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

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Abstract

The dramatic rise in US CEO compensation during the 1990s and early 2000s is a longstanding puzzle. In this paper, we show that much of the rise can be explained by a tendency of firms to grant the same number of options each year. In addition, we show that salary and bonus exhibited downward nominal rigidity. Together, these two forms of rigidity imply that the value of executive pay will grow with firm equity returns, which were very high on average during the Tech Boom. Number-rigidity in options can also explain the increased dispersion in pay, the difference in growth between the US and other countries, and the increased correlation between pay and firm-specific equity returns. We present evidence that number-rigidity arose from a lack of sophistication about option valuation that is akin to money illusion. We show that regulatory changes requiring the disclosure of the grant-date value of options led to a decline in number-rigidity, and helps explain why executive pay increased less with equity returns during the Housing Boom in the mid-2000s.

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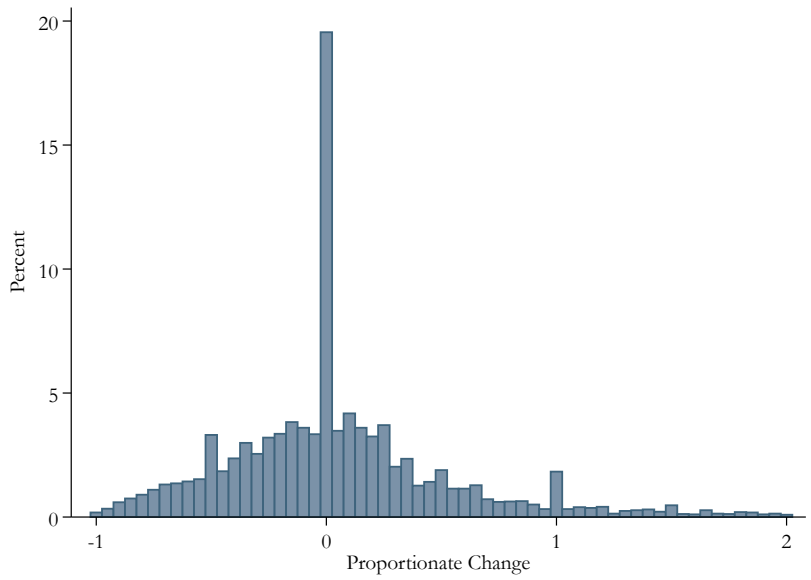


Annual proportionate change in the number of options granted
(S&P 500 CEOs, 1992-2010)

The dramatic rise in compensation granted to US CEOs during the 1990s and early 2000s is a longstanding puzzle. Median compensation in 2011 dollars for S&P 500 CEOs grew more than three-fold from \$2.9M in 1992 to \$9.3M in 2001. After the mid 2000s, growth leveled off considerably, with the median CEO earning \$9M in 2011 (Murphy, 2013). Compensation for US CEOs was also relatively flat in the decades leading up to the 1990s (Frydman and Saks, 2010). Thus, the compensation growth during the 1990s and early 2000s 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 considerably 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 stylized facts (Frydman and Jenter, 2010), particularly the off-trend nature of CEO pay during the 1990s and early 2000s, hereafter referred to as the Tech Boom.

In this paper, we explore an alternative and complementary explanation for this surge in executive compensation. It is well known that the bulk of the growth in CEO pay arrived in the form of new at-the-money option grants. While much of the existing research focuses on the rising grant date *value* of these options, we instead start by examining the *number* of options awarded to executives. We show that there is a high degree of rigidity in the number of options awarded. That is, firms often grant executives the exact same number of options as in the previous year. In addition, other round multiples of the previous year's number are common. These patterns suggests a tendency to think of option compensation in number rather than dollar terms. Such a tendency is also consistent with the fact that many firms use multi-year option plans which pre-specify that the same number of options be granted in consecutive years (Hall, 1999; Shue and Townsend, 2013). This paper shows that, pre-planned or not, rigidity in number can have major value implications, especially if firms choose to keep the number of options granted year-to-year fixed as equity prices experience a sustained increase.

All else equal, if a firm grants its CEO the same number of new 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 will 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. This downward rigidity may explain why other forms of compensation did 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. We find evidence that these changes moved firms away from number-focus toward value-focus. The change in focus helps explain why CEO pay increased less with stock

returns during the stock market boom in the mid 2000s.

Our analysis builds on insights from two comprehensive review articles on executive compensation by Murphy (1999; 2013). Murphy shows a near perfect historical correlation between average executive pay and the S&P 500 index in the 1990s and early 2000s. He notes that this pattern would be consistent with compensation committees focusing on the number of options granted rather than the value of options granted. In this paper, we extend Murphy's insights by providing direct evidence that firms do grant options with a focus on the reference point set by the previous year's number and explore the value consequences of such a policy. We also present new evidence on downward nominal rigidity in other forms of executive compensation and show how these two forms of rigidity combined to explain many of the stylized facts pertaining to compensation during the Tech Boom. Finally, we explore the origins of number-rigidity.

We begin by showing that option grants over our sample period are strongly rigid in number. 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 number rather than dollar terms. Even after adjusting for splits, there are also pronounced spikes at round multiples of the previous year's number, such as double or half. Number increases of exactly 10%, 20%, and so on, are also common.

Next, we estimate what pay growth for the set of number-rigid firms would have been if they had instead granted options in the same manner as non-rigid firms, conditional upon firm performance. This analysis simply constructs a counterfactual, and does not make any assumptions regarding whether number-rigidity is an optimal policy. We categorize option grants each year as number-rigid if they have the same number of split-adjusted options as the grant in the previous year. Consistent with the discussion above, we find that the slope of the relationship between changes in the grant-date value of option awards and a firm's stock return is approximately one when grants are number-rigid. This relationship is significantly less steep for non-rigid option grants. Thus, CEOs with number-rigid grants gain more than CEOs with non-rigid grants when firm returns are high and lose more when firm returns are low. Since firm returns were high on average during the Tech

Boom, number-rigid CEOs experienced high growth in option pay on average. We find a similarly steeper pay-return relationship for total compensation among the number-rigid sample, consistent with our later findings that other forms of compensation did not offset the large changes in pay induced by number-rigidity in options. We then use the relationship estimated from the non-rigid sample to predict counterfactual total compensation growth for each firm the number-rigid sample, conditional on performance.

Using these counterfactuals, we estimate how much number-rigid option grants may have contributed to the overall growth in CEO pay during our sample period. In order to do so, it is important to recognize that pay policies at number-rigid firms may have spillover effects on the level of compensation at non-rigid firms, as both sets of firms compete for CEO talent in an integrated labor market. Therefore, 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 potentially explain much of the off-trend growth in CEO pay during the Tech Boom.

Even if number-rigidity leads to strong growth in the value of options granted, it remains possible that other forms of compensation decrease when returns are high in order to keep total compensation in line. We do not find evidence of negative offsets in other forms of compensation, the bulk of which consisted of cash. We show that one reason for the lack of offsets is that cash compensation is downward rigid in nominal dollars. To quantify the extent of 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. Perhaps more surprisingly, we also find evidence of downward rigidity in bonus compensation. We estimate that 9.3% of CEO-years would have had a bonus cut absent rigidity.

[1]It may appear counterintuitive to use the Gabaix and Landier (GL) model to calibrate number-rigid spillovers because, under certain parameter assumptions, the GL model can already generate strong growth in compensation during the Tech Boom without accounting for number-rigidity and associated spillovers. However, for the GL model to fit the data over a longer time period, model parameters must change dramatically over time (see Section 1.3). It is not the objective of this paper to show that model parameters remained constant over time – they may indeed have changed. However, 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.

Altogether, 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 CEO compensation during the Tech Boom. Our explanation also matches three other stylized facts. First, the cross-sectional dispersion of CEO compensation increased substantially in the 1990s (Frydman and Jenter, 2010). This increase in dispersion is a natural consequence of number-rigidity, which increases the sensitivity of compensation to individual firm returns, which are highly idiosyncratic. Second, non-US CEOs experienced significantly slower compensation growth during the Tech Boom, controlling for country-level growth and firm characteristics (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.

In the remainder of the paper, we explore the origins 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, and choose to hold the number fixed, because number-rigidity implements an optimal incentive scheme. For example, firms may grant number-rigid options to manage executive ownership or to award steep pay-for-performance incentives.

The second broad class of theories includes explanations in which at least one party in the compensation setting process is somewhat unsophisticated about how to value options. Given that options are typically granted at the money, it is not immediately obvious that granting the same number of new options after a stock price increase would coincide with a pay increase. Fully understanding this requires knowledge of option pricing formulas that economists only derived relatively recently (Black and Scholes, 1973). There is ample anecdotal evidence that when option compensation first came into use, many did not understand or trust these formulas. Instead, they used number as a proxy for value. This heuristic is similar to thinking about money in nominal rather than real terms, i.e. money illusion. There were also a variety of regulations that emphasized

the number rather than value of options granted to executives. For example, up until 2006, the SEC only required the number of options granted to top executives to be reported in proxy statements. Similarly, FASB did not require the value of at-the-money option grants to be expensed in income statements until 2005. Finally, NYSE and NASD listing requirements also mandated shareholder approval for only the number of options granted. These regulations likely reflect, but also may have influenced, the way that compensation was commonly measured.

Importantly, this lack of sophistication may be on the part of the CEO or other stakeholders such as the board, shareholders, regulators, and/or lower level employees. For example, shareholders may impose an outrage constraint that limits executive compensation. However, if shareholders do not fully understand that the value of the compensation granted is rising even as the number of options remains fixed, this outrage constraint may fail to bind.

We conduct a number of tests to help distinguish between these two classes of theories. We find consistent results pointing toward the second class of theories, suggesting that number-rigidity arises primarily from imperfect understanding of option valuation. However, we cannot rule out the possibility that, for a subset of firms, number-rigidity arises from optimal contracting.

Our first set of tests examines whether firms become less likely to grant number-rigid options when they transparently report and expense the value of those options. If number-rigidity implements an optimal contract, the contract should remain optimal regardless of whether number or value is directly disclosed. Indeed, if all parties were sophisticated with respect to option valuation, changes in the manner of disclosure should have no effect because it is possible to calculate the value of at-the-money options using the number. On the other hand, if number-rigidity arises from naïveté on someone's part, direct disclosure of value may reduce that naïveté.

As described above, prior to 2005, firms were not required to expense or disclose the value of at-the-money option compensation. Nonetheless, some firms voluntarily chose to do so in the early 2000s. We exploit this to test how disclosure relates to number-rigidity. We find that firms that voluntarily increased transparency were much less likely to grant number-rigid option pay.

We also examine the effect of forced disclosure on number-rigidity. In 2005 and 2006, FASB and

the SEC began requiring all firms to disclose and expense the grant-date value of option grants. We find that, following these regulatory changes, the prevalence of option number-rigidity (conditional on granting options) declined significantly. This was especially true following extreme returns, where holding the number of options fixed would have led to extreme changes in the value of option pay. To control for concurrent time trends, we use a differences-in-differences framework with stock compensation as a control group. Stock compensation also has a number and value associated with it, but its value had to be disclosed and expensed throughout our sample period. We find no change in number-rigidity for stock and a large decline in number-rigidity for options.

It may also be the case that better governed firms are more likely to choose optimal compensation structures and to be aware of option valuation methods. We test the relationship between governance and number-rigidity and find that better governed firms are significantly less likely to be number-rigid. This again cuts against the first class of theories in which number-rigidity arises from optimal contracting.

Given that governance and transparency reduce number-rigidity, one may wonder whether sophisticated CEOs consciously used number-rigidity to conceal high compensation from less sophisticated boards or shareholders. While we cannot rule out that many CEOs understood the value implications of number-rigidity, we find suggestive evidence that at least some CEOs may have thought about option compensation in number units. In particular, we find that following a positive stock split, many CEOs continue to receive the same, non-split adjusted, number of options as in the previous year. Rigidity of this type represents a large decline in CEO pay. In contrast, following a split, very few executives receive the same, non-split adjusted, number of shares of stock as they did in the previous year. This is likely because it is much easier to convert number to value for stock than options. In addition, we examine the relationship between CEO financial sophistication and number-rigidity. We proxy for financial sophistication with MBA education. We find that CEOs with an MBA degree are actually less likely to have number-rigid option pay. This suggests that CEOs that are more likely to understand and trust option valuation formulas were less likely to demand number-rigid option pay. The above results are also consistent with evidence

from executive compensation surveys showing that many executives viewed a decrease in option number as unfair, in much the same way that many workers view a downward change in nominal wages as unfair.

Overall, we show that number-rigidity helps explain many of the striking stylized facts relating to CEO pay during the Tech Boom period. Our analysis also offers a potential explanation for why growth in CEO pay tapered considerably after the Tech Boom, even despite high stock market returns during the Housing Boom of the mid-2000s. We show that firms shifted their focus from number to value during this period, partly due to regulatory changes requiring firms to begin disclosing and expensing the grant date value of option awards.

1 Recent Trends in Executive Compensation

1.1 Growth in Executive Compensation

Before exploring the effects of rigidity on compensation growth, we first review recent trends in executive compensation. Figure 4 shows how CEO compensation evolved from 1992 to 2010, estimated following the method in Murphy (2013). We 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 in each year in 2011 dollars. Each bar is decomposed based upon the mean proportion of each component of compensation in each year. As has been previously documented, total compensation more than tripled from 1992 to 2001, 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 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 partly replaced by stock compensation. 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.

Note that compensation in Figure 4 is reported in terms of grant date value instead of realized

value at exercise. Therefore, the growth in compensation cannot be attributed to the fact that previously granted options and restricted stock are worth more at exercise following strong equity performance. Instead, the figure shows that the grant date value of new option awards each year grew dramatically in the 1990s and early 2000s.

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. This figure shows that CEO option compensation grew much faster than other forms of CEO 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 CEO 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.

1.2 Regulatory Changes and the Use of Options

In this paper, we show that rigidity in the number of options granted, combined with rapidly increasing equity prices and downward nominal rigidity in cash compensation, can explain the patterns just described. We acknowledge that this is somewhat of a partial theory in that it does not explain why option compensation came into use in the first place. Murphy (2013) 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 had to deal with cash-flow issues (from paying the exercise price) and risk (from the possibility that 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, 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.

1.3 Existing Explanations

A number of theories have been proposed for the growth in US CEO compensation in recent decades. 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). One issue with this explanation, however, is that there is little evidence that corporate governance became 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, 2005a; Kaplan, 2008). 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." In later analysis, we show that lack of sophistication with respect to option valuation may have contributed to number-rigidity and explore how number-rigidity interacted with governance.

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 (GL) 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 the correlation between median firm size and CEO pay is much weaker prior to 1970. In a similar vein, (Nagel, 2010) shows that the relationship following 1970 is sensitive to sample-selection and substantially weaker after the early 2000s. More generally, we believe GL's model highlights a very important channel for the growth in executive compensation: the growth in firm size. However, for the growth in firm size to explain *all* of the rise in CEO compensation in recent decades, one must assume that a key parameter, γ, equals one, i.e., that the CEO's impact on earnings displays constant returns to scale. Evidence from Frydman and Saks (2010) and (Nagel, 2010) suggests that γ may be less than one or may have changed over time. If so, the GL model would be an important but not an exclusive explanation for the rise in CEO pay. We stress that it is not the objective of this paper to show that γ is less than one or that γ did not increase during the Tech Boom. However, 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. More specific to number-rigidity, firm-size related theories do not predict that the increase in compensation should come in the form of options or that options should be number-rigid. GL's model also predicts that CEO pay should increase with aggregate returns rather than firm-specific returns, because aggregate returns are a better proxy for an executive's outside option. In practice, number-rigidity tied compensation to firm-specific returns rather than aggregate returns.

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 (2005a) 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 (Frydman and Jenter, 2010). 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 off-trend growth in compensation during the 1990s and early 2000s.

2 Data

2.1 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, number, and value 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.

We supplement ExecuComp data with merged data from Thomson One on restricted stock

grants to insiders. Execucomp offers data on the grant-date value and number of option awards throughout our sample period. However, Execucomp only offers data on the value of stock grants if they were granted prior to 2006. To attain data on the number of shares of stock granted in each year, we use merged data on insider grants from Thomson One which includes information about the exact number of shares of restricted stock granted to each executive in each year.

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.

Our analysis focuses on S&P 500 CEOs because they experienced the most dramatic and publicly scrutinized increases in pay. However, other top executives also experienced strong pay growth during our sample period. In supplementary results, we find strong number-rigidity in extended samples using all top executives in the firm or S&P 1500 firms, suggesting the number-rigidity can account for increases in executive compensation more broadly. These results are presented in the Appendix. To increase estimation power in some regressions, we also expand the sample as noted to S&P 1500 executives.

2.2 Identifying Number-Rigid 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 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 3.

2.3 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 main 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 the 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 grant number-rigid compensation randomly. Indeed, firms that do so may be poorly governed or have less sophisticated management as shown in our later analysis.

3 Results

3.1 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, 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.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.[2]

Next, we examine stock compensation. 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. The value of a stock grant may be easier to conceptualize than the value of an option grant. Therefore, one might

[2]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.

expect executives and boards to be more likely to think about stock compensation in dollar terms – leading to less rigidity in number and more rigidity in value. Consistent with this, we find evidence of rigidity along both the value and number dimensions, with spikes at zero in both histograms. Stock grants are rigid in number, although to a lesser extent than options.

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 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 3.3.

3.2 Number-Rigidity and 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, this exercise does not make any assumptions regarding whether number-rigidity is an optimal or suboptimal policy. 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 compensation growth would have been for this set of observations, using the relationship between firm returns and compensation growth in the non-rigid sample (the control sample). Finally, we estimate the effect of number-rigidity on aggregate growth in total compensation after taking into account potential spillover effects.

3.2.1 The Relationship between Compensation Growth and Firm Returns

We first compare the relationship between option value growth and firm returns 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 annual 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. These results are consistent with our later analysis showing that other types of compensation do not change to

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.

3.2.2 Spillovers and Aggregate 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, the 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 spillovers between 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 previous 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 among S&P 1500 firms 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, as discussed in detail in Section 1.3, 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 so, median compensation should rise one-for-one with aggregate market returns which approximately matched growth in median compensation. If γ is substantially less than one as suggested by Frydman and Saks (2010) and Nagel (2010), then GL's model still describes an important

channel for the growth in compensation, but there is room left for complementary explanations. 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.[3]

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 set f equal to the fraction of number-rigid CEOs in each year of our data. We set λ equal to the average difference between actual and counterfactual pay growth each year in the non-rigid sample, using realized returns and the relationship estimated in Figure 7. For other model parameters, we use $\gamma = 0.5$, $\alpha = 1$, and $\beta = 0.3$. [4]However, we estimate substantial spillovers using a range of alternative parameter values, as shown in Appendix Table 1. Finally, to use the exact formula derived in GL, we assume 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).

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

[3]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 γ being close to one.

[4]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.

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.

Figure 8 also highlights how spillovers from number-rigidity in options changed over time in a manner that helps to explain both the dramatic growth in compensation from 1992 to 2002 and the flattening of compensation thereafter. Note that cumulative growth from number-rigid spillovers plateaus starting in approximately 2002. This occurs for two reasons. First, the prevalence of number-rigidity began declining in the 2000s, thanks in part to to anticipated changes in accounting regulations in 2005 and 2006, which we discuss in detail in Section 4.2. For details, see Appendix Figure 2, which shows how the number-change distribution and prevalence of number-rigidity, conditional on granting options, changed over time. Second, firms became significantly less likely to keep option number constant conditional on experiencing extreme returns. This is particularly important because the wedge between actual and counterfactual value of option pay for number-rigid grants is small if firm returns are moderate (near zero). This wedge is much larger when the firm experiences very high or low returns, resulting in larger spillover effects. We show in Figure 12 and Appendix Figure 1 that, in addition to a general decline in the popularity of number-rigid grants, firms become much less likely to grant number-rigid options conditional on very high or very low returns.

In Panel B of Figure 8, we account for the additional changes in compensation implied by the GL model given growth in firm size. We plot 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 (using the same parameter assumptions of $\gamma = 0.5$, $\alpha = 1$, and $\beta = 0.3$ as in Panel A). 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 for 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. We also stress that we calibrate the GL spillovers model because it is commonly cited in the literature and because it is extremely elegant and tractable. However, spillover effects are likely to operate in any competitive environment, even if the exact assumptions (specifically, the important role of firm size) used in the GL model do not hold.

Our estimates are also likely to be lower bounds for the potential 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 larger total spillover estimates if also account for the positive (and negative) spillovers from CEOs who receive exactly 0.5, 0.75, 1.5 or 2 times the number of options as in the previous year. 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.

3.3 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, Card notes that 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.[5] 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

[5]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).

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 option value than other CEOs with comparable performance. The zone to the left of 0 represents rigid 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 adjusts up slightly when number-rigidity leads to lower than counterfactual option pay, cash pay does not adjust down on average when number-rigidity leads to higher than counterfactual option pay.

4 Sources of Rigidity

4.1 Two Broad Classes of Theories

In the remainder of the paper, we consider explanations for why executive compensation is rigid in various units and components. We start by exploring the origins of number-rigidity in option grants and distinguish between two broad classes of theories. The first class consists of theories in which all parties involved in the compensation negotiation process understand how to value options. Firms choose to hold the number fixed because number-rigidity implements an optimal incentive

scheme. For example, firms may grant number-rigid options to manage executive ownership or to award steep pay-for-performance incentives.

Before proceeding to empirical tests of this class of theories in the next section, we note that there are features of number-rigidity that may be logically inconsistent with some well-known variants of optimal contracting theory. For example, many optimal contracting models posit that managers should be paid for relative performance, after filtering out a luck component. Number-rigidity instead ties pay directly to equity returns, implying that executives will be rewarded for lucky industry-level or macro shocks. In addition, most optimal contracting models suggest that the growth in the grant-date value of equity awards implied by strong pay-for-performance or ownership incentives should be accompanied by declines in other forms of cash compensation, which did not occur on average during our sample period. Finally, number-rigidity is at odds with firm-size theories such as Gabaix and Landier (2008) (GL). GL's model predicts that holding the firm-CEO match fixed, CEO pay should increase with *market* returns rather than firm-specific returns. This is because market returns are a better proxy for an executive's outside option.

The second broad class of theories includes explanations in which at least one party in the compensation setting process is somewhat unsophisticated about how to value options. Given that options are typically granted at the money, it is not immediately obvious that granting the same number of new options after a stock price increase would coincide with a pay increase. Fully understanding this requires knowledge of option pricing formulas that economists only derived relatively recently (Black and Scholes, 1973).

There is ample anecdotal evidence that when option compensation first came into use, many did not understand or trust these formulas. Indeed, the chairman 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 proxy for 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.

Instead of using option valuation formulas, people may have used option number as a proxy for value. This heuristic is similar to thinking about money in nominal rather than real terms, i.e. money illusion (Kahneman et al., 1986; Shafir et al., 1997). In the Appendix, we summarize a survey of executives conducted by a large compensation consulting firm. The survey suggests that executives viewed a decline in the number of options following good performance as unfair, even if the decline in number coincided with an increase in value. Summary briefs by the compensation consulting firm speculate that lower-level employees, many of whom were compensated in the form of options, also distrusted option valuation formulas and valued options in number units.[6]

There were also a variety of regulations that emphasized the number rather than value of options granted to executives. For example, up until 2006, the SEC only required the number of options granted to top executives to be reported in proxy statements. Similarly, FASB did not require the value of at-the-money option grants to be expensed in income statements until late 2005. Finally, NYSE and NASD listing requirements also mandated shareholder approval for only the number of options granted. These regulations likely reflect, but also may have influenced, the way that compensation was commonly measured.

Importantly, this lack of sophistication may be on the part of the CEO or other stakeholders such as the board, shareholders, regulators, and/or lower level employees. For example, shareholders may impose an outrage constraint that limits executive compensation. However, if shareholders do not fully understand that the value of compensation granted is rising even as number of options remains fixed, this outrage constraint may fail to bind.

In the empirical analysis in the next sections, we focus on testing explanations for number-rigidity in options. However, we can similarly distinguish between two broad classes of potential explanations

[6]If lower-level employees do not fully understand options, they may 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.

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 of 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 who invest in risky firm-specific skills.[7] 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 morale-based stories as summarized in Bewley (2007).[8] Last year's level of salary or bonus may set a reference point, and losses relative to this reference point (even as total compensation rises) may be viewed as unfair, thereby lowering morale.

4.2 Sensitivity to Disclosure Regulation and Governance

We conduct a number of tests to help distinguish between the two classes of theories described above. In what follows, we present results consistently pointing toward the second class of theories, suggesting that number-rigidity arises primarily from imperfect understanding of option valuation. However, we cannot rule out the possibility that, for a subset of firms, number-rigidity arises from optimal contracting.

Our first set of tests examines whether firms become less likely to grant number-rigid options when they transparently report and expense the value of those options. If number-rigidity implements an optimal contract, the contract should remain optimal regardless of whether number or value is directly disclosed. Indeed, if all parties were sophisticated with respect to option valuation,

[7] These theories predict 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.

[8] This also relates to the notion of reference-dependent motivation described by Mas (2006) and highlighted in Camerer and Malmendier (2012). See (Baker et al., 2012) for evidence of reference point effects in other corporate settings.

changes in the manner of disclosure should have no effect because it is possible to calculate the value of at-the-money options using the number (one would only need other publicly available data on grant date and volatility). On the other hand, if number-rigidity arises from naïveté on someone's part, direct disclosure of value may reduce that naïveté.

As described in Section 1.2, firms were not required to expense or disclose the value of at-the-money option compensation prior to 2005. However, some firms voluntarily chose to do so in the early 2000s on their income statements. We exploit this to test how disclosure relates to number-rigidity. We collect data on voluntary disclosure in year 2003 (we choose year 2003 because it precedes mandatory value disclosure regulations but covers a period when voluntary disclosure grew in popularity). In Column 1 of Table 5, we regress a dummy for whether option grants are number-rigid on whether the firm voluntarily disclosed option value that year, controlling for basic firm characteristics such as size, leverage, and recent performance. We find that firms that voluntarily increased transparency are 13 percentage points less likely to grant number-rigid option pay. Relative to the base probability of being number-rigid in 2003, voluntary disclosure reduces the probability of being number-rigid by more than half. In Column 3 of the same table, we also find that voluntary disclosure significantly reduces the probability of awarding number-reference option grants by 17 percentage points. Altogether, these results show that firms that voluntarily disclosed and expensed the value of options granted were much less likely to grant the same number or a round fraction of last year's number of options.

Next, we examine the effect of forced disclosure on number-rigidity. In 2005 and 2006, FASB and the SEC began requiring all firms to disclose and expense the grant-date value of option awards. We test whether these regulations caused a decline in number-rigidity of option awards. To control for concurrent time trends, we use a differences-in-differences framework with stock compensation as a control group. Stock compensation also has a number and value associated with it, but its value had to be disclosed and expensed throughout our sample period.

Panel A of Table 6 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. We regress whether the grant is number-rigid or number-reference on whether the grant was awarded after the regulatory change, whether the grant was in the form of options (rather than stock), and the interaction between the option and post-regulation dummies. The regressions show that, throughout our sample period, options are significantly more likely to be number-rigid than stock grants. [9] We also find that, controlling for time trends, the regulation had no effect on number-rigidity for stock grants, consistent with the regulation only targeting option disclosure. Finally, and most importantly, we estimate a significant negative coefficient on the interaction term. This shows that the probability of number-rigidity/number-reference declined more after the regulatory change for options than for stock. These results are consistent with the idea that number-rigidity at least partly results from inattention to value.

In Panel B of Table 6, we show that mandated option value disclosure caused a reduction in number-rigidity particularly for firms that experienced extreme returns. We sort the absolute value of firm returns in the 12 month period before the option or stock grant into quintiles, using the full sample. Columns 1 and 2 restrict the sample to observations corresponding to the lowest quintile of absolute returns (returns closest to zero) while Columns 3 and 4 restrict the sample to observations corresponding to the highest quintile of absolute returns (either very low or high returns). We find that FAS123r did not significantly change the probability of option grants being number-rigid, conditional on moderate firm returns. However, firms became significantly less likely to grant number-rigid options following extreme firm returns. This is important because the wedge between actual and counterfactual value of option pay for number-rigid grants is only large when firm returns are extreme (not close to zero). Therefore, regulated disclosure reduced number-rigidity particularly in cases when number-rigidity would have led to large excess changes in the value of

[9]The fact the option compensation is more likely to be number-rigid than stock grants throughout our sample period also cuts against the first class of optimal contracting theories in which all agents are sophisticated with regard to option valuation. If option compensation is number-rigid for incentive reasons, e.g., to keep CEOs' ownership stake at a certain level, 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. Instead, the tendency of option compensation to be more number-rigid than stock compensation is consistent with options being more difficult to value than stock.

pay.

We also present graphical evidence of how number-rigidity evolved before and after the regulatory change in 2006. In Figure 12 we show that the effect of number-rigidity on the value of grants has 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, nearly 25% 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, less than 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.

Finally, we test how the quality of governance relates to number-rigidity. Better governed firms may be more likely to choose optimal compensation structures and to be aware of option valuation methods. We test the relationship between governance and number-rigidity and find that better governed firms are significantly less likely to be number-rigid. This again cuts against the first class of theories in which number-rigidity arises from optimal contracting. In Columns 3 and 6 of Table 5, we regress the number-rigid and number-reference dummies on the firm's entrenchment index (E-index), controlling for firm characteristics and year fixed effects. Higher values of the E-index serve as a proxy for worse governance (Bebchuk, Cohen, and Ferrell 2006). We find that a one point

increase in the E-index (which ranges from 0-4) corresponds to a 3.5 percentage point increase in the probability of being number-rigid and a 4.5 percentage point increase in the probability of being number-reference. Thus, conditional on granting options, weakly governed firms are more likely grant number-rigid options.

4.3 Splits and CEO Sophistication

Given that improved governance and transparency reduce number-rigidity, one may wonder whether sophisticated CEOs consciously used number-rigidity to conceal high compensation from less sophisticated boards or shareholders. We cannot discern the sophistication levels of each CEO and there is likely to be substantial heterogeneity across CEOs. While we cannot rule out that many CEOs understood the value implications of number-rigidity, we do find evidence that at least some CEOs may have thought about option compensation in number units or endured large losses in value due to number-rigidity.

In particular, we find that following a positive stock split, many CEOs continue to receive the same, non-split adjusted, number of options as in the previous year. Rigidity of this type represents a very large decline in the grant-date value of CEO. In contrast, following a split, very few executives receive the same, non-split adjusted, number of shares of stock as they did in the previous year. This is likely because it is much easier to convert number to value for stock than options.

For our analysis of splits, 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 split 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 corresponds 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 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 are consistent with strong naiveté regarding options. Following positive stock splits, CEOs who continue to receive the same number of options typically experience a 50% decline in the value of their option compensation, all else equal.

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 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 Figure shows that many executives experience large value losses well above one million dollars from lack of split adjustments in the number of options. The dotted line shows the change in other compensation necessary to fully offset these 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, non-option compensation does not change 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.

Finally, we examine the relationship between CEO financial sophistication and number-rigidity. We proxy for financial sophistication with MBA education. In Columns 2 and 5 of Table 5, we regress the number-rigid and number reference dummies on whether the the CEO holds an MBA degree, controlling for firm characteristics and year fixed effects. We find that CEOs with an MBA degree are 2.5 percentage points less likely to receive number-rigid option grants and 4 percentage points less likely to receive number-reference option grants. This suggests that CEOs that are more likely to understand and trust option valuation formulas were less likely to seek number-rigid option pay.

5 Supplementary Discussion

5.1 Contracting Frictions

In the previous section, we distinguished between two broad classes of explanations for number-rigidity in option grants. While we do not claim to rule out the optimal contracting class of explanations, we found evidence consistently supportive of the second class of explanations involving money illusion and lack of sophistication regarding option valuation. We now turn to how these two classes of explanations may interact with another important determinant of compensation schemes: contracting frictions.

Hall (1999) and Shue and Townsend (2013) show that many firms adopted informal, non-binding, multi-year option grant schedules that specified that the same number of new at-the-money options would be granted for several years in a row, after which a new schedule would be adopted.[10] These multi-year schedules likely reduced contracting frictions because they were easy to explain to shareholders. Simple multi-year schedules also prevented the firm from having to engage in potentially costly and uncertain renegotiation of compensation schemes every year.

In theory, firms could have kept number constant for two or three years due to contracting frictions and then adjusted number in flexible years so that, in the long run, the compensation scheme approximated what would be set under an optimal contract. However, such a story is inconsistent with our evidence showing that pay policies changed dramatically following regulation requiring the disclosure of the grant date value of options. As discussed previously, there is no obvious reason for the optimal pay-for-performance relationship or the optimal level of pay to vary with disclosure requirements. We found in earlier analysis in the paper that the growth rate of compensation and the sensitivity of value to firm returns declined significantly after firms began

[10] Hall (1999) and Shue and Townsend (2013) also document the existence of fixed value schedules in which firms grant the same value of new at-the-money options to CEOs each year for several years. Value was often calculated as "face value," defined as the grant date share price multiplied by the number of options instead of the Black-Scholes value. In unreported results, we show that these fixed value plans are unlikely to have exerted downward pressure on CEO pay in competitive labor markets. While option value was fixed within each fixed-value cycle, CEOs received large increases in value at the start of new fixed-value cycles. Fixed-value CEOs received pay increases according to a step function instead of a smoother increase each year. Empirically, CEOs receiving options according to fixed-value cycles received option pay that on average kept up with the growth in option value awarded to other CEOS.

disclosing the grant date value of options. To approximately match these trends in the period prior to 2006, number-rigid firms would have had to adjust compensation *downwards* in flexible years. As shown in previous analysis in Table 8, this did not occur. Firms did not follow an SS-style model with downward adjustment in flexible years. Instead, number-rigid grants were usually followed by flexible years in which number increased, leading to increases in value.

Altogether, we believe that multi-year number-rigid plans may have resulted from contracting frictions. However, firms did not adjust compensation in flexible years to resemble outcomes predicted by optimal contracting models. Instead, the empirical evidence is consistent with contracting frictions coinciding with the second class of explanations involving money illusion and lack of sophistication regarding option valuation.

5.2 Indirect Disclosure of Option Value

Our analysis in Section 4.2 showed that number-rigidity declined significantly with voluntary and regulated disclosure of the grant-date value of options. In this section, we discuss how to interpret our results given that firms were required to *indirectly* disclose the grant date value of options in two ways prior to regulatory changes in 2006.

First, prior to 2006, firms were not required to expense the cost of new at the money options granted on their income statements. However, firms were required to report in a footnote how income numbers would have looked if the firm had expensed the fair value of the total number of options granted to all employees. By comparing numbers in the main income statement with those in the footnote, is would have been possible to arrive at an approximate estimate of the value of new options granted to all employees. However, this information may not have made the value of options granted to the CEO or any other executive very obvious because it appeared in footnote rather than the main text. Further, the footnote is calculated using the total value of options granted to all employees including many lower level employees who also received options during this time period. Therefore, it is not easy to extract the value of options granted to the CEO or any other top executive.

Second, prior to 2006, firms were not required to disclose the grant date value of options in their proxy statements. However, they were required to report the "potential realizable value" of option grants under various percentage stock price appreciation scenarios in the detailed table of the proxy statement. If a reader compared these numbers across years, it would have been possible to infer that the potential realizable value of options changed even as option number stayed constant. Again, these value numbers may not have been very salient because they were reported in the detailed rather than main tables. In addition, agents who distrusted option valuation formulas may have disagreed or distrusted these valuations. For example, surveys of compensation committees suggest that many people thought that, since the options were granted at the money, granting the same number of new options after a stock price did not coincide with a real pay increase. They essentially believed that volatility is constant in dollar units, i.e. if a stock with a price of $100 has some probability of moving to $200, then that same stock at a price of $200 has an equal probability of moving to $300. In reality, volatility is approximately constant in percentage rather than dollar units: if a stock with a price of $100 has some probability of moving to$ 200, then that same stock at a price of $200 has an equal probability of moving to $400 (not $300). Under beliefs about constant volatility in dollars, agents will tend to value at-the-money options at less than potential realizable values when the option is granted following a period of stock price appreciation.

6 Conclusion

Several theories have been proposed to explain the dramatic rise in US CEO compensation during the 1990s and early 2000s. In this paper, we explore an alternative and complementary explanation, based on the observation that there is a high degree of rigidity in the number of options CEOs receive. Number-rigidity in option compensation implies that the grant-date value of option pay will grow with firm equity returns, which were very high on average during the Tech Boom. We also show that salary and bonus exhibit downward nominal rigidity. Thus, cash compensation does not decline to offset rigidity-induced increases in option pay. We then present evidence that number-rigidity arises

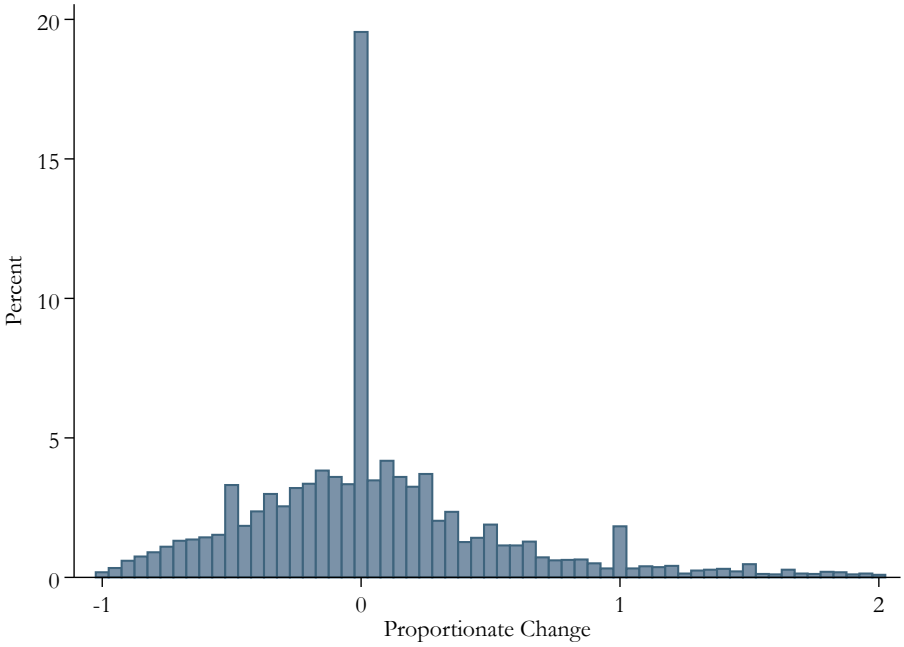
from a lack of sophistication about option valuation that is akin to money illusion. In particular, we show that number-rigidity is more prevalent for option compensation than stock compensation, which is easier to value. Moreover, option number-rigidity *declines* relative to stock number-rigidity when firms (voluntarily or involuntarily) begin to disclose and expense the grant-date value of their option pay. Improved governance also corresponds to reduced number-rigidity in options. Finally, we show that the number of options executives receive following a stock-split often times does not adjust, and that executives with MBA degrees are less likely to have number-rigid pay.

Altogether, 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 CEO compensation during the Tech Boom. Number-rigidity can also explain the increased dispersion in CEO pay, the difference in pay growth between the US and other countries, and the increased correlation between pay and firm-specific equity returns. The decline in number-rigidity, resulting from changes in disclosure requirements, helps to explain why executive pay increased less with equity returns during the Housing Boom in the mid-2000s.

Figure 1
Rigidity in Options Grants

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

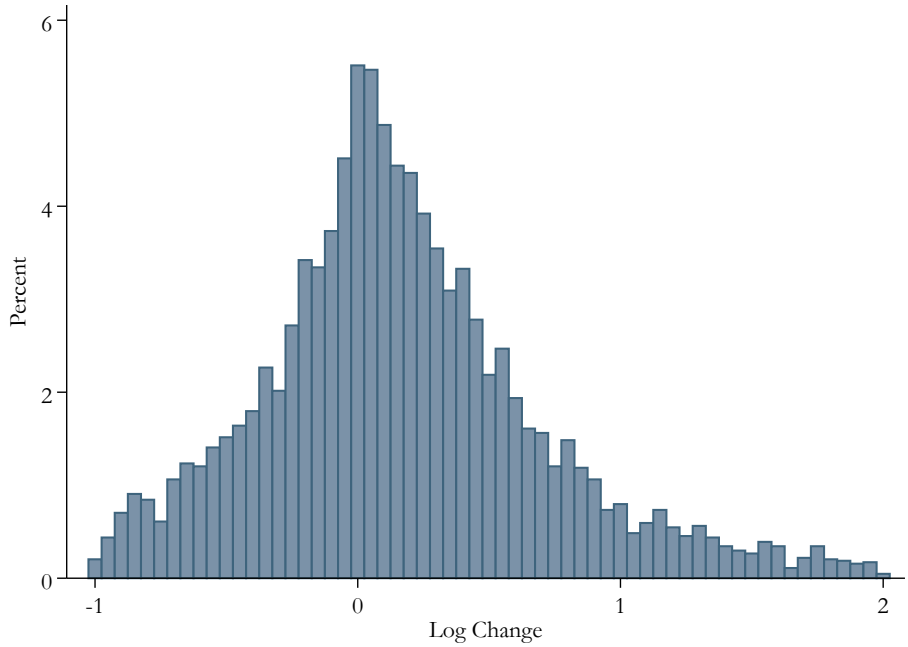
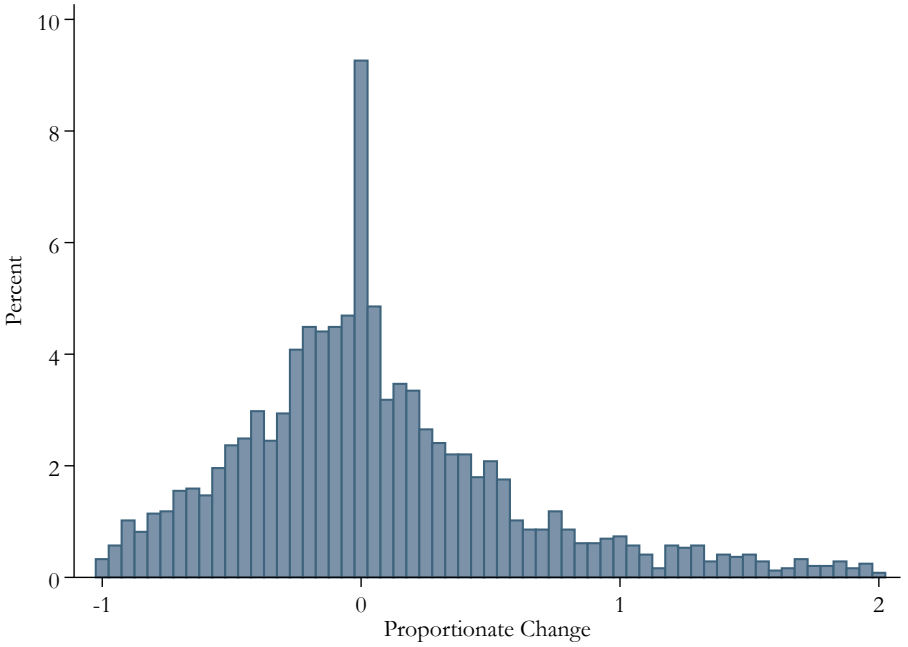


Figure 2
Rigidity in Stock Grants

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

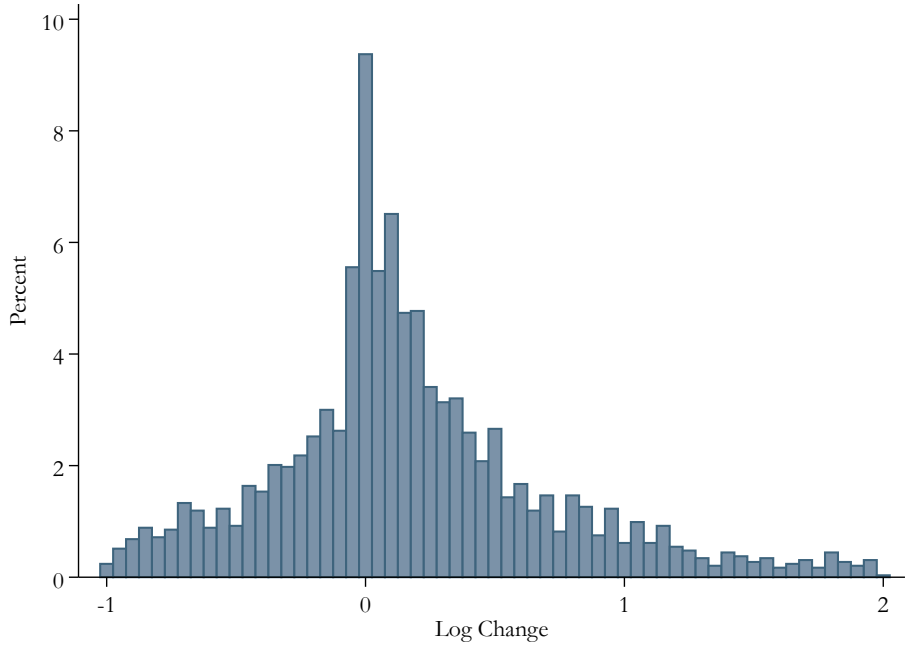
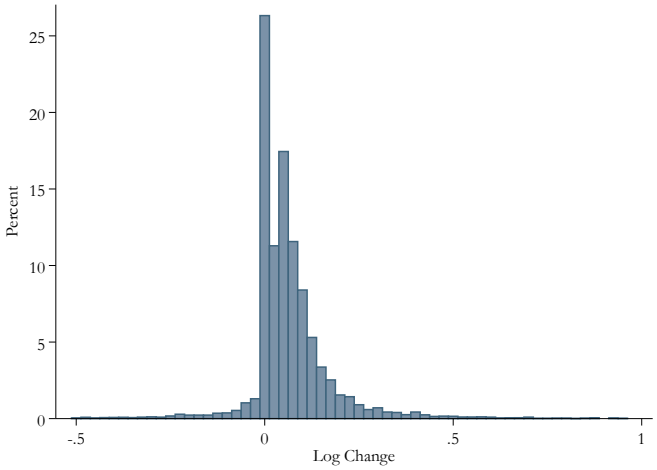


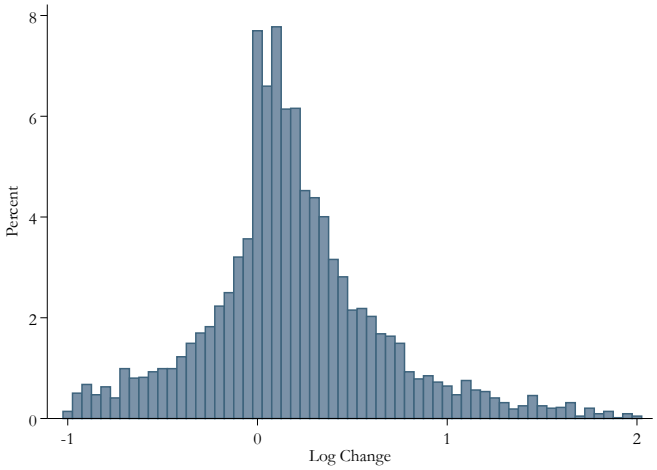
Figure 3
Rigidity in Cash Compensation

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)

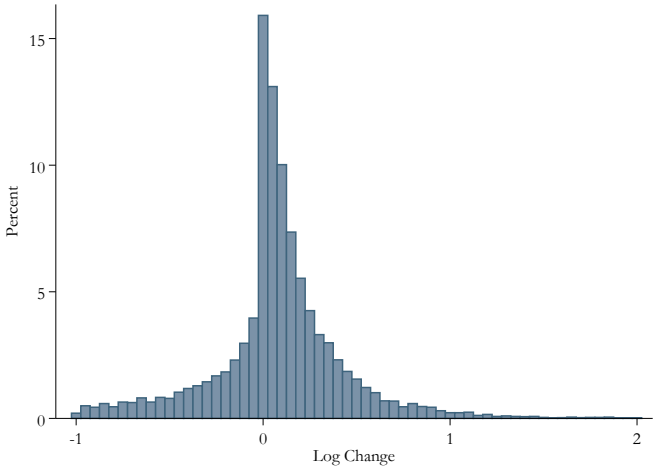


Figure 4
CEO Compensation Over Time

This figure is created following the methodology in Murphy (2013). 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 each year in 2011 dollars. In addition, each bar is decomposed into the mean proportion represented by each component of compensation in each year. The bonus component includes compensation included in non-equity incentive plans and long-term incentive plans. All components of compensation are calculated using grant-date values instead of realized values at exercise.

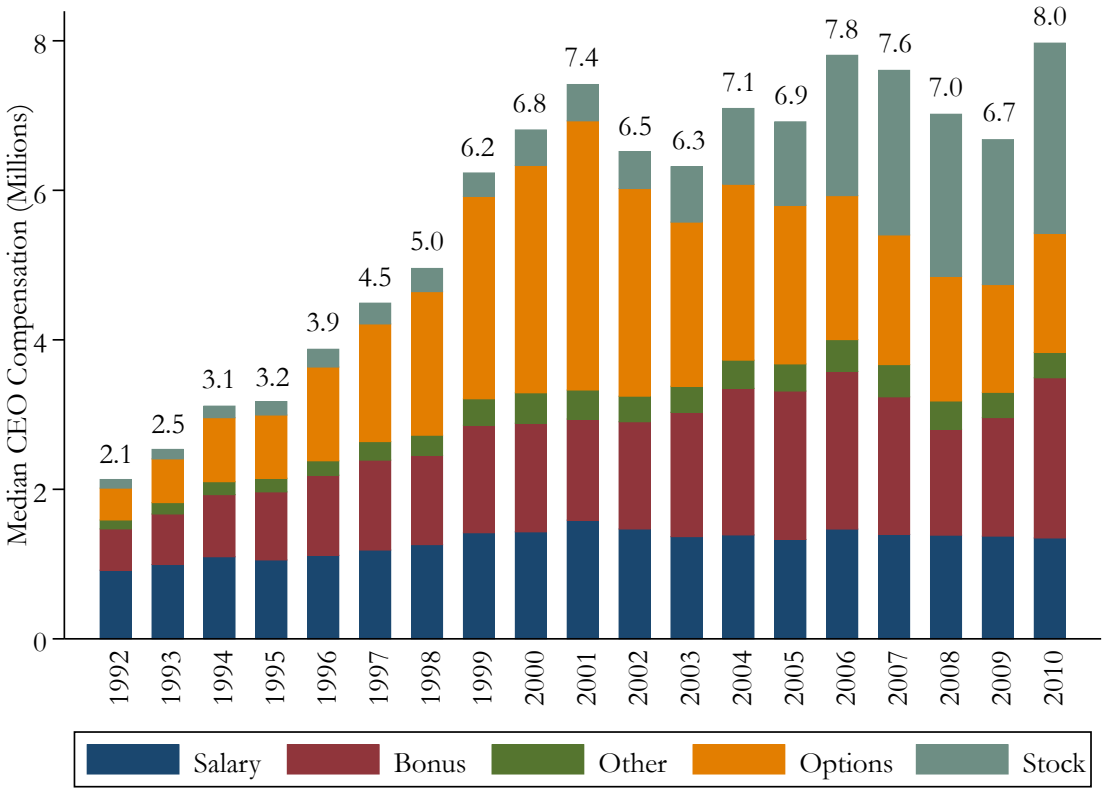


Figure 5
Compensation for CEOs vs. Other High Income Households

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.

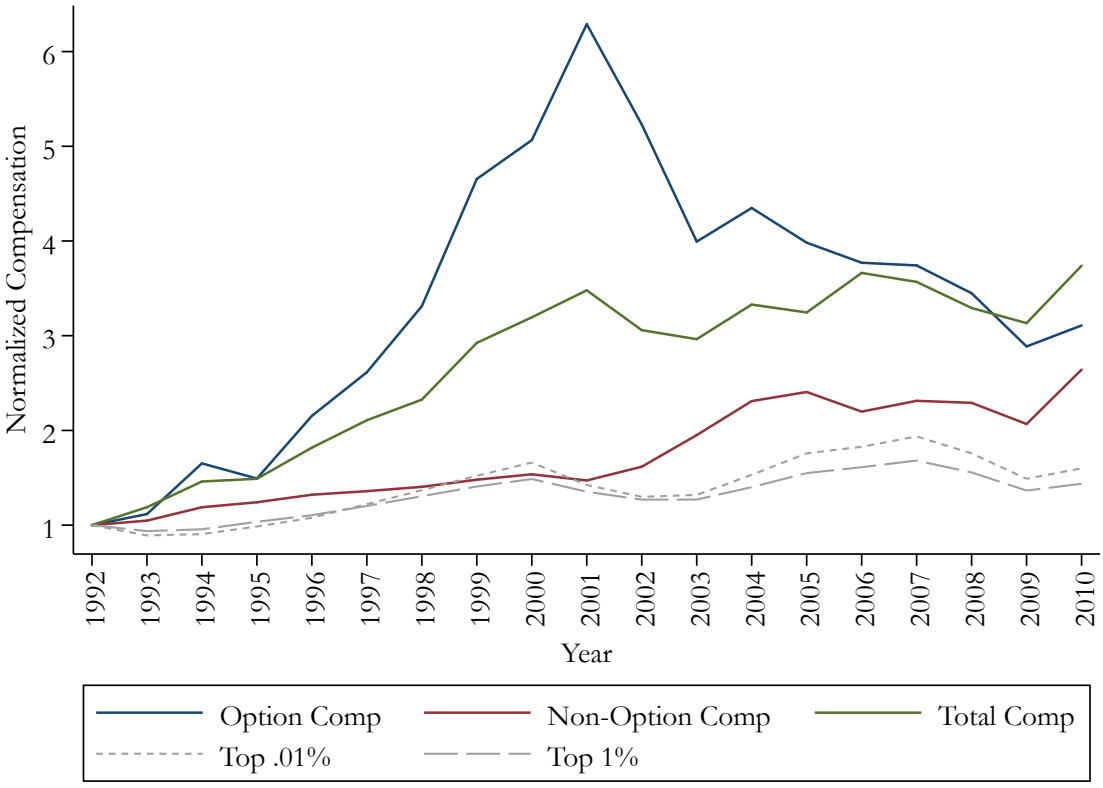


Figure 6

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

This figure plots changes in the log grant date 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.

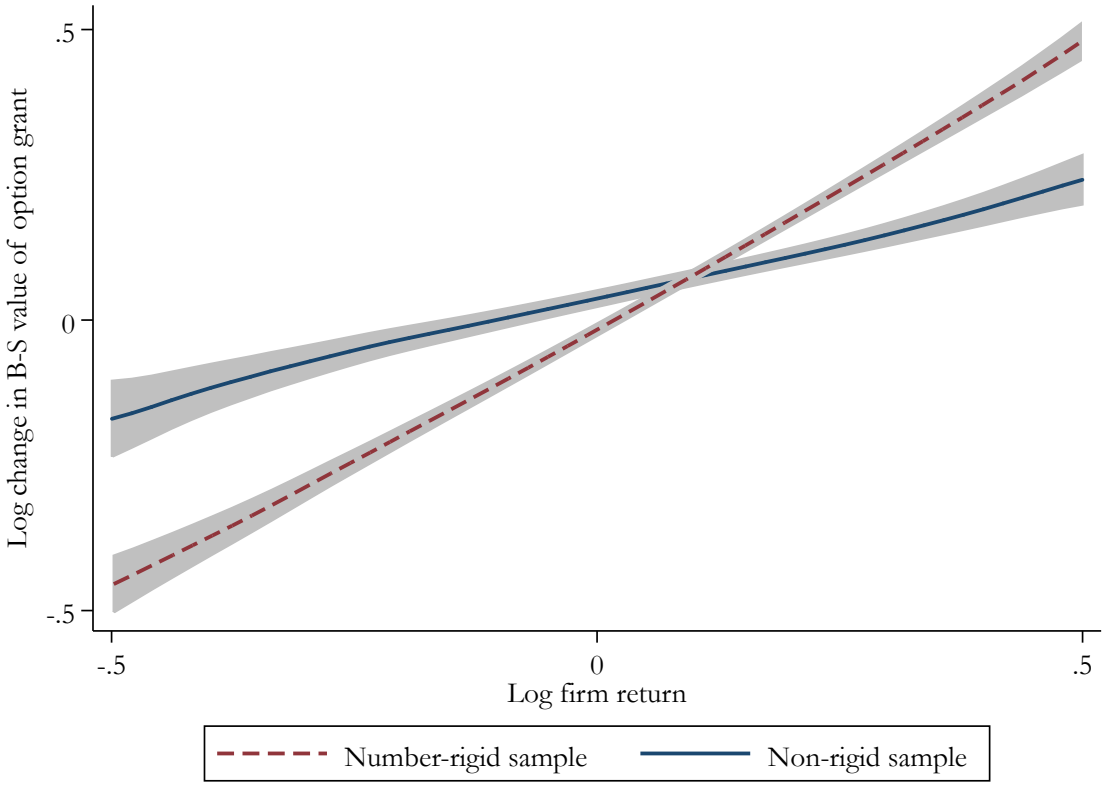


Figure 7

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

This figure plots changes in the log grant date value of total compensation 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.

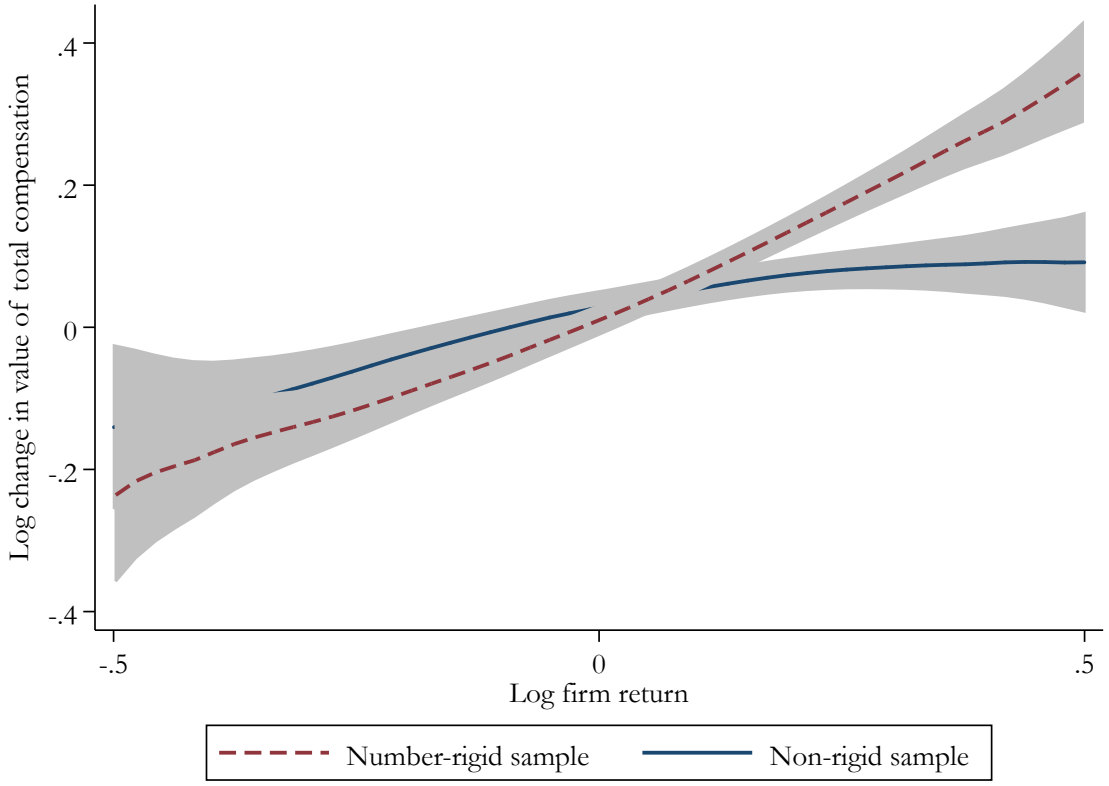
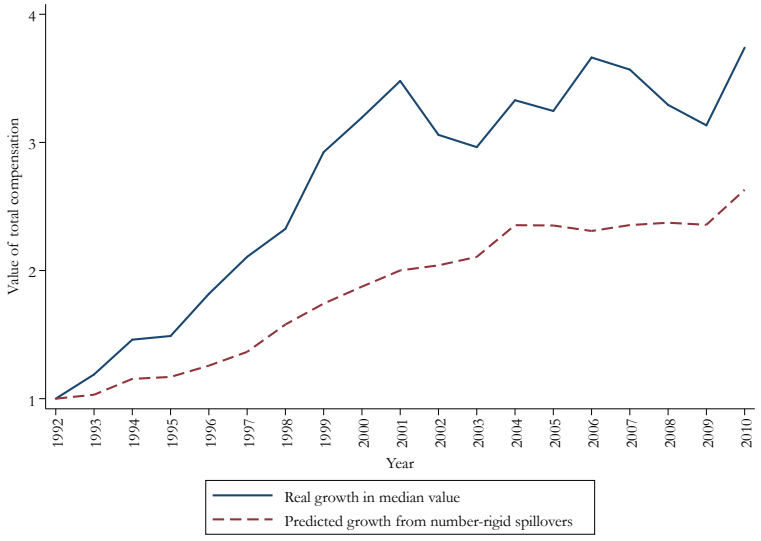


Figure 8
Number-Rigid Spillover Effects in Total Compensation

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 equal to the average difference between actual and counterfactual pay growth each year in the non-rigid sample, using realized returns in each year and the relationship estimated 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 C shows cumulative growth that can be attributed to a combination of spillovers from number-rigid grants and changes in size of the typical firm. The size of the typical firm in each year is calculated as the debt plus equity (former CompuStat codes: (data199*abs(data25)+data6-data60-data74)) of the 250th largest firm in each year, measured in 2000 dollars, following the variable definitions in Gabaix and Landier (2008)

Panel A



Panel B

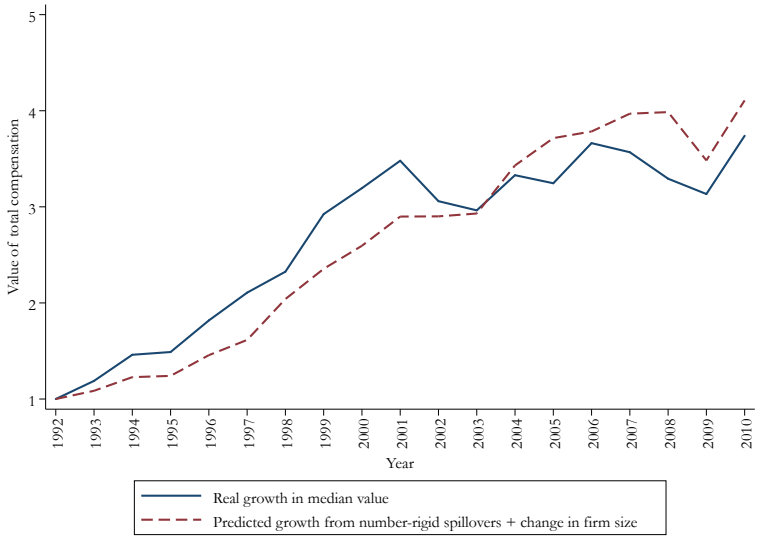
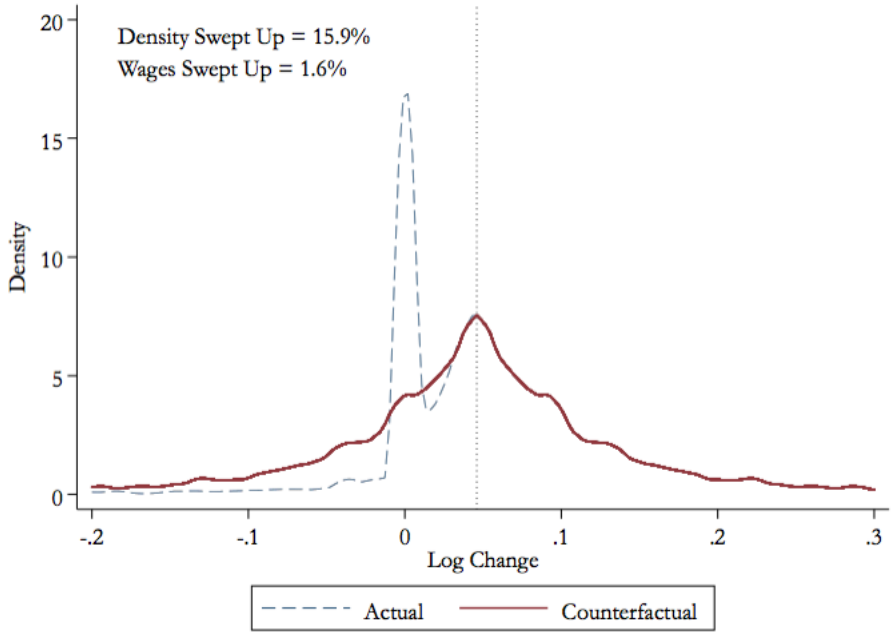


Figure 9
Downward Nominal Rigidity in Cash Compensation

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. "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. "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

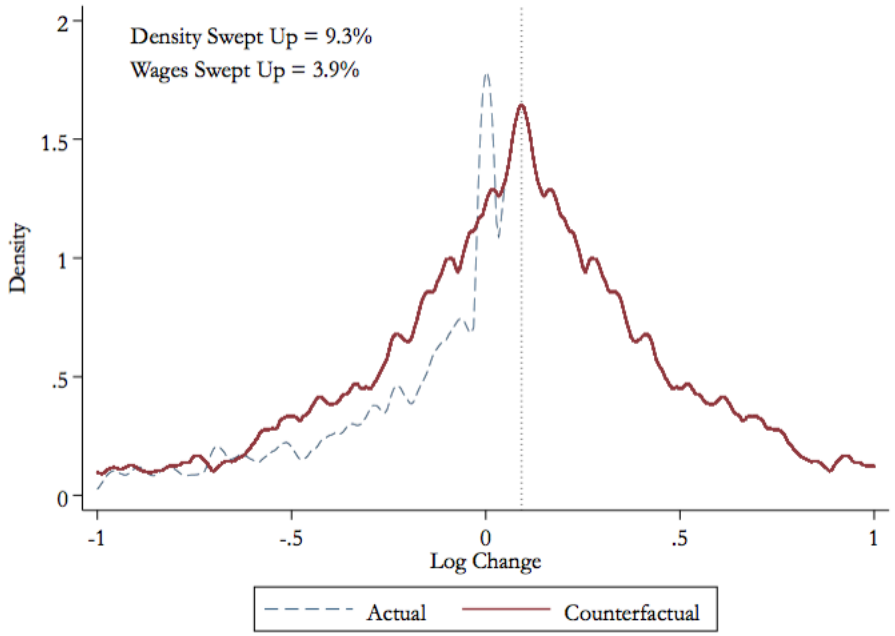
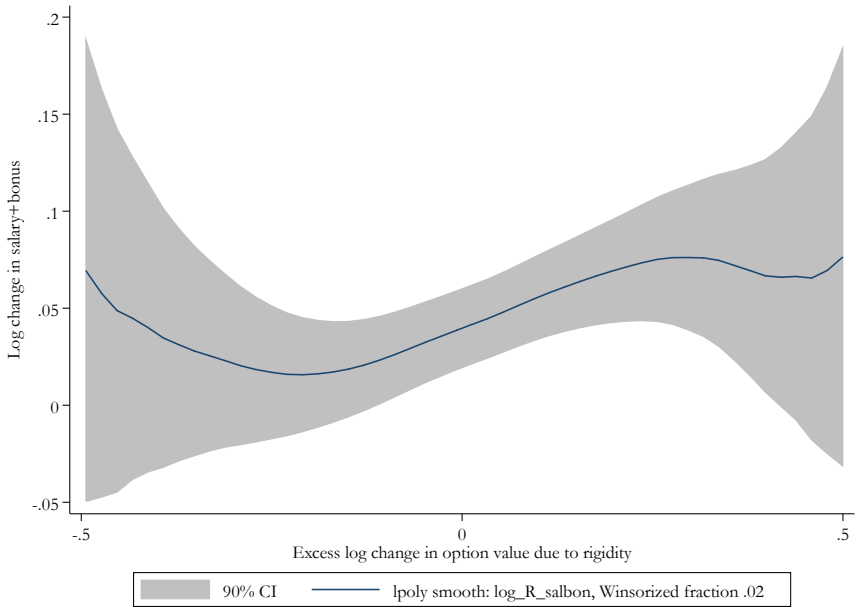


Figure 10
Offsets in Non-Option Compensation

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 B, the y-axis is the annual log change in cash and 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). If changes in other compensation offset excess changes in option value due to number-rigidity, we would expect a downward sloping line.

Panel A: Cash Compensation



Panel B: All Non-Option Compensation

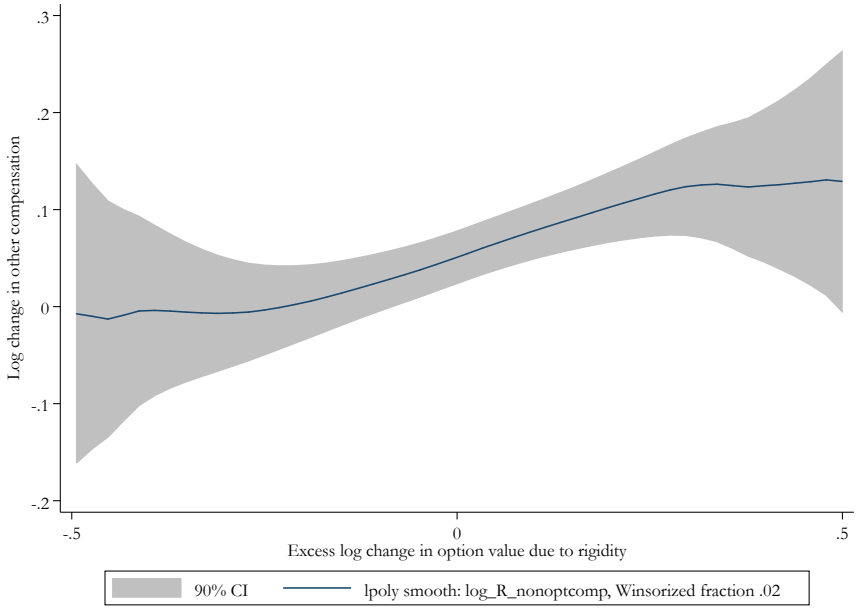
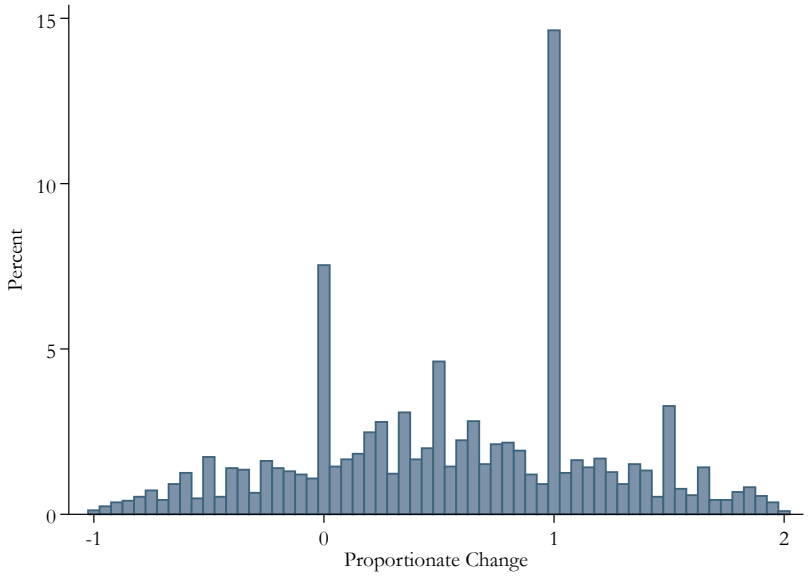


Figure 11
Adjustment to Splits

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 non-split adjusted number of options granted in the current year relative to the previous year. Following these positive stock splits, executives 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 executive-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 top-executive years.

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



Panel B: Adjustment of Non-Option Compensation

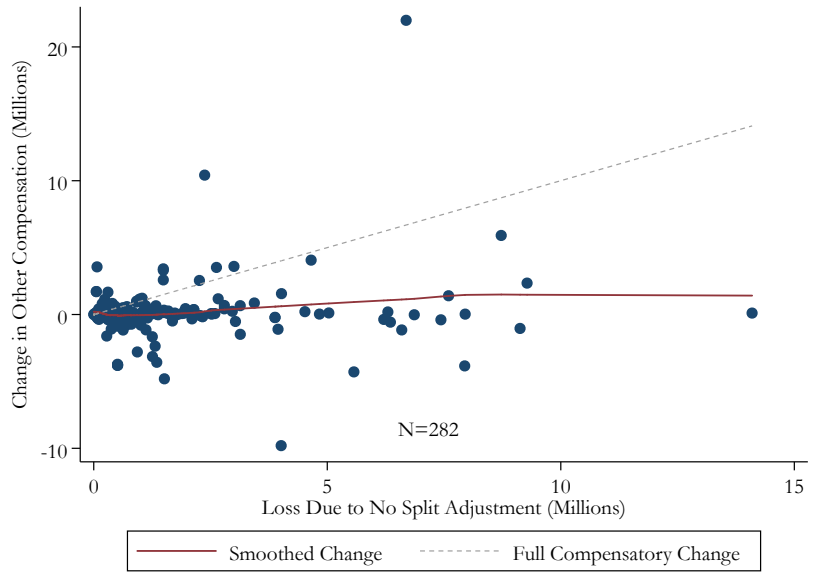


Figure 12

Number Change Distribution over Time for High Return Firm-Years

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 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.

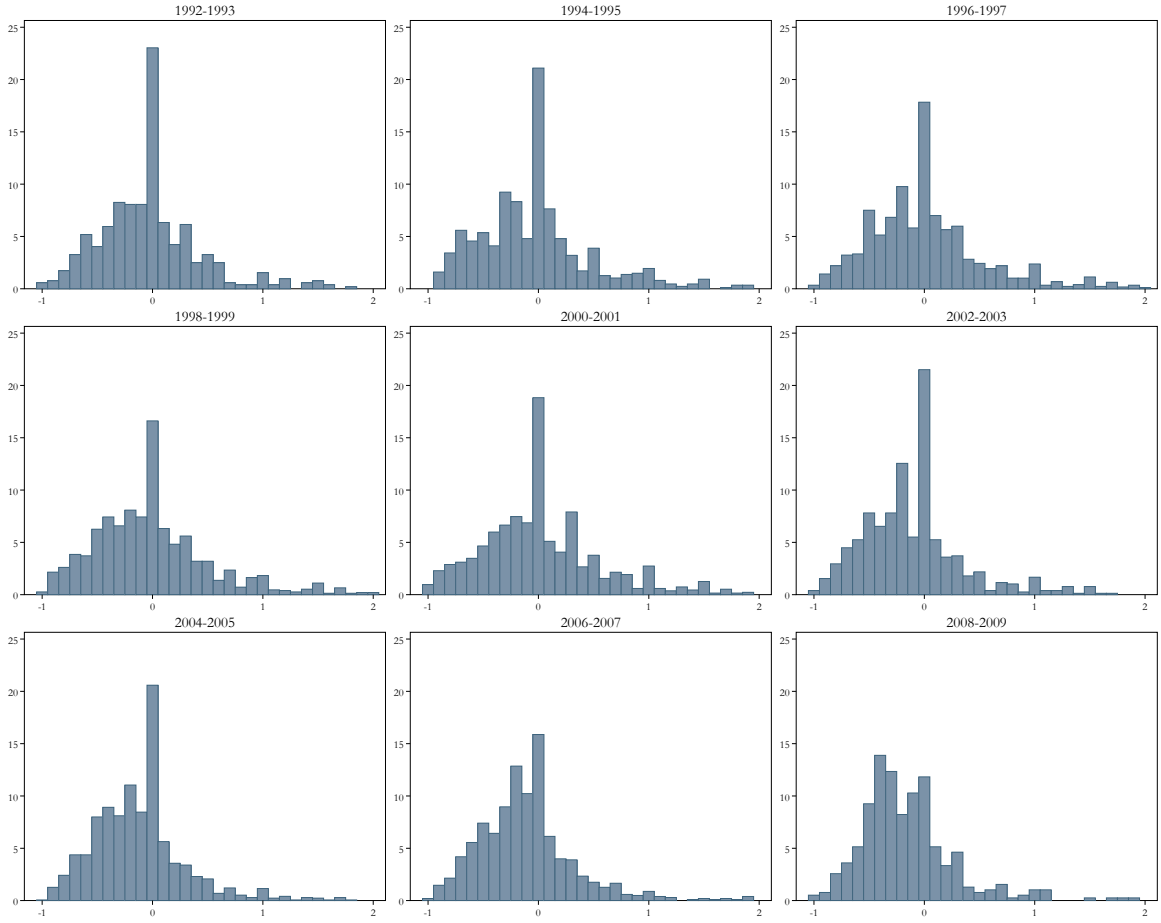


Table 1
Relationship between Number, Value, and Returns

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 S&P 500 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. In Panels B and C, to increase estimation power, we use the sample is all S&P 1500 top-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	-0.00535	-0.00561
	(0.0288)	(0.0292)
Year FE	No	Yes
R^2	0.0000285	0.0150
Observations	1213	1213

Panel C: Test of SS-Style Lumpy Adjustment Model

	Change Total Comp		Change Option Value		Change Option Number	
Lag Rigid	0.0384***	0.0420***	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	0.000492	0.0255	0.000490	0.0393	0.000121	0.0290
Observations	63782	63782	63054	63054	63782	63782

Table 5
Disclosure, Education, and Governance

This table examines how number-rigidity in option grants relates to firm and executive characteristics. The sample is restricted to S&P 1500 CEO-firm years in which the CEO received an option grant in both the current and previous year. Column 1 regresses a dummy for whether an option grant is number-rigid on whether the firm voluntarily disclosed the value of option compensation in fiscal year 2003. The sample is restricted to observations in the same year. Column 2 regresses the number-rigid dummy on whether the CEO holds an MBA degree, a proxy for financial sophistication. Column 3 regresses the number-rigid dummy on the firm's entrenchment index (E-index). Higher values of the E-index serve as a proxy for worse governance (Bebchuk, Cohen, and Ferrell 2006). Columns 3-6 replicate the analysis in the first three columns using the number reference dummy (the ratio of the number granted in the current year relative to the number granted in the previous year is an exact multiple of 0, 1/2, 1/3, ... , or 1/10) as the dependent variable. Firm controls include lagged log assets, leverage to book ratio, ROA, market to book ratio, investment to PP&E ratio, as well as returns in the 12 months preceding the option grant. Standard errors are allowed to be clustered within firm.

	Number Rigid			Number Reference		
	(1)	(2)	(3)	(4)	(5)	(6)
Disclosed value	-0.129***			-0.172***		
	(0.0472)			(0.0656)		
MBA degree		-0.0246**			-0.0382***	
		(0.0102)			(0.0137)	
E-index			0.0349**			0.0447**
			(0.0155)			(0.0203)
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	N/A	Yes	Yes	N/A	Yes	Yes
Exec-Firm FE	No	No	Yes	No	No	Yes
N	869	10143	14416	869	10143	14416
R^2	0.0112	0.0111	0.375	0.0286	0.0540	0.467

Table 6
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). In comparison, firms were required to report the value of stocks granted for the entire sample period from 1992 to 2010. Panel A shows how the prevalence of number-rigidity and number-reference among option and stock grants changes after the passage of FAS123r. 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 firm was required to expense options under FAS123r that year, a dummy for whether the grant was in the form of options (stock grants is the omitted category), and the interaction between the two dummies. The last two columns replicate the analysis using the number reference dummy (the ratio of the number granted in the current year relative to the number granted in the previous year is an exact multiple of 0, 1/2, 1/3, ... , or 1/10) as the dependent variable. Panel B replicates the analysis in the first two columns of Panel A for subsamples of executive-firm-years with either moderate or extreme firm returns. We sort the absolute value of firm returns in the 12 month period before the option or stock grant into quintiles, using the full sample. Columns 1 and 2 restrict the sample to observations corresponding to the lowest quartile of absolute returns (returns closest to zero) while Columns 3 and 4 restrict the sample to observations corresponding to the highest quartile of absolute returns (either very low or high returns). We find that option grants are in general more likely to be number-rigid than stock grants. FAS123r did not change the probability of option grants being number-rigid, conditional on moderate firm returns. However, firms were significantly less likely to grant number-rigid options following extreme firm returns after the passage of FAS123r. Time trends include a linear time trend. Controls variables are as described in Table 5. Standard errors are allowed to be clustered within firm.

Panel A: Difference-in-Differences

	Number Rigid		Number Reference	
	(1)	(2)	(3)	(4)
FAS123r	-0.00529	0.00230	-0.0415**	0.00835
	(0.0114)	(0.0173)	(0.0168)	(0.0233)
Options	0.0926***	0.0823***	0.210***	0.191***
	(0.00902)	(0.0101)	(0.0142)	(0.0156)
FAS123r × Options	-0.0428***	-0.0339**	-0.137***	-0.130***
	(0.0143)	(0.0148)	(0.0206)	(0.0211)
Time Trend	No	Yes	No	Yes
Controls	No	Yes	No	Yes
Firm FE	No	Yes	No	Yes
R^2	0.0152	0.0135	0.0528	0.0537
Observations	10081	9835	10081	9835

Table 6
(Continued)

Panel B: Difference-in-Differences in Moderate vs. Extreme Firm Return Years

	Moderate Firm Returns		Extreme Firm Returns	
	(1)	(2)	(3)	(4)
	Num Rigid	Num Rigid	Num Rigid	Num Rigid
FAS123r	-0.0356	0.0114	-0.000596	-0.0619
	(0.0231)	(0.0411)	(0.0197)	(0.0393)
Options	0.0939***	0.0893***	0.0989***	0.0851***
	(0.0182)	(0.0201)	(0.0144)	(0.0173)
FAS123r × Options	0.0205	0.0134	-0.0727***	-0.0554**
	(0.0300)	(0.0335)	(0.0207)	(0.0230)
Time Trend	No	Yes	No	Yes
Controls	No	Yes	No	Yes
Firm FE	No	Yes	No	Yes
P-value (Extreme=Moderate)	0.0104	0.0117	0.0104	0.0117
R^2	0.0151	0.0207	0.0196	0.0263
Observations	2295	2278	2200	2164

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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 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.

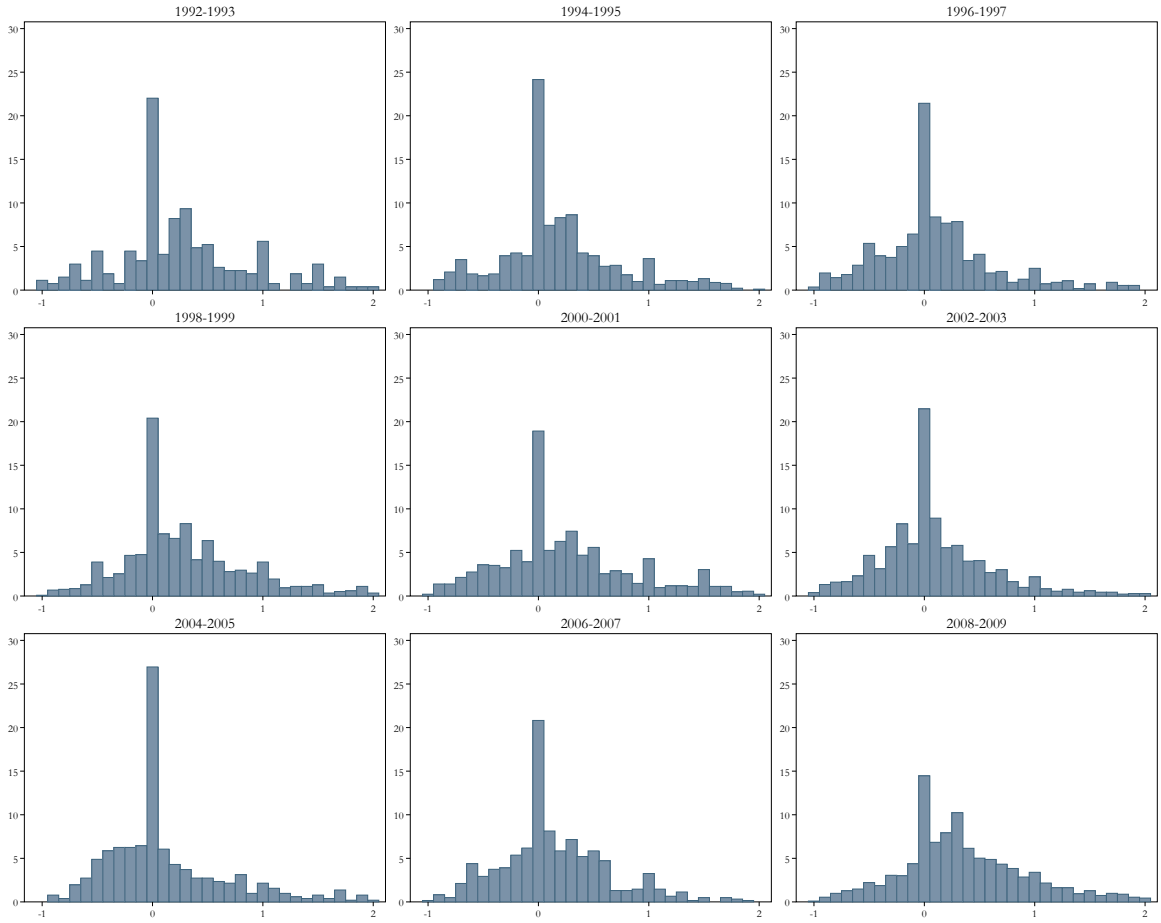


Figure 2
Number Change Distribution over Time for All Firms

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 year intervals but does not restrict the sample condition on recent returns.

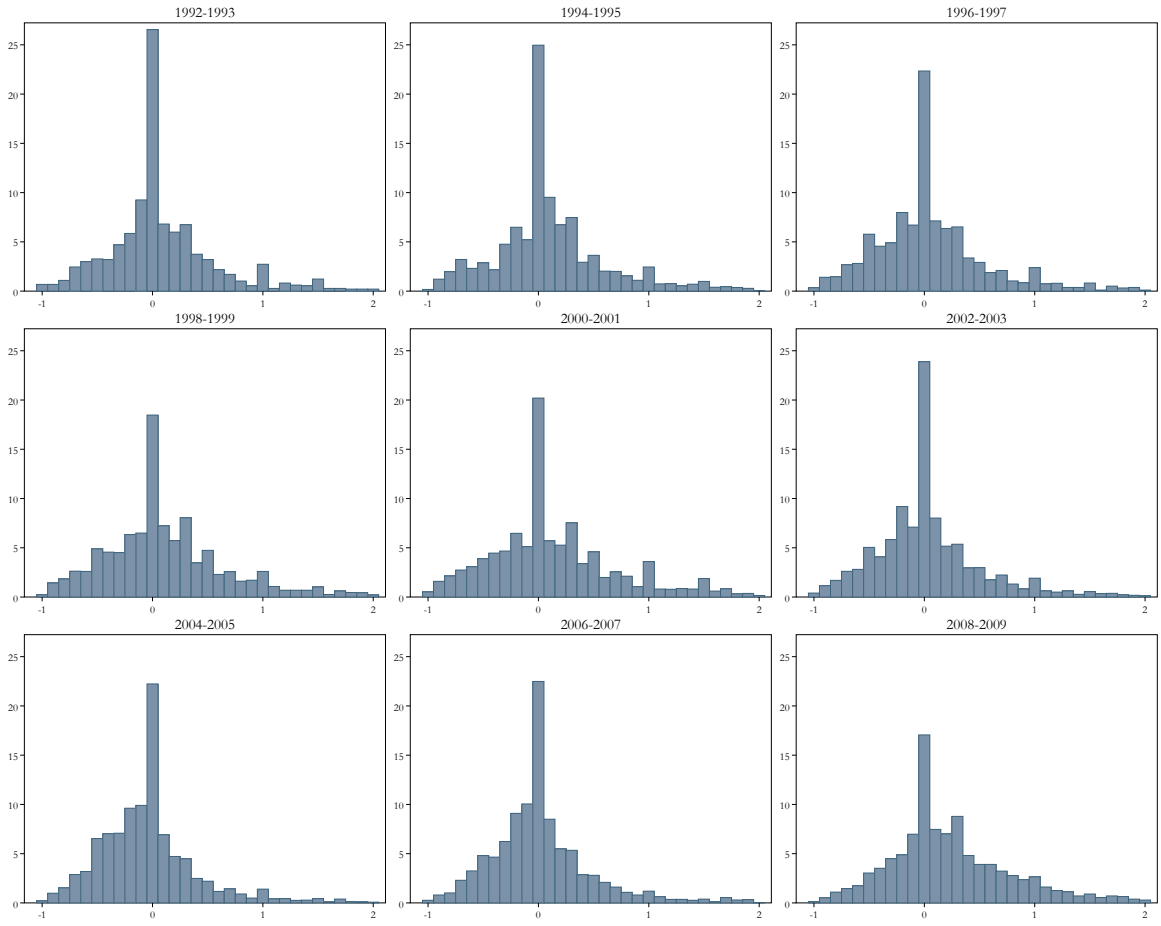
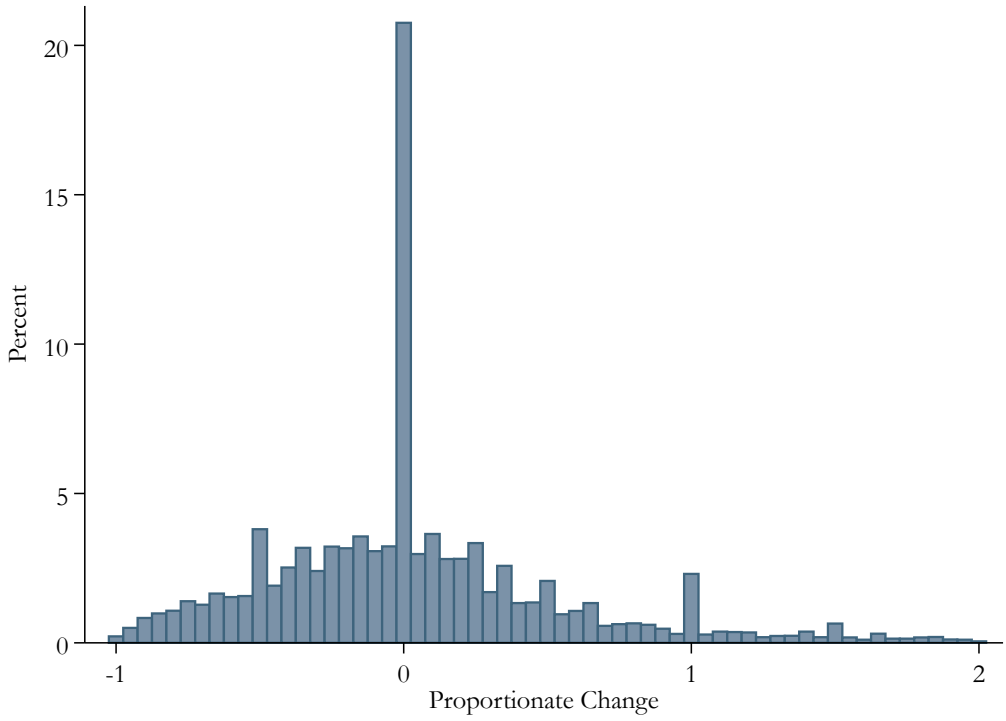


Figure 3
Number of Options Granted in Extended Samples

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

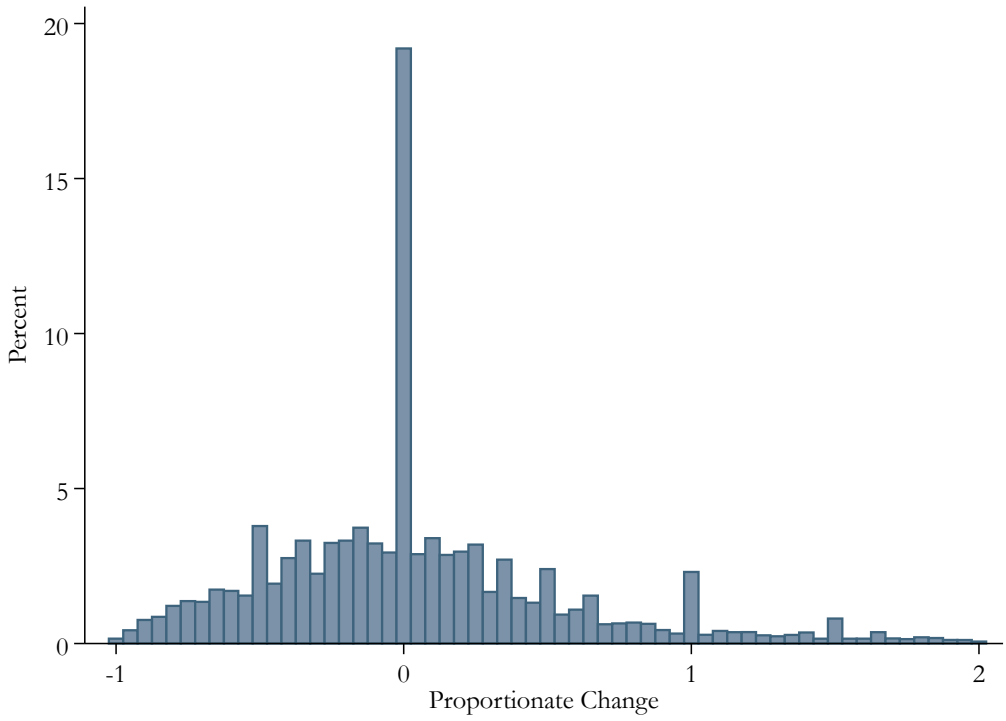


Table 1
Spillovers Calibration Using Alternative Parameter Values

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). γ is estimated to be equal to one in Gabaix and Landier (2008), several other papers described in Section 1.3 suggest it may be substantially less than one if the data is estimated over other time periods. 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	0.37						
	0.5	0.24	0.51					
	0.6	0.20	0.31	0.66				
	0.7		0.24	0.37	0.83			
	0.8			0.28	0.45	1.03		
	0.9				0.32	0.52	1.27	
	1.0					0.37	0.61	1.54

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	0.26	0.60					
	0.6	0.21	0.34	0.80				
	0.7		0.25	0.42	1.05			
	0.8			0.30	0.51	1.35		
	0.9				0.35	0.61	1.72	
	1.0					0.41	0.72	2.16

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 lack of sophistication with regard to option valuation 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.