Executive Compensation:
A New View from a Long-Term Perspective, 1936-2005

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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 corporate reports. This historic perspective reveals several surprising new facts that contrast sharply with data from recent decades. First, the median real value of compensation was remarkably flat from the end of World War II to the mid-1970s, even during times of rapid economic expansion and aggregate firm growth. By contrast, the steep upward trajectory of pay since the 1970s coincided with similarly-large increases in aggregate firm size. A second surprising finding is that the sensitivity of an executive's wealth to firm performance was not inconsequentially small prior to the 1980s. Thus, recent years were not the first time when compensation arrangements served to align managerial incentives with those of shareholders. Taken together, the long-run trends in the level and structure of compensation pose a challenge to several common explanations for the widely-debated surge in executive pay of the past several decades.

1. Introduction

The compensation paid to CEOs of large publicly-traded corporations rose dramatically during the 1980s and 1990s, stimulating much debate on the determinants of managerial pay (Murphy 1999, Hall and Murphy 2003). The discussion has been largely inconclusive, in part because readily available data only exist for the time period after 1970. By constructing a new long-run time series on executive pay we are able to consistently document the trends in the level and composition of pay over most of the twentieth century. These data allow us to reassess some of the most popular explanations for the recent surge in compensation.

Although the stylized facts on executive pay since the 1970s are well established, only a handful of studies analyzed managerial compensation prior to that date (Murphy 1999).[1] Because these studies use different sample designs and employ different methodologies to value the components of remuneration, they cannot provide a systematic description of how executive compensation evolved over the longer run. Instead, we present new evidence on the long-run trends in compensation by hand-collecting a comprehensive panel dataset on the remuneration of individual executives based on proxy statements and 10-K reports from 1936 to 2005. Although our sample is mainly composed of executives employed in the largest corporations in the economy, our results are broadly characteristic of the largest 300 publicly-traded firms.

The data from earlier decades reveal several surprising facts that go against the current view of top executive pay, which has been primarily informed by data from recent decades. First, executive compensation was remarkably flat from the end of World War II to the mid-1970s, even though firms grew considerably during that time.[2] This stability contrasts sharply

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

[2] By contrast, the most comprehensive historical study on executive pay finds that compensation increased considerably during this period (Lewellen 1968). However, Lewellen's analysis severely overstates the value of several components of pay, such as employee stock options (see footnote 20). Consistent with our findings, Boschen

with the evidence from the 1980s to the present, when executive pay and firms expanded at almost the same rate.

A second finding that is surprising in light of more recent data is that stock option grants have been an important part of the compensation package since the 1950s. The panel structure of our dataset allows us to construct the portfolio of stock options held by each executive in our sample. So far, prior research has not included these holdings when examining the relationship between executive pay and firm performance. We find that ever since 1960, most of the executives in our dataset have owned stock options. Combining these stock option holdings with executives' holdings of equity in the firm, we present the first consistently-measured evidence on the relationship between executives' wealth and firm performance ("pay-to-performance") over the past 70 years. [3] The sensitivity of changes in wealth to performance was about the same in the 1950s and 1960s as it was in the 1980s, and somewhat lower in the 1930s, 1940s and 1970s. Pay-to-performance then strengthened considerably from the 1980s to the present. Thus, Jensen and Murphy's (1990) view that CEOs in the 1970s were paid as bureaucrats was not generally true in the past. Although the strength of the incentives provided by these correlations is difficult to assess, we find that the magnitude of the correlation for most of our sample was not inconsequentially small. Thus, recent decades were not the first period in which compensation arrangements generated a strong link between the executives' wealth and firm value.

A comprehensive analysis of the causes of these trends is beyond the scope of the present paper, but the long-run data provide new evidence that inform some of the major hypotheses for the recent surge in executive compensation. First, the run-up in CEO pay and the expanded use

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and Smith (1995) note that the level of compensation was relatively flat from 1948 to 1970 in a panel of 16 firms in the chemical, aerospace and electronics industries. However, the representativeness of their sample is not clear because it is limited to three industries and subject to survivorship bias.

[3] The only study of which we are aware that measures pay-to-performance sensitivities over the longer run (Boschen and Smith 1995) does not include the incentives provided by revaluations of stock or stock options.

of stock options have been linked to managers' ability to extract rents from the firm (Bebchuk and Fried 2003, Bebchuk and Fried 2004, Kuhnen and Zwiebel 2007). However, both the level of pay and the use of options were lower from the 1950s to the 1970s than in more recent years, even though corporate governance was arguably weaker in the earlier period.

A second set of explanations relate executive pay to changes in firm size. High levels of pay may be the result of firms' competition for scarce managerial talent (Lucas 1978, Rosen 1981, Rosen 1982, Tervio 2007), leading to higher compensation in larger firms. Extensions of this theory also predict that compensation should rise along with increases in the size of the typical firm in the market (Gabaix and Landier 2008). However, we find that the strong correlation between executive compensation and the aggregate market value of firms documented in recent decades (Hall and Murphy 2003, Jensen and Murphy 2004, Gabaix and Landier 2008) was almost non-existent prior to the mid-1970s. In addition, the appearance of a strong correlation in more recent decades may be spurious, suggesting that this model may not even explain the post-1970 growth in executive pay.

Another explanation for the high level of pay in recent years is the need to compensate executives for the risk generated by a greater use of incentive pay since the 1980s.[4] However, we find no evidence of a correlation between changes in pay-to-performance and changes in the level of less-risky forms of pay. Finally, the transformation from firm-specific to general managerial skills might have boosted the level of executive compensation (Murphy and Zábojník 2004). However, a slow and smooth evolution of skills suggests that this explanation cannot easily account for the sharp change in the trend in pay in the 1970s and the very rapid increases witnessed in the 1990s.

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[4] The optimal sensitivity of managerial wealth to firm performance may have increased in recent decades due to rising business risk (Inderst and Mueller 2006) or greater international competition (Cuñat and Guadalupe 2006).

Overall, it seems unlikely that a single explanation can account for the long-run trends that we document in this paper, suggesting that the major factors that determine the level of compensation have changed over time. Much of our evidence points to a sharp change in the pattern of compensation around the 1970s. Thus, focusing on factors that changed during that time may contribute greatly to understanding the evolution of pay. More generally, further studies of executive compensation should address these long-run trends to improve our understanding of the determinants of pay and how they have evolved over time.

2. Theories of the determinants of executive compensation

Likely sparked by the surge in executive pay since the mid-1980s, the academic debate has proposed numerous theories addressing the determinants of executive compensation. Since it is not feasible to assess every argument, we focus on the four main economic theories that have been put forth to explain the escalation of executive compensation: managerial rent extraction, the scale of firms, the provision of incentives, and increasing returns to general rather than specific skills.[5] A difficulty of analyzing these theories using only data since the 1980s is that the level of pay has trended upward in conjunction with many variables reflecting the proposed explanations, making it difficult to rule out unobservable factors that might be driving the coincident trends. Evidence from earlier in the century can shed light on each of these explanations by providing a view of how compensation behaved during periods when the many

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[5] See Kaplan and Rauh (2007) and Gabaix and Landier (2008) for a discussion on the main explanations for the evolution for executive compensation.

observable and unobservable factors (such as corporate governance, the scale of firms, and the types of managerial skills) were different.[6]

The first set of theories link executive compensation to managers' ability to extract rents (Bertrand and Mullainathan 2001, Bebchuk and Fried 2004, Kuhnen and Zwiebel 2007). According to this view, poor corporate governance has allowed managers to skim profits from the firm, thereby leading to the considerable increase in the level of CEO pay. Since it should be easier for executives to extract rents in forms of remuneration that are more difficult for shareholders to observe or value, this explanation also provides a plausible justification for the recent growth in stock option use. Applying this theory to fluctuations in executive compensation over time, this hypothesis suggests that the level of pay and the use of forms of remuneration that are easier to conceal (such as stock options) should be higher in periods when corporate governance is weaker.

The second set of explanations relates the level of pay to firm size. Theories of the span of control (Lucas 1978, Rosen 1982, Rosen 1992), superstars (Rosen 1981), and competitive assignment of CEOs to heterogeneous firms (Tervio 2007, Gabaix and Landier 2008) predict a positive cross-sectional correlation between firm size and compensation. In addition, extensions of these models propose that the variation in compensation over time should be positively correlated with increases in aggregate firm size (Gabaix and Landier 2008). This time-series relationship arises because competition for talented managers raises the equilibrium level of pay when the sizes of all potential employers expand. Thus, this view predicts that the level of pay should increase at the same rate as the expansion of aggregate firm size during any period.

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[6] While the long-run trends provide useful variation in pay, a disadvantage of using earlier data is that we lack information on many variables that researchers have argued are related to executive pay in recent years, such as the presence of large shareholders, the tenure of CEOs, and detailed measures of the corporate governance of the firm.

A third proposal relates the upward trend in compensation since the 1980s to the simultaneous rise in incentive pay, since higher remuneration may be necessary to compensate risk-averse executives for a riskier stream of income. This theory is difficult to assess empirically because the relationship between the level of pay and the sensitivity of pay to performance depends on unobservable parameters—such as the shape of the utility function—that may have varied over time. Nevertheless, all else equal one would expect to find larger increases in less risky forms of pay like salaries when pay-to-performance strengthens.

Finally, academics have related the recent rise in compensation to changes in the types of managers. For example, Murphy and Zábojník (2004) argue that CEO pay has risen because of the increasing importance of general managerial skills relative to firm-specific abilities. This explanation suggests that we should observe a higher average and more dispersion of pay across executives as managerial skills become more general.

To inform the debate on executive pay using long-run data, these theories suggest that we need consistently-measured information on the level and structure of pay, the dispersion of pay across executives, the correlation of pay with firm size, the magnitude of pay-to-performance (which requires data on executives' holdings of stock and stock options), and managerial skills. After introducing our data in Section 3, we present evidence concerning each of the first four aspects of executive compensation in Sections 4 to 6. In Section 7 we reassess these theories in light of the long-run trends.[7]

3. Executive compensation data

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[7] Collecting data on the skills of the executives in our sample is time consuming and beyond the scope of the present paper. However, in Section 7 we relate our findings to Frydman (2005), who investigates this question for a subset of our data.

Since its inception in 1934, the SEC has required public corporations to disclose the compensation of their top executives in 10-K reports and proxy statements. Using these corporate reports, we construct a panel dataset on executive compensation from 1936 to 1991.[8] From 1992 to 2005, we use data from Compustat's Executive Compensation database (ExecuComp), which is also based on corporate reports. The SEC's disclosure requirements relating to salaries, bonuses, equity holdings, and stock options (the forms of remuneration that are the main focus of our analysis) have not changed significantly over time, and the corporate reports provide sufficiently detailed information to allow us to track these measures of executive pay in a consistent manner over our entire sample period.

To construct our dataset, we select the largest 50 publicly-traded corporations in 1940, 1960 and 1990.[9] 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 for Research in Security Prices (CRSP) database according to their market value.[10] Because some firms appear among the largest 50 in more than one year, our dataset covers a total of 101 companies. For each firm, we collect annual data on the pay of the top officers for as many years as our sources allow. 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

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[8] Corporations were required to disclose the compensation of top officers in 10-K reports starting in 1934, but 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.

[9] Although randomly sampling firms might be preferable for certain part of the analysis, the considerable size of the data collection effort and the higher likelihood of finding historical corporate reports for large firms caused us to focus on large firms in three particular years. We chose the years 1940, 1960 and 1990 in order to obtain firms that are large near the beginning, middle, and end of our sample period.

[10] Because our intention was to select companies that were large for a reasonable period of time, we measure firm size as the value sales whenever possible. We prefer sales over market value to measure firm size because market value is more susceptible to transitory shocks. A more detailed explanation of the sample design is provided in the Data Appendix.

classification of the new firm does not change (see Appendix Section 1.1 for details). The resulting dataset is an unbalanced panel as companies enter and leave the sample over time.

About 75 percent of the firms in our sample are in manufacturing industries, but our dataset also contains communications, public utilities, and retail companies.[11] Appendix Table A1 lists all of the firms in our sample and Appendix Table A2 shows the distribution of firms by 2-digit SIC code.

By sampling firms that were large at different points in time, our dataset captures some of the structural changes that were experienced by the economy over this 70-year period. The sample includes all available years from 1936 to 2005 for each of the selected firms, so it reflects a broader segment of the economy than the largest 50 publicly-traded firms alone.[12] One potential problem with our methodology is that it might over-sample firms that were growing rapidly prior to each of the 3 selection dates (1940, 1960 and 1990), while regression to the mean could lead to a disproportionate contraction in our sampled firms after these three dates. However, the trends in pay are similar when we separately analyze the firms that were among the largest in 1940, those that were the largest firms in 1960, and those that were largest in 1990, suggesting that these sampling concerns are not driving the trends in our data. Moreover, we show in Appendix Section 3 that the raw medians of our data closely match the medians of a sample weighted to reflect largest 300 publicly-traded corporations in each year. Thus, the trends in median compensation that we discuss can be interpreted as reflecting the evolution of pay at the 150th largest publicly traded firm in the economy.

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[11] Excluding public utilities, which were highly regulated during much of our sample period, from our sample does not alter any of our results.

[12] In particular, it comprises at least 20 percent of the market value of the S&P 500 in every decade, and more than 40 percent prior to 1970 (see Appendix Table A3).

Table 1 reports basic descriptive statistics of our main sample, which includes the three highest-paid officers in each firm.[13] There are more than 15,800 executive-year observations between the years 1936 to 2005, for a total of 2,862 individuals. These officers were the main decision-makers in the firm, as more than 47 percent of these managers held the title "CEO," "president," or "chairman of the board."[14] Furthermore, more than 80 percent of these officers also served on the board of directors (see Table 2).

4. Long-Run Trends in the Level and Structure of Compensation

4.1 Trends in total compensation

Figure 1 shows the median real value of total compensation from 1936 to 2005.[15] 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 more pronounced during World War II, the decline in executive pay continued from the end of the war until the early 1950s. This period of deterioration was followed by 25 years of slow growth, averaging 0.8 percent per year from 1950 to 1975. Finally, the level of executive pay has climbed at an increasing rate since the mid-1970s. Although compensation dipped briefly from 2001 to 2003,

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[13] Although we collected data on the five highest-paid officers in each firm when available, many reports 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 sample over time, but the results are robust to including the 4th and 5th highest-paid executives.

[14] Because the term "CEO" was not frequently used until the 1970s, identifying who held this title 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 percent of the observations). We discuss how our results differ if we focus on CEOs in Section 4.4.

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

it resumed a rapid rate of growth during the last two years of our sample. Thus, the rapid increase in pay in the 1990s did not end with the collapse of the stock market boom in 2000.

4.2 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.[16] These bonuses were generally paid in cash, but some were also paid in company stock. The long-dashed line adds the amount paid to each executive as part of a deferred bonus or long-term incentive payment.[17] 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, compensation was composed mainly of salaries and current bonuses. While long-term bonuses were used as early as the 1940s, they did not make a noticeable impact on median pay until the 1960s.[18] These bonuses were usually based on the firm's profits, with payment in cash or stock distributed in equal installments over a certain number of years.[19] Long-term bonuses became a greater share of compensation over time—reaching more than 35 percent of total pay by 2005—due mostly to the increasing popularity of restricted stock awards.

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[16] Although it would be useful to separate salaries from current bonus payments, many firms reported only the sum of the two prior to 1992. In firms that did report these payments separately between 1947 and 1991 (about 20 percent of the sample in these years), the value of current bonus payments usually ranged between 20 and 45 percent of current pay, with no obvious trend. Therefore, grants of current bonuses do not appear to have followed the same upward trend as the use of long-term pay (discussed below).

[17] 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 bonuses awarded.

[18] The 1950s were not the first period when incentive compensation was used. Historical accounts suggest that both current and deferred forms of incentive pay were almost negligible prior to WWI but became commonly used during the 1920s (Taussig and Barker 1925, Baker and Crum 1935). Most bonus plans were abandoned or suspended as profits plummeted during the Great Depression (Baker 1938).

[19] The deferral period was generally around 5 years, although individual plans varied from 2 to 10 years.

Stock options have also become a larger fraction of compensation over our sample period.[20] Among executives receiving an option award, the median value of grants fluctuated between 15 and 30 percent of total pay from the mid-1950s to the mid-1980s. The upper end of this range is not much less than the median value of 37 percent during the option boom of the late 1990s, suggesting that options have been relevant for executive pay since mid-century.[21]

Because the value of grants relative to the total pay of those executives receiving options has not risen greatly over time, the growing importance of stock options relative to median total pay is largely due to an increase in the *frequency* of grants. The use of employee stock options was almost negligible until 1950, when tax reform legislation introduced the restricted stock option. Taxed as a capital gain instead of as labor income, these options had a considerable tax advantage compared to cash because income tax rates were extremely high. This tax policy had immediate impact, as more than 40 percent of the firms in our sample instituted a restricted stock option plan in the 5 years following this reform. Despite the proliferation of option plans during this period, the use of options was sporadic. 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 increased steadily since then, with more than 82 percent of executives receiving options in the 1990s (see Figure 3).

4.3 Other forms of compensation

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[20] Lewellen (1968) finds a much larger value of stock option grants from 1940 to 1963 than we do. However, he measures the value of stock options as the pre-tax labor income level that an executive should receive to obtain a given after-tax level of options. Because personal income tax rates were significantly higher than the tax rate on options (which were taxed as capital gains), this method severely overstates the value of option grants during this period.

[21] The press also highlighted the significance of options during this earlier period, with headlines such as "Option Opulence" (*Wall Street Journal,* Feb. 1 1955*)* and "Stock Options Popular" (*New York Times*, Mar. 26, 1958).

One concern is that our trends may be biased because our measure of total pay does not include information on two other components: 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 this information on most of the managers in our sample. We exclude perquisites because firms were not required to report this type of pay until the late 1970s.[22] Because pensions and perks are not subject to personal income taxes upon award, these methods of pay may have been disproportionately used in the 1950s and 1960s, when 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, 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 explain the low growth rate of pay 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, an annual average growth rate of 0.5 percent. By contrast, median pay increased by a factor of 4.4 from 1980 to 2000. If we assume that the value of unobserved forms of pay was zero in 1950, these unobserved benefits 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 and strikes us as implausibly

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[22] Regulation introduced in 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. Perquisites and other personal benefits (above a minimum threshold) have been separately reported since 1993. However, the accuracy of data on perks is limited, and so most research has focused on whether a certain perk was offered rather than on its actual value (Rajan and Wulf 2006, Yermack 2006).

large. Moreover, this number underestimates the necessary value of non-taxable benefits in 1970 if the actual level of unobserved benefits was greater than zero in 1950. Thus, 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 observable pay during this period relative to later decades.[23]

4.4 Differences among executives

Given their importance as decision makers, most of the research on executive compensation has concentrated on the chief executive officer. We focus our analysis on a wider group of top executives because the main explanations for the recent increase in executive pay are not specifically related to CEOs but rather apply to all top executives. However, for comparison with the existing literature it is important to know whether the trends for CEOs differ from those of other top executives. As shown by Table 3, the ratio of the CEO's total compensation to the average pay of the other two highest-paid officers in his firm was about 1.4 prior to 1980.[24] Thus, the trends in total compensation were similar among CEOs and other top executives for most of our sample period. The ratio of CEO to other executive pay rose from the 1980s to the 2000-2005 period, suggesting that the return to holding the title "CEO" has increased in the past 25 years. Nevertheless, the level of non-CEO pay also climbed substantially during this period

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[23] Moreover, the available evidence on pensions suggests that this form of remuneration cannot account for the low rate of growth in executive compensation observed during the 1950s and 1960s. Lewellen (1968) reports that retirement benefits were 15 percent of after-tax total pay from 1950 to 1963. Because pensions were taxed at a lower rate than labor income, their value relative to total pre-tax 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 that the ratio of executives' retirement benefits to total pay received during their entire service as CEO was 34 percent in 2004.   Thus, pensions were not a higher fraction of total pay in the 1950s or 1960s than they are today.

[24] As noted in Section 2, proxy statements did not generally use the title "CEO" prior to the 1970s. We identify the CEO as the president of the company in firms where the title "CEO" is not used (see footnote 14). Results are similar if we identify the CEO as the chairman of the board or as the highest-paid executive.

(by more than 6 percent per year). Moreover, we do not find noticeable differences in the structure of compensation between CEOs and other executives (panel B of Table 3). Therefore, the patterns documented in this paper are not specific to CEOs, but characterize the remuneration of top management more generally.

Examining the distribution of compensation both within and across firms, the general trend in pay is similar at the 10th, 25th, 50th, 75th and 90th percentiles of our sample with the exception of two time periods (see Table 3). First, real pay declined sharply in the 1940s only at the higher end of the distribution, suggesting that the "Great Compression" (Goldin and Margo 1992) occurred even among some of the highest-paid individuals in the nation. Second, increases in compensation during the past 25 years were more pronounced for higher-paid executives. Whereas the ratio of pay at the 90th to the 50th percentile fluctuated between 1.8 and 2.4 from 1936 to 1980, this gap had risen to more than 3.5 by 2005.[25] Thus, the dispersion of pay across executives remained fairly constant for several decades after WWII and then began to fan out after the 1970s.

4.5 Representativeness of the sample

Although the trends in pay are roughly similar for all of the executives in our sample, it is not clear how well our sample reflects the compensation of top officers in the economy more generally. For one reason, pay tends to be higher in larger firms (Roberts 1956, Kostiuk 1990, Rosen 1992). In addition, our sample may not reflect compensation at the largest firms in time periods that are not close to 1940, 1960, or 1990—the years in which the firms in our sample

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[25] This widening inequality among managers is also reflected in the average level of executive pay (see Table 3), which is more influenced by outliers than the median.

were selected for ranking among the largest in the economy. We evaluate the representativeness of our sample in Appendix Section 3, and highlight the main results of that analysis here.

A simple graph of median pay in firms of different sizes shows that the trends in total pay are similar in both the larger and smaller firms in our sample (see Figure 4). Managers of larger firms were paid more, but compensation in all firm-size categories stagnated from 1950 to 1980 and then increased markedly during the last 25 years. We evaluate the representativeness of salaries and bonuses in our sample from 1970 to 2005 by comparing them to pay in similar-sized firms from other more representative datasets, and find that our data are similar to firms that are among the largest 300 in the economy (Appendix Section 3.1). To evaluate the representativeness of our data over our entire sample period, we assign a weight to each firm that is inversely proportional to its probability of being selected among the 500 largest publicly-held firms in each year. The unweighted median level of pay in our entire sample closely matches the weighted median of the largest 300 firms in the economy. Thus, the unweighted trends that we analyze in the paper can be interpreted as reflecting the evolution of pay at the 150th largest publicly traded firm in the economy.

Prior research has documented more infrequent option use during the 1970s and the early 1980s than in our sample (Hall and Liebman 1998, Jensen and Murphy 2004, and Murphy 1999).[26] A few measurement issues contribute to this discrepancy. First, prior work used gains from exercising options rather than direct evidence on option grants in the 1970s (Murphy 1999). However, option grants were more likely than option exercises during this period, possibly due

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[26] There is little evidence in prior research on the use of employee stock options prior to the 1970s. Lewellen (1968) provides a notable exception for the period 1940 to 1963. Although he claims that stock options were a much more important share of executive pay than our data suggest, his method of valuing options is substantially different from ours and is likely biased upward. See Section 3.2 of the Appendix for details.

to poor stock market performance.[27] The high use of stock options in our sample is also related to the multi-year reporting of options. Many proxy statements reported option grants and exercises as 3- or 5-year cumulative totals from the late 1960s to the late 1980s, making it difficult to ascertain the actual number granted or exercised in each year. To treat multi-year reporting, we develop a methodology that may bias the *frequency* of grants upwards. However, the average and median *values* of options granted remain unbiased. See Sections 2.2 and 3.2 of the Appendix for further details.

More generally, the trend in the frequency of stock option use in our data might not be representative because our sample includes mainly large firms, which grant options more frequently.[28] In Appendix Section 3.3, we use the relationship between option grants and firm size in the Hall-Liebman data (which extends from 1980 to 1994 and includes a larger number of smaller firms) to estimate options grants and the level of total pay for the firms in our sample. This exercise generates a median level of total compensation that is similar to the median of our raw data, and does not alter our conclusions about the long-run evolution of executive pay.

5. The relationship between executive pay and firm size

A simple graph of the level of compensation and aggregate firm size over the past 70 years suggests that the relationship between compensation and the market value of firms has not always been as strong as it was in the past 25 years. Aggregate market capitalization (measured by the S&P 500 index) increased considerably during the 1950s and 1960s, but the level of pay

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[27] 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.

[28] Somewhat surprisingly, we do not find a strong correlation between firm size and the share of stock options in total pay. By contrast, Hall and Liebman (1998) find a positive relationship between option use and firm size in a larger sample that is more representative of publicly-traded firms in the S&P 500 from 1980 to 1994. We attribute this discrepancy to the fact that the smaller firms in our sample are only included if they were large earlier on, if they will grow larger later in the sample, or if they are experiencing a temporary negative shock.

experienced little change (see Figure 5).[29] To better understand this relationship, Table 4

decomposes the correlation of compensation and firm size into three main components: average

firm size in the previous 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 the

previous 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:

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

where S_{jt-1} is firm j's size in year $t-1$, $\overline{S_{t-1}}$ is the average size across all firms in our sample in

year $t-1$, and $\overline{S_j}$ is the average size of firm j across all years. We measure firm size using the

firm's market value and break the sample into two periods in order to examine how these

correlations have changed over time.[30]

Firm-specific and idiosyncratic components of firm size had a positive and significant

effect on compensation over the entire sample period (the coefficients were about 0.2 and did not

vary noticeably across periods). However, the role of aggregate market value has changed

markedly over time. During the second half of our sample, the relationship between executive

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[29] 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.

[30] We use the average across firms to represent aggregate market size because it fits easily into a variance decomposition framework. However, our results are robust to using other proxies for aggregate market size including the median market value in our sample, average and median market value in the largest 500 publicly-traded firms, and the S&P index.

pay and the average market value of firms was roughly 1-for-1 (col. 3).[31] However, we estimate a much smaller coefficient of 0.1 in the first 40 years of our sample (col. 1). This result cannot be explained by unusual factors related to the Depression or World War II, as we find a similarly small coefficient for the period 1946 to 1975 (col. 2).[32]

The bracketed values in Table 4 report the fraction of the variance in compensation that can be accounted for by each of the independent variables.[33] The firm-specific component of size explains between 13 and 17 percent of this variation in both periods, while idiosyncratic shocks to firm size account for another three to four percent. By contrast, the importance of aggregate firm size has changed substantially over time: it explains 34 percent of the variation in pay from 1976 to 2005, but only two 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. The estimated coefficients on the other two variables are unchanged. Thus, the cross-sectional relationship between firm size and executive pay has remained relatively stable over the past 70 years, while upward and downward shifts in the distribution of firm size have only affected the level of compensation more recently.[34]

One reason for the change in the relationship between compensation and firm size could be that the level of pay is currently tied to contemporaneous fluctuations in firm size, whereas it

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[31] These results are in line with the effects reported by Gabaix and Landier (2008), who use a much larger sample of firms from ExecuComp from 1992 to 2004.

[32] This result would be entirely different if it were based on Lewellen's (1968) estimates of compensation in the decades following WWII. Regressing the logarithm of the real pre-tax level of total compensation that he reports for the five highest-paid executives on the logarithm of the real value of the S&P 500 in the previous year, we find a coefficient of 1.25. Nearly all of this correlation is attributable to his method of valuing stock option grants; the coefficient is 0.06 when the dependent variable is the real value of salary+bonus.

[33] 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).

[34] In Appendix Table A6, we show that the strong correlation between compensation and aggregate firm size was limited to the 1980s and 1990s. For all other decades in our sample, average market value accounts for less than 1 percent of the variation in executive pay.

was more responsive to lagged firm size in the past.[35] Panel 3 of Table 4 shows little support for this conjecture. Although the average market value in year *t-2* had a larger effect on compensation than the year *t-1* value during the earlier sample period, the sum of these two coefficients is still considerably smaller than the corresponding sum in recent years.

Another possible explanation for the change in the correlation is that the relevant measure of firm size has changed over time. However, our results are robust to using the value of sales instead of market value (see cols. 3 and 4 of Table 4).[36] Although the coefficients are two to three times larger for aggregate sales than aggregate market capitalization, the distribution of sales is far more dispersed and the fraction of the variance of compensation explained by each of these variables is about the same. Thus, the importance of the aggregate market was much smaller earlier in the century regardless of how we measure firm size.

It is tempting to conclude that aggregate firm size has become a key determinant of executive pay during the past 30 years.[37] However, these coefficients are only correlations and 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 (panel 4 of Table 4). Moreover, tests for non-stationarity cannot reject the null hypothesis that there is a unit root in the residuals of equation 1 in either period.[38] To address this concern,

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[35] For example, this difference in timing would result from switching from accounting-based to market-based measures of firm performance when determining incentive pay.

[36] We could also consider firm earnings as a size proxy, but we lack data on this variable prior to the 1950s.

[37] Another possible explanation for this result is that our estimated coefficients in the earlier period may be biased downwards if pensions and perks were higher during this time. However, an exercise similar to our back-of-the envelope calculation in Section 3.3 suggests that it is unlikely that these components alone can explain the significant change in the correlation between aggregate market size and the level of pay. If the growth rate of total compensation has a one-to-one correlation with aggregate firm size (as we find for the recent period), the level of compensation should have increased by a factor of 3.3 from 1950 to 1968. In this case, unobserved forms of pay would need to have amounted to $1.6 million by 1968, an improbably high level of perks and other benefits.

[38] Using Pesaran's (2007) panel unit root test, the null hypothesis of non-stationarity in the residuals of the second period has a p-value of 0.59. Therefore the presence of a unit root in the residuals cannot be ruled out. The p-value for the residuals in the early period is 0.01, suggesting that there is less likely to be a trend in the residuals in the first half of the sample.

we estimate the relationship between *changes* in compensation and *changes* in firm size (panel 5 of Table 4). The estimated effects of both the average size of the market and the idiosyncratic component of firm size are notably smaller in this specification, and they both explain a much smaller fraction of the variance in changes in pay than the corresponding specification in levels.[39] 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.

6. The evolution of pay-to-performance over time

6.1 Defining measures of pay-to-performance

Managerial decisions can be influenced by changes in any form of the executive's wealth that is tied to the performance of the firm. Therefore, a comprehensive measure of pay-to-performance should include the remuneration awarded to the executive as well as the revaluations of his stock and stock option holdings (Jensen and Murphy 1990, Hall and Liebman 1998).[40] Even though our measures include these forms of firm-related wealth, we keep in line with the literature by referring to the correlation of changes in wealth with firm performance as pay-to-performance.

Empirical studies of pay-to-performance have used a wide range of specifications to measure this relationship.[41] Two common alternatives are 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 one percent change in the firm's value (or the value of equity at

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[39] Evidence from both Hall and Liebman's 1980-1994 and ExecuComp's 1992-2005 datasets confirms this result in different samples. Using the Hall-Liebman data, we find an elasticity of CEO pay with respect to average market value of 0.85 and the elasticity with respect to the idiosyncratic component of firm size of 0.32. The coefficients are -0.10 and 0.28 respectively for the specification in changes. Using all of the executives in ExecuComp, we find that the effect of average market value falls by half when the regression is estimated in changes instead of in levels.

[40] 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.

[41] For a discussion of the statistics, 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), and Edmans, Gabaix and Landier (2008).

stake).[42] In a simple agency model that allows the marginal product of managerial effort to vary with the value (or size) of the firm, the optimal level of effort (or strength of managerial incentives) depends on the type of CEO activity being considered (Baker and Hall 2004). The Jensen-Murphy statistic is the correct measure of incentives for activities whose dollar impact is the same regardless of the size of the firm, like buying a corporate jet, and the value of equity at stake is appropriate for actions whose value scales with firm size, like restructuring the firm.

Studies that ignore revaluations of equity and option holdings often report an elasticity measure of incentives: the percentage change in compensation for a 1 percent change in firm value.[43] Empirically, calculating this measure is problematic because we only observe firm-related wealth. If non-firm-related assets trended monotonically over time, ignoring these forms of wealth would lead to a systematic bias in our estimates of the level and, consequently, of the percent change in total wealth. Therefore, we focus on the Jensen-Murphy statistic and the value of equity at stake, but we return to this issue in Section 6.5 by calculating the elasticity of *changes* in wealth to firm performance.

6.2 Trends in stock and stock option ownership
In recent decades, most of the sensitivity of pay to performance has been driven by revaluations in stock and stock option holdings (Hall and Liebman 1998). Therefore, we start by documenting the long-run trends in stock and stock option ownership.

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[42] Both of these statistics give an empirical measure of the correlation between pay and firm performance. While a higher pay-to-performance sensitivity will likely influence managerial actions, this correlation is not necessarily caused by firms' desire to provide incentives. The association between pay and firm performance can also be the result of a bargaining or fairness model (Blanchflower, Oswald, and Sanfey 1996, Benjamin 2005).   Although we cast our findings as incentives, we want to stress that we are only calculating a correlation.

[43] A log-log functional form for incentives can be obtained theoretically as the optimal contract if utility is CRRA (Himmelberg and Hubbard 2000) or from a model that embeds incentive pay in a competitive labor market (Edmans, Gabaix, and Landier 2007). A benefit to calculating the elasticity is that it is not sensitive to changes in firm size, as are the other two measures we consider.

Stock option grants began to increase in 1950, and by the 1960s stock option holdings had already become a major component of wealth (Figure 3). In the 1960s, more than 60 percent of the executives in our sample held options.[44] The use of options has become even more widespread over time; since 1990 more than 90 percent of the executives in our sample held options. Moreover, the number of stock options held by the top 3 executives of each firm rose considerably from 1980 to 2000 relative to the number of shares outstanding. By contrast, equity holdings of top executives have declined over the century relative to the firm's total number of shares outstanding, with most of the contraction occurring during WWII (see Table 5).[45] By 2005, median fractional stock holdings were about one third of their pre-war level.[46]

The first two columns of Table 6 report the actual change in wealth experienced by an executive due to changes in the value of his stock and option holdings. These values are calculated from his holdings in the previous year and the firm's realized rate of return (adjusted for stock splits and dividends), so they do not reflect changes due to new grants, exercises of options, or sales of stock during the year. The median value of these revaluations combined was sizable in most decades, but was near zero in the 1930s, 1940s and 1970s. Much of the differences over time are not because executives' ownership of stock or options was lower in the earlier decades, but because the distribution of firms' rates of return was different during these periods. To abstract from variation in wealth due to firms' realized performance, we calculate

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[44] The fraction of executives *receiving* stock options was much smaller than the fraction of executives *holding* options during this period because options had a long duration and vested slowly over time. Consequently, the contribution of option grants to total compensation of the median executive was small throughout this period.

[45] We collect information on equity holdings after 1942 from proxy statements. From 1935 to 1941, we construct stock holdings from an initial SEC report on holdings in 1935 and bi-monthly reports on the equity transactions of each officer The use of transactions data introduces noise in our measure of stock holdings, but we do not find evidence of a large bias. See the Appendix Section 2.4 for further details.

[46] These results differ from Holderness, Kroszner and Sheehan (1999), who find higher stock ownership in 1995 than in 1935. There are two main explanations for this discrepancy. First, the increase in fractional holdings does not occur among the largest publicly-held firms in their sample, which are more comparable to our sample of firms. In addition, they focus on the holdings of *all* top officers and directors. When they restrict the sample to the top of the hierarchy, they find a similar decline in ownership: the holdings of the median CEO in their sample fell from 0.09 percent of shares outstanding in 1935 to 0.06 percent in 1995.

the *ex-ante* change in each executive's wealth in response to a $1000 (Jensen-Murphy) or 1 percent (equity-at-stake) improvement in market value (columns 4 to 7).[47] The *ex-ante* gains related to changes in stock holdings have been important for our entire sample period. Meanwhile, changes in the *ex-ante* gains from holding options increased steadily since the 1950s, and have exceeded the appreciation due to changes in stock holdings since the 1990s.

6.3 Computing measures of pay-to-performance

Many recent studies of pay-to-performance have measured incentives as the sum of the *ex-ante* revaluations of stock and option holdings, which implicitly assumes that the correlation of firm performance with salaries, bonuses and other forms of compensation is negligible (Coles, Daniel, and Naveen 2006, Bergstresser and Philippon 2006). Although this assumption has been accurate since the 1980s (Hall and Liebman 1998), it is possible that incentives were provided through changes in the level of compensation in the past (Jensen and Murphy 1990). Therefore, we estimate the Jensen-Murphy statistic and the value of equity at stake from the following regression:

$$\Delta(\textit{Exec. Wealth})_{ijt} = \alpha_t + \beta_t \, \textit{Firm Performance}_{jt} + \varepsilon_{ijt} \qquad [2]$$

where the realized real change in wealth of executive i in firm j in year t is equal to total compensation (salaries+long-term pay+option grants) plus realized revaluations of stock and option holdings. When firm performance is measured by the firm's real rate of return, $\hat{\beta}$ gives the value of equity at stake and when firm performance is measured by the real $1000 change in

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[47] The *ex-ante* revaluation of option holdings is calculated using data on the number and characteristics of each type of option held in an individual's portfolio and the derivative of the Black-Scholes formula with respect to a 1 percent or 1000 dollar change in market value (Core and Guay's (2002) "delta" measure).

the firm's market value, $\hat{\beta}$ estimates the Jensen-Murphy statistic.[48]   To assess how pay-to-performance has changed over time, we estimate equation [2] for the following time periods: 1937-40, 1941-1949 (excluding 1946), 1950-59, 1960-69, 1970-1979, 1980-1989 and 1990-1999, and 2000-2005.[49]   Because the distributions of compensation and changes in wealth are highly skewed, we estimate equation [2] using a quantile regression to fit the conditional medians of the data.[50]

Columns 1 and 4 of Table 7 report coefficient estimates and standard errors for the Jensen-Murphy statistic and the value of equity at stake.[51]   These estimates are very similar to the sum of the *ex-ante* changes in value of stock and option holdings (cols. 2 and 5), which suggests that the contribution of compensation to pay-to-performance has been very small for our entire sample period.   Indeed, estimating equation [2] using only the real value of compensation as the dependent variable leads to very small coefficients on firm performance (columns 3 and 6 of Table 7).[52]   Because fluctuations in compensation are not empirically important, we use the *ex-ante* revaluations (i.e. cols. 2 and 5) to measure pay-to-performance in the remaining analysis below.   An advantage of using this method is that these measures can be calculated for each individual in our sample (whereas the regression coefficients vary only by

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[48] The change in market value is defined as the number of shares outstanding in the previous year times the rate of return in the current year.

[49] 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.

[50] We find similar results if we compute a robust regression that uses Huber and biweight iterations to down-weight large outliers (the rreg command in Stata) or estimate an OLS regression after trimming the highest and lowest percentiles from the distribution of changes in wealth.   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.

[51] Standard errors are bootstrapped, and account for correlation of observations within the firm.

[52] Estimating regressions where the dependent variables are realized revaluations of stock or option holdings gives very similar results to the median ex-ante revaluations shown in Table 6.

decade) and the individual-level variation is useful for examining the correlation of pay-to-performance with firm size and the level of pay.

In accordance with prior research, both the Jensen-Murphy statistic and the value of equity at stake show a large increase in pay-to-performance during the 1980s and 1990s (Hall and Liebman 1998, Murphy 1999).[53] However, these two measures present different views of the longer-run evolution of pay-to-performance: The value of equity at stake was 12 times higher in the 2000-2005 period than it had been in the 1936-1940, whereas the Jensen-Murphy statistic had not even recovered its pre-war level by the end of our sample period.[54]

6.4 Accounting for changes in the size of firms over time

Because the two measures have opposite correlations with firm size (Schaeffer 1998, Baker and Hall 2004, Edmans, Gabaix and Landier 2007), a possible explanation for the diverging trends in the two statistics of pay-to-performance is the rapid expansion of firms over our sample period.[55] To correct the long-run trends in pay-to-performance for the secular increase in firm size, we regress each measure of pay-to-performance on firm size and time in a series of overlapping 4-year sample periods (1936-1939, 1938-1941, etc). The 2-year change in pay-to-performance is

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[53] Our regression-based estimates of the value of equity at stake are consistent with those reported by Hall and Liebman (1998), but the Jensen-Murphy statistic is smaller. This discrepancy is partly due to larger firm size in our sample. Limiting our data to CEOs between 1993 and 1995, we obtain an estimate of $1.11 for a $1000 increase in firm value in firms among the top 100 of the S&P 500, $2.62 in firms ranked from 100 to 200, and $3.37 for the smallest firms in our sample. Hall and Liebman report a sensitivity of $5.29 for 1994, which is based on a random sample of about 500 of the largest firms between 1980 and 1994.

[54] The trends in pay-to-performance are similar for both CEOs and other top executives.

[55] On the other hand, both measures rose from the 1970s to the 2000s despite further increases in firm size, suggesting that pay-to-performance strengthened enough during the past thirty years to offset the natural downward trajectory of the Jensen-Murphy statistic.

the predicted growth in pay-to-performance from the first half to the second half of each 4-year

sample period keeping firm size constant (see Appendix Section 4 for details).[56]

Since our firm-size adjustments are formed by comparing pay-to-performance

correlations in adjacent 2-year periods, they do not provide estimates of the level of these

correlations but only estimates of how these correlations would have changed over time if firm

size had remained the same. Therefore, we create indexes that are equal to the median value of

pay-to-performance in the 1936-37 period and use size-adjusted growth rates in pay-to-

performance to obtain a new index value in each successive 2-year period (see Figure 6).

Adjusted for firm size, pay-to-performance fell noticeably during WWII, but then rose

during the 1950s and 1960s, reaching a level somewhat higher than its initial value. After falling

back modestly during the 1970s, it began to trend upward again in the mid-1980s. The

sensitivity of pay to performance accelerated rapidly in recent years, reaching a level 3 times

(Jensen-Murphy) or 7 times (equity at stake) higher than its value in the 1930s, and about 3 times

higher than the 1960s level by either measure.[57]

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

In the standard principal-agent model, the optimal degree of managerial incentives is based on a

number of unobservable factors such as the agents' risk aversion and the cost of managerial

effort. Therefore, there is no theoretical benchmark of the "optimal" degree of pay-to-

performance against which to contrast our results (Haubrich 1994). Nevertheless, we gauge the

strength of incentives by calculating an executive's monetary return for a meaningful

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[56] We estimate 2-year instead of 1-year growth rates in order to increase the sample size of each regression. Results are similar—but noisier—when estimating 1-year changes.

[57] The sharp drop in pay-to-performance in the early 1940s and the persistence of a weak correlation until the end of the decade might be related to World War II.

improvement in firm performance. Following Hall and Liebman (1998), we define a meaningful (but modest) improvement in firm performance as a movement from the median rate of return to the 70th percentile rate of return.

To estimate the wealth at stake from this improvement, we calculate the *ex-ante* dollar change in each executive's stock and option holdings if the price of the firm increased from the median rate of return in our sample (8.4 percent) to the 70th percentile rate of return (22.7 percent), based on the *ex-ante* revaluations shown in column 5 of Table 7. The median change in wealth across executives was over $1 million in the 1990s and 2000s, but considerably smaller in earlier decades (col. 1 of Table 8). Even though the dollar value of these changes in wealth rose significantly over time, the upward trend is not as steep when comparing these dollar values to a broad measure of compensation that includes salaries, bonuses, stock option grants, and revaluations of stock and options holdings at the median rate of return (col. 2). With the exception of the 1940s, an improvement in firm performance from the 50th to the 70th percentile has typically led to at least a 30 percent increase in this broad measure of compensation.[58] Moreover, the executive's return to this improvement in firm outcomes was about 50 percent of broad compensation in the 1960s, about as high as it was in the 1990s. Thus, the incentive for an executive to undertake actions leading to an improvement in firm performance of this magnitude has been substantial for most of our sample period. In other words, it appears that managerial incentives have not been "wildly inefficient" for most of the 20th century, to paraphrase Hall and Liebman.

Finally, we divide the percent increase in compensation broadly defined (col. 2 of Table 9) by the improvement in the rate of return from the median to the 70th percentile of

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[58] Although the median percent increases in the 1970s and in the 1980s are about the same, the pattern is U-shaped from the early 1970s to the late 1980s. Thus, our data are consistent with Hall and Liebman (1998), who document a steady increase in managerial incentives from 1980 to the mid-1990s.

performance. Because the numerator is calculated from *changes* in wealth as opposed the *level* of wealth, this measure reflects the elasticity of *changes* in wealth, a concept related to the elasticity of wealth discussed above. This elasticity was greater than 1.6 for every decade in our sample except the 1940s, and about the same in the 1960s as it was in the 1990s. Thus, this measure of pay-to-performance confirms that managerial incentives were not always small prior to the 1980s.

7. Re-assessing theories for the evolution of executive pay

We do not have exogenous variation to causally identify the relative contribution of the many proposed theories for the long-run trends in executive compensation. Nevertheless, the evidence presented in this paper suggests that a number of popular explanations for the recent surge in pay cannot account for the long-run trends.

First, the long-run trends in pay seem inconsistent with explanations related to managerial rent seeking. According to this theory, we should observe higher levels of pay and a higher fraction of pay given in obscure forms of compensation in periods of poor corporate governance. However, we observed lower levels of pay and little use of stock options grants (which are easier to conceal) earlier in the century, when both external and internal corporate governance mechanisms were most likely weaker (Jensen 1993, Holmstrom 2005). Although we lack consistent measures of corporate governance throughout our entire sample, several pieces of evidence speak to an improvement in governance over the century. In particular, proxy fights and takeovers were rare prior to the 1980s (Holmstrom and Kaplan 2001), boards of directors have become smaller and more independent since mid-century (Lehn, Patro, and Zaho 2003), and both the ownership of institutional shareholders and shareholder activism have increased

since the 1950s (Khurana 2002, Gillian and Starks 2007). Among the firms in our sample, the median fraction of the board of directors occupied by officers of the firm fell from 0.42 in 1950 to 0.18 in 1990.[59] These aspects of corporate governance are not comprehensive, nor do they rule out a positive effect of poor corporate governance on compensation, but nevertheless they suggest that the ability of executives to set their own pay may have diminished over time, even as the level of compensation trended up.[60]

We also find that explanations related to the scale of firms are not consistent with the long-run evolution of executive pay. Gabaix and Landier (2008) predict that the time-series evolution in compensation should correlate 1-to-1 with growth in the size of the aggregate value of firms. Although this correlation was present in the past 35 years, it was almost non-existent in earlier decades. Moreover, the seemingly-strong correlation that characterizes the later period may not be causal because it appears to be biased upward by spurious correlation between the market value of firms and the level of pay.

Third, the rising level of pay does not seem to be related to a strengthening of managerial incentives. Despite fluctuations in pay-to-performance from the 1950s to the 1970s, we find little corresponding change in less risky forms of pay, such as salaries. To investigate this lack of correlation more formally, we regress two-year changes in ln(salary+current bonus) on the size-adjusted two-year changes in pay-to-performance described in Section 6.4. No matter which measure of pay-to-performance we use, its coefficient is small and insignificantly

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[59] Board membership was constructed by matching the names of the executives in our data to a list of the board directors from Moody's Manual of Investments. Thus, the fraction of insiders in the board is probably underestimated since we lack information on grey directors.
[60] For example, Bertrand and Mullainathan (2001) find that executives in firms with both weak and strong corporate governance had high levels of pay. They conclude that the remuneration in the latter was not the by-product of managerial malfeasance but rather due to firms' optimal provision of incentives.

different from zero. This result holds both for our full sample and for the period 1985-2005, when both pay-to-performance and compensation trended upward strongly.

Our evidence is also hard to reconcile with stories of increasing returns to general managerial skills. This explanation predicts a positive correlation of the level and dispersion of pay with the degree of generality of managerial skills. The level of pay was lower and differences in remuneration across top managers were smaller in the first half of our sample, when abilities of managers were arguably more firm-specific (Frydman 2005). However, managerial skills have likely evolved smoothly and slowly over time (Frydman 2005), making it hard to explain the sharp changes in the trends in pay that occurred in the 1970s as well as the fast rate of increase in pay since then.

8. Conclusion

There have been important changes in the level and the structure of executive pay from 1936 to 2005. The real value 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 increasing rate from the 1970s to the present. The relative stagnation of compensation during the 1950s and 1960s is surprising because the level of executive pay did not keep pace with the growing size of firms during this period. By contrast, pay and firm size have been more strongly correlated in recent decades. The composition of executive compensation also changed considerably since the 1950s, as both stock options and other forms of incentive pay became larger shares of total compensation over time. Using a broad measure of executive compensation that includes salaries, bonuses, stock option grants, and revaluations of stock and stock option wealth, we find that pay-to-performance

sensitivities were considerable in most decades except the 1940s. Thus, compensation arrangements have served to tie the wealth of managers to firm performance — and perhaps to align managerial incentives with shareholders' interests — for most of the twentieth century.

The new evidence that we present in this paper poses a challenge to the most common explanations for the recent rise in executive pay because the implications of these theories do not hold for the historical data. Our data suggest that the post WWII era can be divided into two distinct periods. Prior to the 1970s we observe low levels of pay, little dispersion across managers, weak correlation between pay and aggregate firm size, and a moderate degree of managerial incentives. Since then, salaries and incentive pay have grown dramatically, differences in pay across executives have widened, the correlation between compensation and aggregate firm size appears to have strengthened, and managerial incentives have gotten stronger. Theories concerning the determinants of pay should address this sharp transformation in executive compensation and why models of pay that appear to fit well in recent decades did not function the same in the past. One possibility is that the IT revolution that began to take hold in the 1970s led to a form of skilled-biased technical change that altered the nature of the job of top managers (Garicano and Rossi-Hansberg 2006). Another explanation is that the poor performance of firms in the 1970s brought about improved board diligence, thereby making the CEO job less secure (Hermalin 2005). This theory is consistent with the increasing fraction of CEOs being hired from outside the firm and the growth in the likelihood of forced departures (Murphy 1999, Huson, Parrino and Starks 2001). Finally, changes in the compensation of top executives might be related to more general factors that contributed to the rise in the relative incomes of all high-earners since the 1970s (Kaplan and Rauh 2007), such as changes in social norms (Piketty and Saez 2003, Levy and Temin 2007).

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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 (a total of 101 firms). 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. Annual market value is measured at the end of the fiscal year.

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 (a total of 101 firms). Job titles were obtained from firm's proxy statements and 10-K reports. 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. Director is the fraction of the executives in the sample that are also members of the board of directors, as reported by the firm's proxy statements and 10-K reports.

Table 3
Level and Structure of Total Compensation by Percentile and CEO Status

	1936 - 1939	1940 - 1945	1946 - 1949	1950 - 1959	1960 - 1969	1970 - 1979	1980 - 1989	1990 - 1999	2000 - 2005
Panel A: Level of Total Compensation (Millions of $2000)									
Three Highest-Paid Officers									
10th percentile	0.36	0.4	0.36	0.39	0.45	0.47	0.57	0.91	1.31
25th percentile	0.53	0.59	0.53	0.55	0.60	0.64	0.85	1.35	2.19
50th percentile	0.85	0.80	0.72	0.77	0.83	0.93	1.33	2.36	4.08
75th percentile	1.24	1.15	1.01	1.09	1.18	1.31	2.05	4.43	9.42
90th percentile	1.80	1.59	1.53	1.63	1.66	1.84	3.18	8.29	16.9
average	0.97	0.95	0.85	0.94	0.99	1.09	1.74	4.35	7.63
Median CEO	1.11	1.07	0.90	0.97	0.99	1.17	1.81	4.09	9.20
Median Other Top Officers	0.74	0.70	0.65	0.67	0.74	0.82	1.12	1.89	3.02
Within-Firm Ratio of CEO to Other Top Officers	1.50	1.48	1.38	1.43	1.29	1.42	1.58	2.00	2.58
Panel B: Structure of Compensation									
Average Long-term pay / Total Compensation									
CEOs	0.00	0.01	0.01	0.03	0.06	0.05	0.07	0.15	0.23
Other Top Officers	0.00	0.01	0.01	0.03	0.05	0.05	0.07	0.15	0.22
Average Stock Option Grants / Total Compensation									
CEOs	0.00	0.00	0.00	0.04	0.07	0.11	0.19	0.32	0.37
Other Top Officers	0.00	0.00	0.00	0.03	0.05	0.10	0.17	0.27	0.31

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. In firms where the title "CEO" is not used, the CEO is identified as the president of the company. Other top officers include any executive among the three highest-paid who is not the CEO. The within-firm ratio is the median across firms of the ratio of the CEO's total compensation to the average compensation of the two other highest-paid officers in the firm.

Table 4
The Correlation between Compensation and Firm Size

	Firm Size = Ln(Market Value)			Firm Size = Ln(Sales)	
	1936-1975	1946-1975	1976-2005	1946-1975	1976-2005
	(1)	(2)	(3)	(4)	(5)
Panel 1: DV = Ln(Comp$_{ift}$)					
Average Size in Year t	.088**	.137**	.935**	.157**	2.65**
	(.026)	(.025)	(.035)	(.032)	(0.11)
[fraction variance explained]	[.010]	[.020]	[.332]	[.017]	[.259]
Average Firm Size	.208**	.212**	.292**	.305**	.358**
	(.033)	(.032)	(.032)	(.037)	(.041)
[fraction variance explained]	[.145]	[.164]	[.135]	[.220]	[.113]
Size – Firm Avg. – Year Avg.	.182**	.199**	.264**	.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		.135**	.969**	.149**	2.63**
		(.024)	(.037)	(.031)	(0.11)
Size – Year Avg.		.218**	.313**	.277**	.389**
		(.040)	(.028)	(.046)	(.046)
Panel 3: Including Lagged Size and Firm FE					
Average Size in Year t		-.019	.622**	.240**	2.31**
		(.037)	(.086)	(.074)	(0.23)
Average Size in Year $t-1$		.152**	.378**	-.088	.362*
		(.041)	(.083)	(.063)	(.210)
(Size – Year Avg.) in Year t		.183**	.369**	.203**	.401**
		(.040)	(.038)	(.045)	(.067)
(Size – Year Avg.) in Year $t-1$		.020	-.064**	.084**	-.040
		(.041)	(.029)	(.030)	(.043)
Panel 4: Including Quadratic Time Trend and Firm FE					
Average Size in Year t		.035	.750**	.143*	-.312*
		(.032)	(.082)	(.079)	(.171)
Size – Year Avg.		.217**	.309**	.272**	.391**
		(.038)	(.028)	(.046)	(.042)
Panel 5: DV = ΔLn(Comp$_{ift}$)					
Δ Average Size in Year t		.012	.210**	.087*	.172
		(.031)	(.080)	(.049)	(.174)
Δ Size – Δ Year Avg.		.092**	.277**	.077**	.145
		(.032)	(.035)	(.024)	(.116)

Note: The dependent variable in panels 1 to 4 is the logarithm of total compensation for each executive and the dependent variable in panel 5 is the change in ln(compensation). Total compensation is the sum of salaries, bonuses, long-term bonus payments, and the Black-Scholes value of stock option grants, measured in $2000 and based on the three highest-paid officers in the largest 50 firms in 1940, 1960 and 1990 (a total of 101 firms). Size is measured by the logarithm of the firm's market value in columns (1) to (3) and by the logarithm of the firm's total sales in columns (4) to (5), both measured in $2000. Standard errors are shown in parentheses and are clustered by firm. Panel 1 decomposes firm size into three components: the average size of all firms in the sample in year t (to proxy for aggregate market size), the average size of the firm the executive works for over the entire sample, and the deviation in the size of the executive's firm from its average firm size and the average size of all firms in that year. Panel 2 controls for firm fixed effects. Panel 3 includes firm fixed effects and measures of firm size in the prior year. Panel 4 includes firm fixed effects and a quadratic time trend. Panel 5 controls for changes in firm size. Values in brackets show the fraction of the total variance explained by each independent variable based on an ANOVA decomposition for each sample period. Standard errors are in parentheses and are clustered by firm. * denotes significance at the 10% level and ** denotes significance at the 5% level.

Table 5
Managerial Stock Holdings Relative to Shares Outstanding
(Percentage Points)

	25th percentile	50th percentile	75th percentile	CEOs (median)	Other Highest-Paid Officers (median)
1936-1940	.019	.111	.402	.130	.088
1941-1949	.010	.038	.159	.048	.031
1950-1959	.011	.035	.109	.043	.031
1960-1969	.012	.037	.103	.047	.034
1970-1979	.008	.023	.064	.039	.019
1980-1989	.008	.019	.054	.029	.015
1990-1999	.011	.030	.084	.069	.021
2000-2005	.010	.028	.074	.072	.018

Note. The proportion of managerial stock holdings relative to shares outstanding at the 25th, 50th, and 75th percentiles are based on the three-highest paid executives in the 50 largest firms in 1940, 1960, and 1990 (a total of 101 firms). In firms where the title "CEO" is not used in the proxy statement, the CEO is identified as the president of the company. Other top officers include any executive among the three highest-paid who is not the CEO. The ownership of stock by each executive was obtained from SEC bi-monthly reports on security holdings and transactions from 1935 to 1942, from firm's proxy statements from 1942 to 1992, and from ExecuComp from 1992 to the present.

Table 6
Median Changes in Executive Wealth
($2000)

	Realized Changes in Value			*Ex-Ante* Changes in Value			
				Option Holdings		Stock Holdings	
	Option Holdings	Stock Holdings	Stock+Option Holdings	For $1000 change in firm market value (Jensen-Murphy)	For a 1 percent increase in firm's rate of return (Equity at Stake)	For $1000 change in firm market value (Jensen-Murphy)	For a 1 percent increase in firm's rate of return (Equity at Stake)
	(1)	(2)	(3) = (1)+(2)	(4)	(5)	(6)	(7)
1936-1940	0	84	84	0	0	1.35	18,401
1941-1949	0	15,404	16,514	0	0	0.39	6,530
1950-1959	0	70,923	117,275	0	0	0.31	9,392
1960-1969	0	43,568	97,133	0.11	7,913	0.35	20,531
1970-1979	0	6,660	24,203	0.12	6,303	0.22	11,766
1980-1989	102,926	77,366	318,687	0.24	13,056	0.17	12,735
1990-1999	343,665	233,842	1127439	0.41	57,975	0.29	36,273
2000-2005	0	135,066	459,726	0.65	127,195	0.27	49,729

Note. Based on the three-highest paid executives in the 50 largest firms in 1940, 1960, and 1990. Col. (1) is the median across executives of the realized change in the Black-Scholes value of the number of stock options held in the previous year. Col. (2) is the median realized change in the value of stock holdings in the previous year. Col. (3) is the median of the sum of these realized changes in stock and option holdings. The realized change in stock and stock option holdings are calculated based on the individual's holdings at the end of the previous year and the firm's realized rate of return during the year. Col. (4)-(7) show the *ex-ante* change in the value of stock or option holdings given a $1000 (Jensen-Murphy) or 1 percent (equity at stake) change in market value. *Ex-ante* revaluations of stock options are computed by calculating the stock option's "delta" for the particular portfolio held by each executive (Core and Guay 2002).

Table 7
Correlation of Changes in Executive Wealth with Firm Performance, 1936-2005

|	Dollar change in wealth for $1000 change in firm market value (Jensen-Murphy)			Dollar change in wealth for 1 percent increase in firm's rate of return (Equity at Stake)		
	Regression Coefficient for ΔWealth	Ex-Ante Revaluations of Stock + Option Holdings	Regression Coef. for Compensation	Regression Coefficient for ΔWealth	Ex-Ante Revaluations of Stock + Option Holdings	Regression Coef. for Compensation
	(1)	(2)	(3)	(4)	(5)	(6)
1936 – 1940	1.14 (0.66)	1.35	0.051 (0.030)	18,075 (5,122)	18,670	276 (891)
1941 – 1949	0.380 (0.121)	0.399	0.118 (0.061)	7,738 (1,867)	6,814	516 (595)
1950 - 1959	0.359 (0.096)	0.452	0.061 (0.016)	23,378 (2,865)	13,975	1,170 (638)
1960 - 1969	0.292 (0.125)	0.675	0.010 (0.007)	40,269 (7,067)	38,978	-472 (657)
1970 - 1979	0.128 (0.048)	0.470	-0.003 (0.004)	22,822 (3,710)	21,743	5 (610)
1980 - 1989	0.258 (0.072)	0.551	0.035 (0.015)	37,086 (5,151)	34,679	3,509 (1,284)
1990 - 1999	0.774 (0.270)	0.946	0.109 (0.017)	135,527 (22,986)	120,342	16,839 (4,076)
2000 - 2005	0.474 (0.092)	1.08	0.011 (0.037)	151,508 (30,123)	227,881	8,951 (11,242)

Note. Based on the three-highest paid executives in the 50 largest firms in 1940, 1960, and 1990 (a total of 101 firms). Col. (1) and (4) report regression coefficients of the realized change in executive wealth (defined as the sum of salary, bonuses, stock options granted during the year and the realized change in value of the previous year's stock and stock option holdings). Col. (1) reports the coefficient on the $1000 change in market value and col. (4) reports the regression coefficient on the firm's rate of return (measured in percentage points). Col. (3) and (6) report similar coefficients where the dependent variable excludes revaluations of stock and option holdings. All coefficients are based on median regressions, with standard errors are given in parentheses and clustered by firm. Col. (2) and (5) show the median across executives of the sum of the *ex-ante* revaluations of stock+option holdings reported in Table 6.

Table 8
The Strength of Managerial Incentives:
Change in Wealth Due to Raising the Firm's Rate of Return from the 50th to the 70th Percentile

	$ change in wealth	Percent change in wealth = $$\frac{(1)}{\text{total comp.}+\Delta\text{wealth at rate of return}^{50th}}$$	Elasticity = $$\frac{(2)}{\text{rate of return}^{70th}-\text{rate of return}^{50th}}$$
	(1)	(2)	(3)
1936 – 1940	265,270	28.6	2.00
1941 – 1949	96,947	9.2	0.64
1950 - 1959	199,046	22.9	1.60
1960 - 1969	556,247	50.7	3.54
1970 - 1979	312,559	29.0	2.03
1980 - 1989	496,266	27.6	1.92
1990 - 1999	1,720,953	52.3	3.66
2000 - 2005	3,212,822	59.0	4.12

Note. Based on the three-highest paid executives in the 50 largest firms in 1940, 1960, and 1990 (a total of 101). The dollar change in wealth is defined as the *ex-ante* revaluation of stock and option holdings assuming a rate of return at the 70th percentile (22.7%) minus the revaluation evaluated at the 50th percentile rate of return (8.4%). Col. (1) shows the median of this value across executives in each decade. The percent change in wealth is the dollar change in wealth for each individual executive divided by the total change in an executive's wealth at median firm performance, defined as the revaluation of stock and option holdings at the 50th percentile rate of return plus salaries, bonuses and stock option grants. Col. (2) presents the median of this value across executives in each decade. Col. (3) approximates an elasticity of changes in wealth to changes in firm performance by dividing col. (2) by the percentage difference in firm value between the 50th and 70th percentiles of firm performance (22.7 – 8.4 = 14.3%).

Figure 1
**Median Value of Total Compensation, 1936-2005**
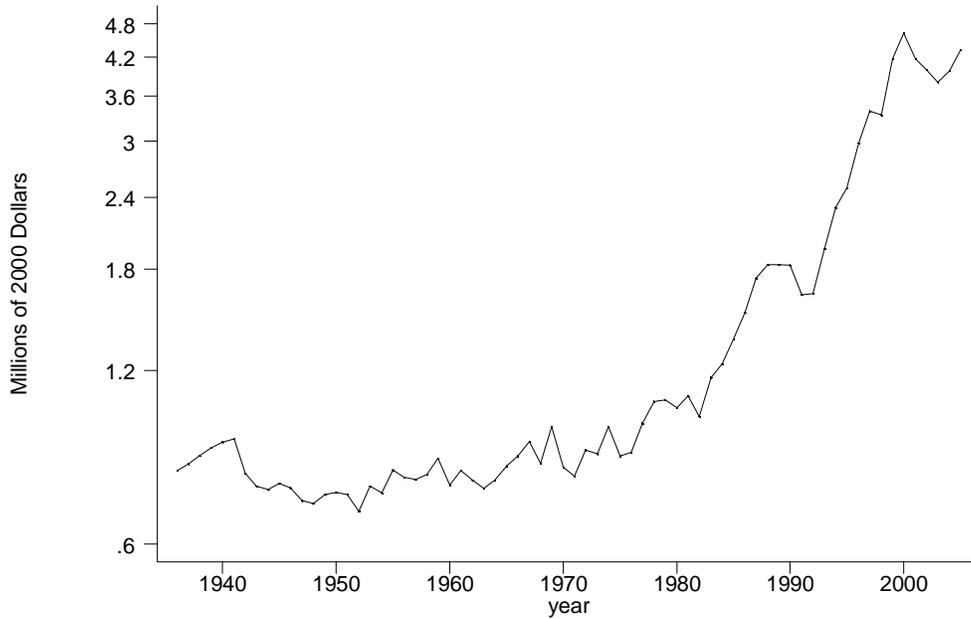
Note: Total compensation is composed of salary, bonuses, long-term bonus payments, and stock option grants. Based on the three highest-paid officers in the largest 50 firms in 1940, 1960 and 1990 (a total of 101 firms).

Figure 2
**Structure of Total Compensation, 1936-2005**
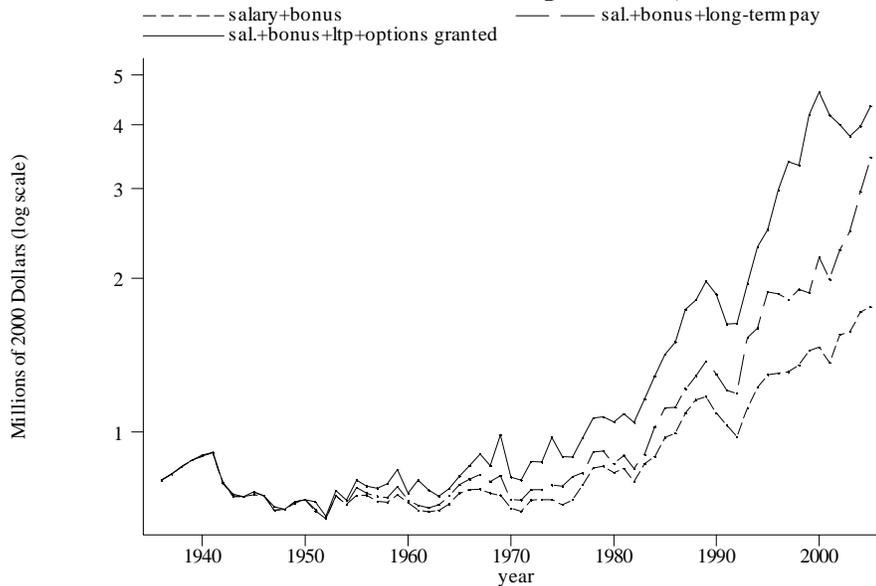
Note: Each line shows the median value of compensation defined as an increasing number of types: salary and current bonuses (paid out in stock or in cash); salary, current bonuses, and long-term incentive payments (paid out in stock or in cash); and salary, current and long-term bonuses, and the Black-Scholes value of stock options granted. Based on the three highest-paid officers in the largest 50 firms in 1940, 1960 and 1990 (a total of 101 firms).

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Figure 3
Fraction of Top Executives Granted and Holding Stock Options
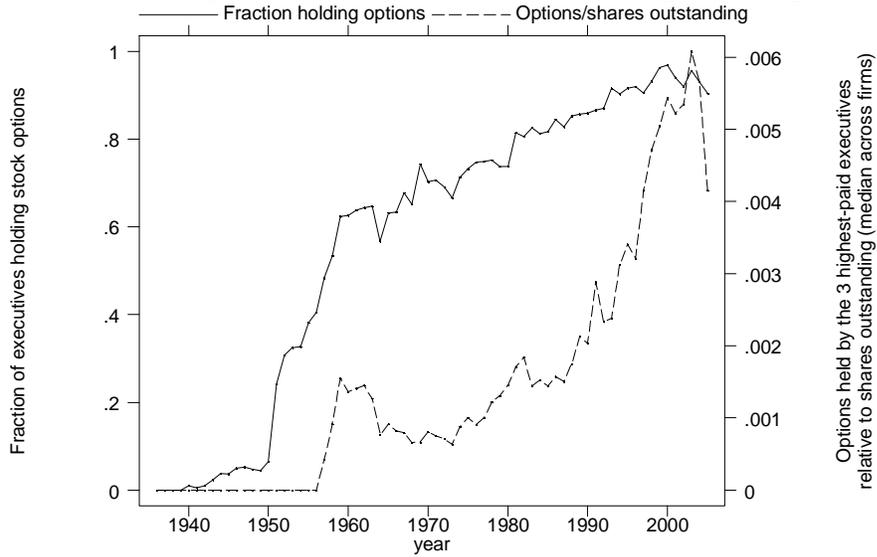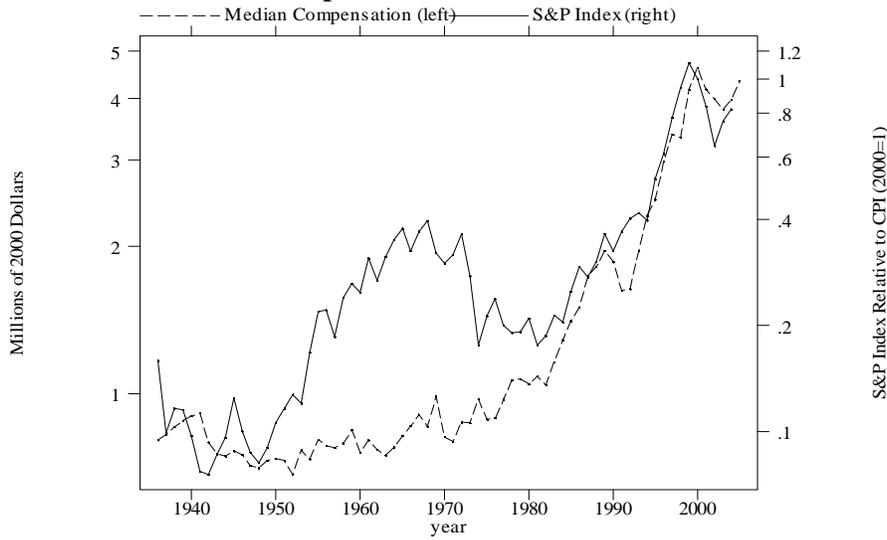

Note: Based on the three highest-paid officers in the largest 50 firms in 1940, 1960 and 1990 (a total of 101 firms). When not explicitly listed in proxy statements, stock option holdings are calculated based on the history of stock option grants and stock option exercises for each individual. The fraction holding options is the fraction of executives in the year that held at least one stock option. Options relative to shares outstanding is the median across firms of the total number of options held by the 3 highest-paid executives in the firm relative to the number of common shares outstanding.

Figure 4
**Median Total Compensation by Firm Size**
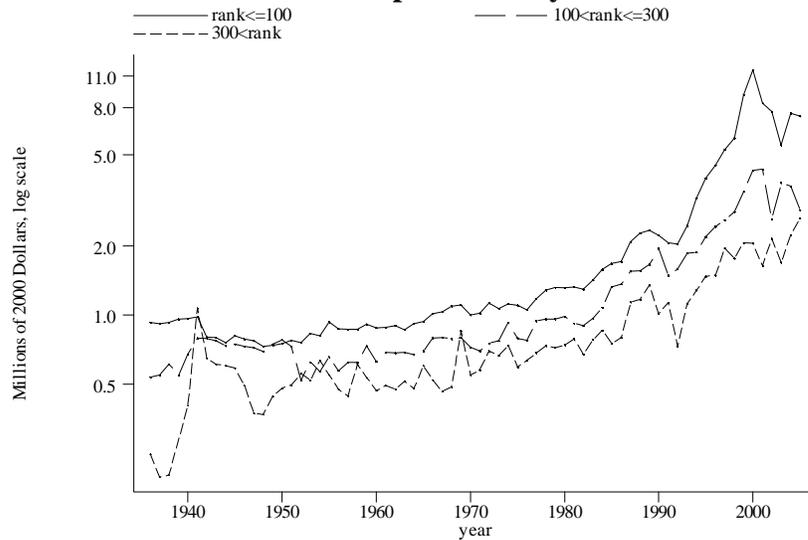
Note: Total compensation is composed of salary, bonuses, long-term bonus payments, and stock option grants. Based on the three highest-paid officers in the largest 50 firms in 1940, 1960 and 1990 (a total of 101 firms). Rank<=100 is the median total compensation across all executives in the sample in firms ranked among the top 100 according to market value in the year; 100<rank=300 is median total compensation for the executives in firms ranked 101 to 300; 300<rank is median total compensation for the executives in all firms in the sample that ranked bellow 300 in the year. 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. Market value for each firm is measured at the end of the fiscal year.

Figure 5
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 (a total of 101 firms). The S&P index is expressed relative to the CPI and equals 1 in 2000.

Figure 6
Size-Adjusted Indexes of Pay-to-Performance
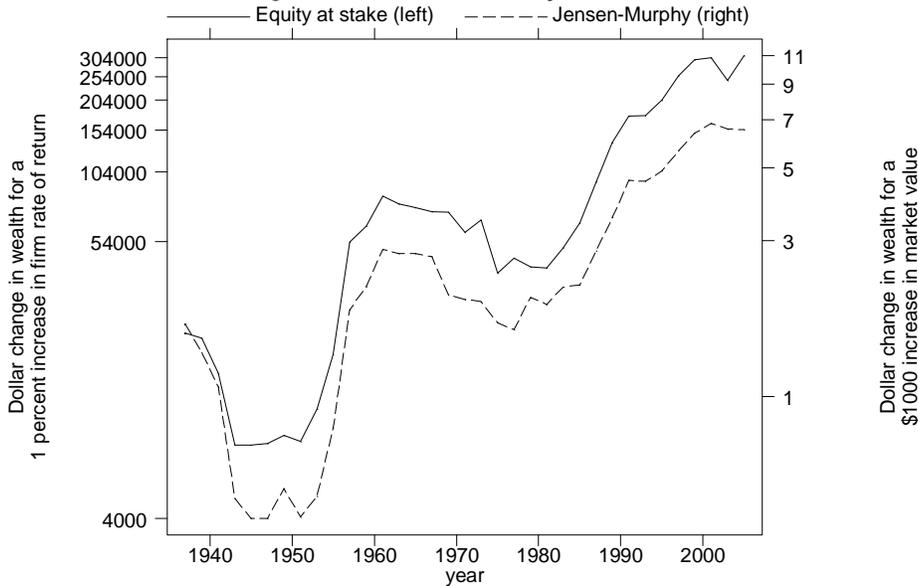
Note. Based on the three-highest paid executives in the 50 largest firms in 1940, 1960, and 1990 (a total of 101 firms). Results are based on regressing the Jensen-Murphy statistic or value of equity at stake of each individual (which are computed from the *ex-ante* revaluations of stock and option holdings) on indicator variables for time and firm size in a series of overlapping 4-year sample periods. Two-year growth rates in pay-to-performance are calculated as the change in the fitted values of these regressions from the first half to the second half of the 4-year sample period. The 1937 index values are set equal to median pay-to-performance in 1936-1937, and changes in these indexes over time reflect the 2-year change in pay-to-performance for a firm of median size. See Appendix Section 4 for details.

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