Growth through Rigidity:
An Explanation for the Rise in CEO Pay

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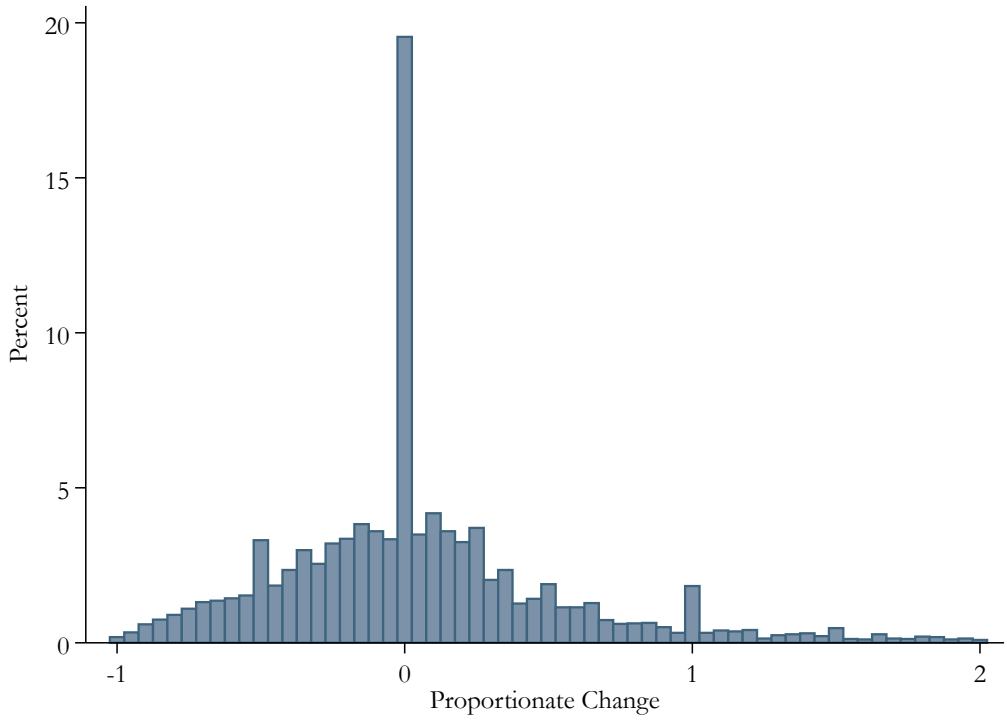
Abstract

We explore a rigidity-based explanation of the dramatic and off-trend growth in US executive compensation during the 1990s and early 2000s. We show that executive option and stock grants are rigid in the number of shares granted. In addition, salary and bonus exhibit downward nominal rigidity. Rigidity implies that the value of executive pay will grow with firm equity returns, which averaged 30% annually during the Tech Boom. Rigidity can also explain the increased dispersion in pay, the difference in growth rates between the US and other countries, and the increased correlation between pay and firm-specific equity returns. Regulatory changes requiring the disclosure of the value of option grants help explain the moderation in executive pay in the late 2000s. Finally, we find suggestive evidence that number-rigidity in executive pay is generated by money illusion and rule-of-thumb decision-making.



Annual proportionate change in the number of options granted
(S&P 500 CEOs, 1992-2010)

1 Introduction

The dramatic rise in compensation received by US CEOs during the 1990s and early 2000s is a longstanding puzzle. Compensation in 2011 dollars for the median S&P 500 CEO grew more than three-fold from $2.9M in 1992 to $9.3M in 2001. After 2002, growth leveled off considerably, with the median S&P 500 CEO earning $9M in 2011 (Murphy, 2012). Using historical data, Frydman and Saks (2010) find that compensation for US CEOs was also relatively flat in the decades leading up to the 1990s. Thus, the dramatic compensation growth during the Tech Boom was a sharp break from both the trend established in preceding years and that which prevailed in subsequent years. Adding to the puzzle, the growth in CEO pay was also off-trend relative to growth in other high income occupations (Kaplan and Rauh, 2010; Kaplan, 2012).

A number of explanations have been proposed for this phenomenon, including weak corporate governance (Bebchuk and Fried, 2004; Kuhnen and Zwiebel, 2008), an increase in managers'

marginal product due to technological advancement (Garicano and Rossi-Hansberg, 2006; Hubbard and Palia, 1995; Cuñat and Guadalupe, 2009a,b; Dow and Raposo, 2005), greater competition for CEOs with general skills (Murphy and Zábojník, 2004; Frydman, 2007), and increases in firm size combined with a multiplicative managerial production function (Gabaix and Landier, 2008; Tervio, 2008). While all of these theories are likely to be important contributors to growth in executive compensation, each also has shortcomings in explaining some of the major stylized facts (Frydman and Jenter, 2010), particularly the off-trend nature of CEO pay during the Tech Boom.

In this paper, we explore an alternative (and complementary) explanation for this surge in executive compensation. We begin with the well-known fact that the bulk of the growth in CEO pay arrived in the form of new at-the-money option grants. Hall (1999) and Shue and Townsend (2013) show that many firms granted options according to multi-year fixed number plans, under which the same number of options were granted in consecutive years. More generally, we show in this paper that firms initially focused on the *number* of options granted rather than the value of those options, which led to rigidity in the number of options granted from year to year. Rigidity in number can have large consequences for compensation growth: all else equal, if a firm pays its CEO the same number of at-the-money options as in the previous year, and the firm's stock price increases by X%, the grant date Black-Scholes value of those options will also increase by X%. Thus, in an environment like the Tech Boom, with rapid growth in stock prices, number-rigidity could lead to rapid growth in the grant date value of option compensation. At the same time, we find that other forms of executive compensation, particularly salary and bonus exhibit strong downward nominal rigidity. The inability of cash compensation to adjust downward meant that other forms of compensation could not adjust to offset the dramatic rise in option pay. Finally, regulatory changes in the 2000s required firms to begin disclosing and expensing the grant date value of option compensation. To the extent that number-rigidity results from a lack of attention to value, these changes may have moved firms away from number-focus, and explain why CEO pay increased less with stock returns during the second stock market boom in the mid 2000s.

We begin by showing that option grants over our sample period are strongly rigid in number.

By far, the modal percentage change in the number of options granted in consecutive years is zero; nearly 20% of new grants contain the same number of options as the previous year's grant. More broadly, the number change distribution suggests that executives and firms think about options in units of number instead of value. Pay increases are often indexed to last year's number, e.g. a 10% increase in last year's number. Even after adjusting for splits, there are also pronounced spikes at round multiples of the previous year's number, such as 2X or .5X.

We categorize option grants each year as number-rigid if they have the exact same number of split-adjusted options as the grant in the previous year. Otherwise, we consider the grant to be non-rigid. We find that the slope of the relationship between changes in the value of option compensation and a firm's stock return is much less steep for non-rigid grants than for number-rigid grants. In other words, CEO's with number-rigid grants gain more than CEOs with non-rigid grants when individual firm returns are high and less when firm returns are low. Since firm returns were high on average in the 1990s and early 2000s, number-focused CEOs experienced high growth in option pay on average. Similarly, we find a steeper pay-return relationship for total compensation among the number-rigid sample relative to the non-rigid sample, suggesting that other forms of compensation do not offset the large changes in pay induced by number-rigidity in options. We use the relationship estimated from the non-rigid sample to predict counterfactual total compensation growth for the number-rigid sample if they had instead been non-rigid.

Next, we show that number-rigid and non-rigid firms compete for CEO talent in an integrated labor market, implying that pay policies at number-rigid firms will have spillover effects on the level of compensation at non-rigid firms. We calibrate a model of competitive spillovers from Gabaix and Landier (2008) to estimate the total effect of number-rigidity on aggregate growth in CEO pay.[1] Our calibrations show that number-rigid option compensation can indeed explain much of the off-trend growth in CEO pay during the Tech Boom.

[1]It may appear counterintuitive to use the Gabaix and Landier (GL) model to calibrate number-rigid spillovers because the GL model can already explain the growth in compensation during the Tech Boom without accounting for any number-rigid spillovers. However, GL can only fit the data during the Tech Boom under the assumption that model parameters changed dramatically over time. We show that spillovers from number-rigidity can help explain the off-trend growth in CEO compensation during the Tech Boom while allowing for more conservative parameter estimates.

Even if the value of option compensation is more sensitive to firm returns for number-rigid firms, it remains possible that non-option compensation decreases when returns are high in order to keep total compensation in line. To investigate this, we examine whether number-rigid firms with high "excess" increases in option compensation (relative to the counterfactual) have a decrease in their cash compensation. We find no evidence of offsets in cash compensation when option compensation is high relative to the counterfactual.

One reason that cash compensation may not offset large excess changes in option compensation is that cash compensation for CEOs is downward rigid in nominal dollars. To test for downward rigidity, we follow the methodology developed by Card and Hyslop (2007). We estimate that 15.9% of CEO-years would have had a salary cut over the sample period absent rigidity and that downward rigidity raised average salary growth by 1.6%. Perhaps more surprisingly, we also find evidence of significant downward rigidity in bonus compensation. We estimate that 9.3% of CEO-years would have had a bonus cut absent rigidity, and that downward rigidity raised average bonus compensation by 3.9% each year.

Overall, we conclude that number-rigidity in options combined with downward rigidity in other forms of compensation can explain much of the off-trend growth in executive compensation during the Tech Boom. Our explanation also matches three other stylized facts in the literature. First, the cross-sectional dispersion of CEO compensation increased substantially in the 1990s (Frydman and Jenter, 2010). This increase in dispersion could follow from number-rigidity, as number-rigidity increases the sensitivity of compensation to individual firm returns, which are highly heterogeneous due to idiosyncratic volatility. Second, CEOs outside of the US experienced significantly slower compensation growth during the Tech Boom, controlling for country-level growth and firm characteristics such as industry and size (Abowd and Bognanno, 1999; Abowd and Kaplan, 1999; Murphy, 1999; Thomas, 2009; Fernandes et al., 2013). Equity-based compensation is less common for non-US CEOs, often for regulatory reasons. For example, option plans were illegal in Germany until 1996. As a result, non-US executives are less likely to have a number-rigid component of their pay. Finally our explanation is consistent with the empirical fact that compensation became very correlated with

firm-specific stock returns in the 1990s.

The primary goal of this paper is not to determine the exact origins of number-rigidity but rather to highlight its implications for compensation growth. Nonetheless, in the remainder of the paper, we explore possible sources of number-rigidity. We distinguish between two broad classes of theories. The first class consists of theories in which all parties involved understand how to value options, but choose to hold the number fixed, possibly because number-rigidity implements an optimal incentive scheme. For example, firms may grant number-rigid options to manage executive ownership or to maintain steep pay-for-performance incentives (although tying pay to raw equity returns implies that executives will also be rewarded for lucky macro shocks). Alternatively, firms may grant a fixed number of options each year so that compensation grows with firm size. In this latter case, the theoretical basis is unclear: most models of competition for managerial talent do not imply that compensation should rise one-for-one with firm-specific returns. For example, Gabaix and Landier (2008) predict that, holding the firm-CEO match fixed, pay should increase with *market* returns rather than firm returns, because market returns are a better proxy for an executive's outside option. Finally, number rigidity may result from a lumpy-adjustment or "SS" style model in which firms allow number to be rigid for several years and then adjust number to offset changes in value in flexible years. We are able to reject the lumpy-adjustment model by showing that following years of number-rigidity, number and value tend to significantly increase in adjustment years relative to a control sample.

The second class of theories are ones in which at least one party in the compensation negotiation process is partially naive about option valuation and uses the number of options granted as a proxy for value. There is ample anecdotal evidence that when option compensation first came into use, many did not understand or trust complex valuation methodologies such as that developed by Black and Scholes (1973). Resistance to using option valuation formulas, such as Black-Scholes, was also rooted in the idea that these methodologies may overstate the true value of options to executives, who face restrictions on how and when options can be exercised. However, these arguments neglect the fact that the Black-Scholes value does reflect the cost of the option grant from the point of

view of shareholders. Further, the value of the option for the CEO (and the expected realized value at exercise) under any valuation method will increase proportionally with firm returns if option number is held constant.

The tendency to mistakenly value options using number may represent a variant of "money illusion," the well-known tendency of individuals to think about money in nominal rather than real values (Kahneman et al., 1986; Shafir et al., 1997). If so, money illusion in number could lead to number-rigidity through any of the standard behavioral explanations of downward nominal wage rigidity (see Bewley (1999) for a comprehensive review). Bewley (2007) reviews the survey/experimental evidence and concludes that nominal wage rigidity is best explained by the morale theory, i.e. the concern that workers consider nominal wage cuts unfair. This also relates to the notion of reference-dependent motivation advanced in Mas (2006) and highlighted in Camerer and Malmendier (2012). Consistent with these morale-based explanations, we find anecdotal evidence from executive compensation surveys that executives viewed a decrease in option number as unfair. However, determining the extent to which morale concerns generates number-rigidity is beyond the scope of this paper.

To shed light on whether some form of naiveté plays a role in number-rigidity, we first exploit the fact that stock compensation also has a number and value associated with it. However, in the case of stock compensation, translating number to value is much simpler than in the case of options. Consistent with this, we find that, while some stock grants are number-rigid, the prevalence of number-rigidity for stock compensation is significantly lower than for option compensation over our sample period.

Second, we take advantage of a regulatory change in 2006 which required firms to report and expense the grant date fair value of option awards. Prior to this regulatory change, firms were only required to report the number of options granted, although a sophisticated agent should have been able to infer the value from the number and the grant date share price. Nevertheless, mandated disclosure of value likely contributed to a shift in focus from number to value. We find that, conditional on granting options, the prevalence of number-rigid option grants decreased significantly

following the regulatory change. Moreover, there was no change in the prevalence of number-rigidity for stock grants, which had to be reported in terms of value throughout the sample period. The sensitivity of option number-rigidity to disclosure regulations also cuts against most simple explanations of number-rigidity as the outcome of an optimal incentive scheme, as we would expect such pay policies to remain unchanged following disclosure shocks.[2]

Finally, we examine how number-rigidity interacts with stock splits. Following a positive stock split, the modal percentage change in the number of options granted is 100%, i.e. split-adjusted number-rigidity in a 2-for-1 split. However, the next most common occurrence is for the number of options granted to remain the same as in the previous year, despite the split. This surprising result suggests that some parties focus on the number of options granted, even following a split. Again, this is in contrast to stock grants where, following a split, very few executives receive the same number of shares as they did in the previous year. Overall, we conclude that the evidence is most consistent with the class of theories in which number-rigidity is generated from a form of money illusion.

Our paper builds on a substantial literature in executive compensation, which we discuss in Section 2. However, our focus on number-rigidity is most closely related to two findings in the literature. First, as already mentioned, Hall (1999) and Shue and Townsend (2013) show that many firms grant options according to fixed number cycles. The existence of these fixed number cycles suggests that some part of number-rigidity may have been consciously pre-planned as part a multi-year option grant schedule. This paper shows that, pre-planned or not, rigidity in number can have value implications, especially if firms choose to remain on a rigid number schedule as equity prices experience a sustained increase.

Second, we build on important insights from a recent survey of executive compensation in Murphy (2012) which argues that regulations requiring firms to report and obtain shareholder approval for the number of options granted led boards and executives to think about options in terms

[2]However, we cannot rule out a more complex optimal contracting theory in which number rigidity implements the optimal incentive contract, but disclosure of value prompts naive shareholders to focus more on value and block the implementation of the optimal incentive contract.

of number. Murphy infers that firms were likely to have focused on number from the correlation between CEO pay and aggregate market returns in the 1990s. Such a focus explains why, in addition to realized compensation at option exercise, the grant-date value of options also varied with the overall market. In this paper, we provide direct evidence that firms granted options with a focus on number and calibrate the value consequences of number-rigidity. We show that number-rigidity in option grants combined with downward rigidity in other forms of compensation can explain growth trends in the value of executive compensation.

The remainder of this paper is organized as follows. Section 2 discusses recent trends in executive compensation and Section 3 summarizes the data. Section 4 quantifies rigidity in executive compensation and estimates the extent to which rigidity can explain the growth in compensation. Section 5 explores potential sources of rigidity and Section 6 concludes.

2 Recent Trends in Executive Compensation

2.1 Growth in Executive Compensation

Before exploring the effects of rigidity on executive compensation growth, we first review recent trends in executive compensation. Figure 4 reproduces a graph from Murphy (2012), restricting the sample to CEOs of firms that were ever a part of the S&P 500 during the sample period. The level of each bar represents the median level of total compensation that year in 2011 dollars. In addition, each bar is decomposed into the separate components of compensation based on the mean proportion represented by each that year. As has been previously documented, total compensation grew rapidly from 1992 to 2001, more than tripling, before subsequently leveling off. As can also be seen, the vast majority of this growth was in the form of option compensation, which came to represent the largest single component of CEO pay. Most of the other components remained relatively flat during this time period. In later years, option compensation appears to have been replaced by stock compensation to some extent. This most likely occurred because firms were required to begin expensing the grant date fair value of options in 2006, which reduced the accounting advantages of

option grants.

Figure 5 shows the time series of median option compensation, non-option compensation, and total compensation for the same sample as Figure 4. Mean income for the top 1% and 0.01% of US earners using data from Piketty and Saez (2003) are also shown for comparison. All values are adjusted for inflation and normalized to equal one in 1992. Again, it is clear from this figure that option compensation grew faster than other forms of compensation from 1992 to 2001. Option compensation grew more than 6-fold over this period, while non-option compensation remained relatively flat, growing at a rate similar to the mean income for the top 1% and 0.01% of earners. Thus, most of the growth in total compensation in excess of other high earners during this period came in the form of options. Also consistent with Figure 4, subsequent to 2001 total compensation leveled off considerably, while option compensation decreased, and non-option compensation increased.

2.2 Regulatory Changes and the Use of Options

In this paper, we show that rigidity in the number of options granted to executives across years, combined with rapidly increasing equity prices, can explain the patterns just described. We acknowledge that this is somewhat of a partial theory in the sense that it does not explain why option compensation came into use in the first place. Murphy (2012) argues that the sudden rise of the use of options as a form of compensation for executives in the 1990s was driven largely by a perfect storm of increased shareholder pressure for equity-based pay combined with various regulatory changes that happened to coincide.

For example, in 1991 the SEC changed its holding period rules so that stock acquired from exercising options could be sold immediately, as long as the exercise date was more than six months after the grant date. Prior to this, executives had to hold stock acquired from exercising options for at least six months. This meant that executives exercising options faced significant short-run cash-flow problems (from paying the exercise price) and increased risk (from the possibility the stock price might decline between the time the options were exercised and the shares obtained were sold). In 1992, the SEC set pay disclosure rules such that only the number of options paid to executives

needed to be disclosed and not the value of those options. In 1993, the Clinton $1M deductibility cap was passed. This made compensation in excess of $1M non-deductible for tax purposes. However, the cap did not apply to performance-based pay, including at-the-money options. In addition to all this, prior to 2006 options did not need to be recognized as an expense on a firm's income statement, making them attractive from an accounting perspective.

Again, we do not attempt to explain why firms began using options. The above factors all likely contributed. Our goal is to highlight that, conditional on using option compensation, a reluctance to change the number of options awarded could lead to high growth in the value of new grants year to year.

2.3 Existing Explanations

A large literature tries to explain the controversial explosion of executive compensation concentrated in the Tech Boom (1990s and early 2000s). One view is that CEOs were able to raise their own pay due to weak corporate governance (Bebchuk and Fried, 2004; Kuhnen and Zwiebel, 2008). According to this view, the reason that most of the increase in compensation came in the form of options is that options are less observable. More in the spirit of this paper, it has also been argued that options may have been difficult for boards to understand (Hall and Murphy, 2003; Jensen et al., 2004), and thus were an easier form of compensation for executives to "skim." One issue with this explanation, however, is that there is little evidence to suggest that corporate governance has become weaker over time or in the 1990s in particular. If anything, it appears that governance has been on an upward trend (Holmstrom and Kaplan, 2001; Hermalin, 2005; Kaplan, 2008).

Another view is that the growth in CEO pay is primarily due to increases in firm size. According to this view, managerial talent has a multiplicative effect on firm output so that matching with a slightly more talented manager can lead to large increases in firm value (Gabaix and Landier, 2008; Tervio, 2008). Gabaix and Landier (2008) show that under certain conditions, CEO pay should move one-for-one with changes in the size of the typical firm. Thus the six-fold increase in CEO pay between 1980 and 2003 can be explained by the six-fold increase in average market capitalization

over that period. However, Frydman and Saks (2010) show that firm size and CEO pay are almost uncorrelated prior to 1970 and the relationship following 1970 is sensitive to sample-selection (Nagel, 2010). Perhaps most importantly, this theory does not predict that compensation should be more strongly tied to individual firm returns than aggregate returns. It also does not predict that the increase in compensation should come in the form of options or that options should be number-rigid.

A final view is that CEO compensation has risen due to changes in the nature of the the job. For example, managers' marginal product may have increased due to improved communications technology (Garicano and Rossi-Hansberg, 2006), increased competition (Hubbard and Palia, 1995; Cuñat and Guadalupe, 2009a,b) or higher volatility of the business environment (Dow and Raposo, 2005; Campbell et al., 2001). Hermalin (2005) suggests that CEOs must be compensated for the increased risk of being fired due to improved corporate governance. Frydman (2007) and Murphy and Zabojnik (2006) show that CEO jobs have increasingly placed a greater emphasis on general rather than firm-specific skills; this may have allowed managers to capture a greater portion of the rents. While all of these theories are likely to be important contributors to growth in executive compensation over the past several decades, they also don't fully capture the unique trends during the Tech Boom. None of these theories are tied directly to option compensation. In addition, the effect of the various factors suggested may not be large or rapid enough to explain the dramatic trends in compensation during the 1990s and early 2000s.

3 Data

3.1 Sources

We use executive compensation data from ExecuComp, which covers firms in the S&P 1500. Our sample period runs from 1992 to 2010. The data are derived from firms' annual proxy statements and contain information regarding the compensation paid to the top executives in a firm (usually five per firm) in various forms (e.g. salary, bonus, stock, options, etc.) during the fiscal year. For options, ExecuComp contains detailed grant-level data on the date and amount of each option grant.

In 20% of cases, executives receive more than one option grant during a fiscal year. Often one grant is specific to the executive, while another is part of a long-term incentive plan that is common among all executives in the firm. In these cases, we focus on the largest option grant (as measured by the number of options) within each fiscal year, to better identify number-rigid grants. Having the exact date of the grant also allows us to precisely measure firm returns between consecutive grants. In 2006, firms were required to begin reporting the fair value of option compensation. Following the literature, we use the Black-Scholes value computed by ExecuComp when fair value is not reported.

Accounting data come from Compustat. Market and firm return data come from the Center for Research in Security Prices (CRSP) and the Fama-French Data Library. For all subsequent analysis, unless noted, we restrict the sample to CEOs of S&P 500 firms. To address sample selection issues, we include past and future data on firms that were ever included in the S&P 500 index during the sample period. The historical S&P 500 index constituents are obtained from Compustat.

3.2 Identifying number-focused and value-focused option grants

We categorize CEO option grants each year as number-rigid if the split-adjusted number of options in the grant divided by the number of options in the previous year's grant is equal to 1. All other CEO-years are considered non-rigid. Because non-rigid CEO-years are more likely to be contain value-focused compensation, we use the terms value-focused and non-rigid interchangeably in the remainder of the paper. Within the set of non-rigid CEO-years, we also categorize grants as number-referenced if the ratio of the number of options granted this year relative to last year does not equal 1, but does equal 1$\pm$ a multiple of 1/3, 1/4, ..., 1/10. Number-reference captures the fact that many option grants contain exactly 1.5, 2, or 0.5 times the number of options awarded in the previous year, or an exact fractional increase (e.g. 10% raise) relative to last year's number. These number-referenced option grants may or may not be number-focused. They could represent pay adjustments targeted at an X% change in number. Alternatively they could represent pay adjustments that were actually targeted at an X% change in *value*, rounded to the nearest round lot in number. Because of this ambiguity, we exclude number-reference grants from the counterfactual

control sample described in Section 4.

3.3 Summary Statistics

Next, we explore the extent to which firms with number-rigid CEO option compensation differ from other firms in terms of their observable characteristics. Because there are likely to be time trends in these variables and the prevalence of number-rigidity has changed over time, we examine three cross-sections of the data from 1995, 2000, and 2005, rather than pool all years together. Table 2 compares firm characteristics across number-rigid and all other firms. Number-rigid firms appear to be fairly similar to other firms in terms of size, market to book, investment, leverage, and profitability. The largest difference is that number-rigid firms are somewhat larger in terms of assets in 2005. Table 3 shows the industry distribution within number-rigid and other firms. Industries are defined according to the Fama-French 12-industry classification scheme. We find that number-rigidity occurs across many industries and that overall the industry distribution is similar for number-rigid firms and others. The main exception is that number-rigid firms are somewhat more likely to be in the manufacturing industry in the earlier years of the sample. It should be noted that our analysis does not assume that firms choose to give number-rigid compensation randomly. Indeed, firms that do so may be poorly governed or have less sophisticated management.

4 Results

4.1 Rigidity in Executive Compensation

We begin by exploring the extent of rigidity in various units for each component of executive compensation over our sample period. By rigidity, we refer specifically to cases in which the distribution of the change in compensation relative to the previous year appears lumpy, with extra mass at zero (no change relative to previous year). First, we compute the proportional change in the (split-adjusted) number of options granted to a CEO in the current year relative to the number granted in the previous year. Panel A of Figure 1 shows a histogram representing the distribution of this

proportional change. The most striking feature of this figure is the large spike at zero. By far, the modal outcome is for a CEO to be paid the exact same number of options in the current year as in the previous year. This is the case for nearly 20% of CEO option grants. Interestingly, there are also spikes at round changes such -50% and 100%. In addition, in later analysis we find that many other proportional changes occur in round units, e.g. an exact 10% increase in the number of options relative to the previous year. Both of these observations suggest that many executives and boards think of option grants in number, rather than dollar terms. To further explore this, we also compute the log change in the grant-date Black-Scholes value of options granted to an executive in the current year relative to the value granted in the previous year.[3]Panel B of Figure 1 shows a histogram representing the distribution of this change in value. We find significantly less evidence of rigidity in terms of value: less than 6% of CEOs receive the same value of options as in the previous year.

Next, we examine stock compensation.[4]The value of a stock grant may be easier to conceptualize than the value of an option grant. Therefore, one might expect executives and boards to think about stock compensation exclusively in dollar terms–leading to rigidity in value rather than number. In Figure 2 we plot the proportional change in the number of shares granted as well as the log change in the value of shares granted. Perhaps surprisingly, we find strong evidence of rigidity along both dimensions, with large spikes at zero in both histograms. Thus, it appears that even stock grants are often thought of in number terms.

Finally, we repeat the same exercise with cash compensation in Figure 3. In this case, everything is naturally measured in nominal dollar terms, so we plot the distribution of the log change in the nominal value relative to the previous year. For salary, we find significantly more weight on the

[3]Before 2006, firms were only required to disclose the number of options granted. Therefore, we use ExecuComp's Black-Scholes value in these years. In addition, we also explore the face value of option grants (defined as the number of options granted multiplied by the price of the underlying equity on the day of the grant) because conversations with compensation consultants suggest that many firms used face value rather than Black-Scholes value as their measure of value during the period prior to 2006. We find minimal rigidity in the Black-Scholes value of options and modest amounts of downward nominal rigidity in the face value of option grants.

[4]Before 2006, firms were only required to disclose the value of a stock grant. Therefore, we estimate the number of shares granted by dividing this value by the stock's closing price on the date of the grant. Our estimate may contain error if the stock was valued according to a stock price other than the closing stock price.

right side of the distribution (above zero), suggesting a resistance to salary cuts. This evidence of downward nominal wage rigidity among CEOs is similar to what others have found in terms of total compensation for the general population of workers, e.g. Card and Hyslop (2007). Perhaps more surprisingly, we also find similar, albeit less striking, evidence of downward nominal rigidity in bonus (and thus total cash compensation). The extent of this downward nominal rigidity and its relationship with option number rigidity will be explored further in Section 4.3.

4.2 Number-Rigidity and Option Compensation Growth

In this section, we estimate how much number-rigid option grants may have contributed to the overall growth in the level of total compensation during our sample period. Importantly, we do not claim that number-rigid compensation is necessarily suboptimal. We simply estimate counterfactual pay growth if the set of number-rigid firms had granted options in the same manner as non-rigid firms conditional upon firm performance. To estimate the counterfactual, we identify a set of number-rigid CEO-years. We then estimate what option value growth would have been for this set of observations, using the relationship between firm returns and option value growth in the non-rigid sample (the control sample). We find that number-rigid option grants award more value than the control sample when firm returns over the previous year are high and award less value than the control sample when firm returns are low. However, firm returns were on average positive and large during our sample period, particularly during the Tech Boom, implying number-focused option awards granted more value on average than value-focused option grants in each year, controlling for firm performance. Finally, we estimate spillover effects. In equilibrium, competition should lead to higher pay for all executives when some receive large raises. We use a model of competitive spillovers to estimate how much of the aggregate growth in total compensation can be attributed to number rigidity.

4.2.1 The Relationship between Option Compensation Growth and Firm Returns

We compare the relationship between option value growth and firm return for the number-rigid and non-rigid samples. Figure 6 plots changes in the log Black-Scholes value of options granted against the log firm return between the two grants. We fit a local linear regression using the Epanichnikov kernel with the rule-of-thumb bandwidth. For the number-rigid sample, we expect the relationship to fall along the 45 degree line because a firm return of $X\%$ should exactly translate to an $X\%$ change in the Black-Scholes value of new at the money option grants, absent any changes in volatility. Because volatility does not change substantially year to year within our sample, we indeed find that the empirical relationship falls very close to the 45 degree line. For the non-rigid sample, we find that the relationship between option value growth and firm returns is approximately linear and substantially flatter than that in the non-rigid sample. The two curves cross just to the right of zero firm returns. This implies that, relative to non-rigid CEOs, number-rigid CEOs receive higher raises in option value when firm returns are positive and lower raises in option value when firm returns are negative. Consequently during boom periods when firm returns are high on average, number-focused CEOs experience higher option value growth than non-rigid CEOs on average.

In Figure 7, we repeat the exercise but focus on the relationship between total compensation growth and firm return for the number-rigid and non-rigid samples. If the non-option components of compensation (salary, bonus, and stock grants) do not move significantly to offset the change in value caused by number rigidity in options, we expect that the relationship between changes in total compensation and past firm returns will also be more steep for number-rigid firms than for non-rigid firms. Empirically, we indeed find a steeper relationship for the number-rigid sample, although the effect is slightly asymmetric. Following positive firm returns, number-rigid CEOs receive significantly larger increases in total compensation relative to the non-rigid sample. Following negative firm returns, number rigid CEOs receive greater declines in total compensation relative to the non-rigid sample, although here the difference is less dramatic and significant. This suggests that other types of compensation do not offset gains caused by number-rigidity when returns are

high but do somewhat adjust to offset losses caused by number-rigidity when returns are low.

In the next section, we use the relationship between total compensation growth and firm returns among the non-rigid sample to estimate counterfactual growth in total compensation for the number-rigid sample. Importantly, the vertical distance between the solid and dotted lines is a lower bound for the difference between number-rigid CEOs' actual and counterfactual compensation growth. Conditional or firm performance, observations within the non-rigid sample are likely to be affected by competitive spillovers from the number-rigid sample. Therefore, the estimated relationship between growth in compensation and firm returns among the non-rigid sample may be steeper than the true relationship in a world without number-rigidity. This will lead us to underestimate the absolute vertical distance between these two lines.

4.2.2 Spillovers and Aggregate Option Compensation Growth

Next, we estimate the effect of number-rigidity on aggregate growth in total compensation after taking into account potential spillover effects. The intuition is that if a subset of firms choose to pay their CEO more (or less) than other firms, then other firms will adjust compensation in the same direction due to competition for CEO talent.

Before describing the spillovers calibration, we present three pieces of motivating evidence that spillover effects across rigid and non-rigid firms are likely to exist. Importantly, we do not claim that firms randomly sort into being number-rigid or non-rigid, although they do appear similar on many observable dimensions as shown previously in Tables 2 and 3. Instead, we show that number-rigid and non-rigid firms compete in a common market for CEO talent such that spillover effects are likely to occur.

First, we show that number-rigid firms (which tend to award higher than predicted compensation) tend to award the same high compensation to new incoming CEOs. This suggests that the compensation levels at number-rigid firms will add competitive pressures to the market for CEO talent. In Panel A of Table 4, we examine how CEO compensation changes following turnover events for number-rigid and non-rigid firms. A firm is characterized as rigid (non-rigid) if the pre-

vious CEO received rigid (non-rigid) compensation in the year before the turnover event. We find that total compensation increases on average following turnover events and the log difference in total compensation between the new and previous CEO is similar among rigid and non-rigid firms. Likewise, the value of option compensation increases on average following turnover events and the log difference in option compensation between the new and previous CEO is also similar among rigid and non-rigid firms.

Second, we show that executives at rigid and non-rigid firms appear to work in integrated rather than segmented labor markets. In Panel B of Table 4, we examine transition probabilities using a sample of all executive transitions during the period of 1992-2010. We find that executives working at number-rigid firms are no more likely than others to transition to another number-rigid firm. These results suggest that rigid and non-rigid firms compete for a common pool of executive talent.

Third and finally, we show that number-rigid firms do not undo the gains in compensation experienced during number-rigid years when they do adjust the number of options granted. In other words, number-rigid firms do not follow a lumpy adjustment or "SS" style adjustment model in which they allow compensation to drift up with returns during rigid years and then implement a large adjustment downwards in value or number during flexible years. It is important to rule out a lumpy adjustment model because such a model would imply that number-rigid firms may not apply upward competitive pressure on aggregate levels of compensation if number-rigid firms also experience large declines in compensation in flexible years. In Panel C of Table 4, we show that number-rigid firms actually tend to increase the value of compensation granted during flexible years as compared to a control sample of firms that did not grant number-rigid options in the previous year. This upward adjustment in value is driven by the fact that number rigid firms tend to increase, rather than decrease, the number of options granted in years in which they adjust the number of options granted.

After presenting evidence that competitive spillovers are likely to occur, we now turn to a calibration of a model of competitive spillovers as presented in Gabaix and Landier (2008), hereafter referred to as GL. At first glance, it may appear counterintuitive to use the GL model to calibrate

spillovers because, under certain parameter assumptions, the GL model can already explain the growth in compensation during the Tech Boom without option number-rigidity. However, the GL model fits the growth patterns during the Tech Boom only if we assume that γ is close to one, i.e. that the CEO's impact on earnings displays constant returns to scale. If $\gamma = 1$, then median compensation should rise one-for-one with aggregate market returns which approximately matched growth in median compensation during the Tech Boom. The issue is that if the GL model is estimated over a longer time period (e.g. using data post 2004 or pre 1992), then estimates of γ fall substantially below one. If γ is substantially less then one, median compensation should rise less than one-for-one with aggregate market returns, so changes in the market size of firms alone cannot match the growth patterns during the Tech Boom. For example, we estimate $\gamma = 0.5$ after extending the GL sample of 1992-2004 to the 1992-2010 period. In what follows, we show that $\gamma = 0.5$ plus spillovers from number-rigidity can explain the off-trend growth in CEO compensation during the Tech Boom.[5]

For brevity, we only summarize the relevant parts of the calibration here. See GL for a full discussion of model assumptions and derivations. As with any calibration exercise, our estimates do not fully account for heterogeneity and are meant to act as a rough approximation of the size of potential spillover effects.

GL's model implies that, if a fraction f of firms wish to pay their CEO λ as much as similarly-sized firms, the pay of all CEOs will increase by

$$\Lambda = \left[f \left(\frac{(1-f)\,\lambda}{1-f\lambda} \right)^{1/(\alpha\gamma-\beta)} + 1 - f \right]^{\alpha\gamma}.$$

We assume that f is the fraction of number-rigid CEOs in each year of our data and that the probability of being number-rigid is uncorrelated with size (an assumption that is approximately true within our sample of S&P 500 firms). The variable λ is the average difference between actual

[5]It is not the goal of this paper to claim that γ is less than one or that γ did not increase during the Tech Boom. It is possible that the CEO production function changed over time. However, we hope to offer a complementary explanation of the rise in compensation that is tied to an easily observable empirical pattern (number-rigidity in option compensation that arose only during the Tech Boom) and does not require assumptions about large changes in parameter values over time.

and counterfactual pay growth each year in the sample, as reported in Figure 7. For other model parameters, we use $\gamma = 0.5$, $\alpha = 1$, and $\beta = 0.3$.[6] However, we estimate substantial spillovers using a range of alternative parameter values, as shown in Appendix Table 1.

Panel A of Figure 8 shows the calibration of spillover effects. The solid line represents the median value of total compensation granted each year in the real data. The dashed line shows cumulative growth that can be attributed to spillovers from number-rigid option grants, assuming that growth absent these spillovers would have been zero. We find that number rigidity can explain more than half of the growth in median compensation during the Tech Boom and over the course of the full sample period from 1992 to 2010.

In Panel B of Figure 8, we estimate cumulative growth that can be attributed to changes in median firm size, assuming zero spillover effects from number-rigid firms. [7] Using the same parameter assumptions of $\gamma = 0.5$, $\alpha = 1$, and $\beta = 0.3$ as we used in Panel A, we find that changes in aggregate firm size over our sample period can explain approximately one-third of the growth in median CEO compensation during the Tech Boom and over the full sample period from 1992 to 2010. Finally, Panel C shows the cumulative growth in median compensation that can be attributed to a combination of spillovers from number-rigid grants and changes in median firm size. We find that spillovers from number-rigid option grants combined with growth in aggregate firm size can approximately match all of the growth in compensation over the sample period.

Our estimates are meant to provide a rough guide as to the potential true magnitude of spillovers from number rigidity. In Appendix Table 1, we estimate spillovers using a range of alternative parameter values. While the estimates vary with parameter assumptions, we find that spillovers are likely to be substantial in most cases. Further, we calibrate the GL spillovers model because it is commonly cited in the literature and elegant/tractable. However, spillover effects are likely to operate in any competitive environment, even if the exact assumptions (specifically, the important

[6] γ represents the impact of CEO skill on firm earnings ($\gamma = 1$ implies constant returns to scale and $\gamma < 1$ implies decreasing returns to scale). α describes the distribution of firm size in the right tail. Most estimates imply that $\alpha = 1$ (see GL for a full explanation). β is determined such that $\gamma - \frac{\beta}{\alpha}$ is equal to the relationship between log compensation and log firm size, which is approximately $0.2 - 0.4$ in the data.

[7] To abstract away from noise caused by the changing identity of the median firm in a small sample of 500 firms each year, we use the log S&P500 return each year to approximate the change in median firm size.

role of firm size) used in the GL model does not hold.

Our estimates are also likely to be lower bounds for the true size of spillovers. We estimate spillovers assuming a fraction f of firms want to pay their CEO λ as much as similarly-sized firms. We underestimate f because we don't account for potential spillovers from firms that award number-reference option grants ($shares_t/shares_{t-1} \neq 1$ but exactly equals $1\pm$ multiple of $1/3$, $1/4$, ... $1/10$). As discussed previously, these firms may have targeted an adjustment in the number rather than the value of options. In unreported results, we find significantly larger spillover estimates if we include CEOs who receive exactly 1.5 or 2 times the number of options as in the previous year in our number-rigid sample. Second, we may also underestimate λ. For each year in the data, λ is measured as the vertical distance between the solid and dotted lines in Figure 7, averaged over the set of firm returns experienced by rigid firms between consecutive option grants. Thus, λ may be underestimated if the relationship between growth in compensation and firm returns among the non-rigid sample is steeper than the true relationship in a world without number-rigidity (because spillovers have already occurred in the control sample, conditional on firm returns). In addition, we assume all non-rigid firms wish to grant an extra fraction λ in compensation due to rigidity even though there is heterogeneity in λ within the rigid sample each year. Not accounting for this heterogeneity leads to an underestimate of spillovers because the effect of pay distortions is asymmetric. In general, if a fraction of firms wish to pay their CEOs $1 + x$ as much as other similarly sized firms, aggregate pay will rise more than it would fall if a similar fraction of firms wished to pay their CEOs $1 - x$ as much as similarly sized firms. We refer the interested reader to GL for a full discussion of these issues.

4.3 Downward Nominal Rigidity in Cash Compensation

In this section, we explore two ways in which downward nominal rigidities in cash compensation can contribute to compensation growth. First, missing mass to the left of zero in Figure 3 implies that average growth in cash compensation will be higher than that in a regime with more flexible wages. Importantly, this does not imply that CEOs are necessarily overpaid, as less skilled CEOs

may be fired or firms may set initial cash pay low in anticipation that cash pay will rarely decline over time. However, missing mass to the left of zero does imply that average wages would rise more among the employed, relative to a regime with flexible wage adjustment. Second, in times when the option growth for number-focused CEOs is very high or very low (i.e. when firm returns are extreme), boards could presumably counteract the change in option compensation by adjusting cash compensation in the opposite direction. However, if cash compensation is downward rigid, then firms may not be able to adjust cash compensation down in times when option grants rise.

We begin by calculating the counterfactual average change in cash compensation if wages had been flexible instead of rigid. Our procedure follows Card and Hyslop (2007), which quantifies nominal wage rigidity among the general population of workers. We compare the actual distribution of changes in cash compensation with a counterfactual distribution in the absence of downward rigidities. Estimation of the counterfactual distribution assumes (1) the distribution of wage changes would be symmetric in the absence of rigidities, (2) the upper half of the distribution of wage changes is unaffected by rigidities, and (3) wage rigidities do not affect employment probabilities. Of these assumptions, assumption (3) may be the most controversial: the inability of pay to adjust downward is commonly discussed as a cause of unemployment. Following Card and Hyslop (2007), in supplementary analysis we relax assumption 3 to assumption 3' in which a fraction 2α of jobs that would otherwise be observed—all associated with nominal wage changes below the median—are lost due to downward wage rigidities.

Under these assumptions, the counterfactual and actual distributions are identical to the right of the median. We reflect the real distribution around the median to form the counterfactual distribution to the left of the median. Figure 9 compares the actual and counterfactual distributions for changes in salary and bonus. In both cases, the actual distributions are double peaked, with one local maximum at zero (reflecting the nominal rigidity) and another local maximum to the right of zero (reflecting the fact that many firms increase CEO salary and bonus annually). Comparing the actual and counterfactual distributions, we see that the actual distribution is missing mass to the left of zero, suggesting that some CEOs had their cash compensation "swept up" by downward

nominal wage rigidities.

Comparing the actual and counterfactual distributions, we quantify two summary statistics: the fraction of CEOs whose cash compensation is affected by rigidities and a measure of the net effect of rigidities on the average change in salary and bonus.[8] We estimate that 15.9% of CEOs have their salary swept up by rigidities and that 9.3% of CEOs have their bonus swept up by rigidities. Rigidities raise the average salary by 1.6% each year and raises bonus by 3.9% each year. Interestingly, we find that downward nominal rigidities in bonus distort average changes in bonus by more than that for salary. This may seem surprising given that the extra spike in mass at zero change in bonus is smaller than the spike for zero change in salary. However, the bonus change distribution has relatively fatter tails (because bonus has greater volatility than salary), so a small amount of downward rigidity can have much larger effects on the average increase in bonus.

Next, we explore the extent to which changes in cash compensation offset changes in the value of option grants among the set of number-rigid CEO-years. In times when option value growth for number-rigid CEOs is very high or very low (i.e. when firm returns are extreme), boards could presumably counteract the change in option compensation by adjusting cash compensation in the opposite direction. This would allow firms to follow a number-rigid policy while simultaneously moderating changes in total pay.

We find that changes in cash compensation generally do not offset changes in the value of option grants caused by rigidity. Figure 10 shows the details of this analysis. We restrict the sample to number-rigid CEO-years. The y-axis is the actual annual growth in cash compensation (salary + bonus). The x-axis represents the difference between the actual value change in option pay and the counterfactual change in option pay (estimated using firm returns and the sample of non-rigid firms). The zone to the right of 0 represents number-rigid CEOs who received a larger raise in options than other CEOs with comparable performance. The zone to the left of 0 represents rigid

[8]The fraction of CEOs with salary or bonus swept up by the rigidity is equal to the area under the counterfactual distribution to the left of zero minus the area under the real distribution to the left of zero. The net effect of rigidities on the average wage change is calculated as the difference between the average wage change calculated using the real distribution and the average wage change calculated using the counterfactual distribution. For a more detailed discussion of these calculations, see Card and Hyslop (2007).

CEOs who receives a smaller raise (or a pay cut) than other CEOs with comparable performance. If cash compensation offsets rigidity-driven changes in option pay, we expect to find a negative relationship. Instead, the actual relationship is upward sloping with a slight U-shape. To the left of zero, number rigid CEOs receive more cash pay when they receive less option compensation. To the right of zero, when number-rigid CEOs receive more option compensation than CEOs of comparable firms, they also receive flat or increasing amounts of cash compensation. In Panel B of the same figure, we find similar results using all non-option compensation instead of cash compensation, although the U-shape becomes more muted.

This finding is consistent with limitations imposed by downward nominal wage rigidity in cash pay. While cash pay can adjust up slightly when options decline, cash pay cannot adjust down when options rise.

5 Sources of Rigidity

The primary goal of this paper is not to determine the exact origins of rigidity in executive compensation, but rather to highlight that number-rigidity in options, combined with downward rigidity in other components of compensation, can help explain much of the rise in CEO pay that occurred during the Tech Boom. Nonetheless, in the remainder of the paper, we explore possible reasons why executive compensation is rigid in various units and components.

To understand number-rigidity in option compensation, we distinguish between two broad classes of theories. The first class of theories are ones in which all parties involved in the compensation-setting process understand option valuation, but choose to hold the number of options granted fixed across years, possibly because number-rigidity implements an optimal incentive scheme. For example, firms may grant number-rigid options to manage executive ownership or to maintain steep pay-for-performance incentives (although tying pay to equity returns implies that executives will also be rewarded for lucky macro shocks). Another possibility along these lines is that firms choose to grant a fixed number of options each year so that compensation will grow proportionally with

firm size. The latter story may at first seem consistent with Gabaix and Landier (2008). However, Gabaix and Landier's model predicts that holding the firm-CEO match fixed, CEO pay should increase with *market* returns rather than firm returns. This is because market returns are a better proxy for an executive's outside option. Thus, the theoretical motivation for firms to behave in the manner just described is unclear. Finally, number rigidity may result from a lumpy-adjustment or "SS" style model in which firms allow number to be rigid for several years and then adjust number to offset changes in value in flexible years. Based upon results in Panel C of Table 4, we are able to reject the lumpy-adjustment model by showing that number and value tend to significantly increase in adjustment years relative to a control sample.

The second class of theories are ones in which at least one party in the compensation negotiation process is partially naive about option valuation and uses the number of options as a proxy for value. Naiveté about options may be on the part of the CEO, the board, or the shareholders.[9] In fact, it may even be that all three of these parties fully understand options, but number-rigid policies originate from lower level employees who do not trust or understand option valuation policies, and therefore demand number-rigid option compensation. Number-rigid compensation may then percolate upwards toward the executive suite as a way to avoid pay inversion within the hierarchy of the firm.

A tendency to focus on number rather than value for options would essentially be a novel form of money illusion, the well-known tendency of individuals to think about currency in nominal rather than real terms (Kahneman et al., 1986; Shafir et al., 1997). It is considerably harder to translate number to value for option compensation than it is to translate nominal to real value for cash compensation. Doing the former requires option pricing formulas that economists only derived relatively recently (Black and Scholes, 1973). Thus it seems plausible that if individuals confuse nominal and real values, they may also confuse number and value of options. Indeed, the chairman

[9]Naiveté regarding option valuation by some but not all members of the CEO compensation negotiation process could be complementary to other explanations of rising executive compensation focusing on poor governance. For example, a sophisticated CEO facing a naive board or shareholders may argue that he should receive last year's compensation package (same number of options), in the hopes that the board and shareholders will not realize that he is actually receiving a large increase in value.

of Price Waterhouse stated that, "Corporate America rightfully is skeptical of any standard that depends upon complex pricing models that provide partial and debatable answers." Resistance to using option valuation formulas, such as Black-Scholes, was also rooted in the idea that they may overstate the true value of options to executives, who face restrictions on how and when options can be exercised. However, these arguments neglect the fact that the Black-Scholes value does reflect the cost of the option grant from the point of view of shareholders. Further, the value of the option for the CEO (and the expected realized value at exercise) under any valuation method will increase proportionally with firm returns if option number is held constant.[10]

Valuing options using number could in turn lead to number-rigidity through several mechanisms. Indeed, most of the behavioral theories of nominal wage rigidity could be modified to account for number-rigidity.[11]. Bewley (2007) reviews the survey/experimental evidence and concludes that nominal wage rigidity is best explained by the morale theory, i.e. the concern that workers consider nominal wage cuts unfair. This also relates to the notion of reference-dependent motivation described by Mas (2006) and highlighted in Camerer and Malmendier (2012). Consistent with these morale-based explanations, we find anecdotal evidence from executive compensation surveys that executives viewed a decrease in option number as unfair. In Appendix B, we report the results of a 1998 Towers Perrin survey of 130 large firms in which the majority of respondents report that the number of options should increase rather than decrease following strong equity returns. Respondents report that a decrease in number (coinciding with an increase in value) would be unfair.

We can similarly distinguish between two broad classes of potential explanations for downward nominal rigidity in salary and bonus. The first class of explanations justify downward rigidity as the result of optimal contracting. We find that the distribution the annual change in salary and/or bonus for CEOs resembles well-known figures depicting downward nominal rigidity in total wages for rank and file workers. A variety of optimal contracting theories, notably Harris and Holmstrom (1982), show that downward rigidity in real wages can optimally compensate and insure workers

[10]It is also not obvious that the CEO's perceived value of an option will be less than the Black Scholes value. Malmendier and Tate (2005) show that managers hold options longer than necessary, suggesting that managers are overoptimistic about future firm performance, corresponding to a high perceived value of the option.

[11]See Bewley (1999) for a comprehensive review of theories of nominal wage rigidity

who invest in risky firm-specific skills.[12] However, these theories only justify downward rigidity in *total* compensation. They do not fit well with the data in executive compensation in which there is strong downward nominal rigidity in each subcomponent of compensation (salary and bonus) even as total compensation rises due to large gains in option compensation. Downward nominal rigidity in subcomponents of executive compensation is more consistent with the aforementioned morale-based stories as summarized in Bewley (2007).[13] Last year's level of salary or bonus may set a reference point, and losses relative to this reference point (even as total wages rise) may be viewed as unfair, thereby lowering morale.

In what follows, we present suggestive evidence consistent with a broad class of behavioral theories relating to naiveté and money illusion. However, determining the exact extent to which morale concerns generates number-rigidity is beyond the scope of this paper. Similarly, we leave examination of exactly who is naive about option valuation (the CEO, board, shareholders, and/or employees) to future research.

5.1 Comparing Stock and Options

In order to shed light on whether some form of money illusion plays a role in number-rigidity we first exploit the fact that stock compensation also has a number and value associated with it. However, in the case of stock compensation, translating number to value is much simpler than in the case of options. Consistent with this, we find that, while some stock grants are number-rigid, the prevalence of number-rigidity for stock compensation is significantly lower than for option compensation. This can be seen by simply comparing Panel A of Figure 1 and Panel A of Figure 2. The magnitude of the spike at zero change in number is less than half as high for stock as it is for options. Moreover, for stock there are also no spikes at -50% and 100% for stock, which is also consistent with less of a focus on number. These differences are statistically significant at the the 1% level and hold over different time periods. If option compensation is number-rigid for incentive reasons e.g. to keep CEOs'

[12] These theories only justify downward rigidity in real rather than nominal wages. However, inflation has historically been moderate in the US, so downward *nominal* wage rigidity among US rank and file workers may not be a large departure from theoretical predictions.

[13] See (Baker et al., 2012) for evidence of reference point effects in other corporate settings.

ownership stake relatively constant, one would expect a similar level of number-rigidity for stock compensation. Likewise, one would expect a similar level of number-rigidity for stock compensation if number-rigidity is primarily designed to ensure that compensation grows one-for-one with firm size.

5.2 Regulatory Changes

Next, we take advantage of a major regulatory change in the treatment of options. Prior to 2006, firms did not need to recognize the payment of at-the-money options to employees as an expense. They only had to report the number of options granted (although a sophisticated agent should have been able to infer the value from the number and the grant date share price). However, in 2006, FASB began requiring firms to expense options at fair value on their income statements. Simultaneously, the SEC began requiring that firms report the fair value of option compensation paid to top executives in their proxy statements. These regulatory changes likely contributed in shifting the focus from number to value for all parties in the compensation-setting process. In the case of stock, however, the value of compensation needed to be expensed and reported throughout our sample period. Motivated by this, we use a difference-in-differences estimation framework to examine whether number-rigidity declined more for options than for stock following these regulatory changes.

Table 5 shows the results. Observations are at the executive by year by grant type level, where grant type represents option grants or stock grants. The sample is restricted to S&P 500 CEOs who received the relevant grant type in the current year and in the previous year. In the first two columns, we regress a dummy for whether the grant is number-rigid on a dummy for whether the grant was disclosed in the period following the regulatory change, a dummy for whether the grant was in the form of options, and the interaction between the two dummies. The "Exact" column categorizes grants as number-rigid if the ratio of securities granted in the current year divided by the previous year is exactly one. The "Close" columns allow a tolerance of 0.025.[14] In the last two

[14]We allow for a tolerance because data on the number of shares granted in stock grants is not always available, so we must estimate it using the reported value of shares on the grant date and the closing share price on the day of

columns the dependent variable is instead the number-focus indicator (which includes both number-rigid grants as well as grants containing .5X and 2X the previous year's number of shares). Across all specifications, we estimate a significant negative coefficient on the interaction term. This suggests that the probability of number-rigidity/number-focus declined 7-10% more with the new reporting format for options relative to stock. These results are consistent with the idea that number-rigidity at least partly results from inattention to value. It is hard to see why number-rigidity would be affected by such regulatory changes under the first class of theories mentioned previously.

In Figure 12 we show that the effect of number-rigidity on the value of grants has also become less distortionary over time. While a substantial mass of firms continue to grant the same number of options in consecutive years, they are less likely to do so when firm returns would imply an extreme change in value. In the figure, we restrict the sample to firms with returns above 25% in the 12 month period prior to the option grant. If firms in this sample choose to keep or increase the number of options granted, then CEOs will receive a greater than 25% increase in the value of options. Such a increase in value would be quite large relative to non-rigid firms that experience similarly high firm returns. Therefore, value-focus should imply that most firms within this sample should reduce the number of options granted.

We find that this is increasingly true over time. Starting in 1992, more than 20% of firms were number-rigid and there is significant mass to the right of zero, implying that many firms actually increased the number of options granted. By the late 2000s, only 15% of firms are number rigid. The mass of firms to the right of zero also falls dramatically, and the average and median change in number is less than zero. This is consistent with the view that firms became increasingly value-focused over time. In the Appendix we also show evidence that number-rigidity is less likely to occur in the 2000s in the sample of firms with very low equity returns and in the full sample of firms.

the stock grant.

5.3 Splits

Finally, we also examine how number-rigidity interacts with stock splits. To do so, we limit the sample to firms that engaged in a positive stock split between the time of the previous option grant and the current grant. Because these events are somewhat rare, we include all S&P 1500 executives in the sample. Panel A of Figure 11 shows the distribution of the proportional change in the (non-split-adjusted) number of options granted in the current year relative to the previous year. Following a stock split, the modal percentage change in the number of options granted is 100%; this amounts to split-adjusted number-rigidity following a 2-for-1 split. However, the next most common occurrence is for the number of options granted to remain the same as in the previous year, despite the split. This surprising result suggests that some parties in the compensation-setting process focus on the raw number of options granted, even following a split. Again, this is in contrast to stock compensation where, following a split, very few executives receive the same number of shares as they did in the previous year. These results suggests a rather extreme form of naiveté regarding options. Indeed, following these positive stock splits, CEOs who continue to receive the same number of options have a substantial decline in the value of their option compensation, all else equal. The fact that the number of options granted does not always adjust in a split is consistent with survey evidence from compensation consultants, who suggest that splits may be a way of keeping option compensation in line without upsetting employees (see Appendix B).

In Panel B of Figure 11, we explore whether the decline in option compensation is offset by an increase in non-option compensation. The sample in this case is limited to the set of observations in which option number remains constant following a positive stock split. The figure plots the change in non-option compensation against the loss in value due to the lack of split adjustment in the number of options granted. The dotted line shows the change in other compensation necessary to fully offset the losses. The solid line represents the relationship between the actual change in non-option compensation and the losses due to the lack of the split adjustment, as estimated using a local linear regression. As can be seen, the smoothed regression line is relatively flat. Moreover, the

difference between the two lines is also statistically significant. Thus, there is no evidence that other compensation adjusts to offset the loss of option compensation due to a lack of split adjustment. Again, these findings seem to run counter to theories that assume all parties understand option valuation.

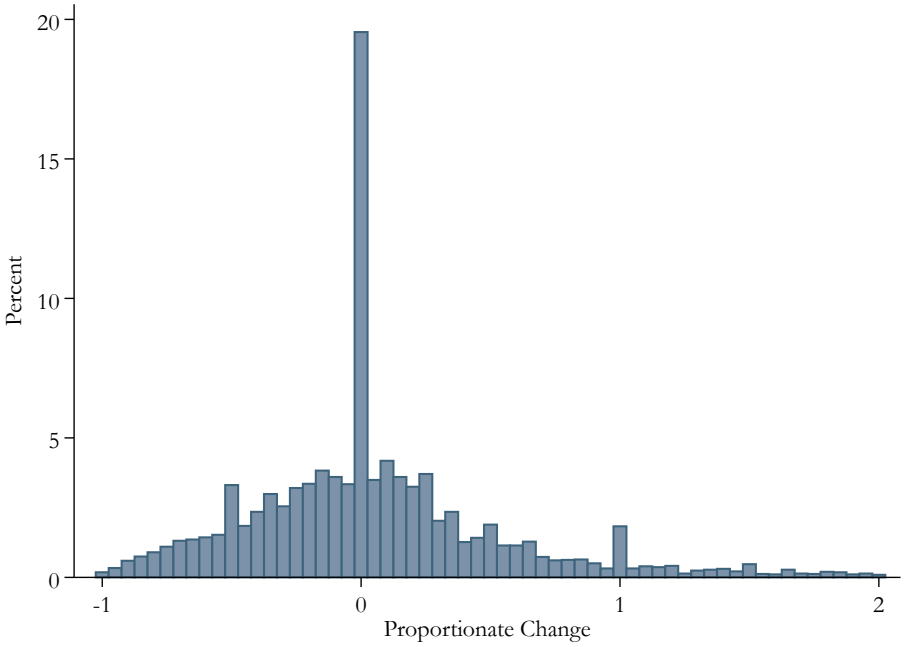
6 Conclusion

In this paper, we explore a rigidity-based explanation of the dramatic and off-trend growth in US executive compensation during the late 1990s and early 2000s. We show that executive option and stock grants are rigid in the number of shares granted. In addition, salary and bonus exhibit downward nominal rigidity. Rigidity implies that the value of executive pay will grow with firm equity returns, which averaged 30% annually during the Tech Boom. Rigidity also explains the increased dispersion in pay across firms, the difference in growth rates between the US and other countries, and the increased correlation between pay and firm-specific equity returns. Regulatory changes requiring the disclosure of the value of option grants help explain the moderation in executive pay in the late 2000s. Finally, we find suggestive evidence that number-rigidity in executive pay is generated by money illusion and reference-dependent motivation.

Figure 1
Number of Options Granted

Panel A shows the distribution of the proportional change in the number of options granted in the current year relative to the previous year. Panel B shows the log change in the nominal grant-date Black-Scholes value of options granted in the current year relative to the previous year. The sample is limited to executives who hold the CEO position in the current and previous year in firms that were ever a part of the S&P 500 from 1992 to 2010.

Panel A: Number of Options Granted



Panel B: Value of Options Granted

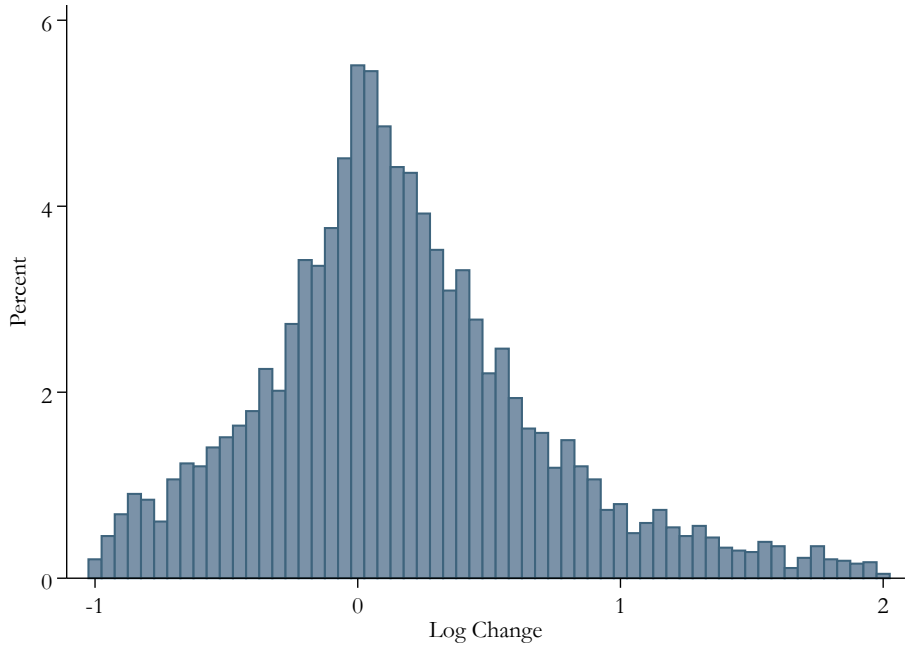
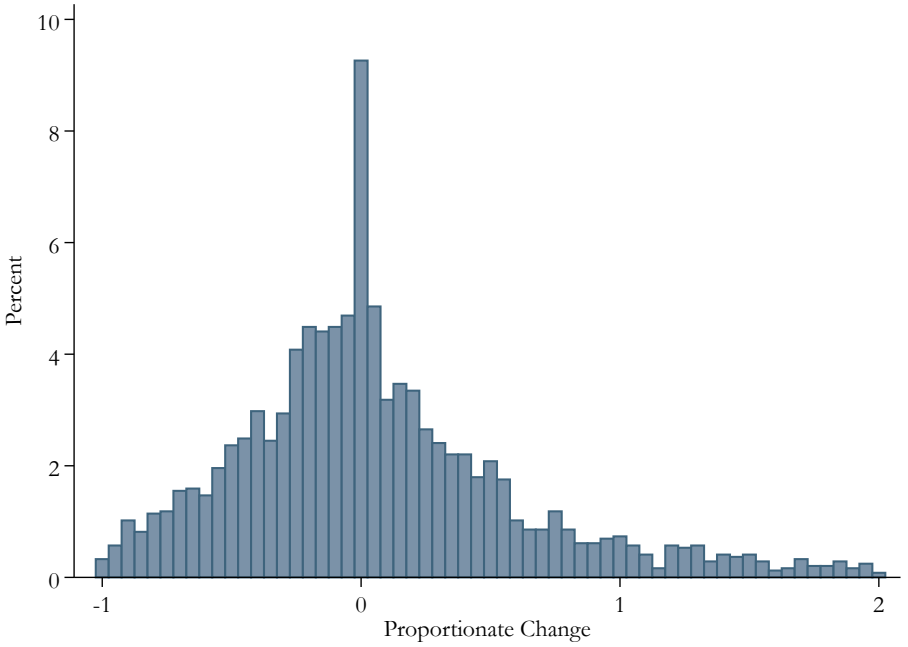


Figure 2
Stock Grants

Panel A shows the proportional change in the number of shares of stock granted in the current year relative to the previous year. Panel B shows the log change in the nominal grant-date value of shares granted in the current year relative to the previous year. The sample is limited to executives who hold the CEO position in the current and previous year in firms that are listed in the S&P 500 at least once in the period from 1992 to 2010.

Panel A: Number of Shares Granted



Panel B: Value of Shares Granted

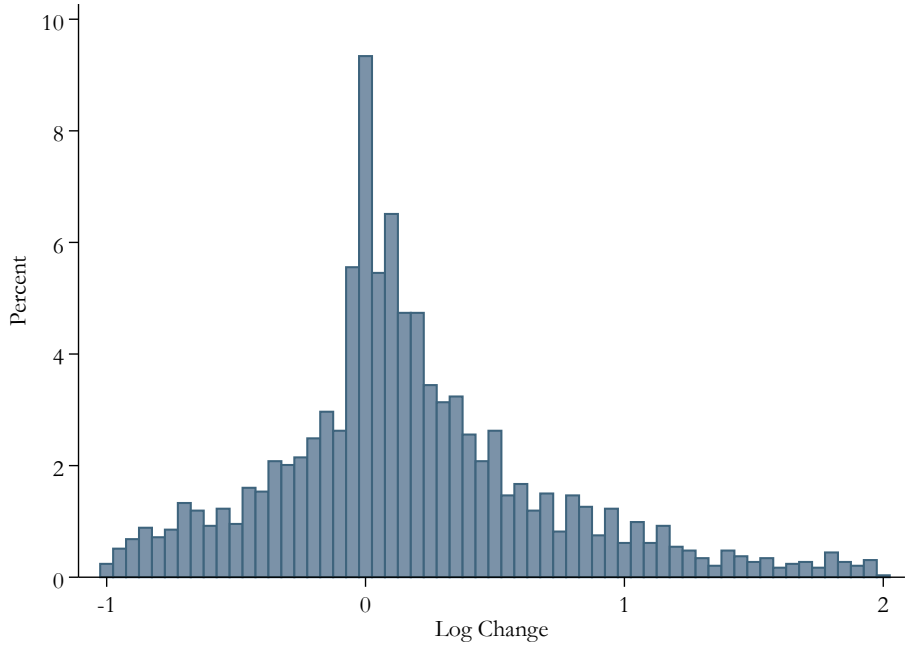
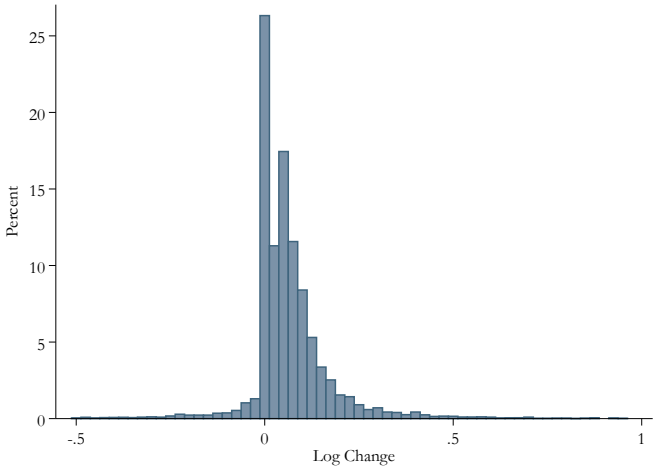


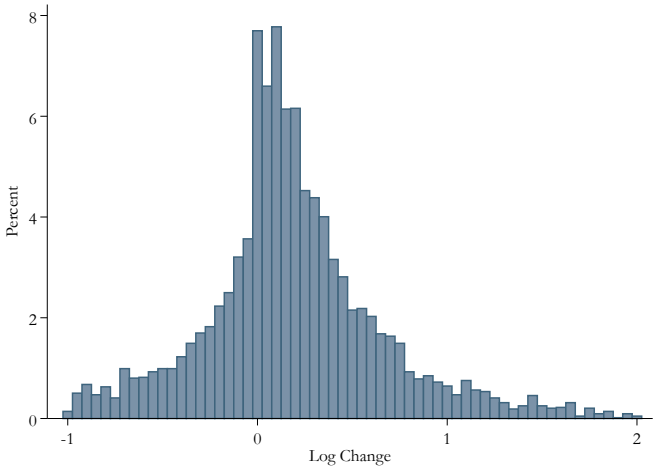
Figure 3
Cash Compensation

This figure show the distributions of the log changes in the nominal values of salary, bonus, and total cash compensation (salary + bonus) awarded in the current year relative to the previous year. The sample is limited to executives who hold the CEO position in the current and previous year in firms that were ever a part of the S&P 500 from 1992 to 2010.

Panel A: Salary



Panel B: Bonus



Panel C: Cash Compensation (Salary + Bonus)

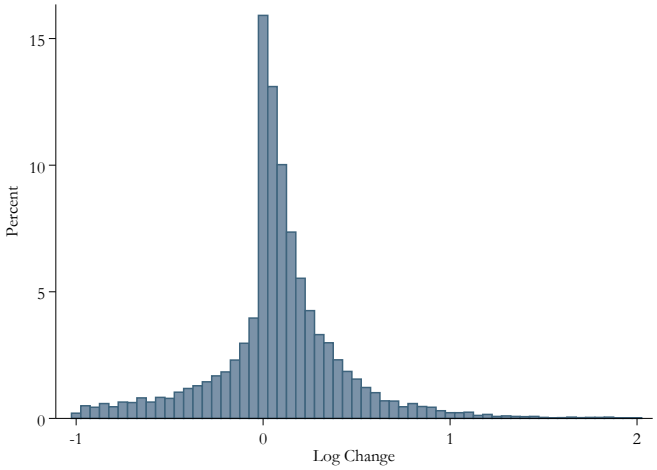


Figure 4
Executive Compensation Over Time

This figure is created following the methodology in Murphy (2012). The sample is restricted to CEOs of firms that were ever a part of the S&P 500 from 1992 to 2010. The level of each bar represents the median level of total compensation that year in 2011 dollars. In addition, each bar is decomposed into the separate components of compensation based on the mean proportion represented by each component that year. The bonus component includes compensation included in non-equity incentive plans and long-term incentive plans.

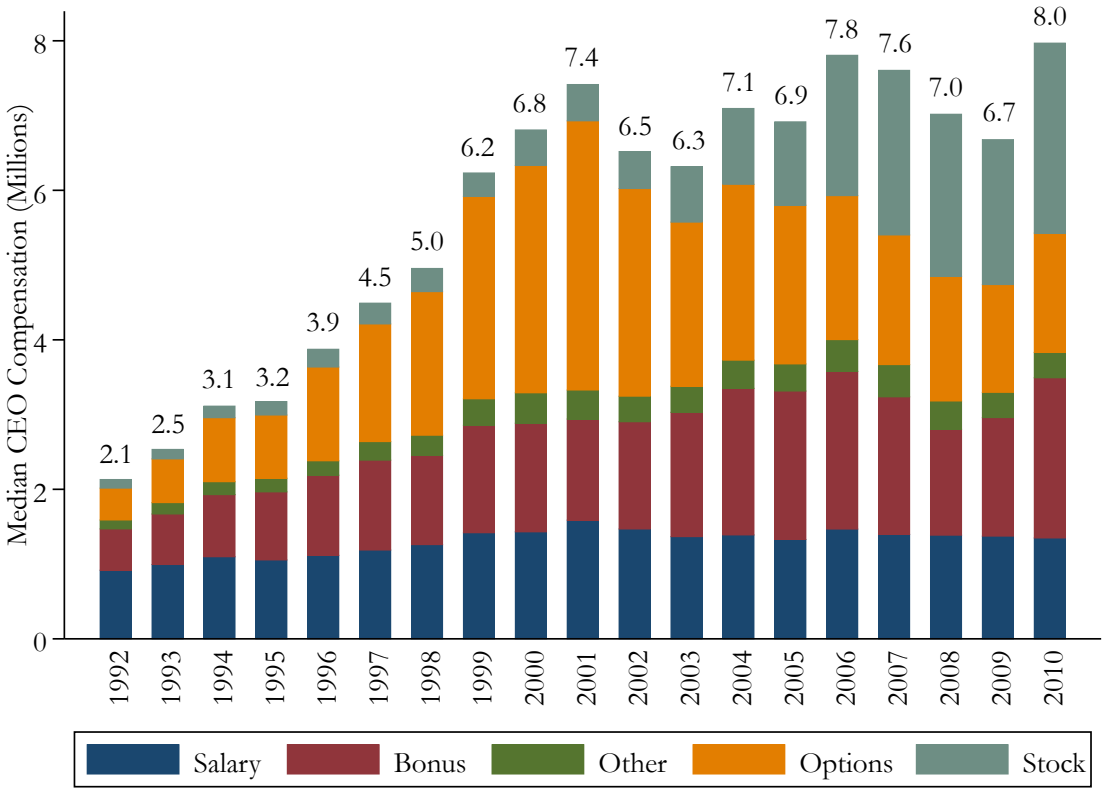


Figure 5
Compensation Growth

This solid lines show the evolution of median option compensation, median non-option compensation, and median total compensation for the sample of CEOs of firms that were ever a part of the S&P 500 from 1992 to 2010. The dotted lines show the evolution of income for the top 0.01% and top 1% of US tax units (including individual and joint tax filers). Data on income are the update version of those from Piketty and Saez (2003). All values are adjusted for inflation using the CPI index and normalized to equal one in the year 1992.

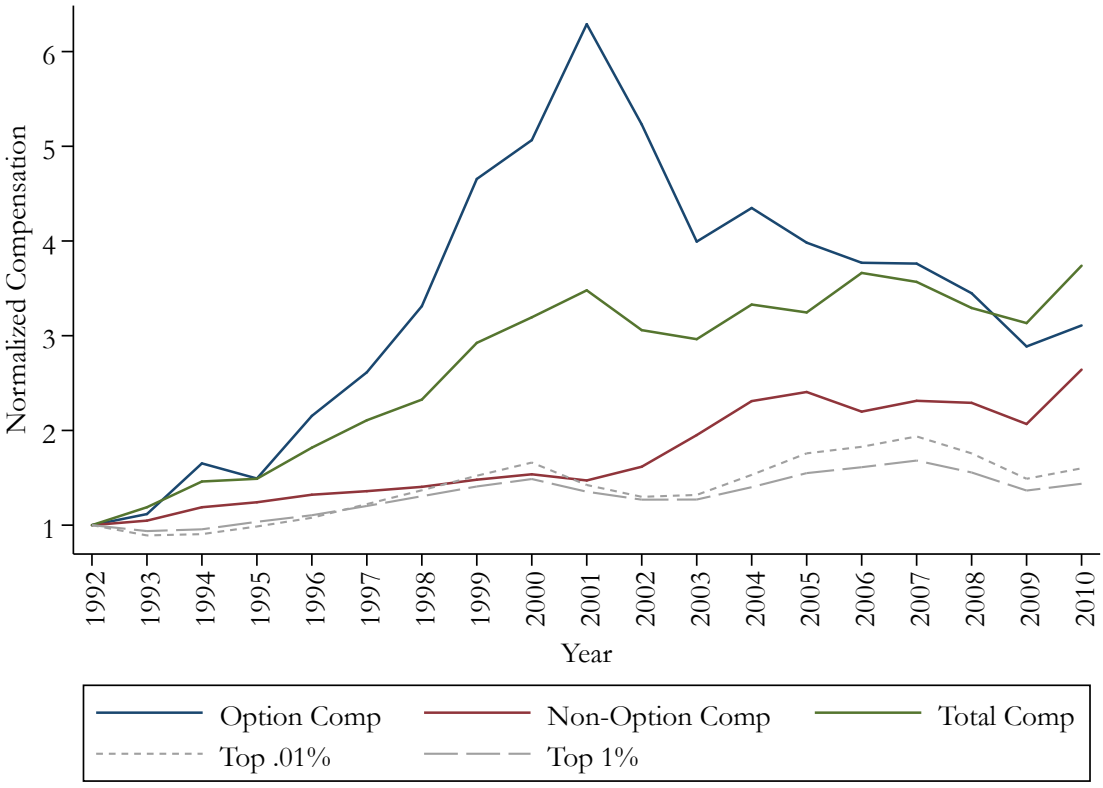


Figure 6

Actual vs. Predicted Option Value Growth For Number-Rigid CEOs

This figure plots changes in the log value of options granted against the log firm return over the previous 12 months. For the number-rigid sample, the relationship falls along the 45 degree line because a firm return of $X\%$ should translate to an $X\%$ change in the Black-Scholes value of option grants, absent any changes in volatility. For the the number-rigid and non-rigid samples, we fit a local linear regression using the Epanichnikov kernel and the rule-of-thumb bandwidth. The sample is limited to executives who hold the CEO position and receive option grants in the current and previous year in firms that were ever a part of the S&P 500 from 1992 to 2010.

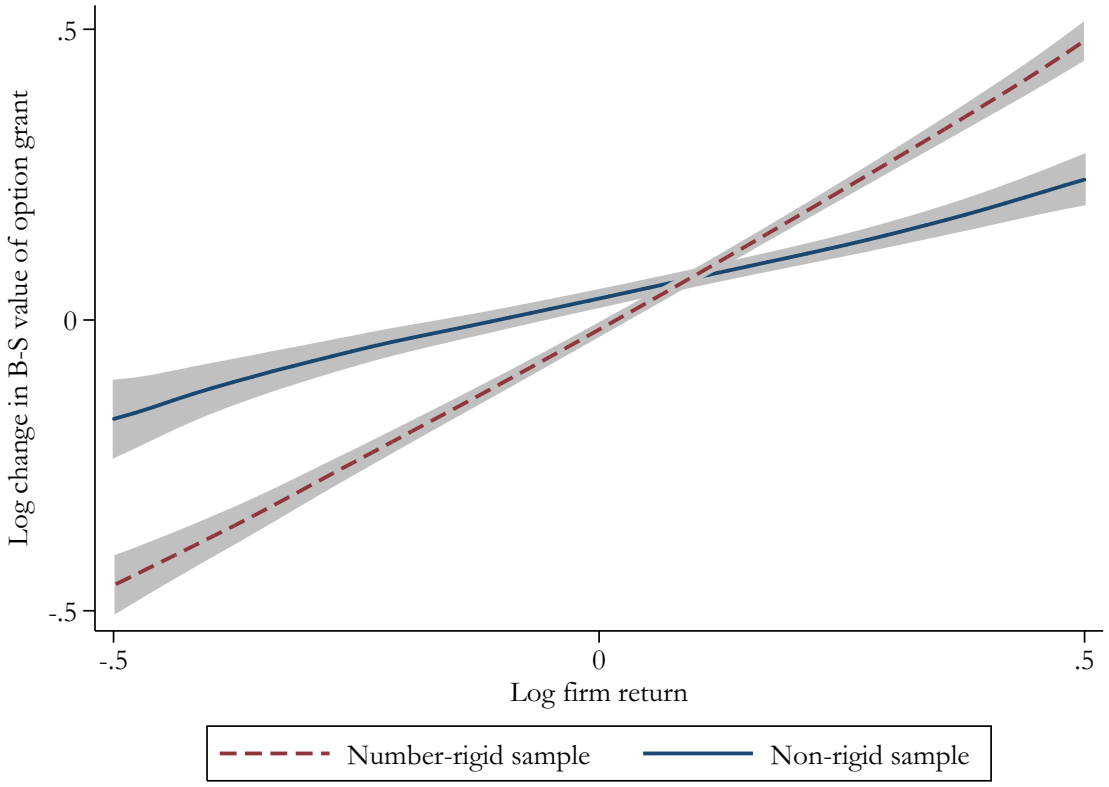


Figure 7

Actual vs. Predicted Total Compensation Growth For Number-Rigid CEOs

This figure plots changes in the log value of total compensation granted against the log firm return over the previous 12 months. For the the number-rigid and non-rigid samples, we fit a local linear regression using the Epanichnikov kernel using the rule-of-thumb bandwidth. The sample is limited to executives who hold the CEO position in the current and previous year in firms that were ever a part of the S&P 500 from 1992 to 2010.

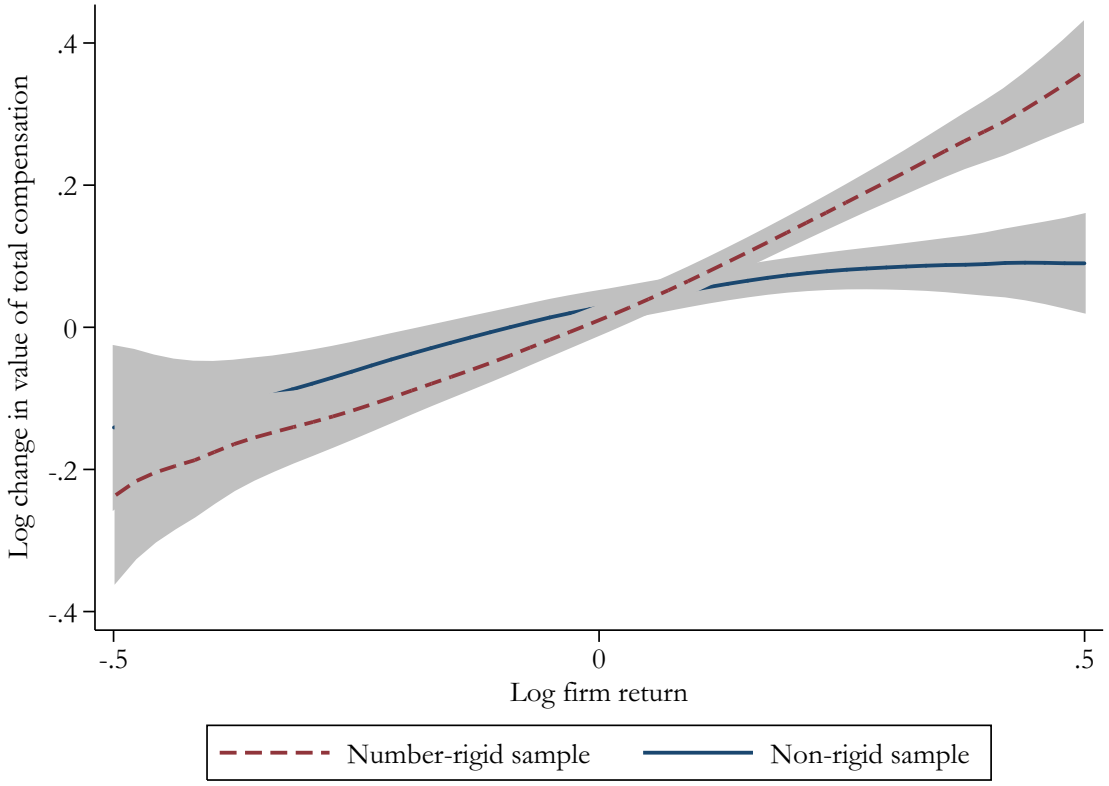


Figure 8
Number-Rigid Spillover Effects in Total Compensation

This figure shows the calibration of spillover effects using the model of Gabaix and Landier (2008). We assume that f is the fraction of number-rigid CEOs in each year of our data and that the probability of being number-rigid is uncorrelated with size (an assumption that is approximately true within our sample). λ is the average difference between actual and counterfactual growth in the value of total compensation in each year in the sample, as reported in Figure 7. For other model parameters, we use $\gamma = 0.5$, $\alpha = 1$, and $\beta = 0.3$. Panel A shows cumulative growth that can be attributed to spillovers from number-rigid grants, assuming that growth absent these spillovers would have been zero. Panel B shows cumulative growth that can be attributed to changes in median firm size, assuming zero spillover effects. Panel C shows cumulative growth that can be attributed to a combination of spillovers from number-rigid grants and changes in median firm size.

Panel A

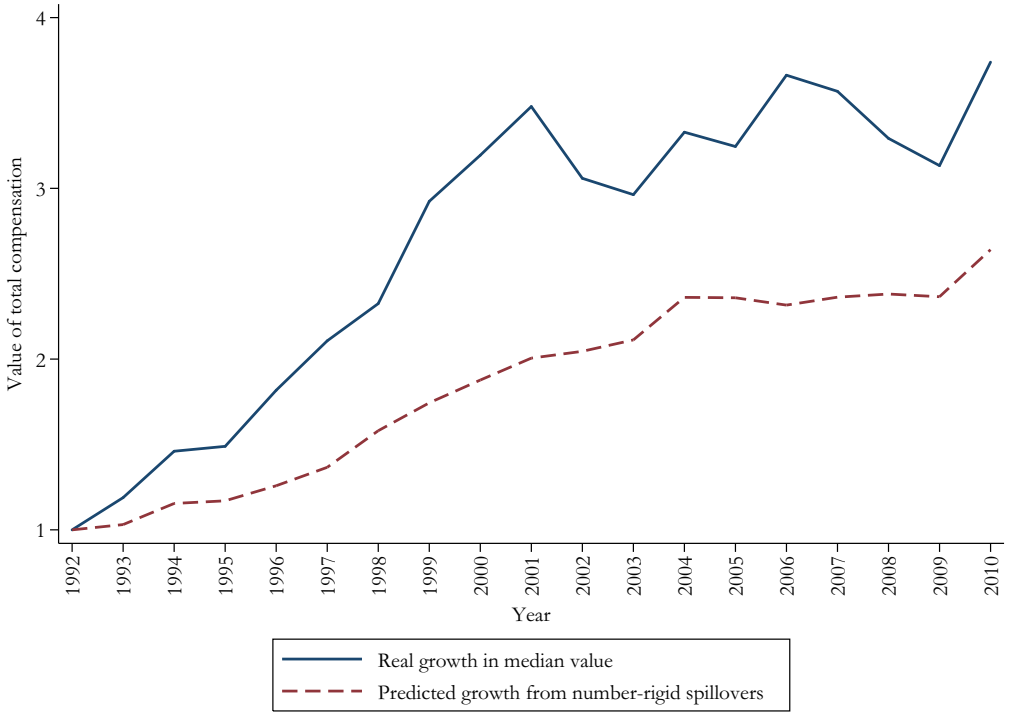
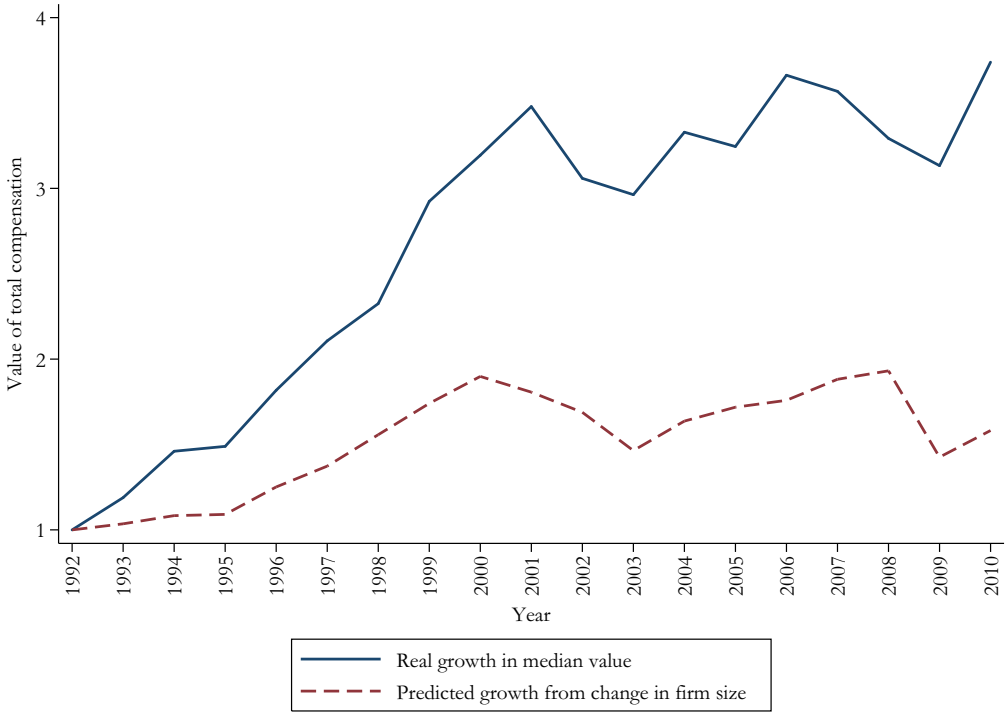


Figure 8
(Continued)

Panel B



Panel C

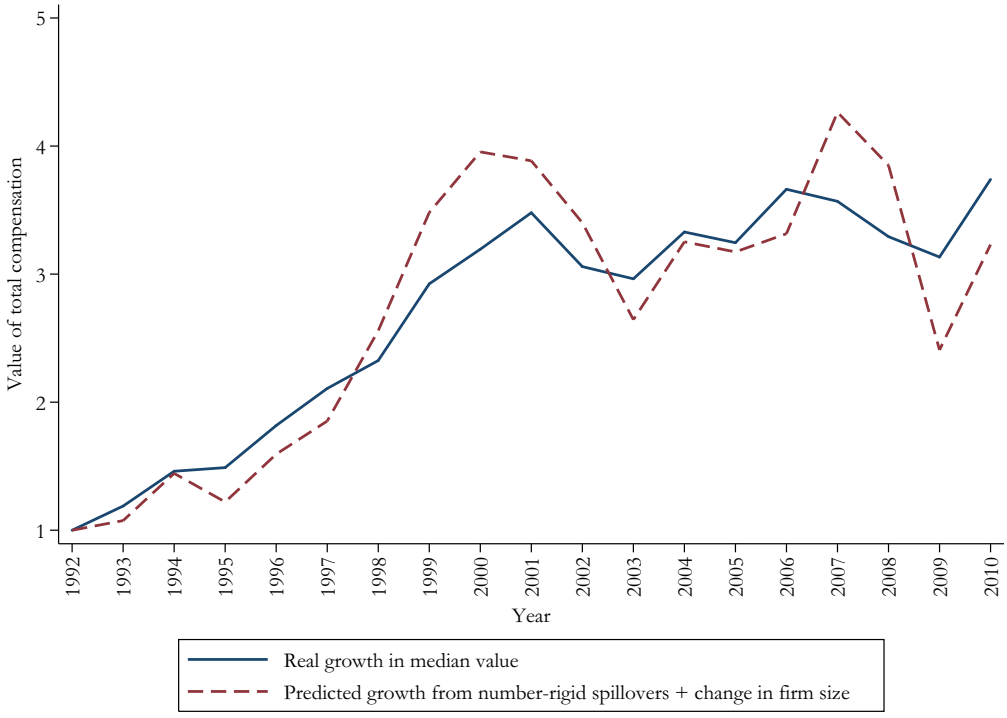
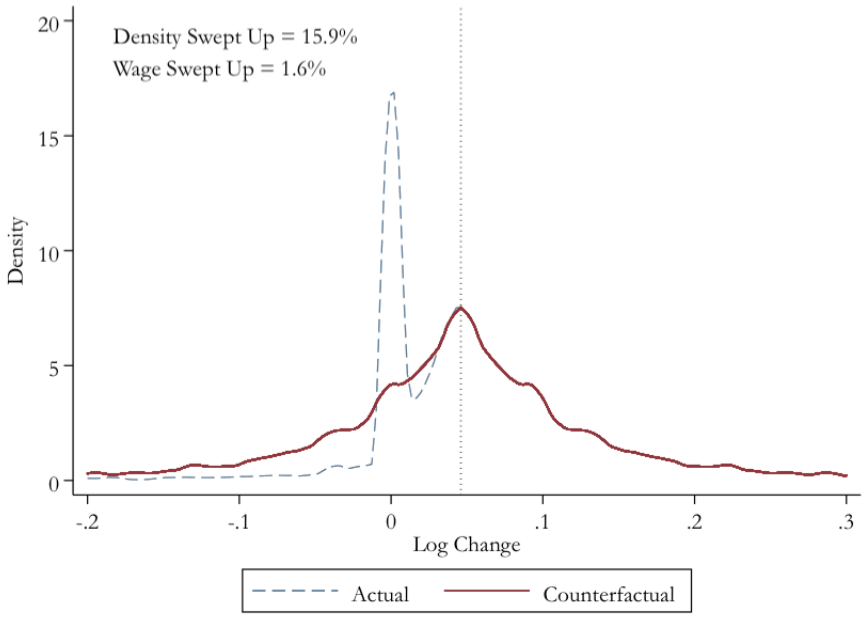


Figure 9
Downward Nominal Rigidity in Cash Compensation

This figure shows actual and counterfactual distributions of year-to-year log changes in nominal salary and bonus. Our procedure to estimate the counterfactual distribution follows Card and Hyslop (2007). Specifically, we reflect the real distribution around the median to form the counterfactual distribution to the left of the median. The "Density Swept Up" is the fraction of CEOs with salary or bonus swept up by rigidity and is equal to area under the counterfactual distribution to the left of zero minus the area under the real distribution to the left of zero. The "Wage Swept Up" is the net effect of rigidities on the average wage change and is calculated as the difference between the average wage change calculated using the real distribution and the average wage change calculated using the counterfactual distribution. The sample is limited to executives who hold the CEO position in the current and previous year in firms that were ever a part of the S&P 500 from 1992 to 2010.

Panel A: Salary



Panel B: Bonus

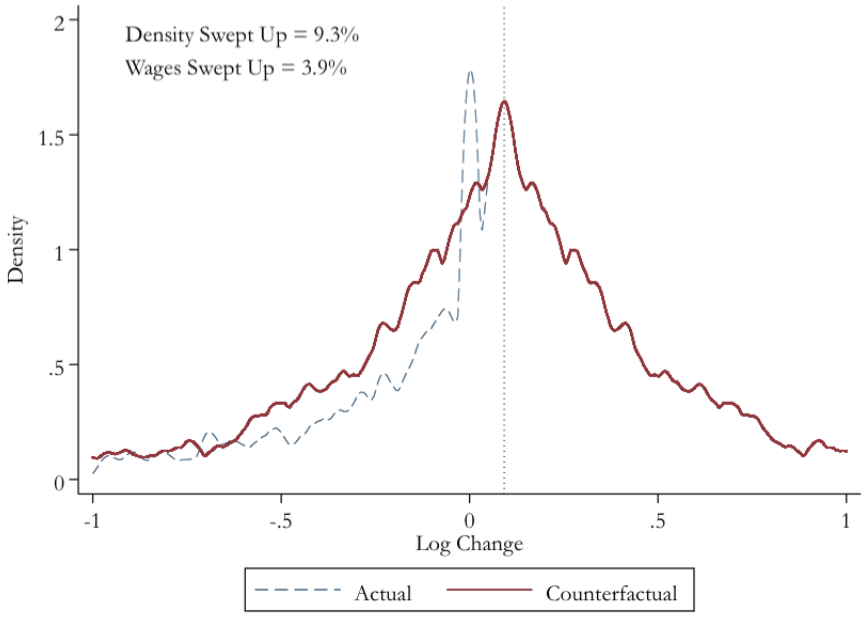
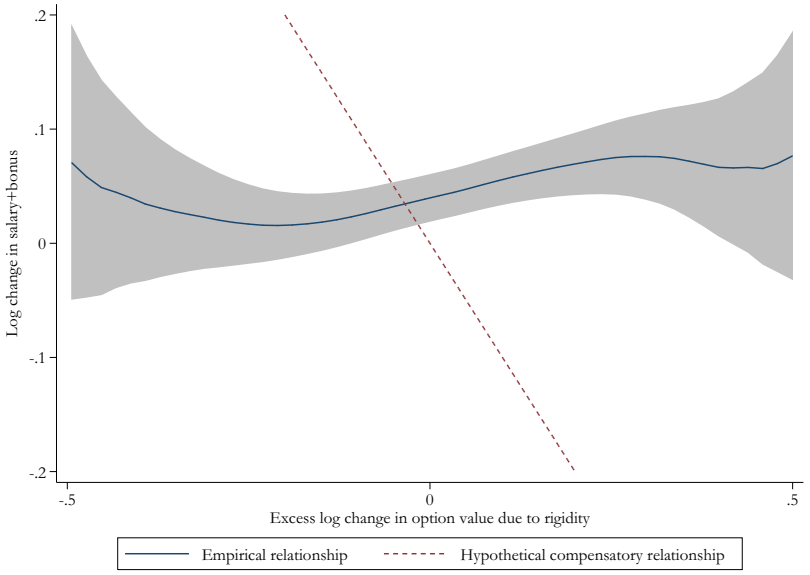


Figure 10
Offsets in Non-Option Compensation

This figure shows how non-option forms of compensation adjust in response to excess option compensation that can be attributed to number-rigidity. We restrict the sample to number-rigid CEO-years. In Panel A, the y-axis is the annual log change in nominal cash compensation (salary + bonus). In Panel A, the y-axis is the annual log change in all other non-option compensation. The x-axis represents the difference between the actual change in the value of option pay and the counterfactual change in the value of option pay (estimated using firm returns and the sample of non-rigid firms). The dotted red line illustrates a hypothetical compensatory relationship in which other forms of compensation offset excess changes in option compensation due to number-rigidity.

Panel A: Cash Compensation



Panel B: All Non-Option Compensation

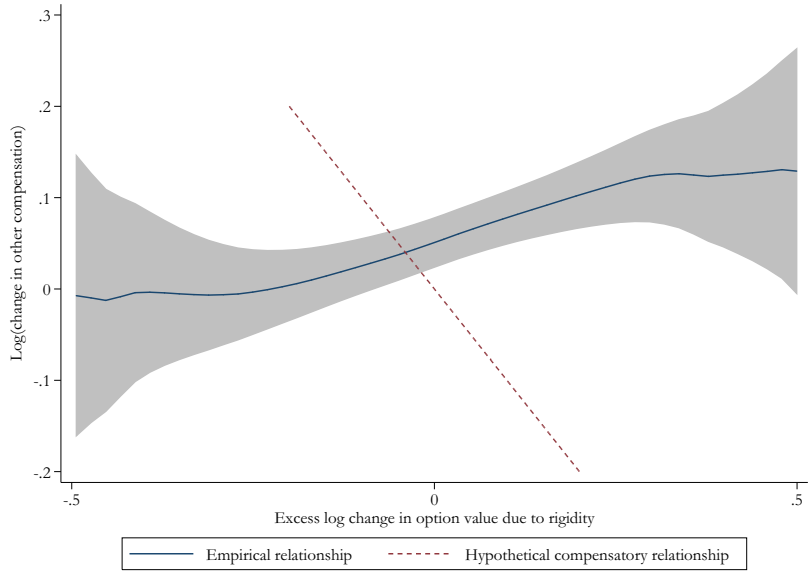
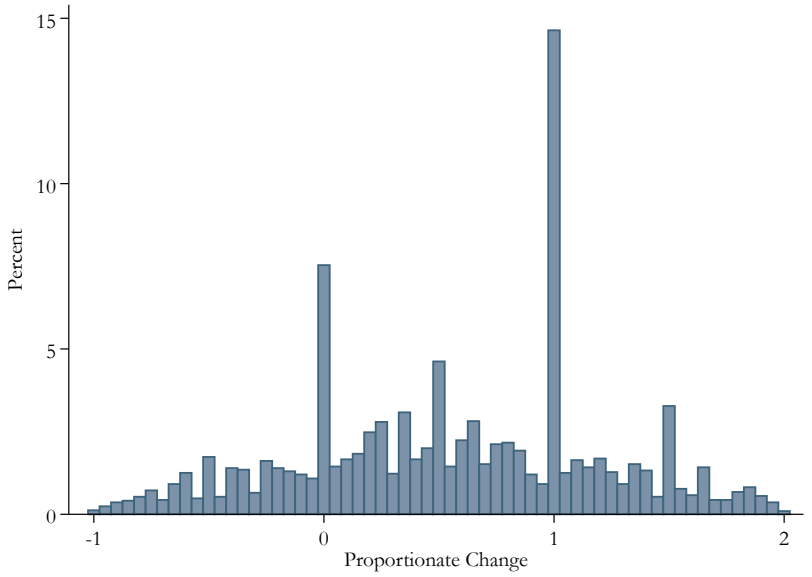


Figure 11
Adjustment to Splits

In Panel A, the sample is limited to firms that engaged in a positive stock split between the time of the previous option grant and the current grant. Panel A shows the distribution of the proportional change in the number of options granted in the current year relative to the previous year. Following these positive stock splits, CEOs who continue to receive the same number of options (proportionate change equal to zero) receive a substantial decline in the value of their option grant, all else equal. In Panel B, the sample is limited to the set of CEO-years in which option number remains constant following a positive stock split. The figure plots the change in non-option compensation against the loss in value due to the lack of split adjustment in the number granted. The dotted line shows the change in other compensation necessary to fully offset the losses. The solid line represents the relationship between the actual change in non-option compensation and the losses due to the lack of the split adjustment, as estimated using a local linear lowess regression. The sample consists of all S&P 1500 executives.

Panel A: Change in Number of Options Granted Following a Split



Panel B: Adjustment of Non-Option Compensation

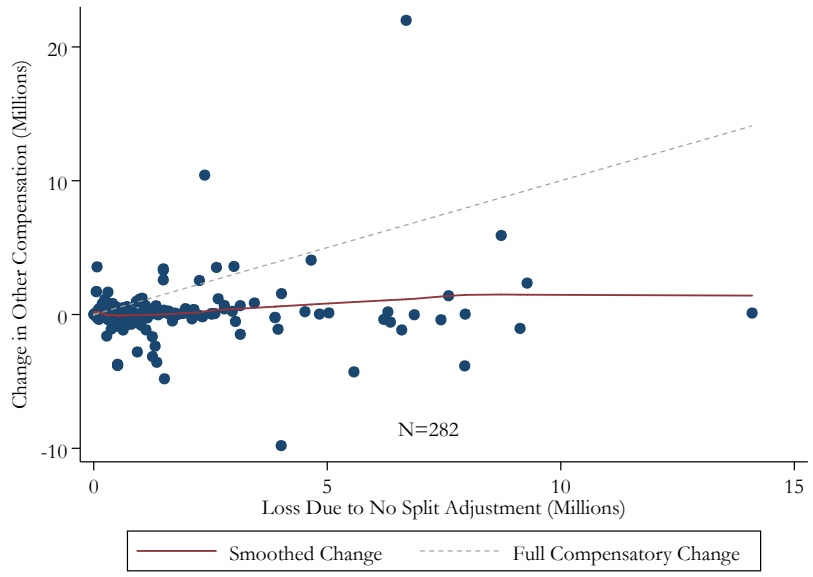


Figure 12
Number Change Distribution over Time for High Return Firms

This figure shows how the distribution of the proportional change in the number of options has evolved over time. The figure replicates 1 within two or three year intervals, and the sample is restricted to firms with high returns (returns above 25%) in the 12 month period prior to the option grant.

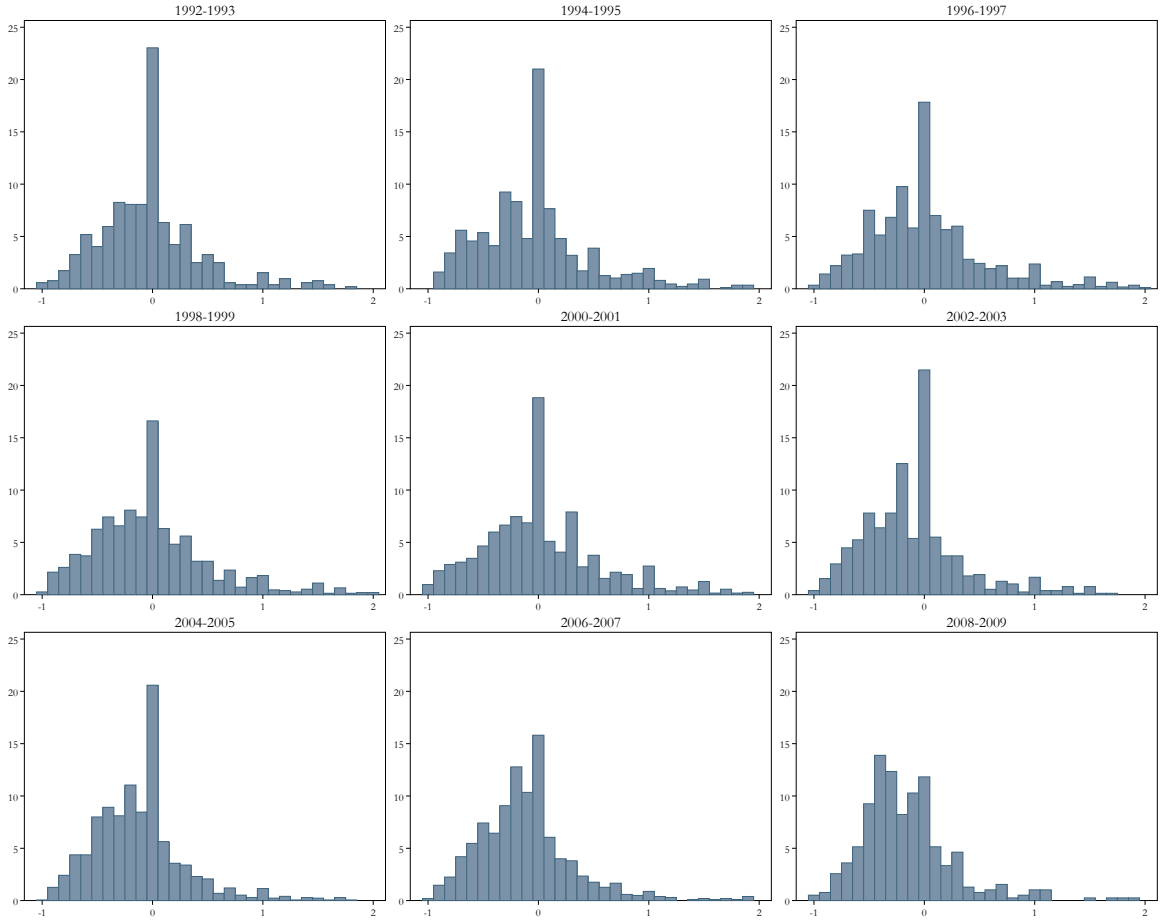


Table 1
Relationship between Number, Value, and Returns

This is a simple example adapted from Hall (1999) to illustrate how the Black-Scholes value of new at-the-money option grants and the number of options granted varies with stock price fluctuations for executives on fixed number and fixed value plans. For illustrative purposes, we assume the annual volatility is 32 percent, the risk-free rate is 6 percent, the dividend rate is 3 percent and the maturity is 10 years.

		Stock price		
		Year 1 Grant	**Year 2 Grant**	**Year 3 Grant**
Plan		**100**	**120**	**144**
Fixed Value	Value of Options	$1,000,000	$1,000,000	$1,000,000
	Number of Options	28,128	23,440	18,752
Fixed Number	Value of Options	$1,000,000	$1,200,000	$1,440,000
	Number of Options	28,128	28,128	28,128

Table 2
Summary Statistics

This table reports summary characteristics for the sample of all firms that were ever a part of the S&P 500 from 1992 to 2010. The table is divided between number-rigid firms-years and all other firm years. A firm-year is categorized as number-rigid if its CEO receives number-rigid option grants in that year. Because the prevalence of number-rigidity has changed over time, we present the summary statistics separately for three cross sections in 1995, 2000, and 2005.

Year: 1995	Number Rigid			All Other		
	p25	p50	p75	p25	p50	p75
Assets (Millions)	1223.86	3557.34	10494.80	1192.63	3378.91	11449.90
Market to Book	1.16	1.49	1.99	1.15	1.52	2.18
CAPX / PPE	0.14	0.19	0.27	0.13	0.21	0.33
Market Leverage	0.10	0.20	0.35	0.08	0.20	0.39
Book Leverage	0.26	0.40	0.53	0.19	0.39	0.58
Total Dividends (Millions)	10.73	44.59	154.41	1.44	43.36	138.00
Firm Return	0.08	0.30	0.48	0.12	0.30	0.48
Return on Assets	0.03	0.07	0.10	0.02	0.05	0.10
Cash Flow / Assets	0.09	0.12	0.17	0.08	0.12	0.17

Year: 2000	Number Rigid			All Other		
	p25	p50	p75	p25	p50	p75
Assets (Millions)	1712.35	5957.98	14690.80	2071.42	5412.80	18373.00
Market to Book	1.17	1.58	3.21	1.14	1.54	2.68
CAPX / PPE	0.14	0.17	0.26	0.14	0.21	0.37
Market Leverage	0.08	0.21	0.42	0.06	0.21	0.44
Book Leverage	0.26	0.42	0.59	0.22	0.42	0.62
Total Dividends (Millions)	0.00	38.09	167.00	0.00	36.15	189.00
Firm Return	-0.12	0.15	0.45	-0.21	0.11	0.47
Return on Assets	0.03	0.08	0.13	0.02	0.05	0.10
Cash Flow / Assets	0.08	0.15	0.20	0.06	0.10	0.17

Year: 2005	Number Rigid			All Other		
	p25	p50	p75	p25	p50	p75
Assets (Millions)	3088.70	9812.00	28138.00	2986.41	7676.59	22588.00
Market to Book	1.30	1.77	2.40	1.23	1.62	2.30
CAPX / PPE	0.12	0.16	0.30	0.12	0.18	0.29
Market Leverage	0.06	0.14	0.27	0.07	0.16	0.35
Book Leverage	0.16	0.30	0.47	0.18	0.34	0.57
Total Dividends (Millions)	3.35	62.53	231.50	0.00	66.27	270.06
Firm Return	-0.08	0.08	0.28	-0.06	0.07	0.28
Return on Assets	0.02	0.06	0.10	0.02	0.06	0.11
Cash Flow / Assets	0.06	0.10	0.15	0.06	0.10	0.16

Table 3
Industry Distribution of Rigid and Non-Rigid Firms

This table reports the industry distribution for the set of number-rigid firms as compared to all other firms. We extend the sample to all firms that were ever a part of the S&P 1500 from 1992 to 2010 in order to provide a more comprehensive view of the prevalence of each industry. However, we find similar results in a sample limited to the S&P 500. A firm-year is categorized as number-rigid if its CEO receives number-rigid option grants in that year. Because the prevalence of number-rigidity has changed over time, we present the summary statistics separately for three cross sections in 1995, 2000, and 2005.

Year: 1995	Number Rigid	All Other
	Percent	Percent
Consumer Non-Durables	7.98	6.57
Consumer Durables	3.07	3.14
Manufacturing	22.70	12.97
Energy	6.13	3.85
Chemicals	3.68	3.49
Business Equipment	10.43	14.80
Telecommunications	0.61	2.78
Utilities	6.13	6.51
Shops	17.18	12.20
Health	6.13	8.05
Finance	9.82	13.38
Other	6.13	12.26
Total	100.00	100.00

Year: 2000	Number Rigid	All Other
	Percent	Percent
Consumer Non-Durables	8.70	6.11
Consumer Durables	2.48	2.67
Manufacturing	17.39	11.81
Energy	2.48	4.15
Chemicals	2.48	3.20
Business Equipment	13.66	19.88
Telecommunications	1.24	2.67
Utilities	4.35	5.28
Shops	11.18	11.93
Health	11.80	6.94
Finance	10.56	13.65
Other	13.66	11.69
Total	100.00	100.00

Table 3
(Continued)

Year: 2005	Number Rigid	All Other
	Percent	Percent
Consumer Non-Durables	4.27	6.00
Consumer Durables	2.44	2.63
Manufacturing	12.20	12.07
Energy	2.44	3.81
Chemicals	3.66	2.81
Business Equipment	22.56	18.32
Telecommunications	0.00	2.38
Utilities	1.83	5.25
Shops	14.63	11.57
Health	10.98	7.69
Finance	15.85	15.26
Other	9.15	12.20
Total	100.00	100.00

Table 4
Competition for CEO Talent

Panel A explores how the value of total compensation and option compensation paid by a firm to the CEO changes following turnover events. Observations are at the firm by year level. The sample consists of firm-years in which a turnover event has occurred i.e. there is a new CEO. The variable Lag Rigid is a dummy equal to one if the firm paid its CEO a number-rigid grant in the previous year. The control group consists of observations in which there is a turnover event that does not follow a number-rigid year.

Panel B tests whether executives who receive rigid and non-rigid option grants operate in integrated labor markets. The regression tests whether an executive who worked for a number-rigid firm in the past (defined as a firm that granted number-rigid options to any executive in the past 3 years) is more likely to transition to another number-rigid firm relative to an executive who worked in a non-rigid firm in his previous job role.

Panel C tests an SS-style lumpy adjustment model. In previous analysis, we show that number-rigidity corresponds to larger changes in the value of compensation granted on average relative to a control group of non-rigid observations. In a lumpy adjustment model, we would then expect large relative declines in compensation following number rigidity to offset the increase in pay. This table explores how compensation changes in flexible years (defined as years in which the number of options granted does not equal the number granted in the previous year) following number-rigid years. The control group is flexible years following other flexible years. The sample is all S&P 1500 executives. In all panels, standard errors are allowed to be clustered within firm.

Panel A: Rigidity and Compensation Changes Following Turnover

	Change Total Comp		Change Option Value	
Lag Rigid	-0.0486	-0.0481	0.107	0.107
	(0.0690)	(0.0705)	(0.0841)	(0.0868)
Constant	0.159***	0.159***	0.190***	0.190***
	(0.0207)	(0.0204)	(0.0313)	(0.0300)
Year FE	No	Yes	No	Yes
R^2	0.000289	0.0289	0.00171	0.0857
Observations	1392	1392	787	787

Panel B: Firm Switching and Rigidity

	(1) Current Firm Rigid	(2) Current Firm Rigid
Previous Firm Rigid	-0.00684	-0.00731
	(0.0288)	(0.0292)
Year FE	No	Yes
R^2	0.0000467	0.0151
Observations	1213	1213

Panel C: Test of SS-Style Lumpy Adjustment Model

	Change Total Comp		Change Option Value		Change Option Number	
Lag Rigid	0.0387***	0.0423***	0.0599***	0.0736***	0.0330**	0.0436***
	(0.00849)	(0.00828)	(0.0140)	(0.0132)	(0.0154)	(0.0150)
Constant	0.0956***	0.0953***	0.0664***	0.0653***	0.238***	0.238***
	(0.00233)	(0.00230)	(0.00402)	(0.00388)	(0.00469)	(0.00454)
Year FE	No	Yes	No	Yes	No	Yes
R^2	0.000498	0.0255	0.000490	0.0393	0.000121	0.0290
Observations	63781	63781	63054	63054	63781	63781

Table 5

Number Rigidity Before and After the Passage of FAS123r

In 2006, FASB began requiring firms to expense options at fair value on their income statements (FAS123r). At the same time, the SEC changed the format in which firms had to report compensation and as part of that change began requiring that firms report the fair value of option compensation paid to top executives. In comparison, firms were required to report the value of stocks granted for the entire sample period from 1992 to 2010. This table shows how the prevalence of number-rigidity and number-focus among option and stock grants changes after firms begin reporting fair value. Each observation is an executive × year × grant type, where grant type represents option grants or stock grants. The sample is restricted to S&P 500 CEOs who received the relevant grant type in the current year and in the previous year. In the first two columns, we regress a dummy for whether the grant is number-rigid (same number in consecutive years) on a dummy for whether the grant was disclosed using the new reporting format, a dummy for whether the grant was in the form of options, and the interaction between the two dummies. "Exact" requires that the number of options or stock granted in consecutive years be exactly the same while "close" requires that the ratio of the number granted in consecutive years be equal to one with a tolerance of 0.025. We allow for a tolerance because exact data on the number of shares granted in stock grants is not reported, so we must estimate it using the reported value of shares on the grant date and the closing share price on the day of the stock grant. The last two columns replicate the analysis using as the dependent variable the number focus dummy (the ratio of the number granted in the current year relative to the number granted in the previous year is equal 1, 0.5, or 2).

	Number Rigid		Number Focus	
	Exact	Close	Exact	Close
New Format	0.0239***	0.0141	0.0272***	0.0300**
	(0.00604)	(0.0111)	(0.00626)	(0.0121)
Options	0.159***	0.117***	0.196***	0.150***
	(0.00748)	(0.0107)	(0.00822)	(0.0119)
New Format × Options	-0.0704***	-0.0542***	-0.0972***	-0.0873***
	(0.0129)	(0.0149)	(0.0135)	(0.0165)
R^2	0.0373	0.0168	0.0498	0.0211
Observations	9664	9664	9664	9664

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Appendix

A Appendix Exhibits

Figure 1
Number Change Distribution over Time for Low Return Firms

This figure shows how the distribution of the proportional change in the number of options has evolved over time. The figure replicates 1 within two or three year intervals, and the sample is restricted to firms with low returns (returns below -5%) in the 12 month period prior to the option grant.

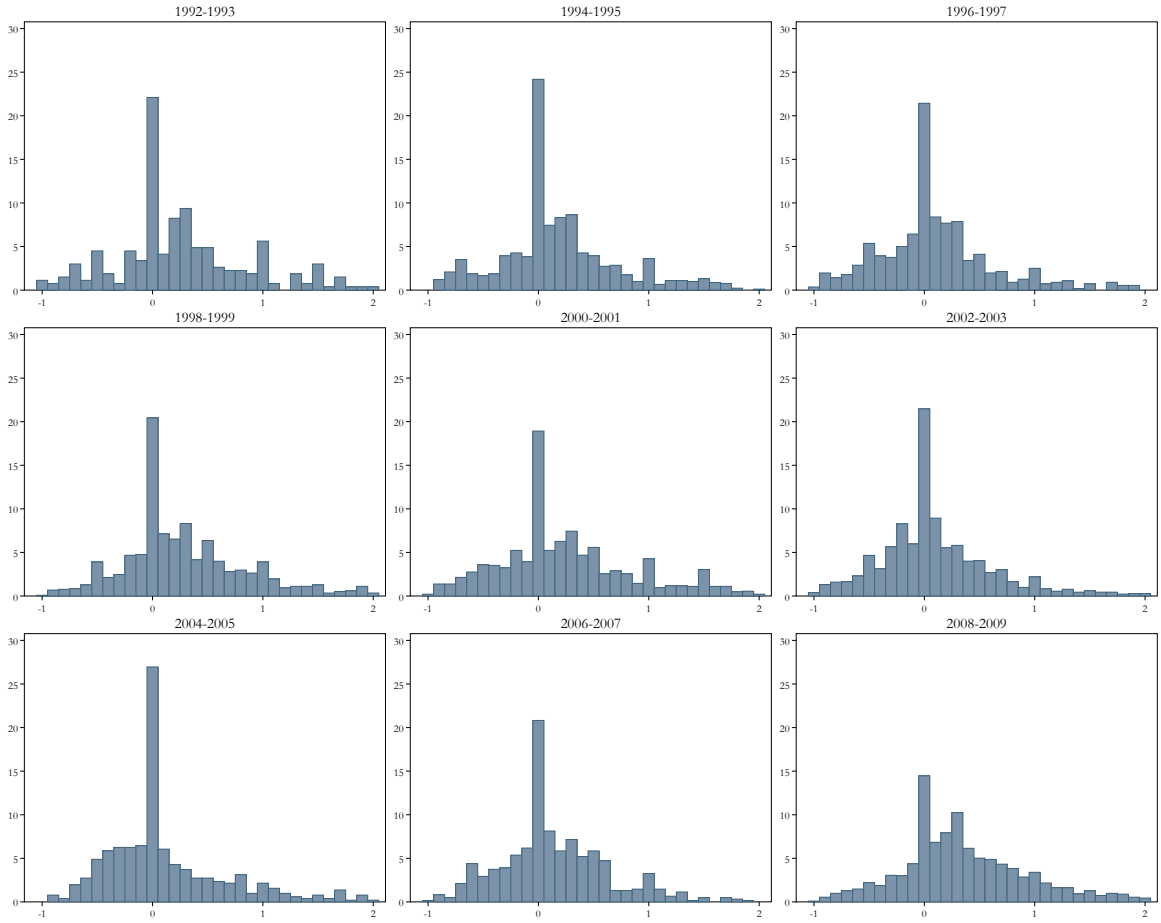


Figure 2
Number Change Distribution over Time for All Firms

This figure shows how the distribution of the proportional change in the number of options has evolved over time. The figure replicates 1 within two or three year intervals.

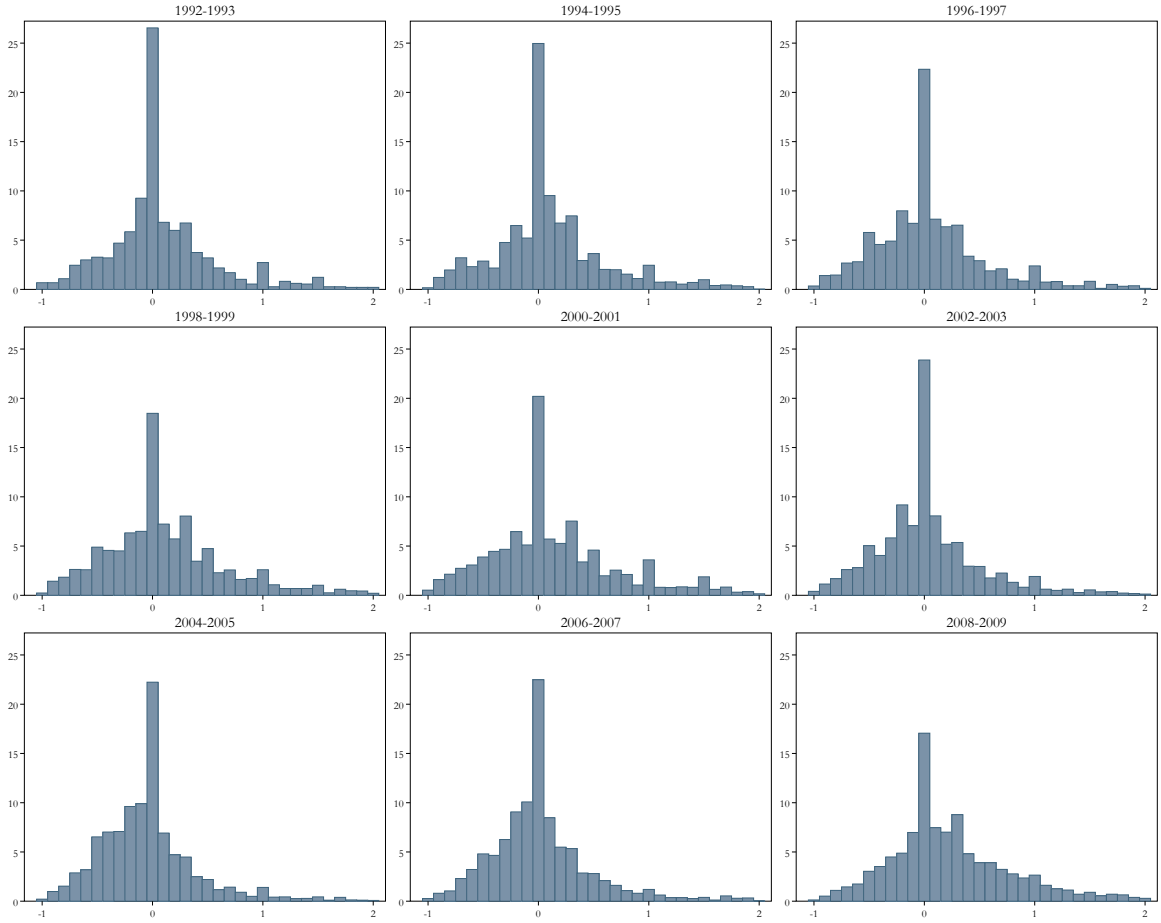
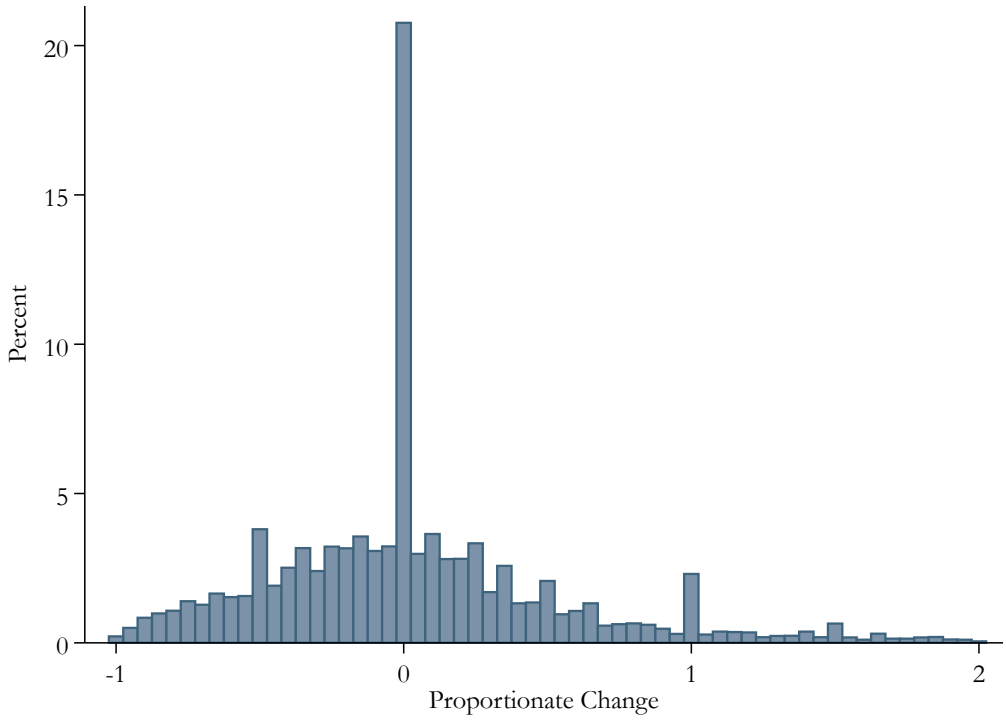


Figure 3
Number of Options Granted in Extended Samples

Panel A shows the distribution of the proportional change in the number of options granted in the current year relative to the previous year. The sample includes executives who hold the CEO position in the current and previous year in firms that were ever a part of the S&P 1500 from 1992 to 2010. Panel B repeats the exercise but further extends the sample to include all top executives (usually five per firm) as reported in ExecuComp.

Panel A: S&P 1500 CEOs



Panel B: S&P 1500 Top-5 Executives

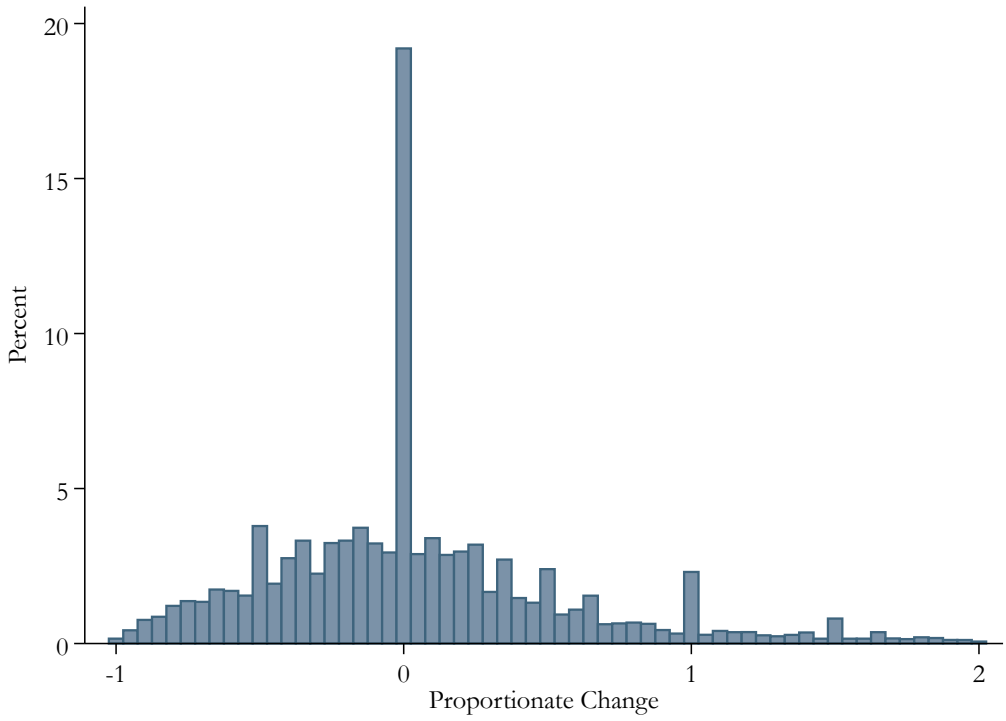


Table 1
Spillovers Calibration Using Alternative Parameter Values

In this table, we present calibrations of spillover affects in the Gabaix and Landier (2008) model using alternative assumptions regarding parameter values. In all calibrations, we assume that median firm size remains constant over the sample period in order to focus on the fraction of growth in total compensation that can be explained by number-rigid spillovers alone. Gamma γ represents the impact of CEO skill on firm earnings ($\gamma = 1$ implies constant returns to scale and $\gamma < 1$ implies decreasing returns to scale) and characterizes the extent to which median compensation should rise with changes in median firm size, absent any spillover effects. γ is estimated to be equal to one in Gabaix and Landier (2008), but is estimated to be substantially lower if the data is estimated over a longer sample period. Alpha α describes the distribution of firm size in the right tail and most estimates imply that $\alpha = 1$. Beta β is determined such that $\gamma - \frac{\beta}{\alpha}$ is equal to the relationship between log compensation and log firm size, which is approximately 0.2-0.4 in the data.

Panel A: Fraction of growth in total compensation from 1992-2002 explained by number-rigid spillovers

		Beta						
		0.2	0.3	0.4	0.5	0.6	0.7	0.8
Gamma	0.4	0.38						
	0.5	0.24	0.51					
	0.6	0.20	0.31	0.66				
	0.7		0.24	0.37	0.84			
	0.8			0.28	0.45	1.04		
	0.9				0.32	0.53	1.28	
	1.0					0.37	0.61	1.55

Panel B: Fraction of growth in total compensation from 1992-2010 explained by number-rigid spillovers

		Beta						
		0.2	0.3	0.4	0.5	0.6	0.7	0.8
Gamma	0.4	0.43						
	0.5	0.27	0.60					
	0.6	0.21	0.34	0.81				
	0.7		0.25	0.42	1.06			
	0.8			0.30	0.51	1.36		
	0.9				0.36	0.61	1.73	
	1.0					0.41	0.73	2.18

B Survey Evidence

The following reports the results of a Towers Perrin CompScan Survey of 130 North American companies with sales averaging just over $5 billion (US) in 1998.

Last year, you personally received options to purchase 1,000 shares ... at the stock's then current price of $50. This year, the share price is up to $70. How many options should you get (assuming, for the sake of this simple example, that the competitive value of your job hasn't changed from last year to this one)?

A) 1,500
B) 1,000
C) 715

If you chose A, you're in the vast majority [> 50% of survey respondents] of option recipients who think they should get more, not fewer, options when the price goes up.

If you selected B ... you're not expecting a bigger grant, more than the 1,000 options you received last year, but you also can't see why the size should be cut back when the stock has performed well.

If you selected C, either your analytic tendencies are dominating or you're thinking chiefly with your corporate hat on ... You may reason that a grant of 715 options would have the same Black-Scholes value as the prior year's grant, because the Black- Scholes value for each option has increased as the stock price went up.

It is telling that more than half of survey respondents chose option A, which required a raise in the number of options, suggesting both number focus and also a reference point set by last year's number.

An important caveat to this explanation is that the behavioral bias need not be on the part of the CEO or the board. Many firms also grant employee stock option plans or ESOPS to lower level managers and rank and file employees. Anecdotally, many of these employees are unaware or distrustful of option valuation formulas and prefer to count option grants in terms of number. For example, Tower's Perrin actually argues in their 1998 survey that firms may engage in stock splits to manage employee expectations regarding option and share grants:

> "Stock splits also offer an opportunity to readjust grant levels, moving back toward more competitive levels, without jolting employees' perceptions or expectations quite so drastically. For instance, among those companies with fixed guidelines that had a stock split in the past three years, exactly half reported holding the line on the number of shares they granted while the other half increased grant levels proportionately."

It could be the case that workers below the level of the CEO view compensation through the lens of number-focus and reference points. This could generate rigidity. Then, internal pay equity concerns may cause rigidity to translate up the firm hierarchy to the CEO level.