Growth Through Rigidity:
Understanding Recent Trends in Executive Compensation

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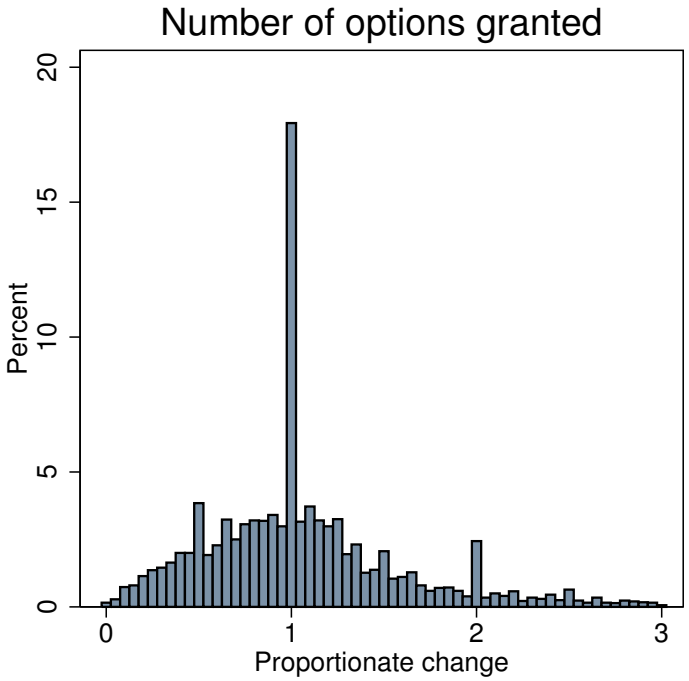
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Abstract

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

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

1 Introduction

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

A number of explanations have been proposed for this phenomenon, including weak corporate governance (Bebchuk and Fried, 2004; Kuhnen and Zwiebel, 2008), changes in technology that increase managers' marginal product (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 these theories are likely to be important contributors to long run growth in executive compensation, each also has shortcomings in explaining some of the major stylized facts (Frydman and Jenter, 2010), particularly the off-trend behavior of executive compensation during the Tech Boom.

In this paper, we explore an alternative explanation for the recent surge in executive compensation. We begin with the well-known fact that the bulk of the growth in executive compensation during this period came in the form of new, at-the-money, option grants. We posit that, due to the complexity and novelty of option valuation methods, firms initially focused on the *number* of options granted rather than the value of those options. Rigidity in the number of options granted can have large value implications: if a firm pays its CEO the same number of options as in the previous year and the firm's stock price increases by X%, the Black-Scholes value of those options will also increase by X% (absent changes in volatility). In an environment such as the Tech Boom with sustained rapid growth in stock prices, number-rigidity will lead to rapid increases in the value of options granted, consistent with the patterns observed in the data. At the same time, we find that other forms of executive compensation, particularly salary and bonus exhibit strong downward nominal rigidity. The inability of cash compensation to adjust downward meant that other forms of compensation could not adjust to offset the dramatic rise in option pay. Finally, regulatory changes in the 2000s required firms to begin disclosing the grant date value of

option grants. This may have moved firms away from number-rigidity, and explain the moderation of executive compensation following the Tech Boom.

In a recent survey of executive compensation, Murphy (2012) notes that the sudden rise of the use of options in the early 1990s was likely driven by a "perfect storm" of increased shareholder pressure for equity-based pay that coincided with regulatory changes. Because firms were only required to report and obtain shareholder approval for the number of options granted rather that the value, boards and executives may have tended to think about options in terms of number. Murphy indirectly infers that firms were likely to have focused on number from the rising correlation between CEO pay and aggregate market returns in the 1990s. In this paper, we extend Murphy's insights by providing direct evidence that firms granted options with a focus on number. We show that option grants were highly rigid in the number granted, and that number rigidity combined with downward rigidity in other forms of compensation had large consequences for growth trends in the value of executive compensation.

We show that option grants during the 1990s and early 2000s were strongly rigid in number. By far, the modal percentage change in the number of options granted in consecutive years is zero; nearly 20% of new grants contained the same number of options as the previous year's grant. Some part of this rigidity may have been consciously pre-planned as part of a fixed-number option grant schedule (Hall, 1999; Shue and Townsend, 2013). Regardless of the intent, rigidity in number can have value implications, especially if firms choose to remain on a rigid number schedule as equity prices experience a sustained increase. More broadly, the number change distribution suggests that executives and firms thought about options in units of number instead of value. In particular there are pronounced spikes at round multiples of last year's number, such as a 10% increase (adjusted for splits). We also find similar patterns for restricted stock grants. However, stock grants account for a much

smaller fraction of total pay, so we focus on option grants in our analysis.

We categorize option grants each year as "number-focused" if they are either "number-rigid" (i.e. have the same number of options as the previous year), or "number-referenced" (i.e. have a round fraction of the number of options paid in the previous year). Otherwise we consider the grant to be "value-focused." We find that the slope of the relationship between changes in the value of option compensation and a firm's stock return is much less steep for value-focused CEO-years than for number-focused CEO-years. In other words, number-focused CEOs gain more than value-focused CEOs when individual firm returns are high and gain less when firm returns are low. Since firm returns were high on average in the 1990s and early 2000s, number-focused CEOs experienced high growth in option value on average. We use the relationship estimated from the value-focused sample to form a counterfactual of what option value growth would have been for the number-focused sample if they had instead been value-focused.

Next, we calibrate a model of competitive spillovers from Gabaix and Landier (2008) to estimate the total effect of number-focus on aggregate growth in executive pay. The model predicts how much aggregate compensation should increase if a certain fraction of firms, f, choose to increase the compensation of their CEO by a fraction, λ. In our setting, we consider f to be the fraction of number-focused CEOs, and λ to be the average difference between actual and counterfactual pay for these CEOs. Our calibrations show that number-focused option compensation can indeed explain much of the off-trend growth in compensation during the Tech Boom. This result is robust to various definitions of number-focused grants and various assumptions of the other parameters of the model.

Even if the value of option compensation is more sensitive to firm returns for number-focused firms, it remains possible that non-option compensation decreases when returns are high in order to keep total compensation in line. To investigate this, we examine whether

number-focused firms with high excess increases in option compensation (relative to the counterfactual) also have a decrease in their cash compensation. We do not find this to be the case and, if anything, the opposite appears to be true. Interestingly, however, when returns are poor such that number-focused CEOs suffer relative to value-focused CEOs in terms of their option compensation, cash compensation does increase.

One reason that the relationship between excess option compensation and changes in cash compensation may not be negative is that cash compensation for CEOs is downward rigid in nominal dollars. This would be consistent with a large literature documenting nominal wage rigidity for the general population of workers. To test for downward rigidity in cash compensation, we follow the methodology developed by Card and Hyslop (2007). We estimate that 16% of CEO-years would have had a salary cut over the sample period absent rigidity and that downward rigidity raised average salary compensation by 1.6% each year. Perhaps even more surprisingly, we also find evidence of downward rigidity in bonus compensation. We estimate that 9% of CEO-years would have had a bonus cut absent rigidity, and that downward rigidity raised average bonus compensation by 4% each year.

Finally, a shift toward value-focus in the mid to late 2000s can explain the moderation in executive compensation growth following the Tech Boom. Because option pricing methods became more accepted over time by executives and boards, the tendency to focus on the number of options granted also declined. In 2005, FASB began requiring firms to expense options at fair value on their income statements. In addition, the SEC began requiring that firms report the fair value of option compensation paid to top executives. These regulatory changes likely shifted focus from number to value. Consistent with this idea, we find that the prevalence of number-focused grants decreased significantly in the mid 2000s. We also find that, while some firms continued to award number-rigid option grants, they were less likely to do so when rigidity would have implied a very large increase in the value of grants

(i.e. when firm returns were very high). The shift toward value-focus also explains why compensation growth remained moderate even as equity prices rose dramatically from 2002 to 2006.

Altogether we conclude that number-rigidity and focus in options combined with downward rigidity in other forms of compensation can explain the off-trend growth in executive compensation during the Tech Boom. Our explanation also matches three other stylized facts in the literature. First, the cross-sectional dispersion of CEO compensation increased substantially in the 1990s (Frydman and Jenter, 2010). Because number-focus increases the sensitivity of new option compensation to individual firm returns, and individual firm returns are volatile, number focus led to increased dispersion across firms. Second, CEOs outside of the US experienced significantly slower compensation growth during the Tech Boom, controlling for country-level growth and firm characteristics such as industry and size (Abowd and Bognanno, 1999; Abowd and Kaplan, 1999; Murphy, 1999; Thomas, 2009; Fernandes et al., 2013). Equity-based compensation is less common for non-US CEOs, often for regulatory reasons. For example, option plans were illegal in Germany until 1996. As a result, non-US executives are less likely to have a number-focused 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 possible reasons for number focus and rigidity in executive compensation. Many theories have been proposed to explain why compensation in general may be rigid with respect to real or nominal wages. These include morale considerations, implicit contracts, and adverse selection in quits/hires[1]. Assuming that executives and firms think about option grants in number rather than dollar terms, most of these theories could be modified to also explain number rigidity. The main goal of this

[1]See Bewley (1999) for a comprehensive review

paper is not to distinguish between these theories, but rather to show that number rigidity in option compensation can lead to large increases in the value of compensation awarded due to the volatility of returns. However, we find suggestive evidence that rigidity in executive compensation is driven by a combination of reference-dependent motivation and money illusion.

We begin by considering a class of theories in which executives and firms fully understand option valuation models but still choose to grant number-rigid options. For example, it is possible that firms manage executive ownership by granting CEOs a fixed number of options each year. However, one would not expect the prevalence of number-rigidity to be sensitive to accounting and disclosure rules. Alternatively, firms may grant a fixed number of options each year so that compensation grows with firm size. However, again, one would not expect the prevalence of number-rigidity to be sensitive to regulatory changes. Also, the theoretical basis for such a policy is unclear. In particular, most models of competition for talent do not imply that executive compensation should rise proportionally with firm-specific returns. For example, Gabaix and Landier (2008) predict that, holding the firm-CEO match fixed, pay should increase with market returns rather than firm returns. This is because aggregate growth is a better proxy for an executive's outside options than firm-specific returns.

Overall, we believe that our results are best explained by the well-known phenomena of reference-dependent motivation (Mas, 2006) and money illusion (Kahneman et al., 1986; Shafir et al., 1997). Reference-dependent motivation describes situations in which worker effort depends on compensation relative to a reference point. Money illusion describes situations in which individuals think in terms of nominal rather than real monetary values. In the case of cash compensation, executives and boards may think about pay in nominal dollars relative to the reference point set by last year's pay, leading to downward nominal rigidity in salary and bonus. In the case of option compensation, executives and boards may

think about options in terms of number instead of real or even nominal value and use last year's number as a reference point. This different type of money illusion (in number instead of nominal units) will lead to downward rigidity in the number of options granted.[2]

The reference-dependent motivation and money illusion explanation is also consistent with ample anecdotal evidence that when option compensation first came into use, many did not understand or trust complex valuation methodologies such as that developed by Black and Scholes (1973). For example, 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." In addition, compensation surveys of large firms find that the vast majority of option recipients feel that they should receive more, not fewer, options when their firm's stock price increases.[3]

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

2 Recent Trends in Executive Compensation

Before exploring the effects of rigidity on executive compensation growth we first review recent trends in executive compensation. Figure 5 reproduces a graph from Murphy (2012), restricting the sample to CEOs of firms that were ever a part of the S&P 500 during the

[2]At first glance, it may appear that the number of options granted is rigid at 1, but not downward rigid. In later analysis, we show that within the set of number-focused executives, the change in the number of options is indeed downward rigid. However, the distribution of changes in the number of options over the full sample does not appear downward rigid because most value-focused executives typically receive a small decrease in the number of options (because equity returns are positive on average and large during the Tech Boom).

[3]"Raising the Stakes: A Look at Current Stock Option Granting Practices," 1998, Towers Perrin Comp-Scan Report.

sample period. The level of each bar represents the median level of total compensation that year in 2011 dollars. In addition, each bar is decomposed into the separate components of compensation based on the mean proportion represented by each that year. As has been previously documented, total compensation grew rapidly from 1992 to 2001, more than tripling, before subsequently leveling off. As can be seen, the vast majority of this growth came in the form of option compensation, which came to represent the largest single component of CEO pay. Most of the other components remained relatively flat during this time period. In later years option compensation appears to have been replaced by stock compensation to some extent, most likely because firm began having to recognize options as an expense after 2006, eliminating their accounting advantage. Figure 6 shows the growth rate of median option compensation and other compensation for the same sample of CEOs. Again, it is clear that option compensation grew faster than other forms of compensation from 1992-2001. After 2001, option compensation generally grew more slowly than other forms.

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

Another view is that the growth in CEO pay is primarily due to increases in firm size. According to this view, managerial talent has a multiplicative effect on firm output so that small increases in talent can lead to large increases in firm value (Gabaix and Landier, 2008; Tervio, 2008). Gabaix and Landier (2008) show that under certain conditions CEO pay should move one-for-one with changes in the size of the typical firm. Thus the sixfold increase in CEO pay between 1980 and 2003 can be explained by the sixfold increase in average market capitalization over that period. However, Frydman and Saks (2010) show that firm size and CEO pay are almost uncorrelated prior to 1970 and that the relationship following 1970 is sensitive to sample-selection (Nagel, 2010). Perhaps most importantly, this theory does not predict that compensation should be tied to individual firm returns, but rather aggregate returns. It also do not predict that the increase in compensation should come in the form of options.

A final view is that CEO compensation has risen due to changes in the nature of the the job. For example, managers' marginal product may have increased due to improved communications technology (Garicano and Rossi-Hansberg, 2006), increased competition (Hubbard and Palia, 1995; Cuñat and Guadalupe, 2009a,b) or higher volatility of the business environment (Dow and Raposo, 2005; Campbell et al., 2001). Hermalin (2005) suggests that CEOs must be compensated for 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. However, again none of these theories is tied directly to option compensation. In addition, the effect of the various factors suggested are unlikely to be large or rapid enough to explain the aggregate trends in compensation.

3 Data

3.1 Sources

We use executive compensation data from ExecuComp, which covers S&P 1500 firms from 1992-2011. The data is derived from firms' annual proxy statements and contains information regarding the compensation paid to the top five earners in various forms (e.g. salary, bonus, restricted stock, option grants, etc.) during the fiscal year. ExecuComp contains detailed grant-level data on the date and amount of each option grant. In 20% of cases, executives receive more than one option grant during a fiscal year. In these cases, we focus on the largest option grant (as measured by number of options within) each fiscal year, to better identify number-rigidity grants. Having the exact date of the grant also allows us to precisely measure firm returns between annual grants. In 2006, firms were required to begin reporting the fair value of option compensation. For data prior to 2006, compute the Black-Scholes value of option grants ourselves. For all option grants, we also calculate the face value, defined as the grant date share price multiplied by the number of options granted. We focus on face value because this was a common way to value options during this time period and because it simplifies our exposition: changes in the total face value of an option grant are only induced by changes in firm returns and changes in the number of shares – changes in volatility are ignored.

Accounting data come from Compustat. Following standard practice, financial firms (6000-6999) and regulated utilities (4900-4999) are excluded from the sample when accounting-based outcomes are used. However, financial firms and regulated utilities are included in all samples which don't focus on accounting-based outcomes to better assess aggregate trends in executive pay. 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 between 1992 and 2011.

3.2 Identifying number-rigid and number-reference option grants

We begin by estimating counterfactual compensation growth for the set of CEOs who received number-focused option grants. Importantly, we do not claim that number-focused compensation is necessarily suboptimal. We simply estimate counterfactual pay growth if the set of number-focused firms had granted options in the same manner as value-focused firms, conditional upon firm performance. To estimate the counterfactual, we identify a set of number-focused CEO-years. We then estimate what option value growth would have been for this set of observations, using the relationship between firm returns and option value growth in the value-focused sample. This allows us to estimate a lower bound for the increase in pay due to number-focus in the number-focused sample. Finally, we estimate spillover effects. In equilibrium, competition should lead to higher pay for all executives. We use a model of competitive spillovers presented in Gabaix and Landier (2008) to predict aggregate option value growth due to number-focus.

We begin by categorizing CEO option grants each year as number focused or value focused. We further divided the set of number-focused grants into number-rigid and number-reference grants. Option grants are considered number-rigid if the number of options divided by the number of options granted last year is equal to 1, with a 0.01 tolerance. Results are similar using a tolerance of 0.005 and 0.02. Option grants are considered number-reference 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, allowing for the same tolerance of 0.01. In some tests, we focus on 1.5, 2, 0.75, and 0.5 because these are particularly common round

units that correspond to significant mass in the data. Note that our categorization may contain error. Number-reference option grants could represent pay adjustments targeted at an X% change in number or pay adjustment that was actually targeted at an X% change in value, but rounded to the nearest round lot in number. In later tests, we will present evidence in favor of the former. Finally, option grants are categorized as value-focused if the ratio of the number of options this year relative to last year does not equal a round fraction.

4 Results

4.1 Rigidity in Executive Compensation

We begin by exploring the extent and units of rigidity in various forms of executive compensation over our sample period. First, we compute the ratio of the (split-adjusted) number of options paid to a CEO in the current year divided by the number paid in the previous year. Figure 1 shows a histogram representing the distribution of this ratio. The most striking feature of this figure is the large spike at one. 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 18% of CEO option grants. Also, interestingly, there are spikes at round ratios such as 0.5 and 2. Both of these observations would seem to strongly suggest that many executives and boards think of option grants in number, rather than dollar terms. To further explore this, we also compute the ratio of the value of options granted paid to an executive in the current year divided by the value paid in the previous year.[4] Figure 2 shows a histogram representing the distribution of this ratio. We find significantly less evidence of rigidity in terms of value in this case. Less than 6% of CEOs receive the same value of options as in the previous year.

[4]Before 2006 firms were only required to disclose the number of options granted, therefore we use ExecuComp's calculated of the Black-Scholes value in these years.

Next, we examine stock compensation.[5] Valuing a stock grant is trivial relative to an option grant. Given this, one might expect executives and boards to think about stock compensation exclusively in dollar terms–leading to rigidity in value but not number. To explore this, we also plot the distribution of the ratio of the current year's number/value of shares granted to the previous year's in Figure 3. Perhaps surprisingly, we find strong evidence of rigidity along both dimensions, with large spikes at one in both histograms. Thus is appears that even stock grants are often thought of in number terms.

Finally, we repeat the same exercise with cash compensation in Figure 4. In this case, everything is naturally only in dollar terms. For salary we find significantly more weight on the right side of the distribution (above one), suggesting a resistance to salary cuts. This evidence of downward nominal wage rigidity among CEOs is similar to what others have found in the general population of workers (Card and Hyslop, 2007). Perhaps more surprisingly, we also find similar, albeit less strong, evidence of downward nominal rigidity in salary (and thus total cash compensation). The extent of this downward rigidity and its relationship with option number rigidity will be explored further in Section 4.3.

4.2 Number-Focus and Option Compensation Growth

In this section we estimate counterfactual compensation growth for the set of CEOs who received number-focused option grants. Importantly, we do not claim that number-focused compensation is necessarily suboptimal. We simply estimate counterfactual pay growth if the set of number-focused firms had granted options in the same manner as non-number-focused firms conditional upon firm performance. To estimate the counterfactual, we identify a set of number-focused CEO-years. We then estimate what option value growth would have been for

[5]Before 2006 firms were only required to disclose the value of a stock grant, therefore back out the approximate number of shares granted by dividing this value by the stock's closing price on the date of the grant.

this set of observations, using the relationship between firm returns and option value growth in the value-focused sample. This allows us to estimate a lower bound for the increase in pay due to number-focus in the number-focused sample. Finally, we estimate spillover effects. In equilibrium, competition should lead to higher pay for all executives when some receive large raises. We use a model of competitive spillovers presented in Gabaix and Landier (2008) to estimate how much of aggregate option value growth is due to number rigidity.

4.2.1 The relationship between option compensation growth and firm returns

Next, we compare the relationship between option value growth and firm return for the number-rigid and value-focused samples. To abstract away from changes in the value of option grants caused by changes in volatility, we measure option value as the face value (number of options $\times$ grant date share price). Figure 7 plots changes in the log value of options granted against the log firm return over the previous 12 months. For the number rigid sample, the relationship falls exactly along the 45 degree line because a firm return of $X\%$ should exactly translate to an $X\%$ change in the face value of option grants. For the value-focused sample, we fit a local linear regression using the Epanichnikov kernel using the rule-of-thumb bandwidth. We find that the relationship between between option value growth and firm returns is approximately linear and substantially flatter in the value-focused sample. The two curves cross just to the right of zero firm returns. This implies that, relative to value-focused CEOs, number-focused 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 should experience higher option value growth than value-focused CEOs.

Importantly, note that the vertical distance between the solid and dotted lines are a lower bound for the difference between number-rigid CEOs' actual and counterfactual option

growth. Observations within the value-focused sample are likely to be affected by competitive spillovers from the number-focused sample. Therefore, the estimated relationship between growth in option value and firm returns among the value-focused sample may be steeper than the true relationship in a world without number-focus. This will lead us to underestimate the absolute vertical distance between these two lines.

We formalize this intuition in Table ?. For each number-rigid CEO-year observation, we calculate the difference between the CEO's actual change in value and his predicted change in value conditional upon his firm's return (using the relationship estimated using the value-focused sample). Column (1) and (2) reports the fraction of CEOs within each year that are number-rigid or number-reference, respectively. Columns (3) and (4) report the different between their actual and counterfactual predicted changes in option compensation. We find that number-focused (both number-rigid and number-reference) experience option growth that exceeds counterfactual predictions in boom years and vice versa for bust years. On average, during the Tech Boom, number-rigid and number-reference CEOs experienced extra growth per year relative to their counterfactual predictions. These estimates (fraction of number-focused CEOS multiplied by the difference between actual and counterfactual pay) represent a lower bound for the effect number-focus on aggregate changes in the value of option compensation.

4.2.2 Spillovers and aggregate option compensation growth

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

We calibrate the model of competitive spillovers in Gabaix and Landier (2008), hereafter

referred to as GL. For brevity, we only summarize 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 is meant to act as a rough approximation of the size of potential spillover effects.

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

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

We assume that f is the fraction of number-rigid or number-reference CEOs in each year of our data and that the probability of being number-focused is uncorrelated with size (an assumption that is approximately true within the sample of S&P 500 firms). The variable λ is the difference between actual and counterfactual pay growth each year in the sample, as reported in Figure 7. For other model parameters, we use $\gamma = 1$, $\alpha = 1$, $\beta = 2/3$.[6]

Panel A of Figure 8 shows the calibration of spillover effects. The solid line represents the median value of options granted each year in the real data. Assuming the same starting point in 1993, the dashed line represents the predicted value of options that result solely from competitive spillovers from number-rigid firms. We find the number rigidity can explain approximately half of the growth in option grants during the Tech Boom. After 2005, almost all of the growth in options can be accounted for by spillovers from number-rigid CEOs.

In Panel B we also account for potential spillovers from number-reference CEOs. We find that spillovers from number-reference who receive exactly 1.5 or 2 times the number of

[6] γ represents the impact of CEO skill on firm earnings ($\gamma = 1$ implies constant returns to scale and $\gamma > 1$ implies increasing returns to scale). α and β are parameters describing the pareto size distribution of CEO talent. In the model, $\gamma - \frac{\beta}{\alpha}$ is equal to the relationship between log compensation and log firm size, which is approximately 1/3 in the data. For simplicity, we use GL's estimates of $\gamma = 1$, $\alpha = 1$, $\beta = 2/3$ in our calibration. This may appear counterintuitive given that these parameter estimates imply that average pay growth should rise 1:1 with average firm returns, and our paper argues that average pay growth may have been lower absent rigidity. However, our calibration estimates are not sensitive to parameter values.

options as in the previous year can explain more than one hundred percent of the growth in option value in the real data. In contrast, in Panel C we estimate very small negative spillovers from number-reference CEOs who receive exactly 0.75 or 0.5 times the number of options as in previous years. This occurs because the fraction of CEOs experiencing a round decline in the number of options is small and also because the effect of pay distortions is asymmetric. In general, if fraction f 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 fraction f of firms wished to pay their CEOs $1-x$ as much as similarly sized firms.

Of course, calibrations using number-reference firms may represent an upper bound on spillovers from number-focus. Some number-reference firms may actually be value focused and round the number of options granted to 1.5x or 2x the previous number. However, our estimates suggest that spillovers from even a small fraction of number-reference firms as well as number rigid-firms can account for almost all of the off-trend growth in compensation during the Tech Boom.

4.3 Downward nominal rigidity in cash compensation

In this section, we explore two ways in which downward nominal wage rigidities in cash compensation can contribute to compensation growth. First, missing mass to the left of 1 in Figure 4 implies that average growth in cash compensation will be higher than that in a regime with more flexible wages. 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 value by adjusting cash compensation in the opposite direction. However, if cash compensation is downward rigid, then firms may not be able to adjust cash compensation down in times when option grants rise.

We begin by calculating the counterfactual average change in cash compensation if wages

had been flexible instead of rigid. Our procedure follows Card and Hyslop (2007), which quantifies nominal wage rigidity among the general population of workers. We compare the actual distribution of changes in cash compensation with a counterfactual distribution in the absence of downward rigidities. Estimation of the counterfactual distribution assumes (1) the distribution of wage changes would be symmetric in the absence of rigidities, (2) the upper half of the distribution of wage changes is unaffected by rigidities, and (3) wage rigidities do not affect employment probabilities. Of these assumptions, assumption (3) may be the most controversial: the inability of pay to adjust downward is commonly discussed as a cause of unemployment. 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 one (reflecting the nominal wage rigidity at one) and another local maximum to the right of one (reflecting that most firms increase cash compensation annually). Comparing the actual and counterfactual distributions, we see that the actual distribution is missing mass to the left of one, suggesting that some CEOs had their wages "swept up" by downward nominal wage rigidities.

Comparing the actual and counterfactual distributions, we quantify two summary statistics: the fraction of CEOs whose wages are affected by rigidities and a measure of the net effect of rigidities on the average wage change.[7] We estimate that 15.6% of CEOs have their

[7]The fraction of CEOs with salary or bonus swept up by the rigidity is equal to area under the counterfactual distribution to the left of one minus the area under the real distribution to the left of one. 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

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.

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 value 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 indeed offset changes in the value of option grants. However, the relationship is strongly asymmetric. When number-rigidity causes the value of option grants to be *low* relative to other firms with comparable performance, firms adjust by increasing salary and bonus. However, when number-rigidity causes the value of option grants to be *high* relative to comparable firms, cash and bonus do not decline and in fact also increase.

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 rigid CEOs who received a larger raise in options 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 U-shaped. Left of zero, number rigid CEOs receive more cash pay when they receive less option compensation. To

distribution. For a more detailed discussion of these calculations, see Card and Hyslop (2007).

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.

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

5 Sources of Rigidity

In the remainder of the paper, we explore possible reasons for number focus and rigidity in executive compensation. Many theories have been proposed to explain why compensation in general may be rigid with respect to real or nominal wages. These include morale considerations, implicit contracts, and adverse selection in quits/hires[8]. Assuming that executives and firms think about option grants in number rather than dollar terms, most of these theories could be modified to also explain number rigidity. The main goal of this paper is not to distinguish between these theories, but rather to show that number rigidity in option compensation can lead to large increases in the value of compensation awarded due to the volatility of returns. However, we find suggestive evidence that rigidity in executive compensation is driven by a combination of reference-dependent motivation and money illusion.

However, there are a class of theories of number-rigidity that we would like to assure are not driving our results. These are theories in which number-rigidity occurs even though executives and firms fully understand option pricing models and thus do not think naively of the value of option grants in number terms. For example, it is possible that firms simply manage executive ownership by granting CEOs a fixed number of options each year. In this case, however, it is unclear why they would not grant shares directly. Also, we find that after

[8]See Bewley (1999) for a comprehensive review

firms begin having to expense/disclose option compensation at fair value, the prevalence of number rigidity declines. This would not be predicted if number-rigidity were driven by incentive provision motives. Instead, it suggests that number-rigidity is driven by a focus on the number of options granted rather than the value of those options.

Alternatively, firms may grant a fixed number of options each year so that compensation grows with firm size. However, again, in this case one would not expect the prevalence of number-rigidity to be sensitive to accounting and disclosure rules. Also, the theoretical basis for such a policy is unclear. In particular, most models of competition for talent do not imply that executive compensation should rise proportionally with firm-specific returns. Gabaix and Landier (2008) predict that, holding the firm-CEO match fixed, pay should increase with market returns rather than firm returns. This is because aggregate growth is a better proxy for an executive's outside options than firm-specific returns. In the GL model, which assumes known CEO ability and no costs of turnover, individual firm returns should mainly predict new CEO-firm matches (if the firm grows, then it should match with a more skilled CEO).

Overall, we believe that our results are best explained by the well-known phenomena of reference-dependent motivation (Mas, 2006) and money illusion (Kahneman et al., 1986; Shafir et al., 1997). Reference-dependent motivation describes situations in which worker effort depends on compensation relative to a reference point. Money illusion describes situations in which individuals think in terms of nominal rather than real monetary values. In the case of cash compensation, executives and boards may think about pay in nominal dollars relative to the reference point set by last year's pay, leading to downward nominal rigidity in salary and bonus. In the case of option compensation, executives and boards may think about options in terms of number instead of real or even nominal value and use last year's number as a reference point. This different type of money illusion (in number instead

of nominal units) will lead to downward rigidity in the number of options granted.

5.0.1 Regulatory Changes

In the early 2000s, there were a number of accounting scandals such as Enron, after which the US government passed Sarbanes Oxley (SOX) in 2002. While SOX did not require the disclosure of the grant date fair value of option grants, the issue was heavily discussed. Many firms began voluntarily expensing the grant date fair value in annual proxy statements because of anticipated rule changes. In 2005 FAS 123r passed, which required firms to expense and disclose options at the grant date fair value. Critically, the regulatory change only affected the form of the disclosures and the timing of when firms would have to expense option grant expenses. The regulations did not directly affect the cash flows of the firms. The regulations also did not affect the information available to the public, as investors could use previously disclosed information about the grant date, number of shares, and share price to value the option grant (which was always granted at the money).

Coinciding with these regulatory changes, we find a significant decline in number focus among US firms. Figure 11 plots the fraction of CEOs each year within our S&P 500 sample that we categorize as number rigid or number reference. Number-rigid CEOs peak at 15% in 2001 and decline to only 3 percent of the sample in 2010.

In Figure 12 we show that the effect of number-focus on the value of grants has also become less distortionary over time. While a substantial mass of firms continue to grant the same number of options in consecutive years, they are less likely to do so when firm returns would imply an extreme change in value. 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 large increase in value would be highly off-trend

relative to the control sample value-focused firms that experience similarly high firm returns. Therefore, value focus should imply that most firms within this sample should reduce the number of options granted.

We find that this is increasingly true over time. Starting in 1992, more than 20% of firms were number-rigid and there is significant mass to the right of one, implying that many firms actually increased the number of options granted. By the late 2000s, only 15% of firms are number rigid. The mass of firms to the right of one also falls dramatically, and the average and median change in number is less than one. This is consistent with the view that firms became increasingly value-focused over time.

5.0.2 Reference Dependent Motivation

Again, the goal of this paper is not to determine the precise mechanism through which a focus on the number of options granted leads to number-rigidity. In general, most theories of wage rigidity can be modified to this setting. Nonetheless, there is suggestive evidence that reference dependent motivation plays an important role (Mas, 2006). Specifically last year's nominal value of cash salary and bonus or last year's number of options or shares may establish a reference point below which which workers and managers lose motivation. A variety of theory and empirical work suggest that morale suffers following declines in wages relative to reference points (again, see Bewley (1999) for a detailed summary). Reference points have also been shown to affect prices in mergers and acquisitions (Baker et al., 2012).

The following reports the results of a Towers Perrin CompScan Survey of 130 North American companies if 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 form last year to this one)?

A) 1,500

B) 1,000

C) 715

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

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

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

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

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

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

It could be the case that workers below the level of the CEO view compensation through the lenses 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.

6 Conclusion

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

Figure 1
Number of Options Granted
This figure show the distribution of the ratio of the number of options granted in the current year to the previous year.

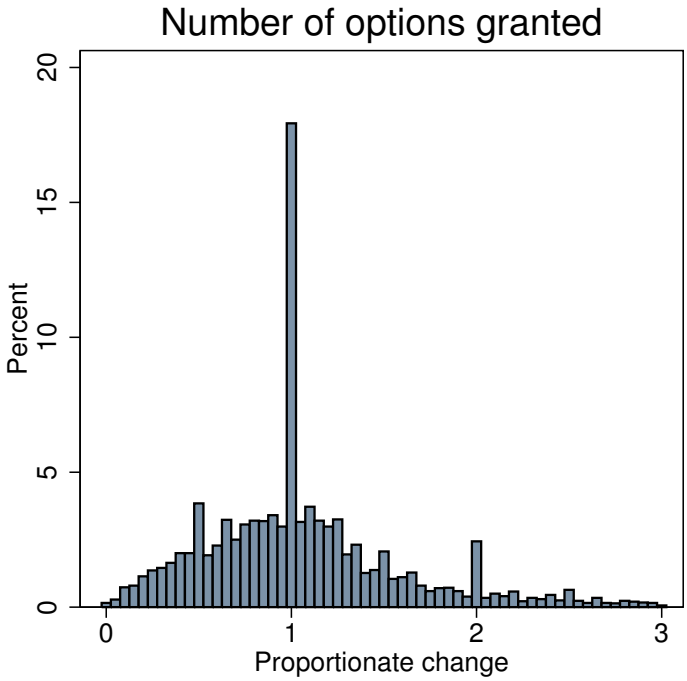


Figure 2
Value of Options Granted
This figure show the distribution of the ratio of the value of options granted in the current year to the previous year.

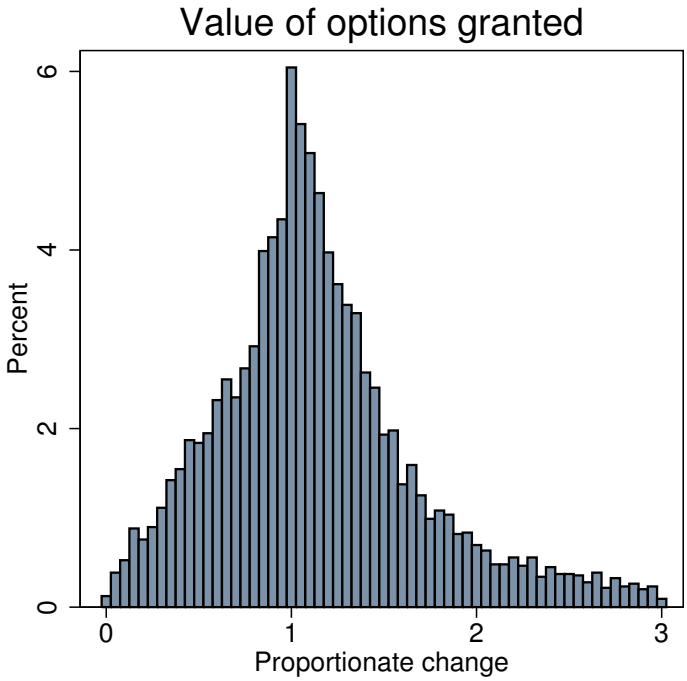


Figure 3
Stock Grants

This figure show the distribution of the ratio of the number and value of shares granted in the current year to the previous year.

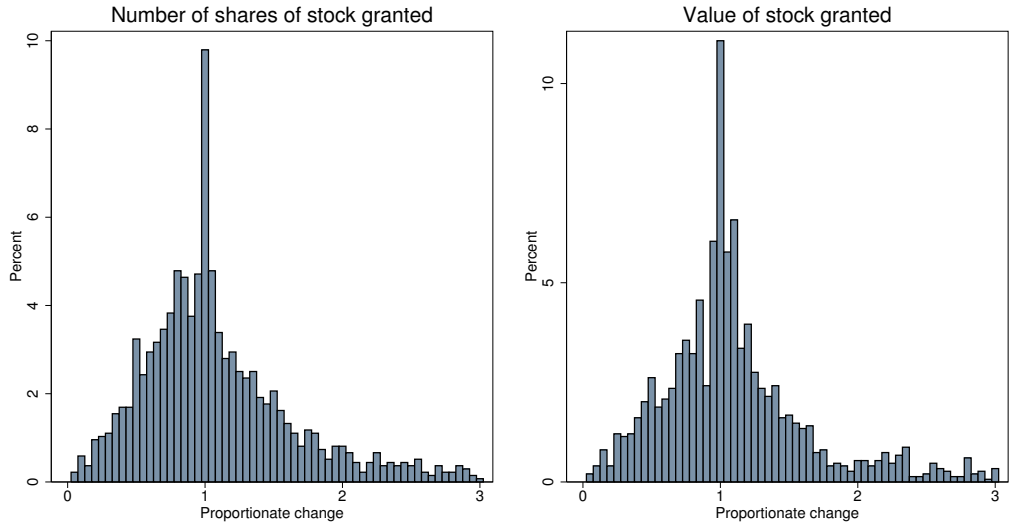


Figure 4
Cash Compensation

This figure show the distribution of the ratio of the cash compensation awarded in the current year to the previous year.

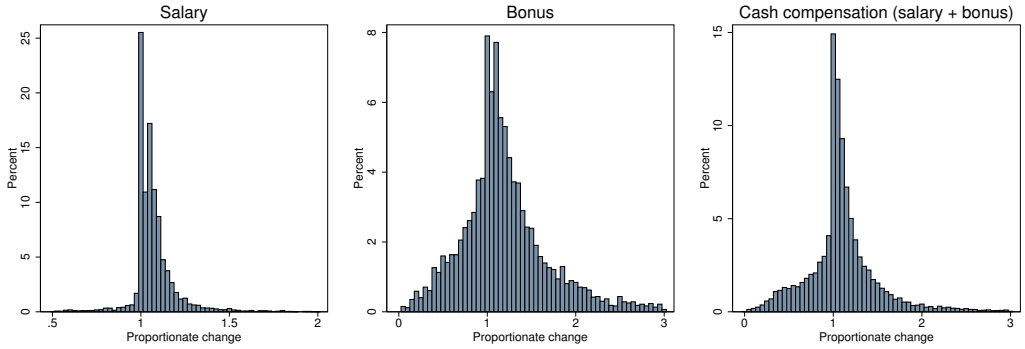


Figure 5
Executive Compensation Over Time

This figure reproduces a graph from Murphy (2012), restricting the sample to CEOs of firms that were ever a part of the S&P 500 during the sample period. The level of each bar represents the median level of total compensation that year in 2011 dollars. In addition, each bar is decomposed into the separate components of compensation based on the mean proportion represented by each that year.

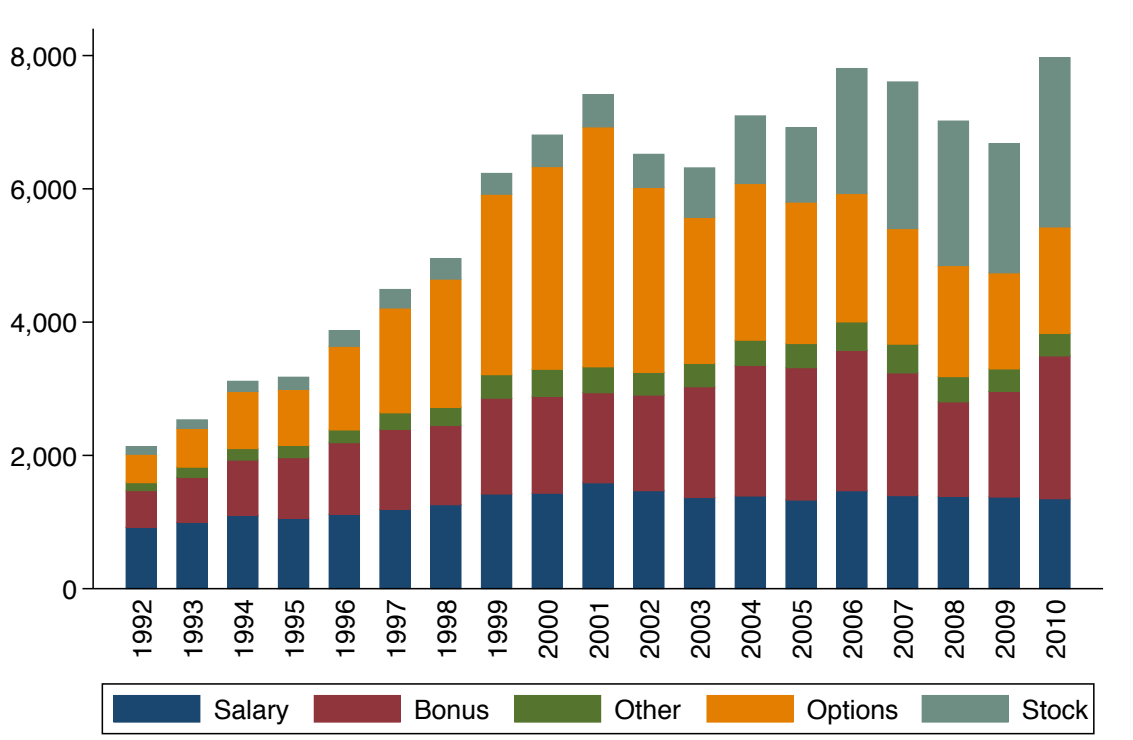


Figure 6
Compensation Growth

This figure shows the growth rate of median option compensation and other compensation for the sample to CEOs of firms that were ever a part of the S&P 500 during the sample period.

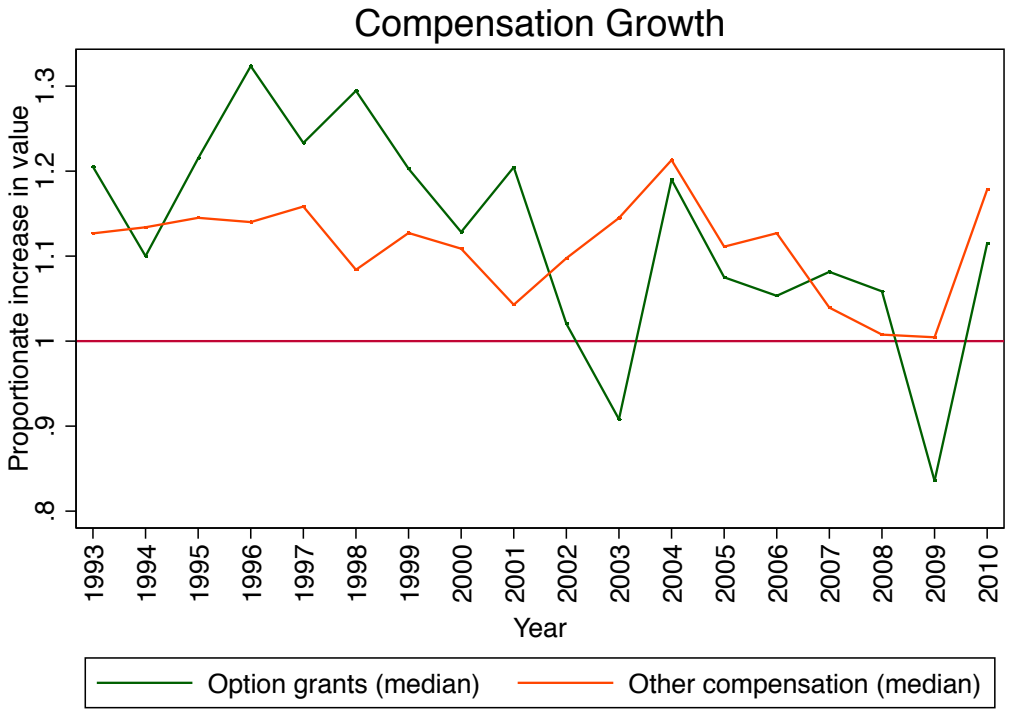


Figure 7

Actual vs. Predicted Option Growth For Number-Rigid CEOs

This figure plots changes in the log value of options granted against the log firm return over the previous 12 months. For the number rigid sample, the relationship falls exactly along the 45 degree line because a firm return of $X\%$ should exactly translate to an $X\%$ change in the face value of option grants. For the value-focused sample, we fit a local linear regression using the Epanichnikov kernel using the rule-of-thumb bandwidth.

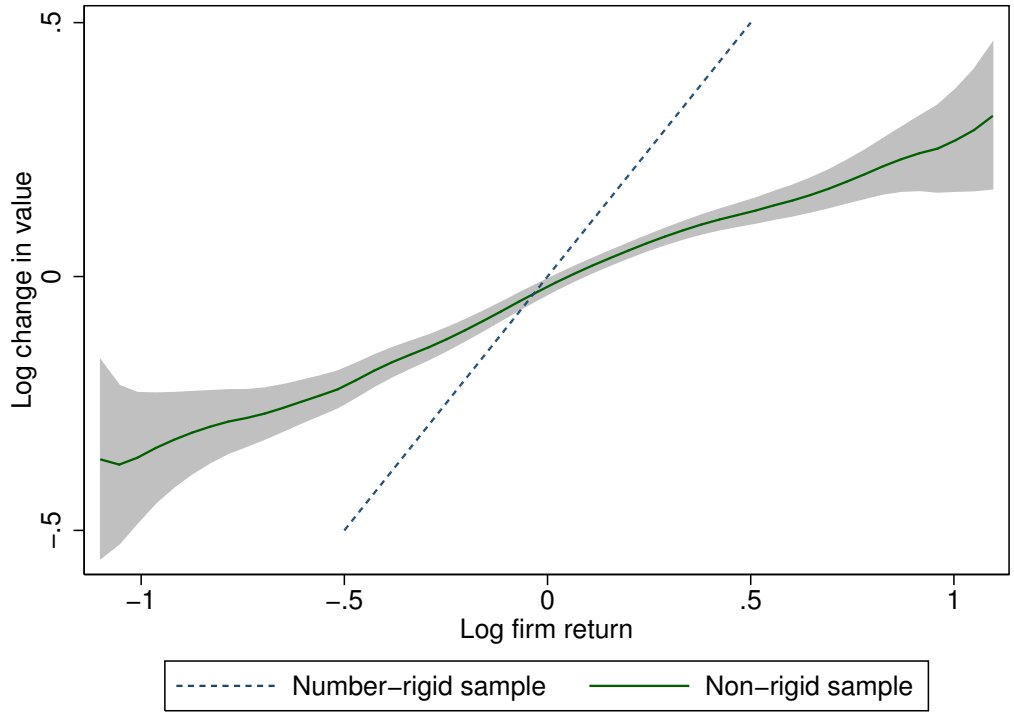


Figure 8
Aggregate Option Growth Due to Rigidity + Spillovers

This figure shows the calibration of spillover effects using the model of Gabaix and Landier (2008):

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

We assume that f is the fraction of number-rigid or number-reference CEOs in each year of our data and that the probability of being number-focused is uncorrelated with size (an assumption that is approximately true within the sample of S&P 500 firms). The variable λ is the difference between actual and counterfactual pay growth each year in the sample, as reported in Figure 7. For other model parameters, we use $\gamma = 1$, $\alpha = 1$, $\beta = 2/3$. Panel A show only spillovers from number-rigid grants. Panels B and C show spillovers from number-reference grants of different types.

Panel A

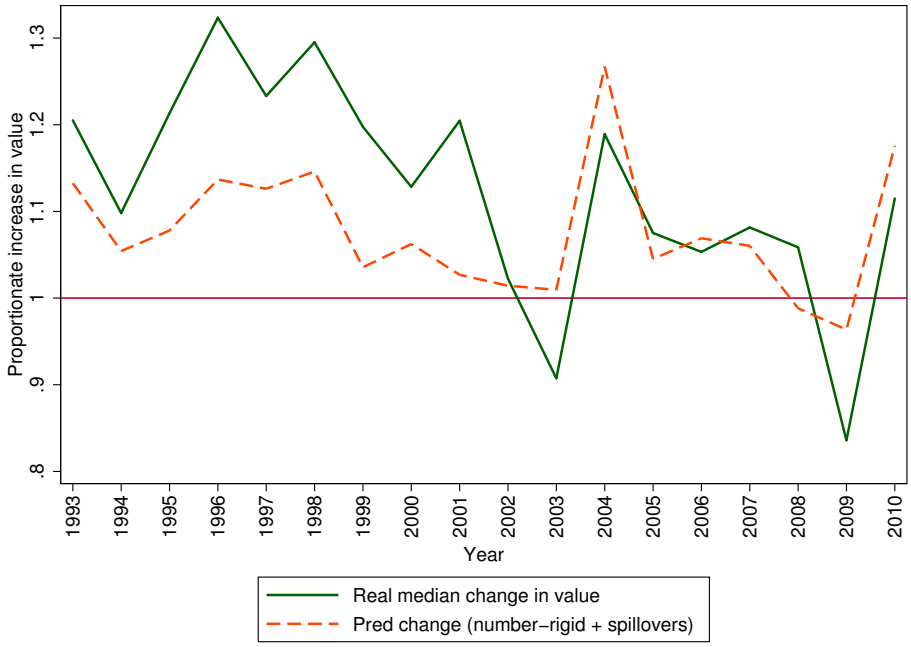
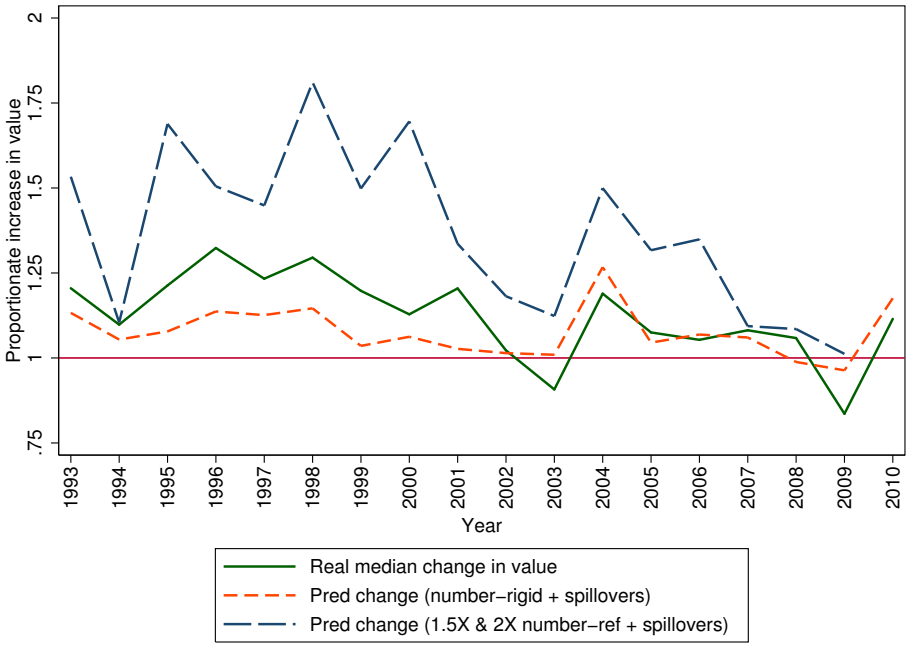


Figure 8
(Continued)
Panel B



Panel C

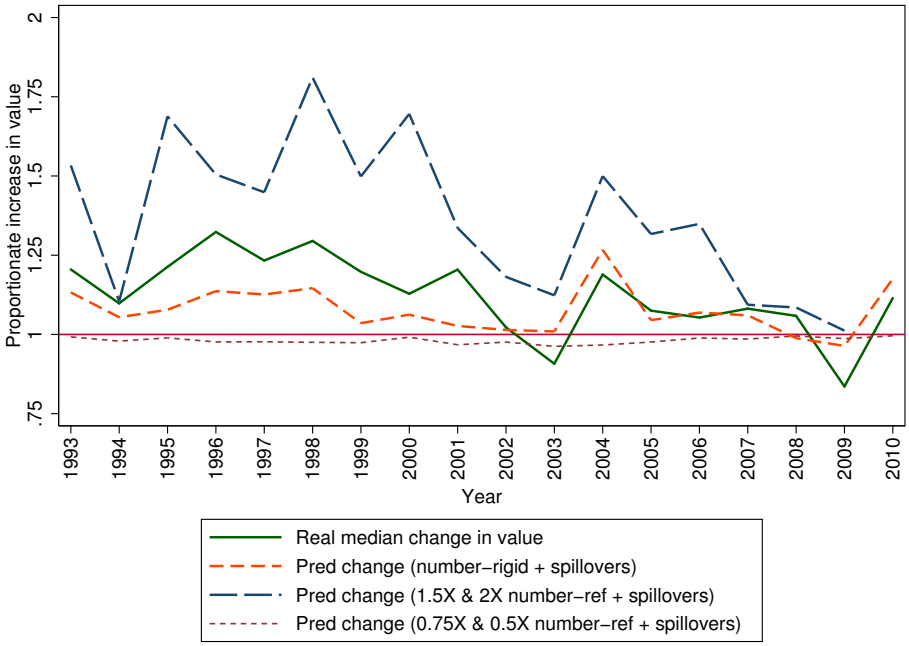
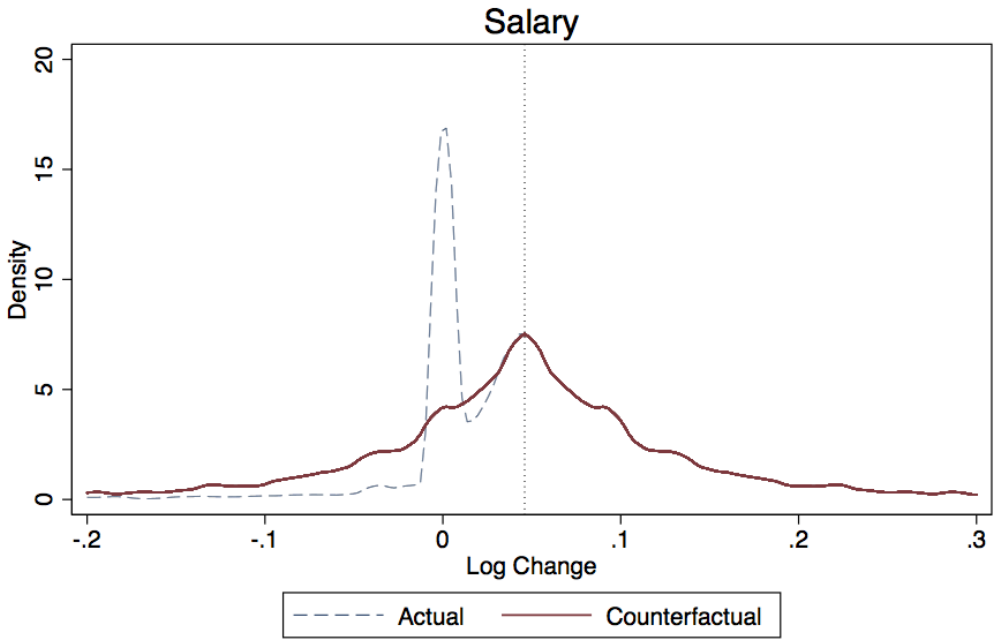


Figure 9
Downward Nominal Rigidity in Cash Compensation

This figure shows actual and counterfactual distributions of year-over-year log changes in 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.



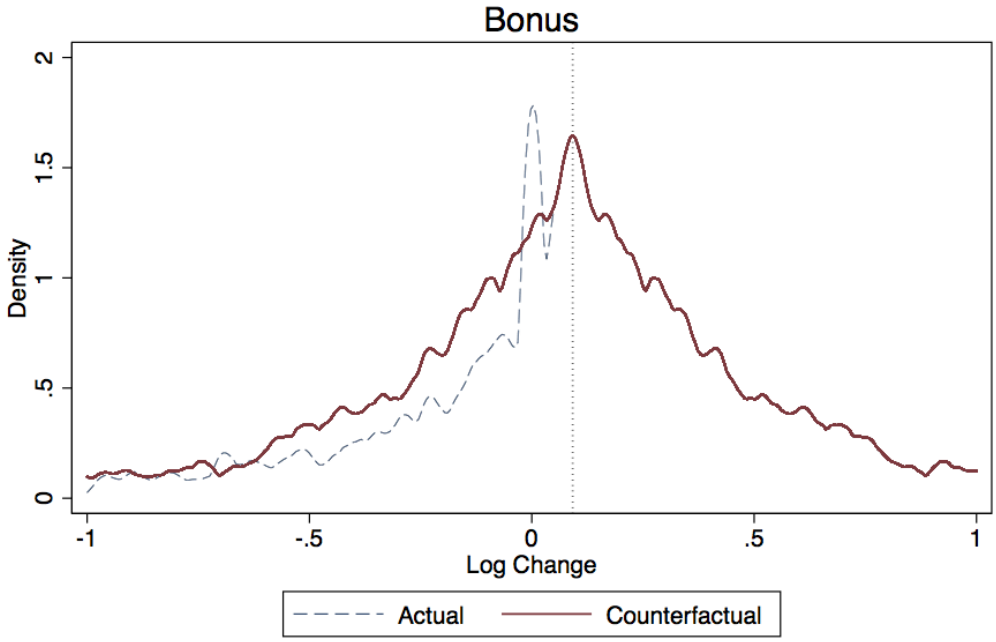


Figure 10
Adjustment of Cash Compensation

This figure shows how cash compensation adjusts in response to excess option compensation. 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).

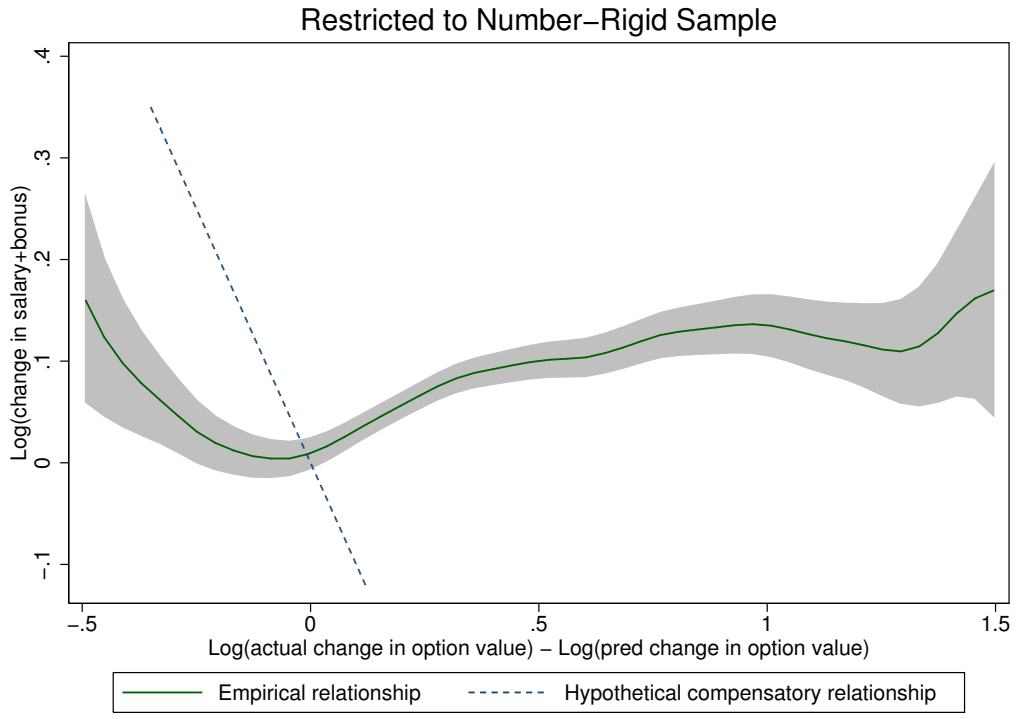


Figure 11
Probability of Number-Focus Over Time

This figure plots the fraction of CEOs each year within our S&P 500 sample that we categorize as number rigid or number reference. The vertical red line in 2005 represents the passage of FAS 123r.

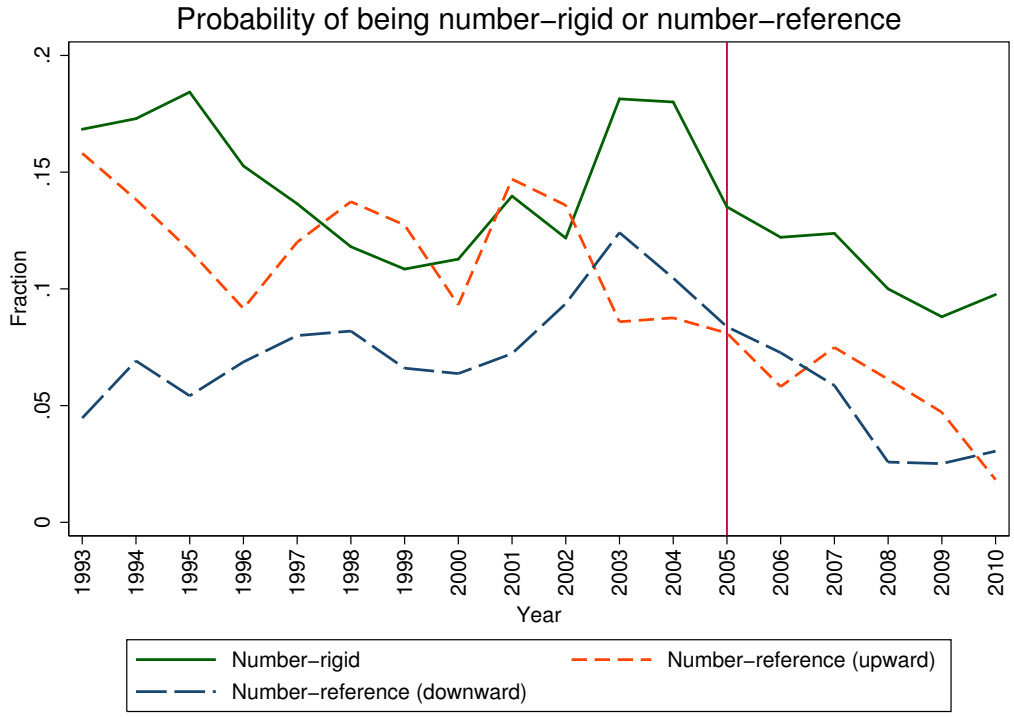


Figure 12

Number Change Distribution over Time for High Return Firms

This figure shows the effect of number-focus on the value of grants over time. It replicates 1 year by year, restricting the sample to firms with returns above 25% in the 12 month period prior to the option grant.

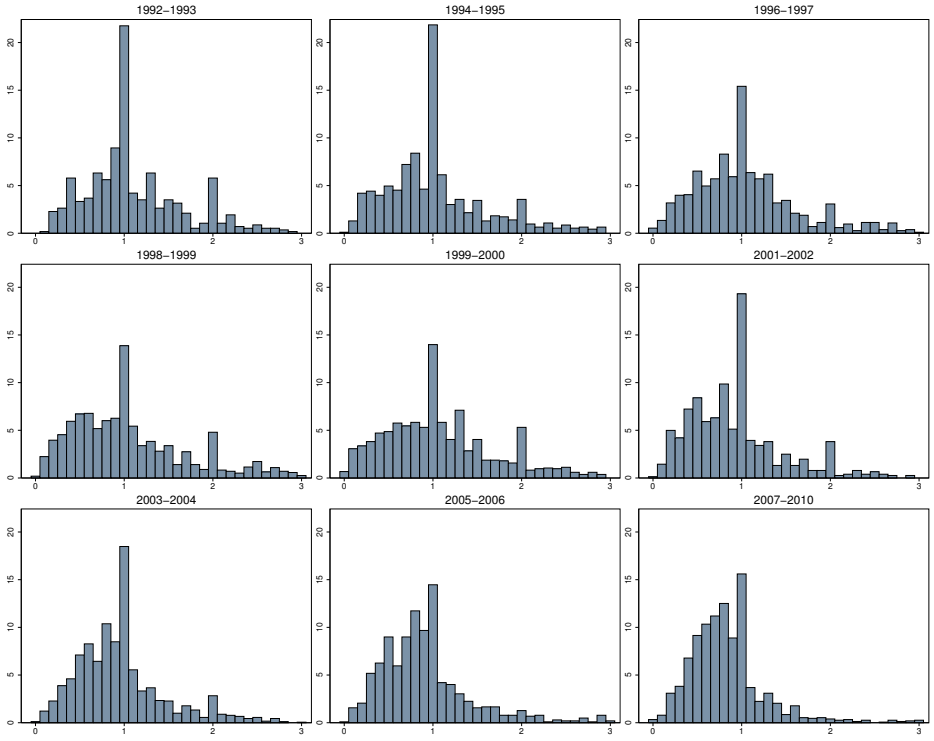


Table 1

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
Self-serving Choices of Reference Points

This table tests whether the choice to be number-referenced may be self serving. We estimate

$$\triangle log\left(option\, value\right) = \beta_0 + \beta_1 I^{\text{number-ref}} + \Delta log(shares_{it}) + \epsilon_{it}$$

The sample in Column 1 is restricted to CEO-years that are upward number-referenced (CEOs who receive 1.25, 1.5, 1.75, or 2 times their previous year's number of options) and a control group that receives similar changes in the number of options (within 1 percentage point) but that are not round multiples of last year's number of options. The control group represents otherwise similar CEO-years but that are likely to be value-referenced. β_1 represents the difference in the value of options for CEOs who receive a number-rigid change in shares relative to similar CEOs who receive a value-focused change in options. $\beta_1 > 0$ suggests that CEOs tend to receive number-rigid compensation when it leads to outsized changes in value. Column 2 explores the same specification among CEOs who receive a round fractional decline in the number of options and finds weaker and insignificant effects.

	Number-ref (upward)	Number-ref (downward)
	(1)	(2)
Number-reference dummy	0.0535***	0.0161
	(0.0188)	(0.0218)
Year FE	Yes	Yes
N	1639	1665
R^2	0.493	0.583

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