 1979	1980 - 1989	1990 - 1999	2000 - 2005
Entire unweighted sample	0.85	0.77	0.77	0.84	0.93	1.33	2.36	4.11
Largest 100 firms								
Ranked by sales, unweighted	--	--	0.86	0.94	1.06	1.53	2.91	7.15
Ranked by market value, unweighted	0.93	0.79	0.83	0.96	1.13	1.60	3.29	8.32
Ranked by market value, weighted by Pr(selected)	0.91	0.76	0.82	0.89	1.06	1.56	3.29	7.29
Ranked by market value, weighted by 1/market share	0.89	0.73	0.77	0.84	1.00	1.44	3.06	6.51
Largest 300 firms								
Ranked by market value, weighted by Pr(selected)	0.74	0.73	0.68	0.76	0.88	1.27	2.31	4.19
Ranked by market value, weighted by 1/market share	0.67	0.73	0.69	0.75	0.89	1.23	2.19	3.89
Largest 500 firms								
Ranked by market value, weighted by Pr(selected)	0.50	0.65	0.61	0.67	0.81	1.19	1.95	3.67
Ranked by market value, weighted by 1/market share	0.61	0.68	0.65	0.69	0.82	1.13	1.99	3.29
Imputing Option Grants from the Hall-Liebman Distribution of Grants by Firm Size								
Entire unweighted sample	0.87	0.77	0.76	0.81	0.90	1.24	2.12	3.50
Largest 300 firms								
Ranked by market value, weighted by Pr(selected)	0.74	0.73	0.66	0.73	0.88	1.17	2.10	3.71
Largest 500 firms								
Ranked by market value, weighted by Pr(selected)	0.50	0.65	0.61	0.63	0.76	1.05	1.67	2.78

Note. Based on the three-highest paid executives in the 50 largest firms in 1940, 1960, and 1990. Total compensation is the sum of salaries, bonuses, long-term bonus payments, and the Black-Scholes value of stock option grants. Rows 4, 6, 8, 10 and 11 calculate the probability that each firm is selected as the number of sampled firms its size category (rank<=50, 50<rank<=100, 100<rank<=200 and 200<rank<=500) divided by the total number of potential firms in that category. Except for row 2, all ranks are defined by market value compared with all firms reported in CRSP. Ranks in row 2 are defined by total sales compared with all firms reported in Compustat. Stock option imputations in rows 9-11 assume that the value of options granted relative to cash compensation in small firms is the same ratio relative to large firms as in Hall and Liebman's sample from 1980-1994. See Appendix Section 3.3 for details.

Table A7
Decomposition of the Variance of Ln(Compensation) by Decade

	Fraction of Explained By:		
	Average Firm Size in Year *t*	Average Firm Size in Decade	Size – Firm Avg. – Year Avg.
1936 - 1939	0.000	0.237	0.007
1940 - 1949	0.000	0.085	0.000
1950 - 1959	0.008	0.196	0.002
1960 - 1969	0.005	0.215	0.016
1970 - 1979	0.011	0.199	0.010
1980 - 1989	0.083	0.114	0.022
1990 - 1999	0.125	0.189	0.011
2000 - 2005	0.004	0.329	0.016

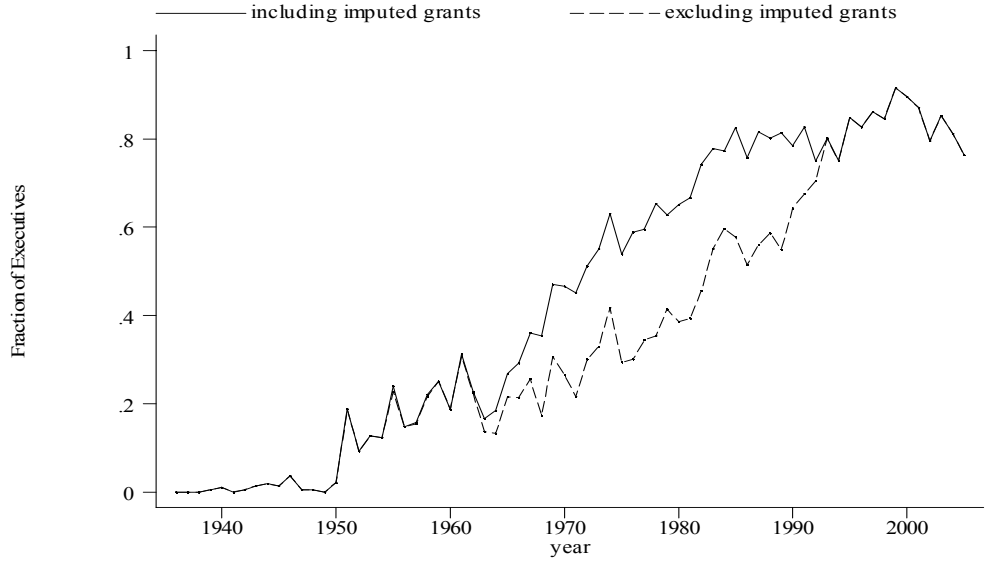
Note. Based on a separate ANOVA regression for each decade. Each cell shows the sum of squared residuals explained by the variable named in the column divided by the total sum of squared residuals. Based on the three-highest paid executives in the 50 largest firms in 1940, 1960, and 1990. Total compensation is the sum of salaries, bonuses, long-term bonus payments, and the Black-Scholes value of stock option grants.

Table A8
Pay-to-Performance Correlations Adjusting for Changes in Firm Size

	Dollar change in wealth for $1000 dollar change in firm market value (Jensen-Murphy)			Dollar change in wealth for a 1 percent increase in firm's rate of return (Equity at Stake)		
	Average Percent Change	Median Percent Change	Percent Change at Median Firm Size	Average Percent Change	Median Percent Change	Percent Change at Median Firm Size
1940 - 1949	-61.0	-68.0	-22.0	-58.6	-69.8	-28.7
1950 - 1959	94.4	71.1	172	206	144	125
1960 - 1969	50.2	51.3	32.3	29.8	34.8	34.8
1970 - 1979	-41.5	-39.7	-39.7	-46.1	-47.5	-51.9
1980 - 1989	52.5	52.4	16.4	55.6	63.9	68.2
1990 - 1999	252	245	245	211	154	154
2000 - 2005	2.8	-26.4	114	29.9	45.1	45.1

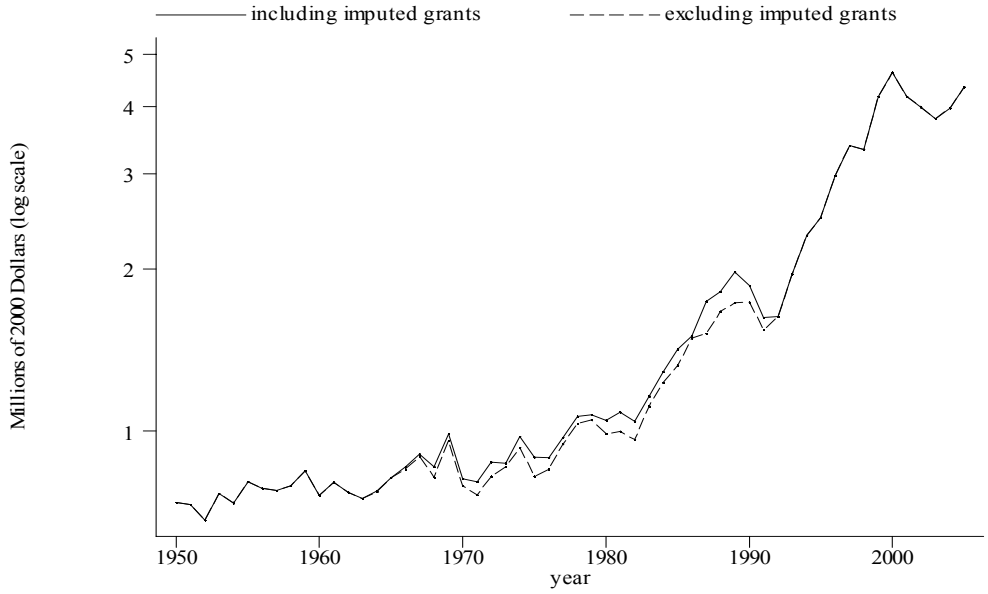
Note. The change in the pay-to-performance correlation for each firm is the percent change in simulated pay-to-performance correlations from the previous decade to the current decade. Simulated correlations for each firm are the fitted values from a regression including interactions of firm performance with a spline function of firm size (using 5 size categories). Simulated values for the previous decade are the coefficient estimates from the previous decade multiplied by an indicator variable for the firm's position in the previous decade's distribution of firm size. Estimates are based on median regressions estimated separately for each decade. Firm size is defined as average market value in the prior three years. The change in executive wealth is defined as the sum of total compensation and the revaluation of stock and stock option holdings. The year 1946 is excluded from all calculations; see footnote 42 for details.

Figure A1
Fraction of Executives Granted Stock Options



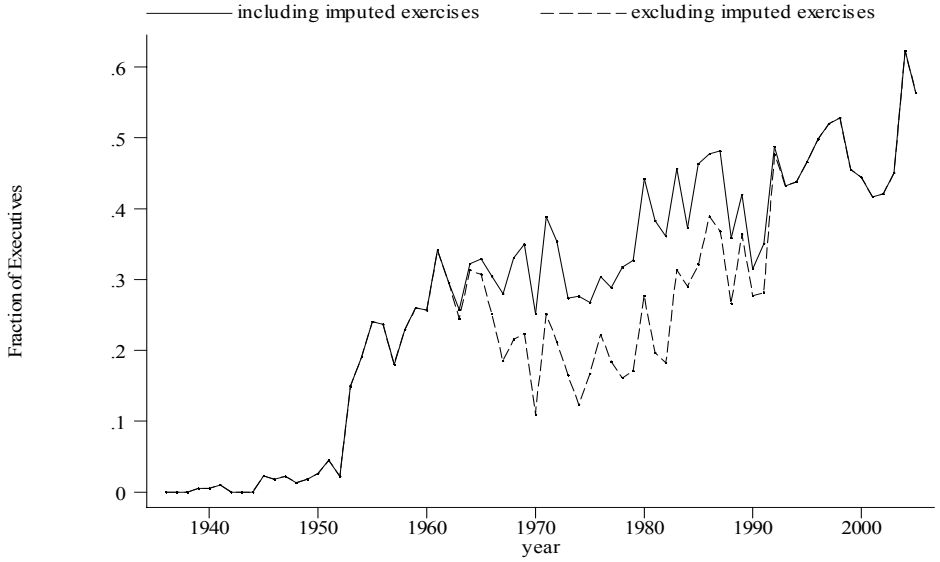
Note: Based on the three highest-paid executives in the largest 50 firms in 1940, 1960, and 1990. Annual stock option grants are imputed for cases when only the cumulative number of options granted in a multi-year period are disclosed in proxy statements. See Appendix Section 2.3 for details of the imputation procedure.

Figure A2
Median Value of Total Compensation, Including and Excluding Imputed Stock Option Grants



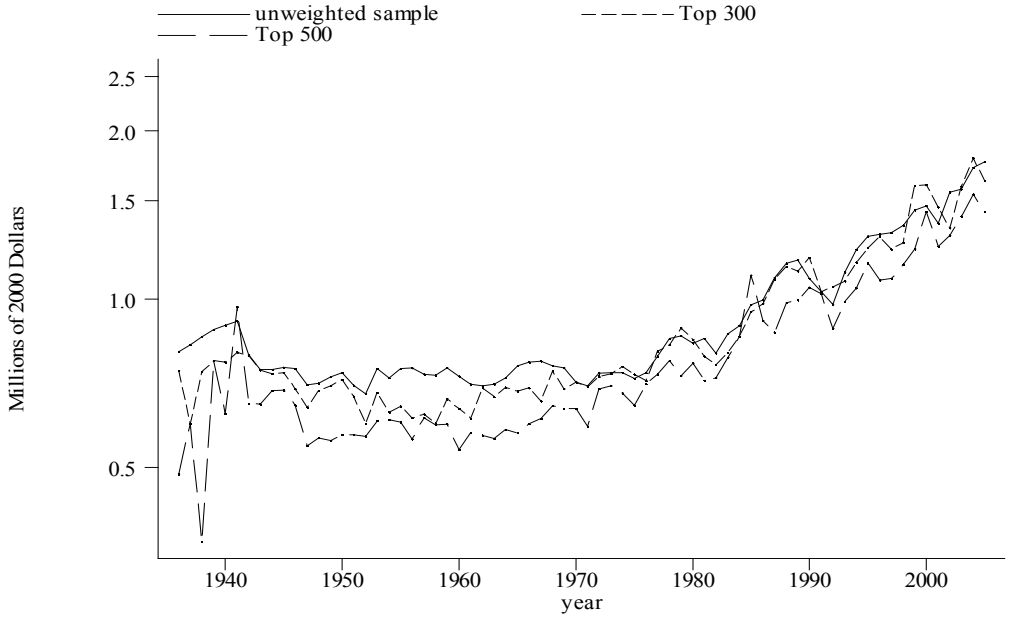
Note: Based on the three highest-paid executives in the largest 50 firms in 1940, 1960, and 1990. Total compensation is composed of salary, bonuses, long-term bonus payments, and stock option grants. Annual stock option grants are imputed for cases when only the cumulative number of options granted in a multi-year period are disclosed in proxy statements. See Appendix Section 2.3 for details of the imputation procedure.

Figure A3
Fraction of Executives Exercising Stock Options



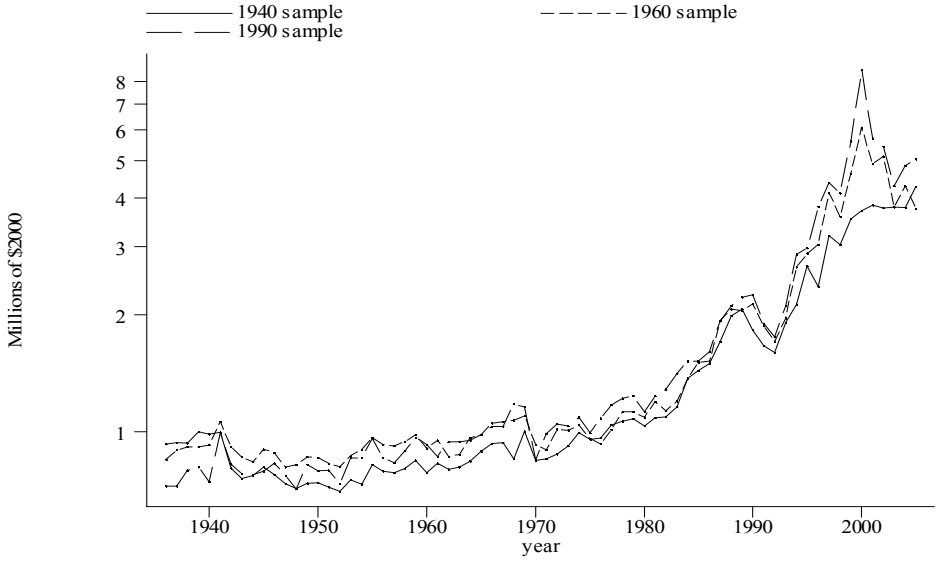
Note: Based on the three highest-paid executives in the largest 50 firms in 1940, 1960, and 1990. Total compensation is composed of salary, bonuses, long-term bonus payments, and stock option grants. Annual stock option exercises are imputed for cases when only the cumulative number of options exercised in a multi-year period are disclosed in proxy statements. See Appendix Section 2.3 for details of the imputation procedure.

Figure A4
Median Salary & Bonus Reweighted by Firm Size



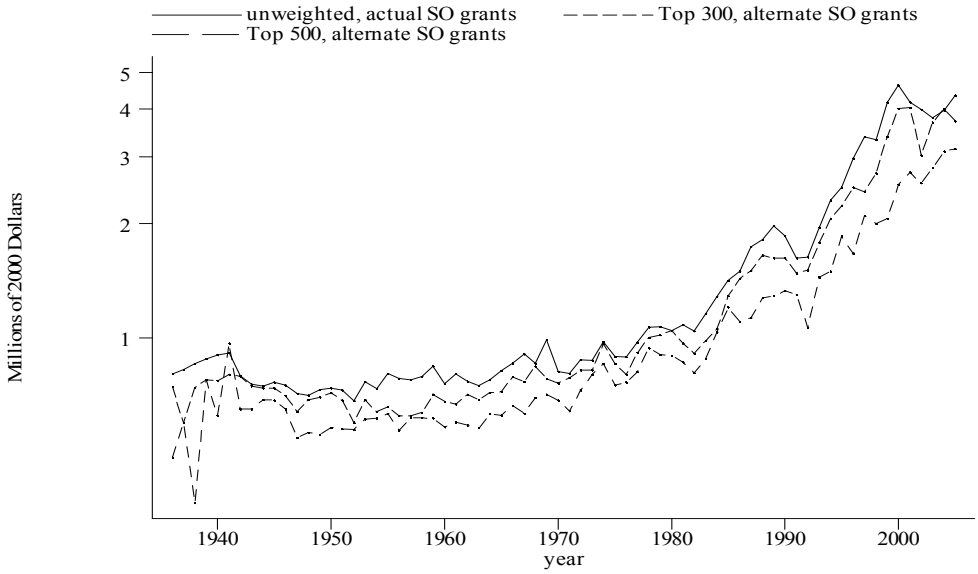
Note: Salary and bonus is defined as the amount received in salary + current bonuses in stock or cash. Based on the three highest-paid executives in the largest 50 firms in 1940, 1960, and 1990. Firms receive a weight inversely proportional to their probability of being in our sample, where this probability is defined as the number of sampled firms in each firm's size category (rank<=50, 50<rank<=100, 100<rank<=200 and 200<rank<=500) divided by the total number of firms in each category. Ranks are defined by market value based on all firms in CRSP. See Appendix Section 3.1 for details.

Figure A5
Median Compensation by Sub-Sample



Note: Based on the three highest- paid executives in each firm. Total compensation is composed of salary, bonuses, long-term bonus payments, and stock option grants. The "1940 sample" includes the 50 largest firms according to market value in 1940; the "1960 sample" and "1990 sample" include to the 50 largest firms according to market value in 1960 and 1990, respectively. See Appendix Section 1.1 for further details of the sample selection methodology.

Figure A6
Median Compensation under Alternate Assumptions for Stock Option Grants



Note: Total compensation is composed of salary, bonuses, long-term bonus payments, and the Black-Scholes value of stock option grants. All samples are based on the three highest- paid executives in 50 largest firms in 1940, 1960, and 1990. The Top 300 and Top 500 samples reweight each firm in our sample by the inverse of the probability of being selected and adjust the value of option grants to match the empirical distribution of option grants by firm size found in Hall and Liebman (1998). See Appendix Section 3.3 for further details.

Table 1
Sample Summary Statistics

	1936-2005
Total # of person-year observations	15883
Total # of executives	2862
Average # of firms in each year	76
Average # of years each executive is observed	5.6
Median # of years each executive is observed	4
Fraction of obs. in firms with market value	
Ranked 1-50	39.0
Ranked 50-100	19.6
Ranked 100-200	19.1
Ranked 200-500	16.7
Ranked 500+	5.4

Note: Based on the three highest-paid officers in the largest 50 firms in 1940, 1960 and 1990. Rankings by market value are based on all firms appearing in the CRSP database, which includes all publicly-traded firms in the NYSE, AMEX and NASDAQ stock exchanges.

Table 2
Distribution of Job Titles

	Fraction of observations		
	Entire sample	1936-1969	1970-2005
Chairman of the board	21.2	15.8	25.9
Vice-chairman	6.4	2.0	10.3
President	28.5	31.6	25.9
Chief executive officer	15.3	2.3	26.8
Chief financial officer	1.8	0.0	3.4
Chief operating officer	5.0	0.2	9.1
Executive or senior vice-president	21.6	15.3	27.2
Vice-president	15.2	27.8	4.1
Treasurer	1.2	2.4	0.1
Comptroller	0.6	1.3	0.1
Other job title	8.7	8.4	9.0
Director	84.7	91.7	78.6

Note: Based on the three highest-paid officers in the largest 50 firms in 1940, 1960 and 1990. The sum of each column is greater than 100 percent because some officers hold multiple titles. Other categories not listed include "secretary," "chairman of the executive committee," and officers of subsidiaries.

Table 3
Real Value of Total Compensation by Percentile
(Millions of $2000)

	10th percentile	25th percentile	50th percentile	75th percentile	90th percentile
1936 - 1939	0.36	0.53	0.85	1.24	1.80
1940 – 1945	0.40	0.59	0.80	1.15	1.59
1946 - 1949	0.36	0.53	0.72	1.01	1.53
1950 - 1959	0.39	0.55	0.77	1.09	1.63
1960 - 1969	0.45	0.60	0.83	1.18	1.66
1970 - 1979	0.47	0.64	0.93	1.31	1.84
1980 - 1989	0.57	0.85	1.33	2.05	3.18
1990 - 1999	0.91	1.35	2.36	4.43	8.29
2000 - 2005	1.31	2.19	4.11	9.42	17.1

Note: Total compensation is the sum of salaries, bonuses, long-term bonus payments, and the Black-Scholes value of stock option grants. Based on the three highest-paid officers in the largest 50 firms in 1940, 1960 and 1990.

Table 4
Compensation and Firm Size

	Firm Size = Ln(Market Value)			Firm Size = Ln(Sales)	
	1936-1975	1946-1975	1976-2005	1946-1975	1976-2005
Panel 1: DV = Ln(Comp$_{ift}$)					
Average Size in Year *t*	.088	.137	.935	.157	2.65
	(.026)	(.025)	(.035)	(.032)	(0.12)
[fraction variance explained]	[.010]	[.020]	[.332]	[.017]	[.259]
Average Firm Size	.207	.212	.292	.305	.358
	(.033)	(.032)	(.032)	(.037)	(.041)
[fraction variance explained]	[.145]	[.164]	[.135]	[.220]	[.113]
Size – Firm Avg. – Year Avg.	.183	.200	.265	.240	.346
	(.038)	(.041)	(.032)	(.052)	(.048)
[fraction variance explained]	[.039]	[.036]	[.043]	[.041]	[.032]
Panel 2: With Firm Fixed Effects					
Average Size in Year *t*		.134	.970	.149	2.63
		(.024)	(.037)	(.031)	(0.11)
Size – Year Avg.		.219	.313	.277	.388
		(.040)	(.028)	(.046)	(.046)
Panel 3: Including Lagged Size and Firm FE					
Average Size in Year *t*		-.028	.620	.279	2.26
		(.035)	(.082)	(.074)	(0.25)
Average Size in Year *t-1*		.165	.376	-.115	.406
		(.041)	(.080)	(.061)	(.223)
Size – Year Avg.		.188	.364	.208	.393
		(.037)	(.037)	(.044)	(.066)
Size – Year Avg. in *t-1*		.021	-.062	.086	-.036
		(.039)	(.029)	(.029)	(.042)
Panel 4: DV = Ln(After-Tax Comp$_{ift}$) (and including Firm FE)					
Average Size in Year *t*		.309	1.08	.622	3.12
		(.021)	(0.04)	(.028)	(0.11)
Size – Year Avg.		.128	.327	.170	.393
		(.048)	(.028)	(.041)	(.047)
Panel 5: Including Quadratic Time Trend and Firm FE					
Average Size in Year *t*		.033	.736	.147	-.264
		(.031)	(.082)	(.077)	(.165)
Size – Year Avg.		.224	.304	.277	.382
		(.039)	(.027)	(.046)	(.041)
Panel 6: DV = ΔLn(Comp$_{ift}$)					
Δ Average Size in Year *t*		.004	.221	.147	.188
		(.030)	(.077)	(.064)	(.156)
Δ Size – Δ Year Avg.		.095	.269	.065	.128
		(.029)	(.035)	(.026)	(.114)

Note: Standard errors are shown in parentheses and are clustered by firm. Values in brackets show the fraction of the total variance explained by each independent variable. Total compensation is the sum of salaries, bonuses, long-term bonus payments, and the Black-Scholes value of stock option grants. Based on the three highest-paid officers in the largest 50 firms in 1940, 1960 and 1990.

Table 5
Mean and Median Executive Compensation, by Components of Pay
(Millions of $2000)

	Salaries and bonuses	Value of stock option grants	Total Compensation	Revaluation of stock option holdings	Revaluation of company stock holdings	Total change in executive wealth
	(1)	(2)	(3) = (1) + (2)	(4)	(5)	(6) = (3)+(4)+(5)
			Panel A: Mean Change in Executive Wealth			
1936-1940	1.00	0.00	1.00	0.00	1.32	2.45
1941-1949	0.89	0.00	0.89	0.01	0.07	1.28
1950-1959	0.88	0.06	0.93	0.24	0.86	2.21
1960-1969	0.89	0.10	0.99	0.18	0.62	2.12
1970-1979	0.91	0.18	1.09	0.08	-0.52	1.95
1980-1989	1.28	0.45	1.74	0.57	2.14	5.05
1990-1999	2.43	1.92	4.35	3.64	8.03	17.4
2000-2005	4.50	3.15	7.65	0.78	1.92	11.4
			Panel B: Median Change in Executive Wealth			
1936-1940	0.86	0	0.87	0	0	0.90
1941-1949	0.76	0	0.76	0	0.03	0.92
1950-1959	0.74	0	0.77	0	0.08	1.10
1960-1969	0.77	0	0.83	0	0.04	0.98
1970-1979	0.80	0.04	0.93	0	0.01	1.04
1980-1989	1.03	0.19	1.33	0.11	0.08	1.93
1990-1999	1.58	0.59	2.36	0.35	0.23	3.97
2000-2005	2.48	1.21	4.11	0	0.13	4.03

Note. Based on the three-highest paid executives in the 50 largest firms in 1940, 1960, and 1990. Column (1) includes the value of salaries and bonuses (both current and long-term). Column (2) is the Black-Scholes value of stock option grants. Column (4) is the change in the value of stock options held in the end of the previous year. Column (5) is the change in the value of company stock held in the end of the previous year. Medians reported in columns (3) and (6) of Panel B are the median of the sum of the component types of wealth. The year 1946 is excluded due to an anomalous distribution of rates of return; see footnote 42 for details.

Table 6
Correlation of Change in Executive Wealth with Firm Performance, 1936-2005

	Dollar change in wealth for $1000 dollar change in firm market value (Jensen-Murphy)	Dollar change in wealth for a 1 percent increase in firm's rate of return (Equity at Stake)
1936 – 1940	1.14	18,075
	(0.66)	(5,122)
1941 – 1949	0.380	7,738
	(0.121)	(1,867)
1950 - 1959	0.359	23,378
	(0.096)	(2,865)
1960 - 1969	0.292	40,269
	(0.125)	(7,067)
1970 - 1979	0.128	22,822
	(0.048)	(3,710)
1980 - 1989	0.258	37,086
	(0.072)	(5,151)
1990 - 1999	0.774	135,527
	(0.270)	(22,986)
2000 - 2005	0.474	151,508
	(0.092)	(30,123)

Note. Based on the three-highest paid executives in the 50 largest firms in 1940, 1960, and 1990. The change in executive wealth is defined as the sum of total compensation and the revaluation of stock and stock option holdings. Results are based on median regressions estimated separately for each decade. Standard errors are given in parentheses and are clustered by firm. The year 1946 is excluded from all calculations; see footnote 42 for details.

Table 7
Pay-to-Performance Correlations by Type of Wealth

	Dollar change in compensation for $1000 dollar change in firm market value (Jensen-Murphy)			Dollar change in compensation for a 1 percent increase in firm's rate of return (Equity at Stake)		
	Compensation	Option Holdings	Stock Holdings	Compensation	Option Holdings	Stock Holdings
1936 - 1940	0.051	0	1.015	276	0	18,132
	(0.030)	--	(0.487)	(891)	--	(3,878)
1941 - 1949	0.118	0	0.315	516	0	5058
	(0.061)	--	(0.094)	(595)	--	(1,131)
1950 - 1959	0.061	0	0.195	1,170	0	11,602
	(0.016)	--	(0.036)	(638)	--	(2,423)
1960 - 1969	0.010	0.043	0.167	-472	6,654	21,939
	(0.007)	(0.010)	(0.080)	(657)	(1,623)	(3,680)
1970 - 1979	-0.003	0.032	0.084	5	4,201	12,374
	(0.004)	(0.014)	(0.034)	(610)	(922)	(2,395)
1980 - 1989	0.035	0.099	0.094	3,509	10,496	13,825
	(0.015)	(0.021)	(0.027)	(1,284)	(1,955)	(2,260)
1990 - 1999	0.109	0.357	0.219	16,839	57,587	37,408
	(0.017)	(0.046)	(0.098)	(4,076)	(9,680)	(7,907)
2000 - 2005	0.011	0.263	0.167	8,951	84,901	44,401
	(0.037)	(0.045)	(0.053)	(11,242)	(22,390)	(6,783)

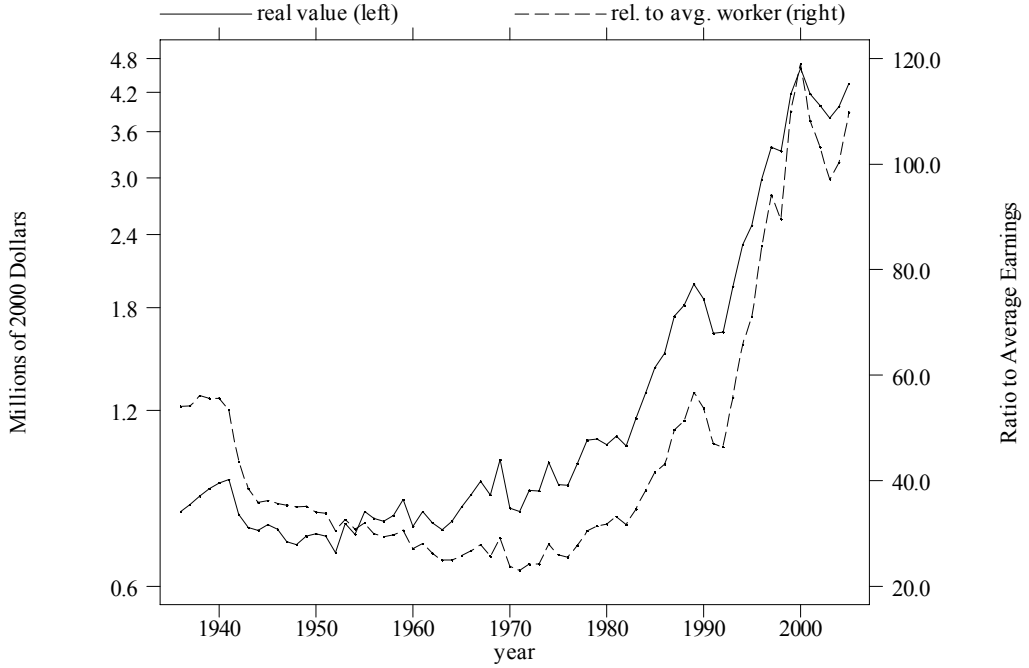
Note. Based on the three-highest paid executives in the 50 largest firms in 1940, 1960, and 1990. Estimates are based on median regressions estimated separately for each type of wealth in each decade. Totals across each row do not add up to the correlation of total changes in wealth reported in Table 6 because the estimates are based on median regression. Compensation is the sum of salaries, bonuses, and the Black-Scholes value of stock option grants. Option holdings are the revaluation of stock options held at the end of the previous year. Stock holdings are the revaluation of company stock held at the end of the previous year. The year 1946 is excluded from all calculations; see footnote 42 for details.

Table 8
The Strength of Managerial Incentives

	Change in wealth for a change in the firm's market value from the 50th to 70th percentile		Change in wealth for a change in the firm's rate of return from the 50th to 70th percentile		MEMO: Median Wealth (=cash comp. + equity + stock options) ($ Millions)
	$	Relative to median wealth	$	Relative to median wealth	
1936 – 1940	33,227	0.143	3,51,730	0.151	2.32
1941 – 1949	84,842	0.029	98,181	0.033	2.93
1950 - 1959	171,770	0.046	299,570	0.080	3.74
1960 - 1969	189,727	0.041	512,659	0.111	4.64
1970 - 1979	62,979	0.020	330,235	0.107	3.09
1980 - 1989	249,742	0.049	567,662	0.112	5.08
1990 - 1999	1,418,508	0.126	1,995,878	0.177	11.3
2000 - 2005	946,431	0.055	1,888,958	0.110	17.2

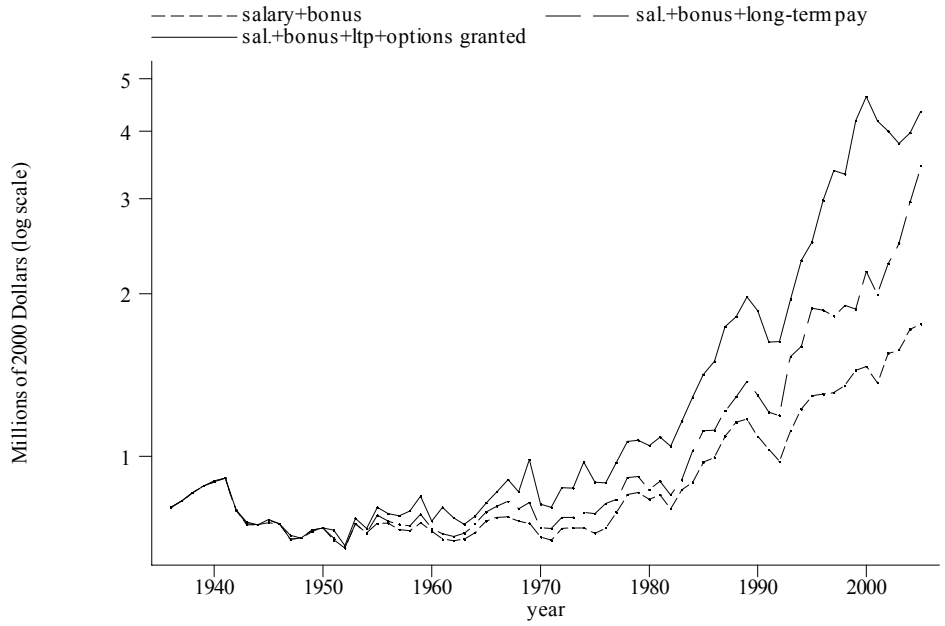
Note. Based on the three-highest paid executives in the 50 largest firms in 1940, 1960, and 1990. Col. (1) and (2) multiply the estimates reported in Table 6 by the difference in firm performance between the 50th and 70th percentiles of each decade. Wealth is defined as the sum of compensation, equity in the firm, and stock option holdings. The year 1946 is excluded; see footnote 42 for details.

Figure 1
Median Value of Total Compensation, 1936-2005



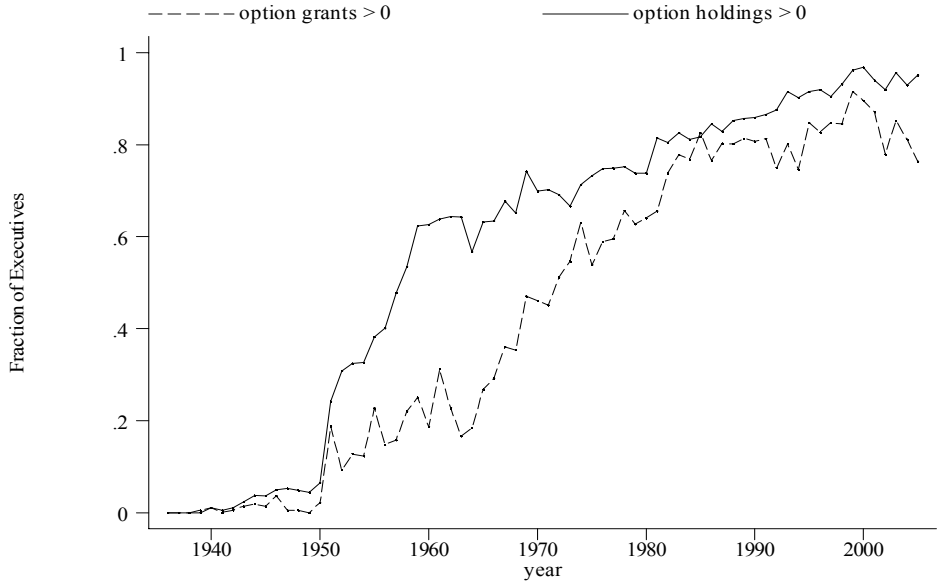
Note: Total compensation is composed of salary, bonuses, long-term bonus payments, and stock option grants. Relative compensation is defined as total compensation divided by total wage and salary accruals per full-time equivalent employee from table 6.6 of the National Income and Product Accounts. Based on the three highest-paid officers in the largest 50 firms in 1940, 1960 and 1990.

Figure 2
Structure of Total Compensation, 1936-2005



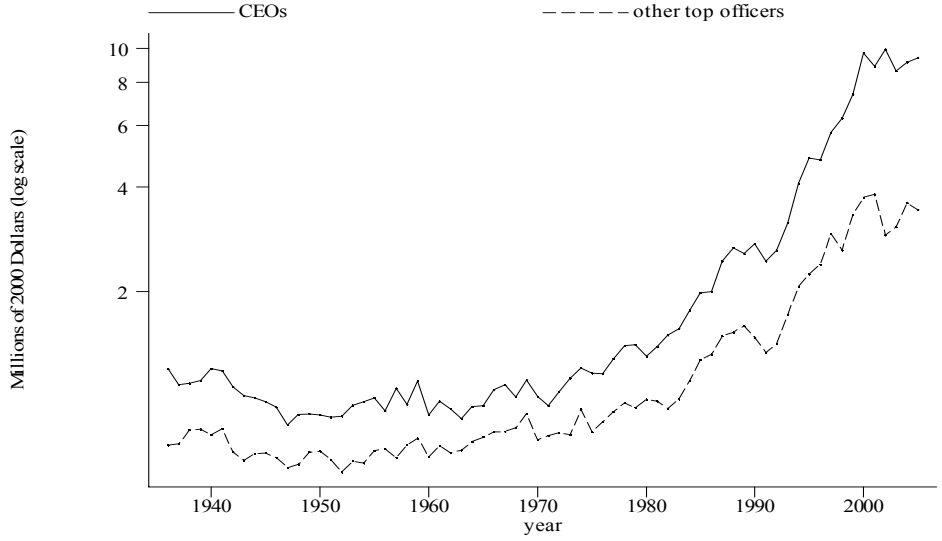
Note: Each line shows the median value of compensation defined as an increasing number of types. Based on the three highest-paid officers in the largest 50 firms in 1940, 1960 and 1990.

Figure 3
Fraction of Top Executives Granted and Holding Stock Options



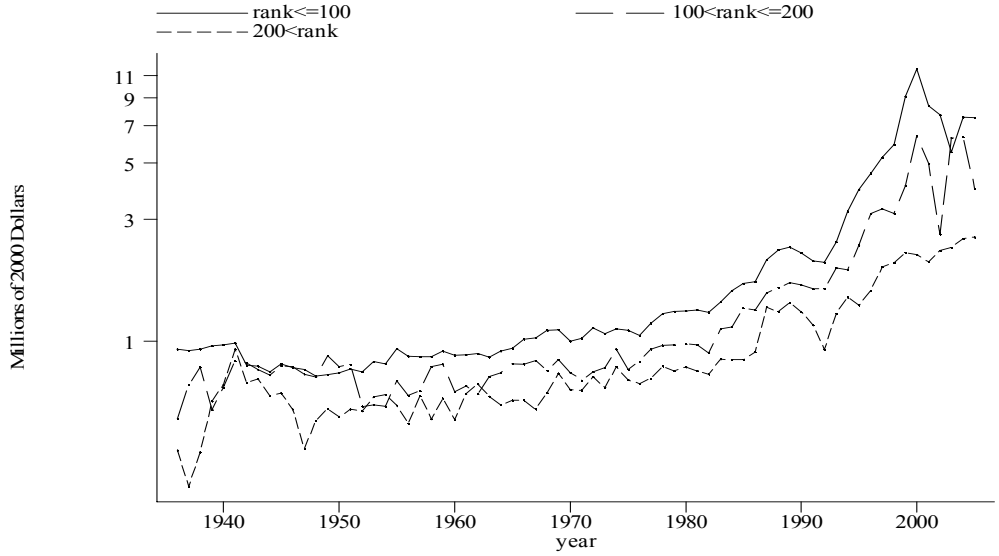
Note: Based on the three highest-paid officers in the largest 50 firms in 1940, 1960 and 1990. Fraction of executives granted options includes imputations for cases when only the cumulative number options awarded over a multi-year period is reported. See Appendix Section 2.3 for details.

Figure 4
Median Total Compensation of CEOs and Other Top Officers



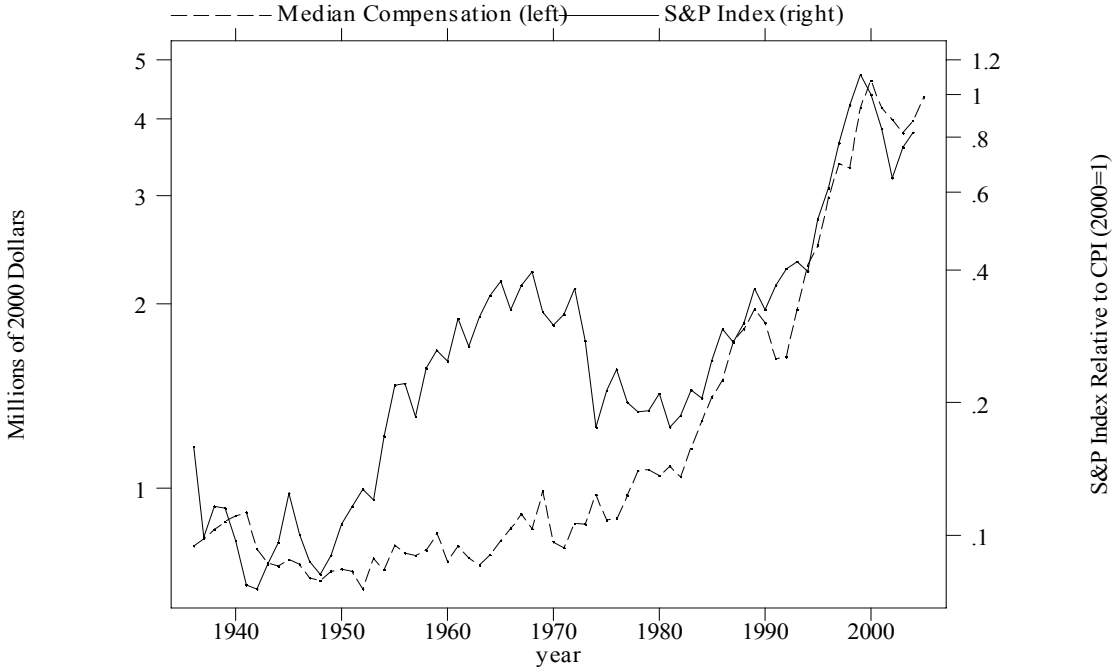
Note: Total compensation is composed of salary, bonuses, long-term bonus payments, and stock option grants. In firms where the title "CEO" is not used, the CEO is identified as the president of the company. Other top officers include any executives among the 3 highest-paid who are not the CEO. Based on the three highest-paid officers in the largest 50 firms in 1940, 1960 and 1990.

Figure 5
Median Total Compensation by Firm Size



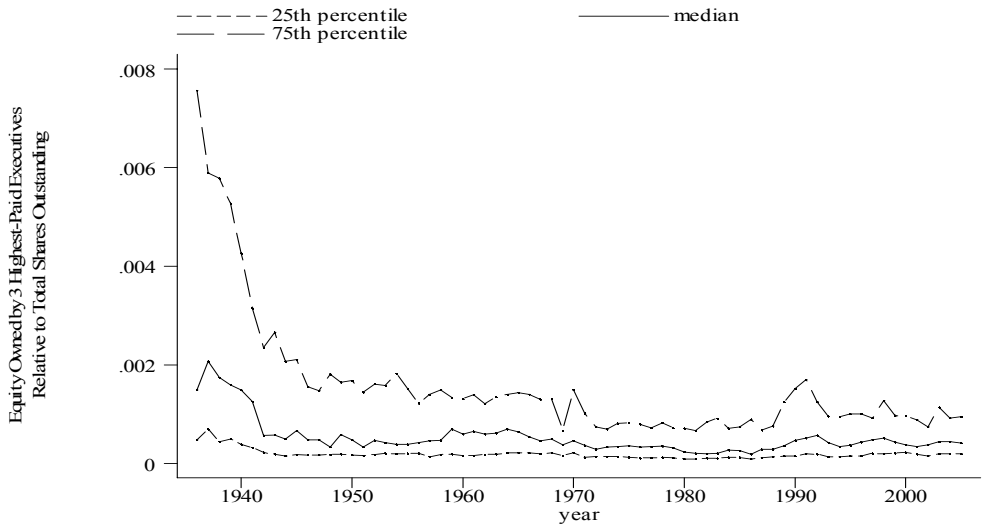
Note: Total compensation is composed of salary, bonuses, long-term bonus payments, and stock option grants. Based on the three highest-paid officers in the largest 50 firms in 1940, 1960 and 1990. Rankings by market value are based on all firms appearing in the CRSP database, which includes all publicly-traded firms in the NYSE, AMEX and NASDAQ stock markets.

Figure 6
Total Compensation and the S&P Index



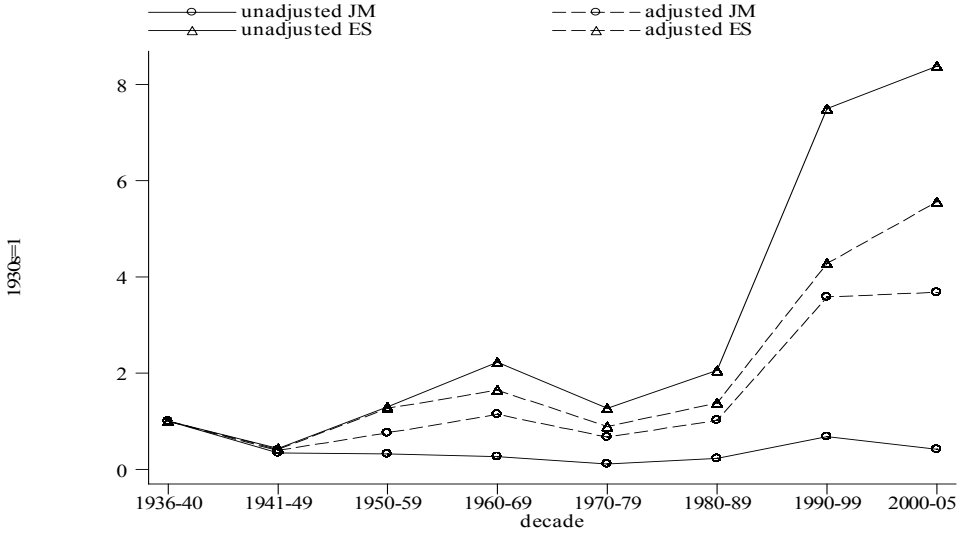
Note: Total compensation is composed of salary, bonuses, long-term bonus payments, and stock option grants. Based on the three highest-paid officers in the largest 50 firms in 1940, 1960 and 1990. The S&P index is expressed relative to the CPI and equals 1 in 2000.

Figure 7
Managerial Stock Holdings as a Fraction of Total Shares Outstanding



Note. Based on the three-highest paid executives in the 50 largest firms in 1940, 1960, and 1990. Stock holdings in 1935 are from the *Official Summary of Holdings of Officers, Directors and Principal Stockholders*. For the 1936-1941, stock holdings are calculated from bi-monthly reports on equity transactions. From 1942-2005, stock holdings are from proxy statements. See Appendix Section 2.4 for details.

Figure 8
Unadjusted and Size-Adjusted Indexes of Pay-to-Performance



Note. Based on the three-highest paid executives in the 50 largest firms in 1940, 1960, and 1990. All measures are indexed to 1 for the 1936-40 period. Results are based on median regressions estimated separately for each decade. The unadjusted ES is the value of equity at stake and the unadjusted JM is the Jensen-Murphy statistic estimated from equations 2 and 3 in the text. Size adjustments are described in Section 5.4 and Appendix Section 4. The year 1946 is excluded from all regressions; see footnote 42 for details.