CHAPTER 7

Executive Compensation: A Survey of Theory and Evidence*

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1. INTRODUCTION

Executive compensation is a rich, complex, and controversial topic. In addition to there being an intense debate among academics on its drivers, the efficiency of current practices, and the case for reform, few topics have sparked as much interest among the general public. Politicians, regulators, investors, and executives themselves have all taken strong positions on whether and how to reform pay.

This paper sheds light on this debate by surveying the theoretical and empirical literature on executive compensation. We start in Section 2 by presenting the stylized facts, starting with U.S. data on public firms going back to 1936. We show that, while the level of pay has generally increased over time, this trend has been neither constant nor uniform, contrary to popular belief. We next decompose total pay into its components, illustrating in particular the rise and fall of option compensation, and discuss the increasing use or disclosure of other forms of pay, such as performance-based equity, (multi-year) bonus plans, pensions, perquisites ("perks"), and severance pay. We then present evidence on the level and composition of pay in non-U.S. countries, and survey recent findings on pay in U.S. private firms.

There is considerable debate among both academics and practitioners on what causes the observed trends in pay. There are three broad perspectives. One is the "shareholder value" view, which argues that compensation contracts are chosen to maximize value for shareholders, taking into account the competitive market for executives and the need to provide adequate incentives. Section 3 presents a simple unifying model of the level and sensitivity of pay, in both a static and dynamic setting, under shareholder value maximization. We discuss its empirical implications and the extent to which a shareholder value view can explain the stylized facts. We also address the optimality of relative performance evaluation and debt-based pay, and whether incentives should be provided using stock or options. Section 4 discusses the "rent extraction" view, which argues that contracts are set by executives themselves to maximize their own rents. Since the theoretical development of this view is more limited, we focus on presenting empirical findings suggestive of rent extraction, such as pay for non-performance, hidden pay, and the association of certain practices with poor corporate governance. A third perspective, which we discuss in Section 5, is that pay is shaped by institutional forces, such as regulation, tax, and accounting policies.

While Sections 3–5 explore the determinants of executive pay, Section 6 summarizes evidence on its effects. Such evidence is relatively scarce, since compensation contracts are endogenous and causal identification is difficult, but we discuss some promising approaches. Section 7 tackles policy interventions that have been proposed, and in some cases enacted, and critically evaluates them using both theory and evidence. Section 8 suggests directions for future research, and Section 9 concludes. We also include an Appendix that provides an overview of institutional detail, such as legislation, disclosure requirements, accounting treatments, and tax treatments, focusing on the U.S. but also discussing the U.K. and Europe. We hope this overview will be particularly useful to those new to the literature.

In addition to the specific conclusions of each chapter, we make the following broader points.

- Observed compensation arrangements result from a combination of potentially conflicting forces – shareholders' desire to maximize firm value, executives' desire to maximize their rents, and the influence of legislation, taxation, accounting policies, and social pressures. No one perspective can explain all of the evidence, and a narrow attachment to one perspective will distort rather than inform our view of executive pay.
- Recent theoretical contributions make clear that shareholder value models can be consistent with a wide range of observed compensation patterns and practices, including the large increase in executive pay since the 1970s. The challenge is now to confront these new models more rigorously with the data, explore their limitations, and contrast them with (mostly yet-to-be-written) rent extraction models.
- Theories of executive pay must take into account the specific features of executives' jobs; models of the general principal–agent problem are not automatically applicable to executives. For example, the skills of executives may be particularly scarce, and CEOs have a much larger impact on firm value than rank-and-file employees, which can fundamentally change the nature of the optimal contract.
- Theorists should consider very carefully their modeling choices. Seemingly innocuous features of the modeling setup, often made for tractability or convenience (such as the choice between additive or multiplicative utility and production functions, or between binary and continuous actions) can lead to large differences in the model's implications – and thus conclusions as to whether observed practices are consistent with theory.
- Compensation contracts have evolved over time. For example, the U.S. has seen a shift in the largest component of CEO pay from cash in the 1970s to options in the 1980s and 1990s and to performance-based stock in the 2000s. The reasons for this evolution are not fully understood. Likely drivers include boards learning over time how to improve pay practices as well as regulatory and institutional changes.
- Attempts to improve CEO pay should focus on the incentives created, and especially on the sensitivity of CEO wealth to long-term performance. The level of pay receives the most criticism, but usually amounts to only a small fraction of firm value. Badly structured incentives, on the other hand, can easily cause value losses that are orders of magnitudes larger.

- Any high-powered incentive contract creates incentives to manipulate the performance measure(s) it relies upon. However, finding that a pay practice, such as equity-linked pay, is associated with manipulation does not imply that incentive contracts are worse than no incentive contract.
- Most of what we know about executive pay concerns CEOs of U.S. public firms. We need more research on top executives other than CEOs, countries outside the U.S., and private firms.
- Identifying the causal effect of compensation contracts on any interesting outcome variable is extraordinarily difficult. These contracts are endogenous – executives, directors, and compensation consultants spend time and effort designing them, taking into account unobservable firm, industry, and executive characteristics. As a result, compensation contracts are inevitably correlated with these unobservable characteristics, which in turn affect firm behavior, performance, and value.
- There are almost no instrumental variables or natural experiments that create as-good-as-random variation in compensation contracts. The few exceptions have significantly advanced our understanding of the causal effects of executive pay, and we strongly welcome any additions to this short list. On the other hand, insistence on clean identification frequently results in the use of bogus "instruments" that almost certainly violate the exclusion restriction, a focus on narrow questions, or the avoidance of research on executive pay altogether. Much can be learned from papers that do not attempt to identify causal effects, and instead carefully study how firms endogenously choose compensation contracts in different settings.

This chapter builds on and significantly expands three earlier surveys on executive pay (co-)written by the authors: Frydman and Jenter (2010), which focuses on empirics, and Edmans and Gabaix (2009, 2016), which focus on theories. Other notable surveys include Core et al. (2003a), which focuses on empirics, and Murphy (2013), which is particularly valuable for a historical and institutional perspective.

2. THE STYLIZED FACTS

This section presents the important facts about CEO pay, covering both the past and the present. We focus on the level and composition of CEO pay and the relation between CEO pay and firm performance. Much of the data is from the U.S., where more and better data have traditionally been available, but international evidence is included wherever available. The presentation in this section draws heavily on Frydman and Jenter (2010).

2.1 The level of pay

The increase in CEO pay since the 1970s, and particularly its rapid acceleration in the 1990s, is well documented.[1] By 2014, the median CEO in the S&P 500 earned $10.1 million per year, which is substantially higher than in other countries and represents a sixfold increase since 1980. Pay of the average worker has risen much more slowly. Across the S&P 500, the average ratio of CEO pay to average worker pay was 335 times in 2015 (according to the AFL-CIO), compared to 40 times in 1980 (according to the Economic Policy Institute). Piketty and Saez (2003) and Piketty (2014) argue that the rapid increase in executive pay has contributed significantly to the recent rise in income inequality, and thus has political economy implications.

It would be a mistake, however, to view the history of executive compensation as one of ever increasing pay. In fact, executive pay levels in the U.S. fell during World War II and did not change much from the 1940s to the mid-1970s, when they started their meteoric rise. For the largest firms, this rise came to a halt in the 2000s, with average pay levels falling and median pay levels roughly constant from 2001 to 2014. For medium-sized and small public firms, executive pay levels continued rising after 2001, and the ratio of CEO pay to the pay of other top executives kept increasing.

The evolution of pay from 1936 to 2005 for the three highest-paid executives in the 50 largest U.S. firms, taken from Frydman and Saks (2010), is shown in Fig. 1.[2] Total annual pay, expressed in 2014 dollars, is measured as the sum of the executive's salary, realized payouts from bonuses and long-term incentive plans ("LTIPs"), plus the grant-date value of new stock and option awards, the latter calculated using Black–Scholes.[3] Total pay follows a J-shaped pattern over the 1936–2005 period. Following a sharp decline during World War II and a further slow decline in the late 1940s, it increased slowly (by 0.8% per year on average) from the early 1950s to the mid-1970s. Rapid pay growth only started in the mid-1970s and continued almost until the sample ends in 2005. The increases were most dramatic in the 1990s, with annual growth rates in excess of 10% by the end of the decade. Fig. 1 also shows that CEO pay grew more rapidly than the pay of the other highest-paid executives since the late-1970s, but not before. The median ratio of CEO pay to that of other top executives was stable at approximately 1.4 before 1980 but rose to almost 2.6 by 2000–05.

[1] See, for example, Jensen and Murphy (1990a), Hall and Liebman (1998), Murphy (1999), Bebchuk and Grinstein (2005), Frydman and Jenter (2010), and Murphy (2013).

[2] The Frydman and Saks (2010) sample contains the largest 50 firms in 1940, 1960 and 1990 (for a total of 101 firms). Firms are selected based on total sales in 1960 and 1990 and based on market value in 1940. Compensation data is hand-collected for all available years from 1936 to 1992; the S&P ExecuComp database is used to extend the data to 2005.

[3] Black–Scholes values are likely to overstate both the cost of option compensation to the firm and its value to the executive (Lambert et al., 1991; Carpenter, 1998; Meulbroek, 2001; Hall and Murphy, 2002; Ingersoll, 2006; Carpenter et al., 2010, 2017). Section 2.1.2 examines the value of equity compensation to the executive.

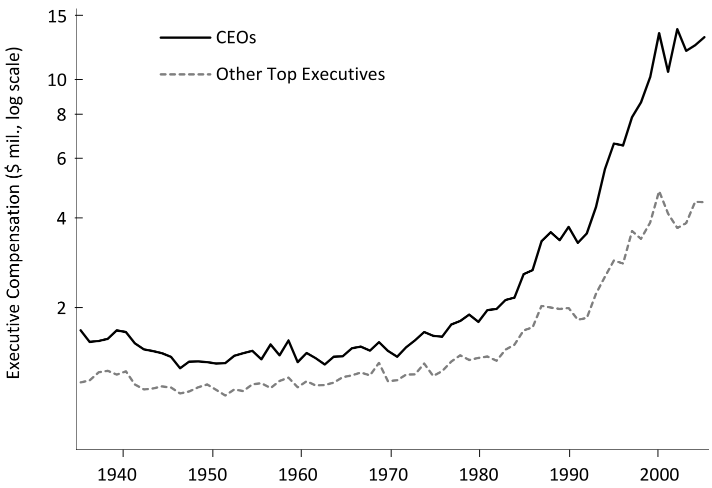

Figure 1 Median compensation of CEOs and other top executives from 1936 to 2005. The figure, taken from Frydman and Saks (2010), uses data on the three-highest paid executives in the 50 largest firms in 1940, 1960, and 1990. Firms are selected according to total sales in 1960 and 1990, and according to market value in 1940. Compensation data is hand-collected from proxy statements for all available years from 1936 to 1992; the S&P ExecuComp database is used to extend the data to 2005. Total compensation is composed of salary, annual and long-term bonus payments, grants of restricted stock, and stock option grants (valued using Black–Scholes). The CEO is identified as the president of the company in firms where the CEO title is not used. "Other Top Executives" include any executives among the three highest paid who are not the CEO. All dollar values are in inflation-adjusted 2014 dollars.

The surge in pay during the 1990s was not restricted to only the largest firms. Table 1 and Fig. 2 show the evolution of pay levels from 1992 to 2014 for CEOs and other top executives in large-cap firms (members of the S&P 500 index), in mid-cap firms (S&P MidCap 400), and in small-cap firms (S&P SmallCap 600). Total pay has risen for firms of all sizes, even though the increases were steeper in larger firms. For CEOs of S&P 500 firms, the median level of pay climbed rapidly from $3.1 million in 1992 to a peak of $10.0 million in 2001, a 223% increase. After 2001, median CEO pay stabilized between $8 and $10 million for more than ten years. It passed its 2001 peak only in 2014, reaching $10.1 million.

In mid-cap firms, median CEO pay rose more slowly during the 1990s, from $1.9 million in 1994 to $3.5 million in 2001, for a 90% increase. In small-cap firms, median pay increased by only 45%, from $1.3 million in 1994 to $1.9 million in 2001. Even though mid-cap and small-cap CEOs saw smaller raises during the 1990s, their pay continued to climb after 2001, when the pay of large-cap CEOs stagnated. Median pay for mid-cap (small-cap) CEOs rose from $3.5 ($1.9) million in 2001 to $5.4 ($2.8) million in 2014.

Table 1 Compensation levels from 1992 to 2014. The two panels show the median and mean annual pay for CEOs (Panel A) and non-CEO top executives (Panel B) from 1992 to 2014 in S&P 500, S&P MidCap, and S&P SmallCap firms. The calculations use ExecuComp data and include the CEO and the three highest-paid executives for each firm-year. Non-CEOs are any executives among the three highest-paid who are not the CEO. Annual compensation is the sum of salary, bonus, payouts from long-term incentive plans, the grant-date value of option grants (calculated using Black–Scholes), the grant-date value of restricted stock grants, and miscellaneous other compensation. All values are in inflation-adjusted 2014 millions of dollars

Panel A: CEO compensation levels from 1992–2014

	S&P 500		S&P MidCap 400		S&P SmallCap 600	
Year	**Median**	**Mean**	**Median**	**Mean**	**Median**	**Mean**
1992	3.1	4.1				
1993	3.1	4.4				
1994	3.9	5.4	1.9	3.0	1.3	1.9
1995	4.2	5.9	2.0	3.3	1.3	1.8
1996	5.0	8.5	2.3	4.1	1.4	2.1
1997	5.8	10.4	3.0	5.0	1.7	2.7
1998	6.7	13.1	3.0	5.5	1.8	2.7
1999	8.0	14.6	3.2	6.4	1.8	2.8
2000	8.8	20.0	3.5	6.0	2.0	3.0
2001	10.0	16.6	3.5	5.7	1.9	3.1
2002	8.7	12.5	3.9	5.4	1.8	2.8
2003	8.5	11.3	3.4	4.8	1.9	2.5
2004	9.0	12.2	4.0	5.4	2.3	3.1
2005	8.6	12.2	4.0	5.6	2.3	3.4
2006	9.6	13.1	4.0	5.5	2.0	2.8
2007	9.3	12.1	4.5	5.3	2.1	2.8
2008	8.3	11.2	4.1	4.8	1.9	2.8
2009	7.8	9.5	3.9	4.9	1.9	2.4
2010	9.3	11.1	4.7	5.6	2.3	2.7
2011	9.4	11.7	4.7	5.6	2.4	2.9
2012	9.4	11.0	4.7	5.5	2.4	3.0
2013	9.9	11.8	5.0	5.7	2.6	3.3
2014	10.1	12.0	5.4	6.4	2.8	3.3

(continued on next page)

Beyond the overall rise in pay, Table 1 reveals four important facts. First, the increase in *mean* CEO pay during the 1990s was larger than the increase in *median* pay. This was due to a relatively small number of extremely highly-paid CEOs in the late 1990s. After 2001, this trend reversed, and a decline in outliers decreased the skewness of CEO pay for firms of all sizes. For the S&P 500, the difference between mean and median CEO pay declined from 67% in 2001 to only 19% in 2014. As a result, whether

Table 1 (*continued*)
Panel B: Non-CEO compensation levels from 1992–2014

	S&P 500		S&P MidCap 400		S&P SmallCap 600	
Year	**Median**	**Mean**	**Median**	**Mean**	**Median**	**Mean**
1992	1.7	2.2				
1993	1.7	2.6				
1994	2.0	2.7	1.1	1.7	0.7	1.1
1995	2.1	3.2	1.1	1.8	0.7	1.1
1996	2.5	4.0	1.3	2.2	0.8	1.2
1997	2.8	5.4	1.5	2.5	1.0	1.5
1998	3.2	6.5	1.6	2.5	1.0	1.5
1999	3.8	7.7	1.8	3.0	1.0	1.5
2000	4.4	10.0	1.9	3.3	1.0	1.6
2001	4.5	8.2	1.8	2.6	1.0	1.6
2002	3.7	6.1	1.7	2.6	1.0	1.4
2003	3.7	5.3	1.6	2.3	1.0	1.3
2004	4.0	5.7	1.7	2.5	1.1	1.5
2005	3.8	5.8	1.7	2.5	1.1	1.6
2006	4.2	6.5	1.8	2.4	1.1	1.4
2007	4.2	6.2	1.9	2.4	1.0	1.5
2008	3.7	5.4	1.8	2.3	1.0	1.3
2009	3.5	4.9	1.7	2.3	1.0	1.2
2010	3.8	5.3	2.0	2.6	1.1	1.4
2011	3.9	5.8	2.0	2.6	1.1	1.4
2012	3.8	5.6	1.9	2.6	1.1	1.4
2013	4.1	5.4	2.1	2.7	1.2	1.6
2014	4.1	6.0	2.2	3.0	1.2	1.6

a researcher chooses to represent "average" CEO pay by the mean or the median has important implications (Frydman and Jenter, 2010). Both are appropriate under different circumstances. Mean pay is relevant in assessing aggregate levels in pay across all CEOs, while median pay is relevant in assessing the pay for a typical CEO (Murphy, 2013). Moreover, the skewness of pay levels means that it is important to control for outliers in cross-sectional analyses.

Second, contrary to popular belief, pay has not constantly risen over time, and there are long periods – even decades – in which pay has been constant or declining. As a result, similar to the choice of means versus medians, the choice of a starting point to measure time trends in pay is far from innocuous. This also means that any explanation for changes in the level of pay will have to explain not only why pay rose in some periods, but also why pay was flat in other periods, and suggests that any single hypothesis is unlikely to be able to explain trends in pay since World War II.

Third, there are interesting differences in the evolution of pay levels between large-cap, mid-cap, and small-cap firms. Executive pay increased across the board during the

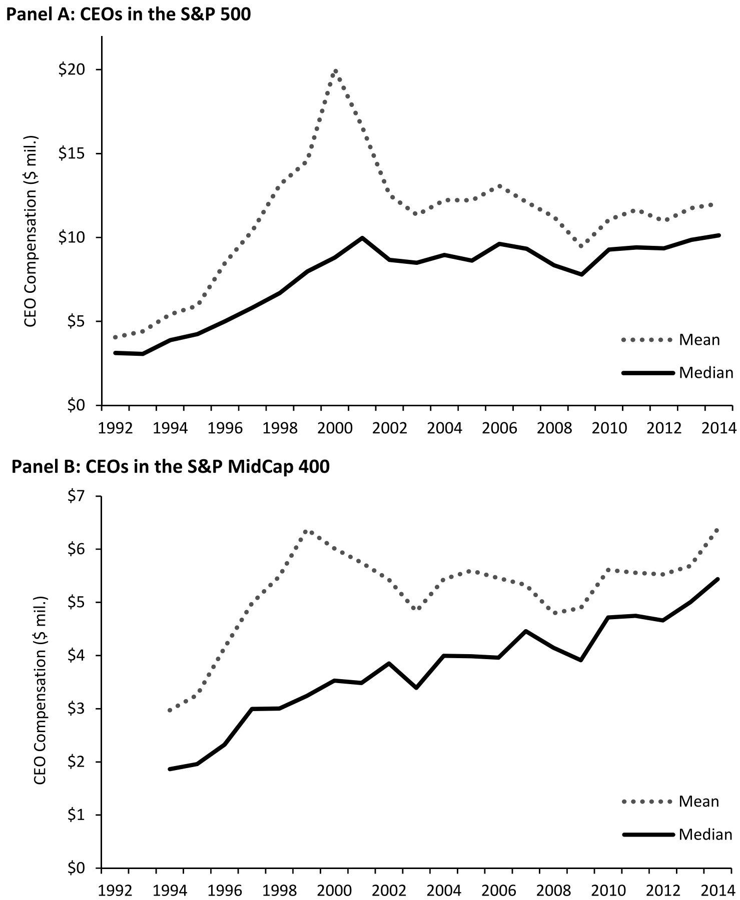

Figure 2 CEO compensation levels from 1992 to 2014. The three panels show median and average annual pay for CEOs from 1992 to 2014 in S&P 500, S&P MidCap, and S&P SmallCap firms, respectively, and are based on ExecuComp data. Annual compensation is the sum of salaries, bonuses, payouts from long-term incentive plans, the grant-date values of option grants (calculated using Black–Scholes), the grant-date values of restricted stock grants, and miscellaneous other compensation. All dollar values are in inflation-adjusted 2014 dollars.

1990s, but much more so in larger firms. Shown in Fig. 3, the premium for running a larger firm increased during the 1990s and fell afterwards. In 1994, the pay of the median S&P 500 CEO was 109% larger than that of the median mid-cap CEO. In 2001, this difference had risen to 186%, before falling to only 86% by 2014. Comparing mid-cap to small-cap CEOs, the premium for running a mid-cap firm was 45% in 1994, rose to a first peak of 109% in 2002, a second peak of 116% in 2008, and then declined to 96% by 2014.

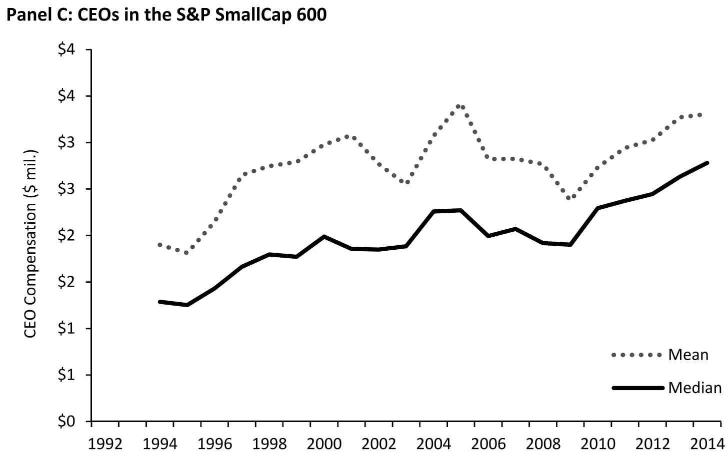

Figure 2 (*continued*)

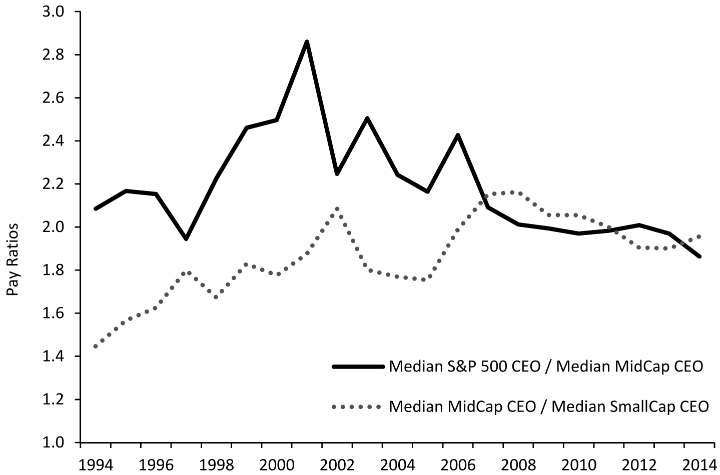

Figure 3 Comparing CEO pay across large-cap, mid-cap, and small-cap firms. This diagram shows the ratio of median CEO pay in S&P 500 firms to median CEO pay in S&P MidCap firms, and the ratio of median CEO pay in S&P MidCap firms to median CEO pay in S&P SmallCap firms from 1992 to 2014. The calculations use ExecuComp data. Annual compensation is the sum of salaries, bonuses, payouts from long-term incentive plans, the grant-date values of option grants (calculated using Black–Scholes), the grant-date values of restricted stock grants, and miscellaneous other compensation.

Finally, CEO pay has grown faster than the pay of other top executives. This increase in the CEO pay premium, shown in Fig. 4, is fairly uniform across firms of different sizes. For S&P 500 firms, the median of the within-firm ratio of CEO pay to the average pay of other top-3 executives rose from 1.8 in 1992 to 2.4 in 2014. For mid-cap

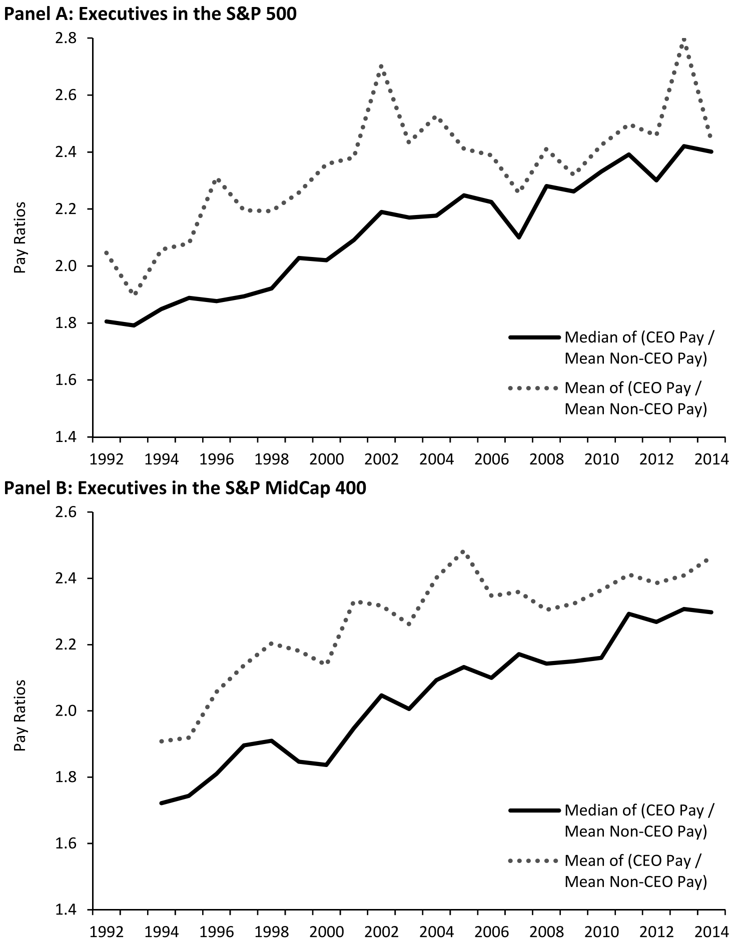

Figure 4 Comparing CEO to non-CEO top executive pay. The three diagrams show the median and average ratio of CEO pay to average non-CEO top executive pay within the same firm from 1992 to 2014 in S&P 500, S&P MidCap, and S&P SmallCap firms, respectively. The calculations use ExecuComp data. Non-CEOs are any executives among the three highest-paid who are not the CEO. Annual compensation is the sum of salaries, bonuses, payouts from long-term incentive plans, the grant-date values of option grants (calculated using Black–Scholes), the grant-date values of restricted stock grants, and miscellaneous other compensation.

(small-cap) firms, the median of the same ratio increased from 1.7 (1.7) in 1994 to 2.3 (2.1) in 2014.

To summarize, the post-World War II era can be divided into three distinct periods. Prior to the 1970s, we observe low levels of pay and little dispersion across top managers. From the mid-1970s to the late 1990s, pay grew dramatically, and differences in pay across executives and firms widened. Finally, from 2001 to 2014, median CEO pay was

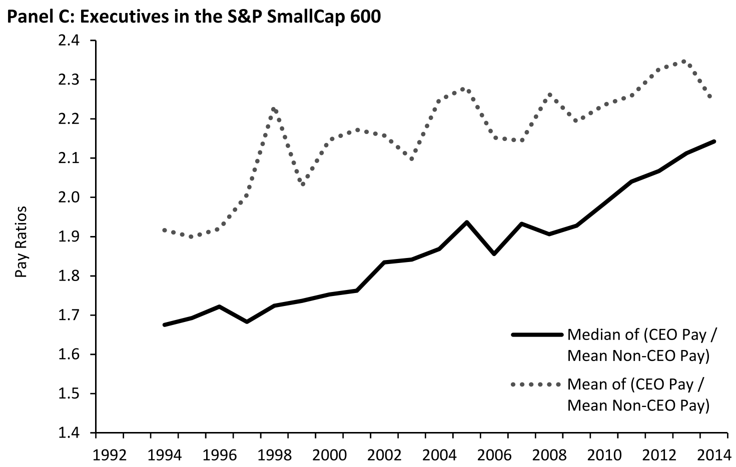

Figure 4 (*continued*)

essentially flat for S&P 500 CEOs, while it continued to rise for mid-cap and small-cap CEOs. The skewness of CEO pay declined, but the pay premium for CEOs over other top-3 executives continued to rise even after 2001.

2.1.1 Cross-sectional variation in pay

This section explores how the level of CEO pay correlates with firm and CEO characteristics.[4] Table 2 regresses annual CEO pay from 1992 to 2014 on firm value, volatility, stock return performance, CEO age, CEO tenure, and a female CEO indicator. The sample is the S&P 1,500, which combines the S&P 500, MidCap 400, and SmallCap 600. CEO pay is strongly positively correlated with total firm value, with a CEO pay-firm size elasticity of about 0.45. This elasticity is robust to the inclusion of industry, year, and industry-year fixed effects. A positive relationship between firm size and CEO pay has been documented by, among others, Roberts (1956), Murphy (1985), Baker et al. (1988), Barro and Barro (1990), Murphy (1999), Gabaix and Landier (2008), Frydman and Saks (2010), and Gabaix et al. (2014). Section 3.1 relates the observed CEO pay-size elasticity to the predictions of CEO-firm assignment models, and Section 3.3 to the predictions of assignment models with moral hazard.

CEO pay is also positively related to stock return volatility, and this correlation is again robust to the inclusion of industry, year, and industry-year fixed effects.[5] A one

[4] Graham et al. (2012) show that, after controlling for characteristics, there are large managerial fixed effects in CEO pay, which suggests a large role for unobserved CEO characteristics.

[5] The positive correlation between volatility and pay becomes small and insignificant with CEO fixed effects (column 5). Changes in volatility within a CEO's tenure are highly correlated with changes in performance, which makes interpreting the correlation between volatility and pay difficult.

Table 2 Cross-sectional variation in CEO pay. The table shows panel regressions of annual CEO pay on firm and CEO characteristics using ExecuComp data from 1992–2014 for S&P 500, S&P MidCap, and S&P SmallCap firms. Annual compensation is the sum of salary, bonus, payouts from long-term incentive plans, the grant-date value of option grants (calculated using Black–Scholes), the grant-date value of restricted stock grants, and miscellaneous other compensation. Firm value is market value of equity + (book assets − book equity − deferred taxes). Volatility is the standard deviation of monthly log returns over the previous 60 months, requiring that at least 48 months of returns are available. If more than one class of stock is traded, returns are the capitalization-weighted average return. Column (6) includes only CEOs with at least 5 years of tenure. Industries are the 48 Fama and French (1997) industries. Total pay, firm value, and volatility are winsorized at the 1% level, and all nominal values are in inflation-adjusted 2014 dollars. Standard errors are clustered at the firm level. *, **, and *** denote statistical significance at the 5%, 1%, and 0.1% levels, respectively

	ln(Total Pay_t)					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
ln(Firm $value_{t-1}$)	0.426***	0.459***	0.456***	0.455***	0.303***	0.463***
	[0.008]	[0.008]	[0.008]	[0.009]	[0.017]	[0.011]
$Volatility_{t-1}$	2.842***	1.488***	1.606***	1.527***	0.00727	2.047***
	[0.177]	[0.185]	[0.199]	[0.197]	[0.233]	[0.257]
ln(Age_t)				−0.163*	0.950	
				[0.083]	[0.864]	
ln($Tenure_t$)				0.00854	0.0365*	
				[0.011]	[0.017]	
$Female_t$				0.0404		
				[0.056]		
Ln(1+$Return_t$)						0.293***
						[0.016]
Ln(1+$Return_{t-1}$)						0.146***
						[0.016]
Ln(1+$Return_{t-2}$)						0.0915***
						[0.016]
Ln(1+$Return_{t-3}$)						0.0748***
						[0.015]
Ln(1+$Return_{t-4}$)						0.0648***
						[0.014]
Constant	4.097***	3.509***	3.994***	4.651***	1.311	3.840***
	[0.075]	[0.078]	[0.082]	[0.325]	[3.275]	[0.106]
Year FEs		Yes			Yes	
Industry FEs		Yes				
Industry × Year FEs			Yes	Yes		Yes
CEO FEs					Yes	
N	36,009	35,771	35,771	35,193	35,410	22,872
R^2	0.408	0.492	0.513	0.516	0.797	0.524

standard deviation increase in the volatility of monthly stock returns is associated with an 8 to 15% increase in annual CEO pay. A positive relationship between risk and CEO pay is consistent with evidence in Garen (1994) for salaries and in Cheng et al. (2015) for total pay in financial institutions. Section 3.2 surveys models of optimal CEO compensation that relate pay to volatility.

Columns 4 and 5 introduce CEO age, tenure, and a female CEO indicator into the pay regressions. In the pooled cross-section and time series (column 4), CEO pay is correlated negatively with age and insignificantly positively with tenure. When CEO fixed effects are introduced (column 5), the correlation of pay with age becomes positive but insignificant, while the positive correlation with tenure becomes significant. Section 3.7 reviews dynamic contracting models that link optimal CEO pay to tenure, while Section 4 explores the idea that entrenchment and rent extraction might increase with tenure.

There is no significant difference in the annual pay of male and female CEOs after we control for firm size, CEO age, and tenure. In fact, the point estimate suggests a small wage premium for female CEOs. This is consistent with the earlier results of Bertand and Hallock (2001), who also note that women tend to run smaller firms. Female CEOs remain extraordinarily rare, making up only 2.5% of our sample.

The last column of Table 2 introduces stock returns into the regression. CEO pay is strongly positively correlated with both contemporaneous and lagged returns, consistent with a literature going back to Murphy (1985) and Coughlan and Schmidt (1985) that documents a significant pay-for-performance relationship. The effect of past performance on current pay remains highly significant even after four years, consistent with Boschen and Smith (1995). Section 3.7 surveys dynamic contracting models that predict these long-term effects of performance on CEO pay.

Even though the coefficients in column 6 suggest a strong pay-performance relationship, they underestimate CEOs' incentives. Most CEOs have large equity holdings in their employer, which directly tie their wealth to stock price performance. For the typical CEO, the wealth changes caused by stock price movements are much larger than the corresponding changes in annual pay. In Section 2.3, we therefore measure CEOs' overall wealth-performance relationship.

We emphasize that the relationships in Table 2 are correlations and not causal effects. Important explanatory variables for CEO pay, such as firm size or risk, are themselves affected by CEOs' incentives and actions, and are also correlated with unobservable firm, industry, and executive characteristics that affect pay. Consequently, their correlations with pay are difficult to interpret. For example, CEO pay might be positively correlated with risk because higher risk causally requires firms to pay more, or because higher pay causes CEOs to take more risk, or because risk is correlated with other determinants of pay such as investment opportunities, product market competition, or CEO risk aversion.

2.1.2 The value of pay to the executive

The pay levels analyzed in the previous sections measure the cost of compensation to shareholders. The (pre-tax) value of the same pay to a risk-averse executive is potentially much lower. Executives receive performance-linked pay and have often large holdings of company stock and options that are highly correlated with their firm-specific human capital (Lambert et al., 1991; Meulbroek, 2001; Hall and Murphy, 2002). Thus, rational executives should value equity grants well below their fair market values, which are determined by diversified investors in financial markets.

Calibration exercises suggest that the appropriate valuation discounts can be large. Hall and Murphy (2002), using reasonable assumptions for executive risk aversion and exposures to company stock price, find discounts of 40 to 60% for typical at-the-money options with a 10-year life. Given these sizable discounts, to be consistent with shareholder value maximization, equity grants need to be justified by their incentive or retention effects.

The valuation discounts differ across compensation instruments. Discounts are larger the more exposed to the stock price, and hence the riskier, a compensation instrument is. Thus, for example, they are higher for options than stock, because options are a levered claim with higher volatility. As a result, a shift in the composition of pay can change the value perceived by executives, even if the fair market value stays unchanged. In Section 2.2, we show that the increase in executive pay during the 1990s was mostly an increase in option compensation. If executives assign low valuations to options, their utilities may have increased much less during the 1990s than suggested by the increase in pay levels. Similarly, the relative stability in pay levels between 2001 and 2014 was accompanied by a shift from option compensation to performance-based stock. If executives assign lower discounts to the latter, the perceived value of pay might have increased over this period, even though the fair market value of pay did not.

There are at least two other reasons why the value of equity awards to the executive may be below their market value, although these reasons also lower their cost to the firm. First, risk-averse executives, seeking diversification and liquidity, exercise options earlier than prescribed by the value-maximizing exercise strategy (Carpenter, 1998; Bettis et al., 2005; Carpenter et al., 2010, 2017). Second, sunset provisions lead to the executive forfeiting equity on retirement, resignation, or death. Dahiya and Yermack (2008) estimate that, for CEOs aged over 65 who expect to retire in a year, such provisions reduce the value of new option awards by more than half, and the value of total pay by 25%.

2.2 The structure of pay

Despite substantial heterogeneity in pay practices across firms, most executive pay packages contain five basic components: salary, annual bonus, payouts from LTIPs, restricted

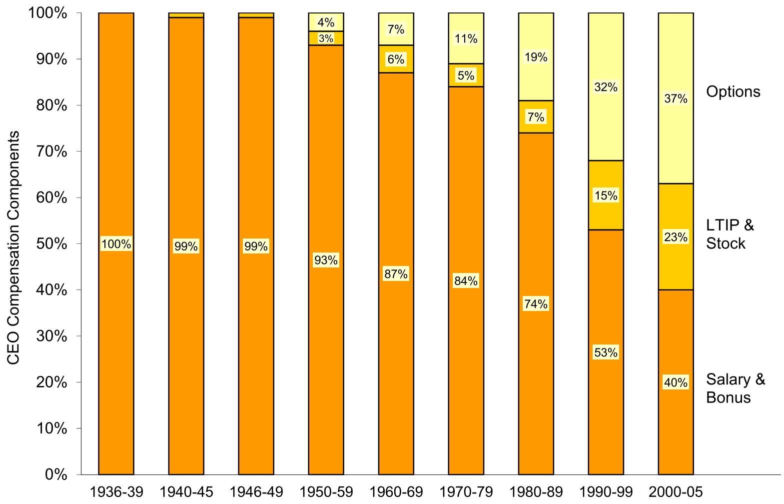

Figure 5 The structure of CEO compensation from 1936 to 2005. The diagram shows the average composition of CEO pay in the 50 largest firms in 1940, 1960, and 1990 (for a total of 101 firms) and is based on Frydman and Saks's (2010) data and analysis. Firms are selected according to total sales in 1960 and 1990, and according to market value in 1940. Compensation data is hand-collected from proxy statements for all available years from 1936 to 1992; the S&P ExecuComp database is used to extend the data to 2005. The figure depicts the three main components that can be separately tracked over the sample period: salaries and current bonuses, payouts from long-term incentive plans (including the value of restricted stock), and the grant-date values of option grants (calculated using Black–Scholes).

option grants, and restricted stock grants. In addition, top executives often receive perks, defined-benefit pension plans, and severance payments upon departure. The relative importance of these compensation elements has changed considerably over time.

2.2.1 The main components of executive pay

Fig. 5 illustrates the importance of the major pay components for CEOs of the 50 largest U.S. firms from 1936 to 2005, using again the Frydman and Saks (2010) data. From 1936 to the 1950s, pay comprised mainly salaries and annual bonuses. Like today, bonuses were typically non-discretionary, tied to one or more measures of annual accounting performance, and paid in either cash or stock. LTIPs started to become significant from the 1960s. These are bonus plans based on multi-year performance, often paid out over several years, in cash or stock.

The most striking pattern in Fig. 5 is the large increase in stock option compensation starting in the early 1980s. The use of options was negligible until 1950, when a tax reform permitted certain option payoffs to be taxed at the much lower capital gains rate rather than at the income tax rate. Although many firms responded by instituting option plans, option grants remained a small proportion of total pay until the late 1970s.

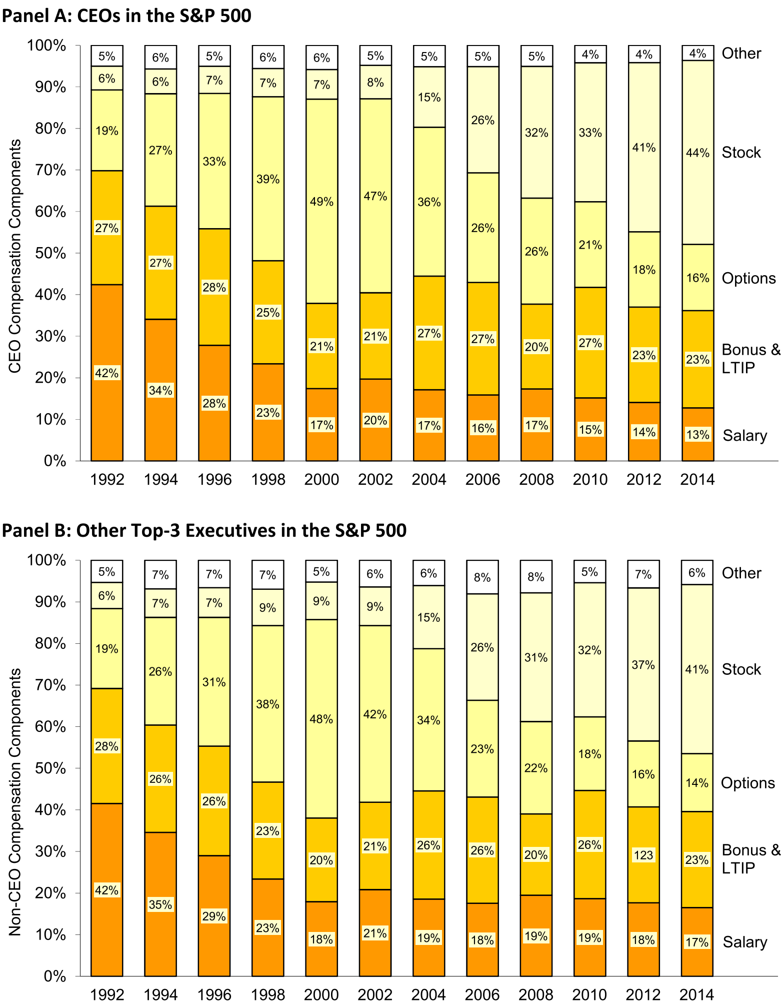

Figure 6 The structure of executive compensation in the S&P 500 from 1992 to 2014. The diagrams show the average composition of CEO (Panel A) and non-CEO top-3 executive pay (Panel B) in S&P 500 firms from 1992 to 2014. The figure, based on ExecuComp data, depicts the main compensation components: salaries, bonuses and payouts from long-term incentive plans, the grant-date values of option grants (calculated using Black–Scholes), the grant-date values of restricted stock grants, and miscellaneous other compensation.

During the 1980s and especially the 1990s, options surged to become the largest component of executive pay. Panel A of Fig. 6 illustrates this development for large-cap CEOs from 1992 to 2014. Options increased from only 19% of pay in 1992 to 49% by 2000. Thus, a large portion of the overall rise in CEO pay is growth in options, and any theory that explains the surge in CEO pay needs to account for this important change in the structure of pay as well. The growth in options did not occur at the expense of other components of pay; median salaries are constant at $1.2 million, and short- and long-term bonuses rose from $0.9 to $1.4 million over the same period (all in 2014 dollars).

A second important shift in the structure of pay occurred after the end of the 1990s technology boom and the stock market decline of 2000–01. Options rapidly declined, both in relative and absolute terms, and by 2006 restricted stock grants had become more popular. Between 2000 and 2014, options declined from 49% to 16% of pay, while restricted stock increased from 7% to 44%. The rise of restricted stock was accompanied by a further important change: the replacement of conventional time-vesting stock by grants for which the number of shares vested depends on one or more performance measures. We discuss the rise and characteristics of so-called "performance-based equity" in Section 2.3.3.

The composition of pay evolved in the same manner for other top-3 executives. Panel B of Fig. 6 shows that non-CEO top executives in S&P 500 firms receive a slightly smaller portion of their pay in stock and options than CEOs (55% vs. 60% in 2014), and a slightly larger portion in salary (17% vs. 13% in 2014). The changes in pay structures over time were almost identical for the two groups of executives: a surge in options until 2000, followed by their gradual replacement with restricted stock.

Figs. 7 and 8 show the major pay components for executives of S&P MidCap and S&P SmallCap firms. Executives in smaller firms receive less of their pay in stock and options and more in salary. In 2014, small-cap CEOs received on average 43% of their pay as stock and options, compared to 54% for mid-cap and 60% for S&P 500 CEOs. The salary proportion was 29%, 19%, and 13%, respectively. The evolution of pay structures, and specifically the increase in options until 2000 and their subsequent replacement by restricted stock, is remarkably similar across firms of different sizes.

Explaining these drastic changes in the structure of pay since the 1980s, especially the surge in option compensation and its replacement by (performance-based) restricted stock, remains a challenge. Section 3.5 surveys the predictions of shareholder value models for the use of stock and options in incentive contracts. Section 4.3 explores whether self-serving executives might choose compensation instruments that shareholders find difficult to observe or value. Sections 5.1 and 5.2 examine tax policies and accounting rules as potential drivers of the composition of pay.

To summarize, the composition of executive pay has changed dramatically over time. In parallel with changes in the level of pay, the post-World War II era can be divided into three distinct periods. Prior to the 1970s, pay was dominated by salaries and annual bonuses, with only moderate levels of equity. From the mid-1970s to the end of the 1990s, options surged and became the largest component of CEO pay. Between 2001 and 2014, performance-based stock replaced options as the most popular form of equity compensation.

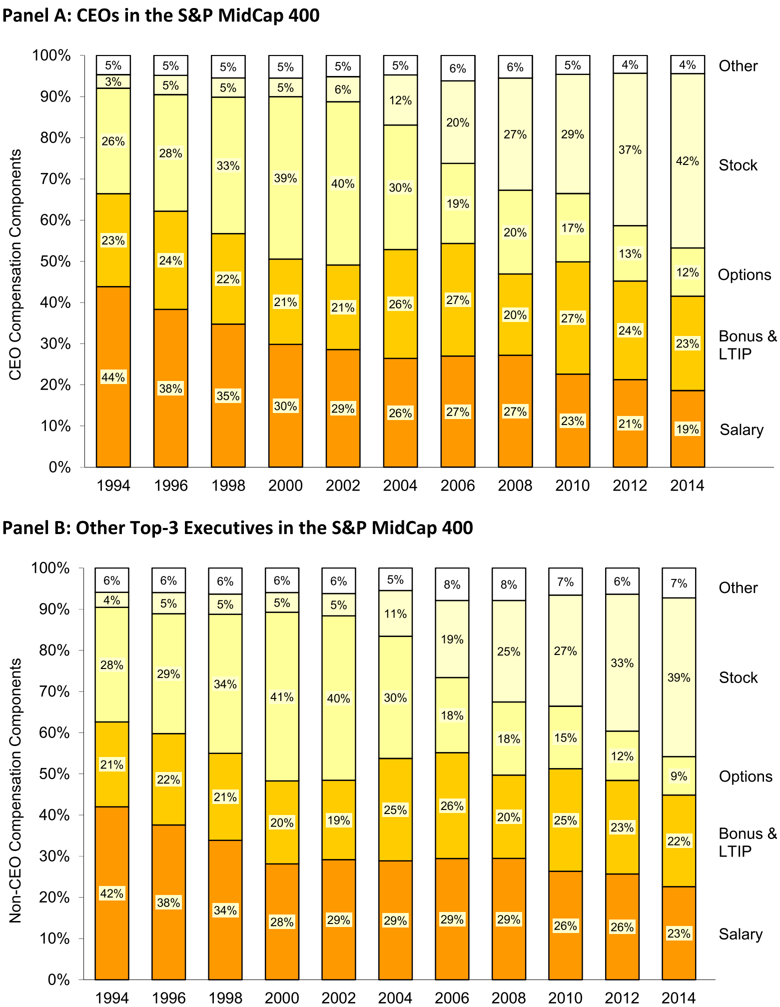

Figure 7 The structure of executive compensation in the S&P MidCap 400 from 1994 to 2014. The diagrams show the average composition of CEO (Panel A) and non-CEO top-3 executive pay (Panel B) in S&P MidCap 400 firms from 1994 to 2014. The figures, based on ExecuComp data, depict the main compensation components: salaries, bonuses and payouts from long-term incentive plans, the grant-date values of option grants (calculated using Black–Scholes), the grant-date values of restricted stock grants, and miscellaneous other compensation.

2.2.2 Other forms of pay

Three important components of executive compensation that have received less attention in the literature are perks, pensions, and severance pay. Obtaining comprehensive

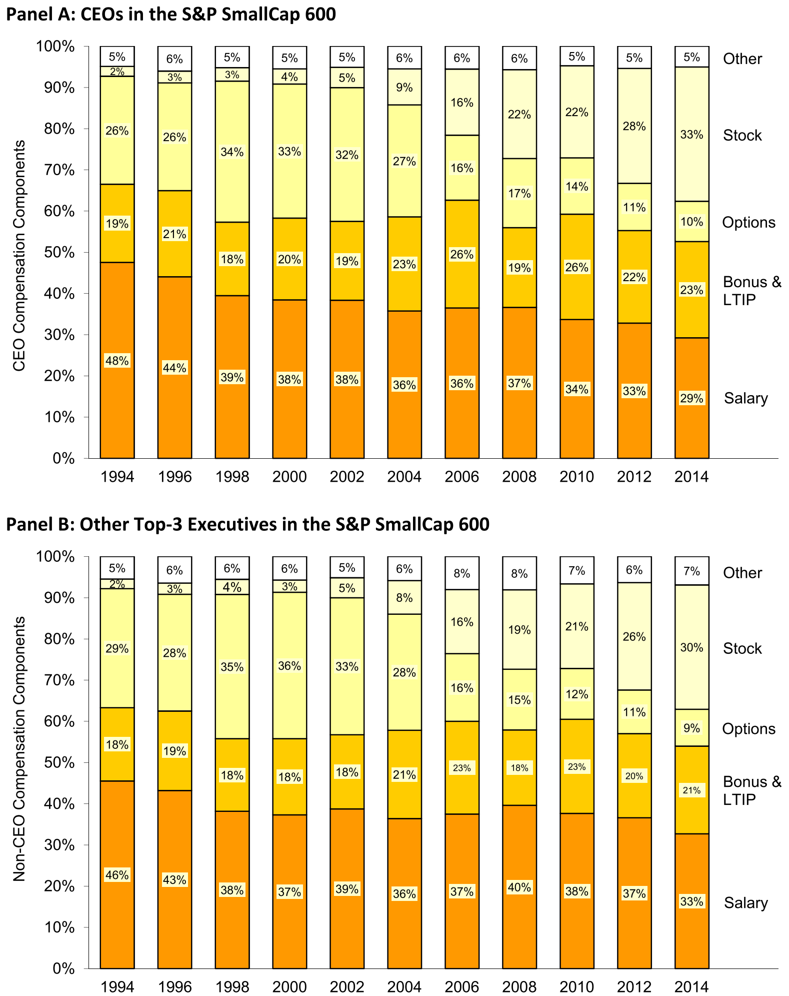

Figure 8 The structure of executive compensation in the S&P SmallCap 600 from 1994 to 2014. The diagrams show the average composition of CEO (Panel A) and non-CEO top-3 executive pay (Panel B) in S&P SmallCap 600 firms from 1994 to 2014. The figures, based on ExecuComp data, depict the main compensation components: salaries, bonuses and payouts from long-term incentive plans, the grant-date values of option grants (calculated using Black–Scholes), the grant-date values of restricted stock grants, and miscellaneous other compensation.

information on these forms of pay was extremely difficult until the SEC increased its disclosure requirements in 2006.

Perks encompass a wide variety of goods and services provided to the executive, including corporate jets, club memberships, and personal security. Section 4.3 reviews the limited evidence on their use and discusses the extent to which perks can be interpreted as rent extraction. The historical evidence on defined benefit pensions is similarly sparse. Prior to December 2006, SEC disclosure rules did not require firms to report the actuarial values of executive pensions. In their absence, Bebchuk and Jackson (2005) estimate pension claims in a small sample of S&P 500 CEOs. Conditional on having a pension plan, the median actuarial value at retirement corresponds to roughly 35% of the CEO's total pay throughout his tenure. Using a larger sample of Fortune 500 CEOs from 1996–2002, Sundaram and Yermack (2007) estimate annual increases in pension values to be approximately 10% of total CEO pay.

Since 2006, U.S. public firms are required to disclose both the present value of executives' accumulated pension benefit and its year-to-year change. Cadman and Vincent (2015) report that the use of defined benefit pension plans has declined since this tightening of disclosure requirements, from 48% of S&P 1,500 CEOs in 2006 to only 36% in 2012. The mean (median) year-on-year change in pension plan value within this time period is 15% (11%) of annual CEO pay. The mean (median) overall pension value over this period is 23% (15%) of the CEO's total wealth held in the firm. This suggests that ignoring pensions can result in a significant underestimation of total CEO pay.

A lack of readily available data has also hampered the study of severance pay. Researchers have to hand-collect information from employment contracts, separation agreements, and other corporate filings. There are two types of severance pay: golden handshakes, which are awarded to retiring or fired CEOs, and golden parachutes, which are awarded to CEOs who lose their job because their firm is acquired. Rusticus (2006) shows that ex-ante separation agreements, signed when CEOs are hired, are common and, on average, promise golden handshakes equal two times the CEO's cash compensation. Yermack (2006b) reports that ex-post payments of golden handshakes are also common, but usually moderate in value (see Section 4.2). Goldman and Huang (2015) show that 40% of S&P 500 CEOs receive ex-post separation pay in excess of that specified in their ex-ante severance contract. Finally, golden parachutes, which became widespread during the 1980s and 90s, are usually part of CEOs' ex-ante compensation contracts, but are also frequently increased ex-post at the time a merger is approved (Hartzell et al., 2004). Section 3.7.2 surveys shareholder value models in which severance pay can be efficient, while Sections 4.2 and 4.3 explore whether severance pay may be a form of rent extraction.

2.3 The sensitivity of executive wealth to performance

Principal–agent problems between shareholders and executives have been a concern since the separation of corporate ownership from control at the turn of the twentieth century (Berle and Means, 1932). If managers are self-interested and shareholders cannot perfectly monitor them (or do not know the best course of action), executives are likely to pursue their own well-being at the expense of shareholder value.

Executive contracts can be used to alleviate agency problems by aligning managers' interests with those of shareholders (Jensen and Meckling, 1976). In principle, pay should be based on any signal that is incrementally informative about whether the executive has taken actions that maximize shareholder value (Holmström, 1979). In reality, many incentive contracts use equity instruments to directly link executives' payoffs to shareholder value, the principal's ultimate objective. The evidence surveyed in this section shows that the sensitivity of CEO wealth to stock price performance surged in the 1990s, mostly owing to rapidly growing option holdings, and has remained high. At the same time, most CEOs' equity ownership remains low as a percentage of the firm's total equity, which suggests that at least certain types of moral hazard problems remain a serious concern.

2.3.1 Quantifying managerial incentives

Measuring the incentives created by executive pay to increase value has been a central goal of the compensation literature since at least the 1950s.[6] Early studies focused on identifying the measure of firm size or performance (e.g., sales, profits, or market capitalization) that best explains differences in pay levels across firms (Roberts, 1956; Lewellen and Huntsman, 1970). The next generation of studies tried to quantify managerial incentives by relating changes in executive pay to stock price performance (Murphy, 1985; Coughlan and Schmidt, 1985). Although these studies found the predicted positive relationship between pay and stock returns, they systematically underestimated the level of incentives by focusing on current pay (Benston, 1985; Murphy, 1985). Most executives have considerable stock and option holdings in their employer, which directly tie their wealth to their employer's stock price performance. For the typical executive, the direct wealth changes caused by stock price movements are several times larger than the corresponding changes in their annual pay.

A comprehensive measure of incentives must take all links between firm performance and executive wealth into account. Current performance affects not only current pay, but also future pay by decreasing the probability of dismissal or improving the executive's outside options and bargaining power. The largest effect of current performance, however, is on the value of the executive's stock and option *holdings*. Any empirical measure of executive incentives must take into account the incentives provided by changes in the value of the executive's equity holdings – i.e., measure wealth-performance sensitivities, rather than pay-performance sensitivities. Focusing only on changes in salary, bonuses, and new equity grants misses the majority of incentives, at least in countries such as the U.S. and U.K., where equity holdings are substantial.

[6] We focus here on incentives to increase shareholder value and consider risk-taking incentives in Sections 3.5 and 6.2.2.

Table 3 Managerial incentives and equity holdings from 1936 to 2005. The table shows median effective percentage and dollar equity ownership and median stock and option holdings of the three-highest paid executives in the 50 largest firms in 1940, 1960, and 1990 and is based on Frydman and Saks's (2010) data and analysis. Firms are selected according to total sales in 1960 and 1990, and according to market value in 1940. Compensation data is hand-collected from proxy statements for all available years from 1936 to 1992; the S&P ExecuComp database is used to extend the data to 2005. Each column shows the median across all executives in each decade. Effective percentage ownership is calculated as (number of shares held + number of options held × average option delta)/(number of shares outstanding). Option deltas are computed using the Core and Guay (2002) approximation. Effective dollar ownership is the product of effective percentage ownership and the firm's equity market capitalization. The value of stock holdings is the number of shares owned at the beginning of the year multiplied by the stock price. The value of option holdings is the Black–Scholes value calculated at the beginning of the year. All dollar values are in inflation-adjusted 2014 dollars

	Median incentives		**Median dollar value of equity held**	
	Effective percentage ownership (%) (1)	**Effective dollar ownership ($ mil.) (2)**	**Value of stock holdings ($ mil.) (3)**	**Value of option holdings ($ mil.) (4)**
1936–40	0.14	2.6	2.2	0.0
1941–49	0.04	0.9	0.9	0.0
1950–59	0.05	1.9	1.6	0.0
1960–69	0.07	5.4	3.2	0.3
1970–79	0.05	3.0	1.8	0.3
1980–89	0.06	4.8	2.2	1.3
1990–99	0.09	16.5	5.6	5.0
2000–05	0.11	31.3	6.8	9.8

Jensen and Murphy (1990a) are the first to integrate many of these effects in a study of large publicly traded U.S. firms from 1974 to 1986. They measure CEO incentives by the change in CEO wealth for a $1,000 increase in firm value, which they calculate to be only $3.25 – corresponding to an effective percentage ownership of only 0.325%. Hence, Jensen and Murphy (1990b) conclude that U.S. CEOs are paid like bureaucrats.

Table 3 confirms the Jensen and Murphy (1990a) result using Frydman and Saks's (2010) 1936–2005 data for the top three executives in the 50 largest U.S. firms. We follow the literature and use two approximations to calculate an executive's effective percentage ownership. First, we consider only changes in wealth due to revaluations of stock and option holdings. This channel has swamped the incentives provided by annual changes in pay for most of the twentieth century (Hall and Liebman, 1998; Frydman and Saks, 2010). This channel can also be estimated on an ex ante basis – by calculating the delta of the executive's shares and options, we obtain his sensitivity to future changes in the stock price.[7] In contrast, the incentives provided by changes in future flow pay can only be estimated ex post, which requires many years of data. Second, we follow Core and Guay (2002) and use an approximation to measure the sensitivity of the executive's option portfolio to the stock price. Appendix B in Edmans et al. (2009) describes our implementation of the Core and Guay algorithm. After 2006, disclosure is improved and no approximation is needed.

Column 1 of Table 3 shows that executives' effective percentage ownership declined sharply in the 1940s, recovered in the next two decades, and shrank again in the 1970s. While it increased rapidly since the 1980s, it has yet to reach its pre-World War II value. Its level is small throughout, with the typical top-3 executive never holding more than 0.14% of his firm's equity. Fig. 9 zooms in on CEO incentives in S&P 500 firms from 1992 to 2014. Consistent with the long-run sample, the median effective percentage ownership doubled from 0.37% in 1992 to 0.74% in 2002, before falling back to only 0.34% in 2014. Thus, if the median CEO extracts $1 million of perks, the value of his equity falls by only $3,400.

In contrast to Jensen and Murphy (1990a), Hall and Liebman (1998) dispute the view that CEO incentives are insufficient on two grounds. First, the increase in option compensation in the 1980s and 90s has strengthened the link between CEO wealth and performance. Second, the changes in CEO wealth caused by typical changes in firm values are in fact large. Even though CEOs' percentage stakes are small, the dollar values of those stakes are not. As a result, the typical CEO stands to gain millions from improving firm performance. This leads Hall and Liebman to propose the dollar change in wealth for a percentage – not dollar – change in firm value as measure of incentives. In practice, this measure is simply the executive's effective dollar ownership, or his "equity-at-stake."[8]

Using again the Frydman and Saks (2010) data, Column 2 of Table 3 reports the effective dollar ownership for the typical top three executive in the 50 largest U.S. firms from 1936 to 2005. Although dollar ownership follows a similar pattern of ups and downs as the ownership percentage, it paints a very different picture of the strength of incentives toward the end of the sample. Based on dollar ownership, incentives have been higher than their 1930s level in every decade since the 1960s, reaching a peak in

[7] Delta is the dollar change in value for a $1 increase in stock price. Jenter (2002) shows that, with risk-averse executives, measuring option incentives using deltas is problematic. Options pay off in states of the world in which marginal utility is low, which causes the incentives created by a given delta to be smaller for options than for stock.

[8] It is also the Jensen–Murphy effective ownership percentage times the firm's equity market capitalization. Some researchers refer to the Hall–Liebman measure as "delta." We recommend not using this terminology since the delta of an option is the dollar change in its value for a *dollar* change in the underlying stock price, so the "delta" should refer to the Jensen–Murphy measure. To avoid such ambiguities, we use the terms "effective percentage ownership" and "effective dollar ownership".

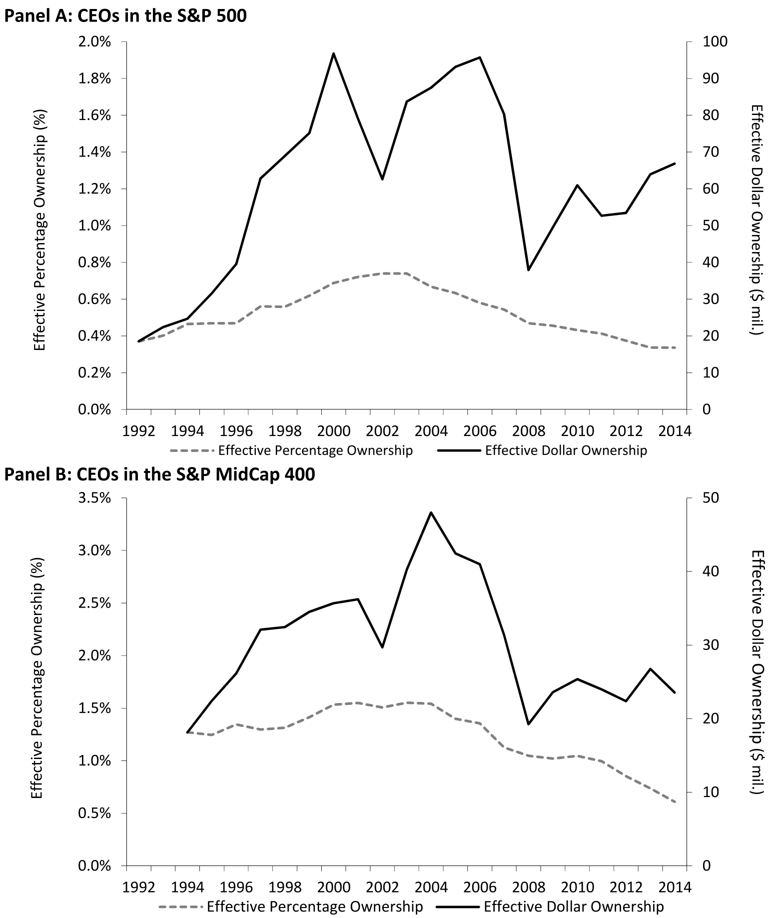

Figure 9 CEO incentives from 1992 to 2014. The diagrams show the median equity incentives of CEOs in S&P 500 (Panel A), S&P MidCap (Panel B), and S&P SmallCap (Panel C) firms from 1992 to 2014 and are based on ExecuComp data. Effective percentage ownership is calculated as (number of shares held + number of options held × average option delta)/(number of shares outstanding). Option deltas and holdings are computed using the Core and Guay (2002) approximation. Effective dollar ownership is the product of effective percentage ownership and the firm's equity market capitalization. All dollar values are in inflation-adjusted 2014 dollars.

2000–05 at 12 times their level in 1936–40. The sharpest increase in incentives occurred during the 1990s and 2000s, once again driven by the increase in options. By 2000–05, the typical top-3 executive has more than $31 million of effective equity ownership, vastly higher than the $4.8 million in 1980–89 (all in 2014 dollars).

For S&P 500 firms, top executives' effective dollar ownership has reached similar heights. Fig. 9 shows its value for the median S&P 500 CEO from 1992 to 2014. Dollar

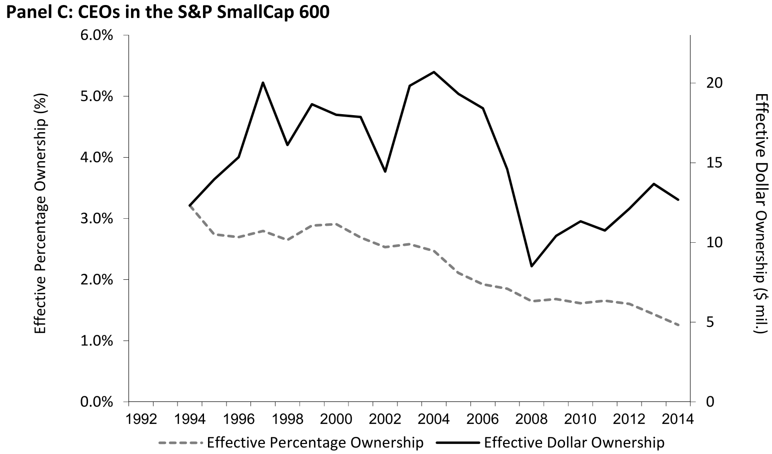

Figure 9 (*continued*)

ownership rose from $19 million in 1992 to $97 million in 2000, fell to $38 million in 2008, and recovered to $67 million by 2014. These large swings are at least in part due to movements in the aggregate stock market. The overall time trend, however, is upwards, with CEOs' effective dollar ownership more than three times larger in 2014 than in 1992.

There are interesting differences between S&P 500, MidCap, and SmallCap firms in both level and evolution of the two incentive measures. Panels B and C of Fig. 9 show that CEOs' effective percentage ownership is larger in smaller firms. In 2014, the typical mid-cap (small-cap) CEO has an ownership percentage of 0.61% (1.26%), far higher than the 0.34% for S&P 500 CEOs. Over time, however, ownership percentages have declined for both mid-cap and small-cap CEOs, and 2014 percentages are less than half their 1994 level. The ownership percentages of S&P 500 CEOs have declined less, from 0.46% in 1994 to 0.34% in 2014.

Given the differences in firm sizes, the larger ownership percentages of mid-cap and small-cap CEOs translate into smaller dollar holdings. By 2014, the typical mid-cap (small-cap) CEO has effective dollar ownership of $24 ($13) million, much less than the $67 million of S&P 500 CEOs. Neither mid-cap nor small-cap CEOs have experienced the same growth in stock and option holdings as S&P 500 CEOs. Their level of effective dollar ownership is roughly the same in 2014 as in 1994, while it almost tripled for S&P 500 CEOs.

The juxtaposition of effective percentage and dollar ownership in Table 3 and Fig. 9 highlights that alternative measures of the wealth-performance sensitivity can lead to very different views on the strength of incentives. The divergence in the level of these two incentive measures is mostly due to growth in firm values over time: Executives tend to own smaller percentage but larger dollar stakes in larger firms (Garen, 1994; Schaefer, 1998; Baker and Hall, 2004; Edmans et al., 2009), with the result that firm growth leads to lower percentage but higher dollar ownership. Nevertheless, at least for the largest firms, *both* measures rose from the 1970s to the 2000s, mostly due to increasing option holdings. By 2000–05, the median large-firm executive holds options worth $9.8 million, significantly larger than his stock holdings of $6.8 million, and almost 30 times his option holdings in 1970–79 (Columns 3 and 4 of Table 3). For S&P 500 CEOs, dollar ownership peaks in the late 1990s and remains high, with the median CEO's equity exposure at $97 million in 2000 and at $67 million in 2014.

To summarize, the vast majority of executive incentives stem from revaluations of stock and option holdings, rather than changes in annual pay. Effective dollar ownership was sizeable for most of the twentieth century and increased strongly between 1970 and 2000, mostly owing to rapidly growing option portfolios. Since 2000, dollar ownership has fallen but remains at least at the levels of the early 1990s. By contrast, percentage ownership has always been low and is even lower today than in the 1930s.

Because of these conflicting signals about top executives' incentives, we examine the merits of different incentive measures in Section 3.2.1. In brief, the correct measure of incentives depends on how executive actions affect firm value, i.e., on the executive's production function (Baker and Hall, 2004; Edmans et al., 2009). With an additive production function, executive actions have the same dollar impact on value regardless of firm size, and the effective percentage ownership is the right measure of incentives. For example, the cost to an executive of wasting funds on an unnecessary corporate jet depends on his percentage ownership. With a multiplicative production function, the impact of executive actions on value scales with firm size, and effective dollar ownership is the right measure of incentives. For example, the benefit to an executive of a restructuring that increases firm value by 1% depends on his dollar ownership. Because top executives engage in both types of activities, both measures of incentives are important. The high values of dollar ownership and the low percentage ownership levels in Fig. 9 suggest that today's CEOs are well motivated to restructure their firms but may still find it optimal to waste money on perks. Thus, direct monitoring, rather than incentives, may be the best way to control additive actions (Edmans et al., 2009).

The above incentive measures gauge an executive's *monetary* reward from actions to increase the firm's *equity* value. However, incentives stem from the effect of stock returns on the executive's utility, rather than his monetary wealth, which will differ if he is risk-averse (see Jenter, 2002; Dittmann and Maug, 2007; and Section 2.1.2). Dittmann and Maug (2007) estimate a measure of utility-adjusted wealth-performance sensitivity based on assumptions on CEOs' relative risk aversion. In addition, an executive's actions may affect the firm's total value rather than its equity value. If the firm is highly levered, the executive's incentives to increase equity value may significantly overestimate his incentives to increase total firm value, since those value gains may primarily benefit debtholders. Measuring the sensitivity of CEOs' stock and option holdings to changes in total firm values, rather than to changes in equity values, is therefore a promising research direction (see Chesney et al., 2017).

2.3.2 Cross-sectional variation in incentives

This section explores how CEOs' ownership incentives correlate with firm and CEO characteristics. Table 4 regresses CEOs' effective percentage and dollar ownership on firm size, volatility, stock return performance, CEO age, tenure, and a female CEO indicator in the S&P 1,500 from 1992 to 2014.

CEOs' effective percentage ownership, shown in Panel A, is strongly negatively related to total firm value, with a firm size elasticity of about −0.35. CEOs' effective dollar ownership, shown in Panel B, is strongly positively related to total firm value, with a firm size elasticity of about 0.55. Hence, CEOs tend to own smaller percentage but larger dollar equity stakes in larger firms. Both elasticities are robust to the inclusion of industry, year, and industry-year fixed effects. A negative correlation between firm size and CEOs' percentage ownership has been documented by, among others, Jensen and Murphy (1990a), Garen (1994), Schaefer (1998), Baker and Hall (2004), and Edmans et al. (2009). A positive correlation between firm size and CEOs' dollar ownership has been documented by, among others, Baker and Hall (2004) and Edmans et al. (2009).[9] Section 3.3 compares the observed elasticities to the predictions of a market equilibrium model with moral hazard.

Column 4 of Panels A and B introduces CEO age, tenure, and a female CEO indicator into the regressions. Both effective percentage and dollar ownership are positively correlated with CEO tenure and negatively with CEO age. Section 3.7 reviews dynamic contracting models that predict how optimal CEO incentives evolve with tenure. Female CEOs hold smaller percentage and smaller dollar stakes, even though the association with percentage ownership is only significant at the 10% level.

Column 5 of Panels A and B adds contemporaneous and lagged stock returns to the regressions. Both effective percentage and dollar ownership are strongly positively correlated with stock returns. The correlation between stock returns and dollar ownership is largely mechanical – stock returns directly change the dollar value of CEOs' holdings. Likely causes of the positive correlation with percentage ownership include the positive effect of returns on option deltas, which mechanically increases effective

[9] Edmans et al. (2009) report a more negative percentage ownership-firm size elasticity of −0.61, and a less positive dollar ownership-firm size elasticity of 0.39. There are two reasons for the differences: First, Edmans et al.'s estimates are for the largest 500 firms in each year only, and effective dollar (percentage) ownership stakes increase less fast (decrease faster) with firm size for larger firms. Second, we measure percentage ownership as percentage of equity, while Edmans et al. measure it as percentage of total firm value.

Table 4 Cross-sectional variation in CEO ownership incentives. The table shows panel regressions of CEOs' effective percentage ownership (Panel A), effective dollar ownership (Panel B), and annual changes in firm-related wealth (Panel C) on firm and CEO characteristics using ExecuComp data from 1992–2014 for S&P 500, S&P MidCap, and S&P SmallCap firms. Effective percentage ownership and effective dollar ownership are calculated as in Table 3. Annual changes in firm-related wealth are the sum of annual flow compensation plus annual stock returns times the CEO's beginning-of-year effective dollar ownership. Firm value is market value of equity + (book assets − book equity − deferred taxes). Volatility is the standard deviation of monthly log returns over the previous 60 months, requiring that at least 48 months are available. If more than one class of stock is traded, returns are the capitalization-weighted average return. Dollar volatility is percentage volatility times equity market capitalization at the start of the year. Column (4) of Panels A and B includes only CEOs with at least 5 years of tenure. Industries are the 48 Fama and French (1997) industries. Volatility is winsorized at 1%, and all nominal values are in inflation-adjusted 2014 dollars. Standard errors are clustered at the firm level. $^{+}$, *, **, and *** denote statistical significance at the 10%, 5%, 1%, and 0.1% levels, respectively

Panel A: Effective percentage ownership

	ln(Effective Percentage Ownership)				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
ln(Firm value$_t$)	−0.357***	−0.373***	−0.379***	−0.349***	−0.375***
	[0.014]	[0.015]	[0.015]	[0.013]	[0.018]
Volatility$_t$	3.242***	1.323***	1.467***	2.166***	2.667***
	[0.350]	[0.324]	[0.352]	[0.303]	[0.432]
ln(Age$_t$)				−0.266*	
				[0.127]	
ln(Tenure$_t$)				0.691***	
				[0.018]	
Female$_t$				−0.179^{+}	
				[0.093]	
Ln(1+Return$_t$)					0.320***
					[0.024]
Ln(1+Return$_{t-1}$)					0.234***
					[0.023]
Ln(1+Return$_{t-2}$)					0.219***
					[0.023]
Ln(1+Return$_{t-3}$)					0.194***
					[0.021]
Ln(1+Return$_{t-4}$)					0.190***
					[0.019]
Constant	−1.704***	−1.788***	−1.311***	−1.841***	−1.253***
	[0.144]	[0.137]	[0.148]	[0.499]	[0.178]
Year FEs		Yes			
Industry FEs		Yes			
Industry × Year FEs			Yes	Yes	Yes
N	35,472	35,263	35,263	34,700	21,973
R^2	0.221	0.335	0.365	0.533	0.403

(continued on next page)

Table 4 (*continued*)
Panel B: Effective dollar ownership

	ln(Effective Dollar Ownership)				
	(1)	(2)	(3)	(4)	(5)
ln(Firm $value_t$)	0.503***	0.554***	0.541***	0.573***	0.529***
	[0.016]	[0.016]	[0.017]	[0.014]	[0.019]
$Volatility_t$	1.613***	−1.851***	−2.043***	−1.410***	−0.0237
	[0.424]	[0.372]	[0.400]	[0.354]	[0.446]
ln(Age_t)				−0.515***	
				[0.135]	
ln($Tenure_t$)				0.735***	
				[0.019]	
$Female_t$				−0.198*	
				[0.098]	
Ln(1+$Return_t$)					0.751***
					[0.026]
Ln(1+$Return_{t-1}$)					0.564***
					[0.024]
Ln(1+$Return_{t-2}$)					0.477***
					[0.024]
Ln(1+$Return_{t-3}$)					0.400***
					[0.022]
Ln(1+$Return_{t-4}$)					0.337***
					[0.020]
Constant	−1.286***	−1.558***	−1.175***	−0.791	−1.199***
	[0.171]	[0.152]	[0.166]	[0.531]	[0.191]
Year FEs		Yes			
Industry FEs		Yes			
Industry × Year FEs			Yes	Yes	Yes
N	35,506	35,297	35,297	34,733	21,999
R^2	0.244	0.390	0.419	0.564	0.511

(continued on next page)

percentage ownership, and high returns indicating more valuable effort, in turn increasing the optimal level of incentives (see the model of Holmström and Milgrom (1987), laid out in Section 3.2.3).

The prior literature disagrees on the relationship between stock return volatility and CEOs' ownership incentives. While Lambert and Larcker (1987), Aggarwal and Samwick (1999a), and Jin (2002) find a negative relationship, Core and Guay (1999), Oyer and Schaefer (2005), and Coles et al. (2006) document a positive one, and Garen (1994), Yermack (1995), Bushman et al. (1996), Ittner et al. (1997), Conyon and Murphy (2000), Edmans et al. (2009), and Cheng et al. (2015) show either no relationship

Table 4 (*continued*)

Panel C: Annual changes in firm-related wealth

	Median regressions: change in firm-related wealth				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Dollar return$_t$	0.0407***	0.0417***	0.0411***	0.0328***	0.0360***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Dollar return$_t$ × CDF(Dollar volatility$_t$)	−0.0099***	−0.0102***	−0.0097***		−0.0154***
	[0.002]	[0.002]	[0.002]		[0.001]
Dollar return$_t$ × CDF(Volatility$_t$)				0.0047***	0.0054***
				[0.001]	[0.001]
Dollar return$_t$ × CDF(Firm value$_t$)	−0.0290***	−0.0298***	−0.0297***	−0.0320***	−0.0202***
	[0.001]	[0.002]	[0.002]	[0.001]	[0.002]
CDF(Dollar volatility$_t$)	8246.6***	8400.2***	5620.8***		4724.4***
	[197.1]	[400.4]	[441.3]		[458.9]
CDF(Volatility$_t$)				1277.2***	439.9*
				[179.8]	[215.3]
CDF(Firm value$_t$)	29.02	85.66	3571.6***	10298.1***	4631.5***
	[177.4]	[303.0]	[478.9]	[156.7]	[566.3]
Constant	211.0***	−668.5***	−1188.2	−2929.8***	−1739.8+
	[47.46]	[106.7]	[1321.9]	[867.7]	[958.7]
Year FEs		Yes	Yes	Yes	Yes
Industry FEs			Yes	Yes	Yes
N	32,932	32,932	32,755	32,755	32,755
Pseudo-R^2	0.109	0.110	0.110	0.113	0.115

or mixed results. Section 3.2 surveys shareholder value models that make predictions about the relationship between volatility and incentives.

Table 4 Panel A shows that stock return volatility and CEOs' effective percentage ownership are positively correlated, suggesting that CEOs own larger percentage stakes in riskier firms. This correlation is robust to the inclusion of industry, year, and industry-year fixed effects. A one standard deviation increase in the volatility of monthly stock returns is associated with a 7 to 18% increase in CEOs' effective percentage ownership.

Panel B shows that CEOs' effective dollar ownership is positively correlated with stock return volatility in the overall cross-section (Column 1), but that this correlation turns negative when industry fixed effects are included (Columns 2–4). This negative within-industry correlation, however, vanishes again when contemporaneous and lagged stock returns are included (Column 5). The reason is that volatility and stock price performance are negatively correlated, so high volatility proxies for low stock returns if the latter are omitted, which creates a spurious negative correlation with dollar ownership. With stock returns included, the within-industry correlation between volatility and dollar ownership is effectively zero.

Aggarwal and Samwick (1999a) use an alternative approach to measure the effect of volatility on the wealth-performance sensitivity: they regress annual dollar changes in CEOs' firm-related wealth on contemporaneous dollar changes in shareholder value and an interaction between changes in value and volatility.[10] The coefficient on CEO wealth is equivalent to the CEO's effective percentage ownership, and the interaction coefficient measures how percentage ownership varies with volatility. Aggarwal and Samwick also argue that the relevant measure of risk for percentage ownership is the variance of dollar returns, not the variance of percentage returns.[11] (Section 3.2.3 discusses how the appropriate measure of risk depends on the production function.) Intuitively, dollar variance captures that the same percentage stake exposes the owner to more risk in a larger firm. To accommodate the skewness of dollar variances and firm values, Aggarwal and Samwick replace their values by their scaled ranks within the sample, and run median regressions.

Panel C of Table 4 presents the regressions, which show that the positive effect of dollar returns on CEO wealth diminishes as dollar volatility increases. This negative interaction, which is robust to the inclusion of year and industry fixed effects, suggests that CEOs' effective percentage ownership declines as *dollar* volatility increases. Columns 4 and 5, however, confirm that the effective ownership percentage increases in *percentage* volatility, consistent with Panel A. This discrepancy between percentage and dollar volatility is another promising direction for future research.

To summarize, firm size and CEOs' ownership incentives are strongly correlated, with smaller effective percentage stakes and larger effective dollar stakes in larger firms. The relationship between stock return volatility and ownership incentives is more complex and depends on whether volatility is measured in percentages or in dollars. However, we emphasize once again that the relationships in Table 4 are correlations and not causal effects. Important explanatory variables for CEOs' ownership incentives, such as firm size and volatility, are themselves affected by CEOs' actions, and are also correlated with unobservable firm, industry, and executive characteristics that affect incentives. Consequently, the correlations between these explanatory variables and CEOs' ownership incentives have to be interpreted with caution.

10 Annual changes in CEOs' firm-related wealth are measured as the sum of flow pay plus the change in the value of stock and option holdings due to stock returns. This value change is calculated as the annual stock return multiplied by the CEO's effective dollar ownership at the start of the year. Daniel et al. (2012) improve on this approximation by accounting for stock sales, stock purchases, and option exercises.

11 Dollar returns are the product of percentage returns with the firm's once-lagged equity market capitalization, and the dollar variance is the product (or interaction) of the percentage variance with the once-lagged equity market capitalization.

2.3.3 Performance-based equity

Since the mid-2000s, the relationship between firm performance and executive wealth has become more complex. In Section 2.2.1, we observed that between 2001 and 2014, restricted stock grants have replaced options as the most popular form of equity compensation. However, many of these new stock grants are not conventional time-vesting grants but instead "performance-based" grants, for which vesting depends on firm performance. This is an important change with first-order effects on the wealth-performance relationship.

Most performance-based equity comes in one of two varieties.[12] With "performance-vesting stock (options)", the executive receives a *fixed* number of shares (options) at the end of the vesting period, which is often three years, if the executive is still with the firm and one or more performance conditions have been fulfilled. For example, the executive might receive 10,000 shares if earnings-per-share are above a pre-determined threshold during each year of the vesting period. This contrasts with time-vesting restricted stock, which vests independently of performance, as long as the executive remains with the firm.[13]

The second popular variety of performance-based equity are "performance shares (options)." Conditional on still being with the firm, the executive receives a *variable* number of shares (options) at the end of the vesting period, with the number a function of one or more performance metrics. The mapping from the performance metric(s) into the number of securities is usually non-linear, with a lower performance threshold below which no securities are granted, a discrete jump at the threshold, an "incentive zone" over which the number of securities increases linearly (or piecewise linearly) with performance, and a ceiling beyond which the number of securities does not increase. Towards the middle of the incentive zone is a "target" performance level at which a "target" number of securities is awarded.

Fig. 10 shows a typical performance-vesting stock grant (Panel A) and a typical performance-share grant (Panel B). For simplicity, the figure assumes that each grant uses only one performance metric, even though real-world grants are frequently based on more than one. The mapping from the performance metric into the number of securities delivered at vesting, depicted as the bold line, is given by the terms of the grant. The mapping from performance into the dollar payoff received is less clear and depends on the stock price at vesting. Under the assumption that performance and stock

[12] A third variety is performance-accelerated stock and option grants, which vest faster if one or more performance conditions are fulfilled and otherwise behave like time-vesting grants. They saw some use in the late 1990s but vanished almost completely by 2010 (Bettis et al., 2016).

[13] Performance-based equity first gained prominence in large publicly traded U.K. firms in the late 1990s (Conyon et al., 2000). In 1995, the U.K. Greenbury Report recommended that "grants under incentive schemes, including[...] grants under [...] option schemes, should be subject to challenging performance criteria".

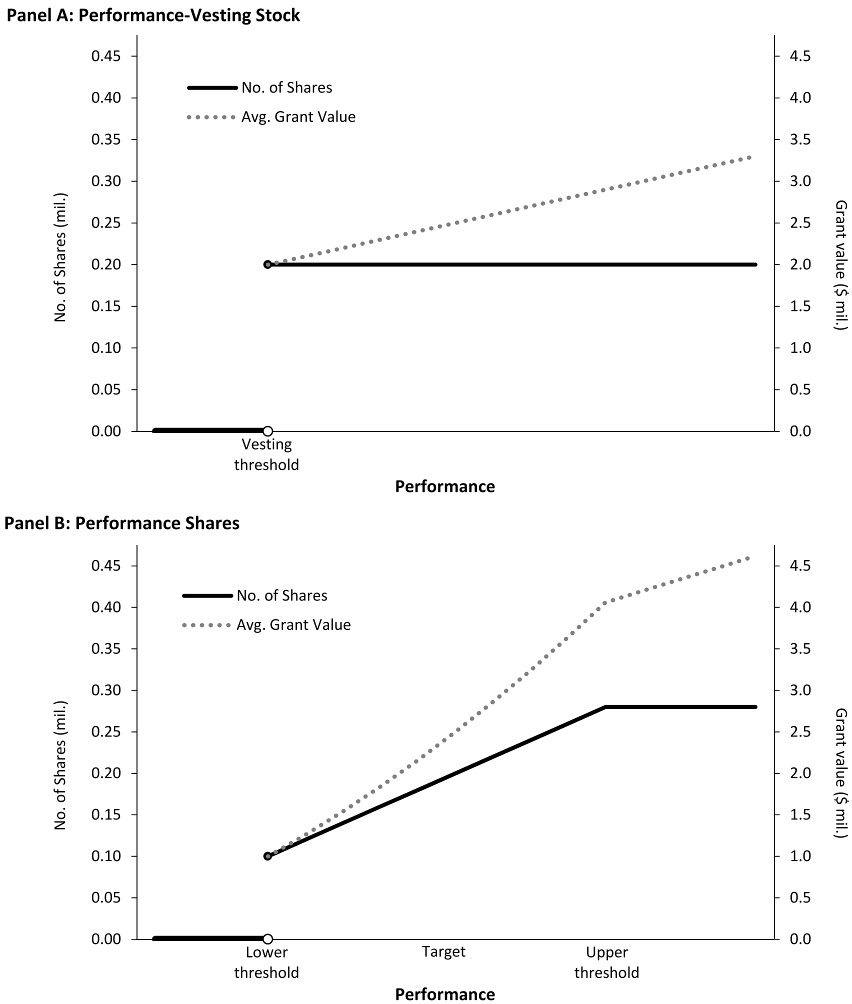

Figure 10 Performance-vesting stock and performance shares. The figures depict a typical performance-vesting stock grant (Panel A) and a typical performance-share grant (Panel B). Each grant uses only one performance metric. The mapping from performance into the number of securities delivered at vesting, depicted as the bold line, is given by the terms of the grant. The dollar payoff, depicted as the dotted line, depends on the stock price at vesting. The figures assume that the stock price increases linearly with performance.

prices are positively correlated, the value of the equity received is increasing in performance. This is depicted as the dotted line in the diagrams. For performance shares, an interaction effect ensues: In the incentive zone, better performance delivers both more shares and more valuable shares to the executive, which makes the wealth-performance relationship convex.

Unlike conventional stock and option grants, empirically observed performance-based grants are heterogeneous and vary along several dimensions. The securities received at vesting can be shares or options, the number of securities received can depend on one or more performance metrics, and the metrics might be based on market prices, accounting numbers, or anything else the board deems worth rewarding (e.g., customer satisfaction or workplace safety).

The use of performance-based equity has increased dramatically over time. Among the 750 largest U.S. public firms, Bettis et al. (2016) find that the fraction using performance-based equity rose from 20% in 1998 to 70% in 2012. By 2012, the number of firms granting performance-based equity exceeded that granting time-vesting stock for the first time.

Combining the hand-collected samples of Gerakos et al. (2007), Bettis et al. (2010), and Bettis et al. (2016) reveals several interesting facts about the use of performance-based equity:

- Performance-based grants have become more complex over time. The earlier studies observe relatively simple performance-vesting grants, with zero vesting up to a threshold and full vesting at the threshold. After 2010, grants for which the number of securities varies piecewise linearly with the performance metric(s) dominate.
- Accounting-based performance metrics are used more frequently than stock-price based metrics, and the use of accounting metrics has increased over time. Earnings-based metrics, such as earnings-per-share, are the most common accounting measures, while total shareholder return is the most popular stock-based metric.
- More awards use absolute than relative performance measures. However, relative performance metrics, which compare firm performance to that of a peer group or index, still feature prominently. In 2012, 48% of firms granting performance-based equity used at least one relative performance metric (Bettis et al., 2016).
- The performance requirements of performance-based grants have considerable bite. Bettis et al. (2016) find that target performance levels are achieved for only 47% of grants, and that performance provisions reduce the grant-date value of awards by 42% compared to similar grants without provisions.
- Stock is the back-end security for more than 90% of all performance-based grants, with options making up the rest.

The shift to complex performance-based equity awards creates serious challenges for board members, shareholders, regulators, and researchers. Determining the ex-ante values of performance-based equity grants, and especially of grants using accounting performance metrics, is difficult. The grant-date fair values reported by firms are typically the result of (opaque) Monte Carlo simulations done by compensation consultants. Bettis et al. (2016) apply their own valuation models to performance-based grants and report large discrepancies with the values reported by firms. Surprisingly, they find that companies appear to overstate values. Studies that use these reported grant-date values to measure pay are likely to suffer from both measurement error and biases.

Determining the incentives created by performance-based equity is even more of a challenge, especially for grants that use multiple performance metrics. Holding the grant-date value constant, making the number of securities delivered at vesting a function of performance increases the sensitivity of wealth to stock returns. The magnitude of this increase depends on the performance provisions and on the correlation between the performance metric(s) and stock returns. Moreover, executives' risk taking incentives are affected by convexities and concavities in the wealth-performance relation created by the performance provisions.[14]

2.3.4 Bonus plans

Even though the literature has focused on the incentive effects of executives' stock and option holdings, most top executives also participate in annual or multi-year bonus plans. Bonus payments are usually a function of one or more measures of accounting performance, such as earnings per share, operating income, or sales, with most plans using more than one metric (Murphy, 1999, 2000; De Angelis and Grinstein, 2015). Many bonus plans use at least one relative performance measure, such as sales growth minus the average sales growth of a peer group (Gong et al., 2011). Performance may be measured over one or across multiple years. The proportion of S&P 500 firms with bonus plans based on multi-year accounting performance rose from 17% in 1996 to 43% in 2008 (Li and Wang, 2016). In addition to pre-specified, formula-based plans, many firms also award discretionary bonuses based on qualitative evaluations of executive performance (Murphy, 1999).

Fig. 11 illustrates the payoff structure of a typical formula-based bonus plan. No bonus is paid until performance reaches a lower threshold, at which point the payoff jumps discretely. On the upside, the bonus is capped at a second threshold beyond which the payoff does not increase. In the "incentive zone" in between, the bonus increases in performance. This increase may be linear, as shown in Fig. 11, but may also be convex or concave. In the middle of the incentive zone is a "target" performance level at which a "target" bonus is awarded. The overall pay-for-performance relation is indicated by the bold line, which has strong similarities to the payoff structure of performance shares (Fig. 10).

Comparing the strength of the incentives from bonus plans to those from stock and option holdings is not trivial. On the one hand, the variation in wealth caused by changes in the value of equity holdings is much larger than that caused by changes in bonus payments (Hall and Liebman, 1998). On the other hand, the link between executives' actions and the performance metrics underlying bonus payouts is often more

[14] See Johnson and Tian (2000) for an analysis of the incentive effects of performance-vesting options.

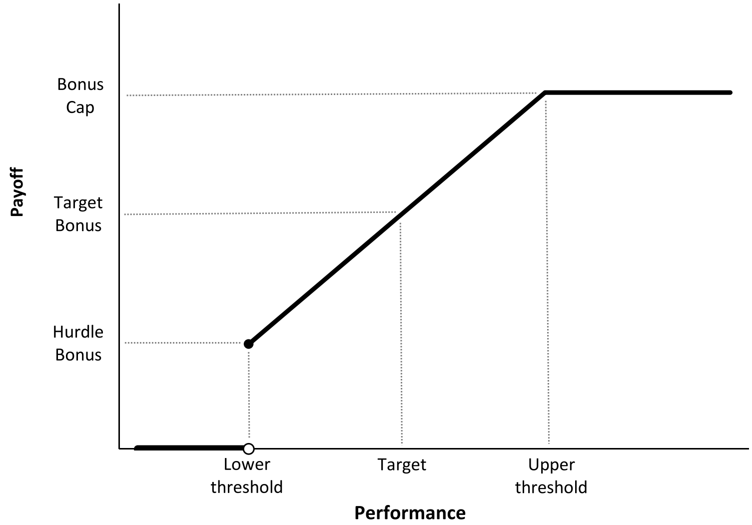

Figure 11 Bonus plans. The figure depicts a typical bonus plan (that uses only one performance metric). No bonus is paid until performance reaches a lower threshold, at which point the payoff jumps to the "hurdle bonus". On the upside, the bonus is capped at a second threshold. In the "incentive zone" between the lower and upper threshold, the bonus increases in performance. This increase may be linear, as shown in the figure, but may also be convex or concave. In the middle of the incentive zone is a "target" performance level at which a "target bonus" is awarded.

direct than the link between actions and stock price changes. For example, an executive might understand how winning a new contract affects earnings and sales, but might be much less certain about the effect on the stock price. As a result, the incentive effects of bonus plans might be stronger than suggested by simply measuring wealth-performance sensitivities (Murphy, 2013).

A frequent criticism of both bonus plans and performance-based equity is that the discrete jumps and nonlinearities in the payoffs give executives strong incentives to manipulate performance (Murphy, 2013). For example, an executive with performance just below the lower threshold gains much by inflating performance to exceed the threshold, while an executive with performance far above the upper threshold optimally slacks off and defers additional performance to the next period. We examine these issues and the related evidence in Section 6.2.1.

2.3.5 Executive turnover

The threat of termination after poor performance can provide CEOs and other executives with additional incentives (see Section 3.7.2). Both forced and total turnover rates for U.S. CEOs have slowly increased since the 1970s (Huson et al., 2001; Kaplan and Minton, 2011; Jenter and Lewellen, 2017). The probability of forced turnover increases as stock or accounting performance decline (Coughlan and Schmidt, 1985; Warner et al., 1988; Weisbach, 1988; Jensen and Murphy, 1990a; Denis et al., 1997; Parrino, 1997; Murphy, 1999; Huson et al., 2001; Kaplan and Minton, 2011; Jenter and Lewellen, 2017). However, the economic magnitudes are modest. Depending on the sample and the performance measure used, the annual probability of forced CEO turnover is 2 to 6 percentage points higher for a bottom decile than for a top decile performer. This led Jensen and Murphy (1990a) to conclude that dismissals are not an important source of CEO incentives. Even under the aggressive assumption that the CEO receives no severance package and is unable to find alternative employment until retirement, Jensen and Murphy (1990a) estimate that incentives from expected dismissals are equivalent to an equity stake of only 0.03%.

One reason for these weak incentives is that the observed rate of forced turnover is low – less than 3% per year in most studies. The literature distinguishes forced from voluntary turnovers based on CEO characteristics, especially CEO age, and characteristics of the turnover process (Warner et al., 1988; Denis and Denis, 1995; Kim, 1996; Parrino, 1997). Crucially, these classification schemes do not use performance to identify forced turnovers. Kaplan and Minton (2011) and Jenter and Lewellen (2017) note that turnovers usually classified as "voluntary" are significantly more frequent at lower levels of performance, suggesting that many of them might in fact be caused by bad performance. Poor performance may lead to not only the CEO being fired (a "forced" turnover) but also the CEO choosing to quit given the disutility and reputational damage from underperformance (a "voluntary" turnover) – either way, the turnover would not have occurred had performance been better. Jenter and Lewellen (2017) attempt to estimate the number of "performance-induced" turnovers directly from the turnover-performance relationship, without any prior classification into forced vs. voluntary. Their estimates suggest that around half of all CEO turnovers in publicly traded U.S. firms are performance-induced.

2.4 International evidence

Academic research on executive pay has focused on the U.S., mostly because of data availability. While the U.S. has required detailed disclosure of executive pay since the 1930s, most other countries have historically required at most the disclosure of aggregate cash compensation for all top executives combined, with no individual data and little information on other pay components (Murphy, 2013). For most countries, this forced researchers to rely on industry surveys (Abowd and Boggano, 1995; Abowd and Kaplan, 1999; Murphy, 1999; Kato and Kubo, 2006; Thomas, 2009; Fabbri and Marin, 2016), to focus on only the cash component of pay (Kato and Rockel, 1992; Conyon and Schwalbach, 2000; Kato and Long, 2006; Kato et al., 2007), or to examine the combined pay of the entire management team (Kaplan, 1994; Elson and Goldberg, 2003; Bryan et al., 2006; Muslu, 2010). Notable exceptions with better disclosure are

Canada and the U.K., which have required detailed pay disclosures since 1993 and 1995, respectively.

An almost universal conclusion of international pay comparisons is that U.S. executives are paid more and receive a higher fraction of pay in equity than in other countries. Many studies rely on surveys of compensation consultants, such as Tower Perrin's Worldwide Total Remuneration Reports, to reach this conclusion (Abowd and Boggano, 1995; Abowd and Kaplan, 1999; Murphy, 1999; Thomas, 2009). Using actual corporate disclosures, Zhou (2000) confirms that in 1993–95, Canadian CEOs received less than half the pay of U.S. CEOs, a smaller fraction of pay in equity, and had lower wealth-performance sensitivities. Using Japanese tax records from 2004, Nakazato et al. (2011) show that, controlling for firm size, Japanese executives earned only 20% of the pay of their U.S. counterparts.

Comparing CEO pay in the U.S. and U.K. in 1997 and controlling for firm size, industry, and other firm and executive characteristics, Conyon and Murphy (2000) find that U.S. CEOs earned almost twice as much and had six times higher wealth-performance sensitivities. Comparing propensity-score matched U.S. and U.K. CEOs, Conyon et al. (2011) report that the U.S. pay premium declined from a mean (median) of 200% (118%) in 1997 to 81% (23%) in 2003. They argue that the pay premium completely vanishes by 2003 if CEO pay is adjusted for the risk associated with more equity-based pay.

Disclosure has improved markedly in recent years (Murphy, 2013). Ireland and South Africa require detailed executive pay disclosures from 2000 and Australia from 2004. By 2006, following a prior recommendation by the E.U. Commission, Belgium, France, Germany, Italy, the Netherlands, and Sweden had mandated detailed disclosure, as had (outside the E.U.) Norway and Switzerland.

Using newly available data from 14 countries that required individual pay disclosures by 2006, Fernandes et al. (2013) argue that the U.S. pay premium has become economically small: Controlling for standard firm characteristics (such as industry, size, and performance), but also for ownership and board structure, U.S. CEOs earned only 26% more than their foreign counterparts in 2006. U.S. firms tend to have higher institutional ownership and more independent boards, both of which are associated with higher pay and more equity-based pay. They also have fewer large inside blockholders (large shareholders), such as families, that are associated with lower pay and less equity-based pay, potentially because direct monitoring reduces agency problems. Fernandes et al. also compare pay levels after adjusting for the risk of equity-based pay. Because U.S. firms continue to grant more equity, this reduces the U.S. pay premium further and makes it statistically insignificant by 2006.

Table 5 presents some of the data utilized by the Fernandes et al. analysis for 2002–9. Our sample, taken from BoardEx and ExecuComp, includes CEOs of the largest publicly-traded firms with available data from 10 European countries (Belgium,

Table 5 CEO compensation across countries. The table shows the level and composition of CEO pay in 11 countries from 2002–2009. The U.S. data is from ExecuComp and the non-U.S. data from BoardEx. First-year CEOs, firms that cannot be matched to Worldscope, and firm-years with incomplete compensation data are dropped. All non-U.S. compensation numbers are converted to U.S. dollars using annual average exchange rates. Bonus includes all non-equity incentive payments, Stock & Options include grant-date values of stock options and restricted stock (including performance shares), and Other includes pensions and other benefits

		Compensation levels ($ mil.)		Compensation structure (%)			
Country	**Obs.**	**Mean**	**Median**	**Salary (%)**	**Bonus (%)**	**Stock & Options (%)**	**Other (%)**
Belgium	218	1.72	0.87	60	20	10	11
France	1,455	2.52	0.88	63	18	16	3
Germany	582	3.11	1.93	42	40	10	8
Ireland	406	2.73	1.15	47	15	27	11
Italy	488	3.37	1.94	57	14	9	20
Netherlands	583	1.89	1.17	49	19	19	13
Norway	227	1.38	0.39	77	10	7	7
Sweden	659	1.72	0.67	65	13	2	20
Switzerland	210	4.86	2.37	51	14	24	10
United Kingdom	3,957	2.29	1.28	48	17	26	9
Non-U.S.	8,785	2.42	1.23	53	18	19	10
United States	13,361	4.90	2.80	30	22	42	6

France, Germany, Ireland, Italy, Netherlands, Norway, Sweden, Switzerland, U.K.) and the U.S.[15] With no controls for firm or governance characteristics, the level of CEO pay remains highest in the U.S. and exceeds that in other countries by 102% on average. Differences in taxation exacerbate rather than attenuate differences in gross pay: Piketty et al. (2014) find that CEOs are paid more in countries with low marginal tax rates.

Fig. 12 and Table 5 also show large differences in the composition of pay across countries. Stock and option compensation is a larger fraction of CEO pay in the U.S. than in any other country, which may explain at least in part why U.S. CEOs are paid more. U.S. CEOs receive on average 42% of pay in stock and options, compared to only 19% in other countries. Salary, on the other hand, is 53% of CEO pay outside the U.S. but only 30% in the U.S.

[15] We restrict our analysis to 2002–9 because the BoardEx data covers many fewer firms both before and afterwards. We are grateful to Nuno Fernandes, Miguel Ferreira, Pedro Matos, and Kevin Murphy for answering numerous questions about the data used in their paper.

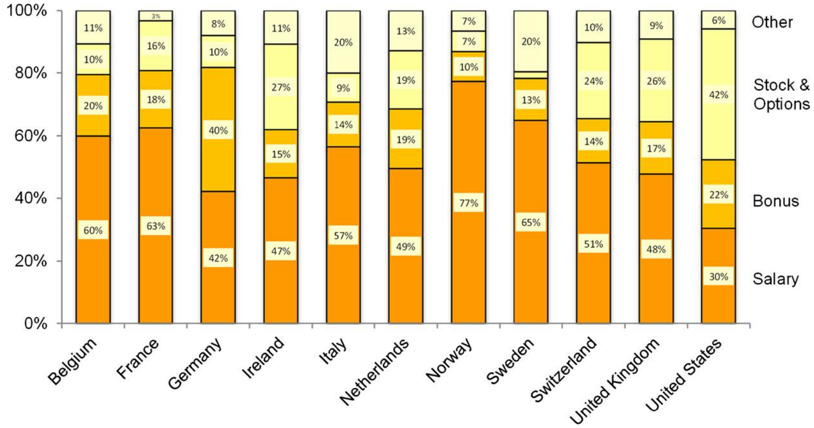

Figure 12 The structure of CEO compensation by country. This diagram shows the average composition of CEO pay in 11 countries from 2002–2009. The U.S. data is from ExecuComp and the non-U.S. data is from BoardEx. First-year CEOs, firms that cannot be matched to Worldscope, and firm-years with incomplete compensation data are dropped. Bonus includes all non-equity incentive payments, Stock & Options include grant-date values of stock options and restricted stock (including performance shares), and Other includes pensions and other benefits.

To summarize, based on simple univariate comparisons, pay levels are significantly higher in the U.S. than other countries. However, the pay gap has narrowed in recent years, and controlling for firm and pay characteristics reduces the gap. U.S. firms tend to be larger and pay their CEOs more with equity, which explains much of the U.S. pay premium.

2.5 Private firms

Almost all studies of executive pay examine publicly-traded firms, simply because regulators usually do not require private companies to disclose pay. As a result, little is known about pay levels and pay design in privately-held firms. The few existing studies of executive pay in private firms are either based on surveys or on small, selected samples.

Several studies examine the information on "officers' compensation" in the Survey of Small Business Finances ("SSBF"), a nationally representative sample of more than 4,000 U.S. businesses with fewer than 500 employees. Questions about executive pay were included in the survey's 1993 and 2003 iterations. Combining the results of Cole and Mehran (1996), Cavalluzzo and Sankaraguruswamy (2000), Farrell and Winters (2008), Michiels et al. (2013), and Cole and Mehran (2016) reveals several interesting patterns. First, CEO pay increases with firm size, regardless of whether size is measured as sales, book assets, or number of employees. Cole and Mehran (2016) report that the pay-size elasticity is higher for small private firms than for large public firms. Second, CEOs with higher percentage equity ownership tend to receive less pay. Third, studies disagree about the relationship between CEO pay and accounting profitability, which suggests that this relationship is weak and not robust to the inclusion of controls. Because the SSBF does not permit following the same firm over time, this pay-performance sensitivity is estimated from the cross-section of firms and difficult to interpret. Fourth, comparing the 1993 and 2003 surveys suggests a decline in inflation-adjusted CEO pay, a remarkable difference to the steep increase in large public firms shown in Fig. 2.

An important caveat to studies on private firms is that many of the CEOs are the controlling shareholder of their firm. This is a crucial difference to most public firms, in which CEOs tend to be employees with only small equity stakes. If a CEO is a controlling shareholder, the standard considerations of contract design – attraction, retention, and incentive alignment – are mostly irrelevant. As a result, his pay is determined by other considerations, such as liquidity needs and tax optimization. For example, an owner-manager might find it optimal to pay himself a larger salary out of pre-tax corporate income instead of receiving the same pay as a dividend (Ke, 2001).

The SEC requires privately-held U.S. firms to reveal information about top executive pay if the firm has a class of equity securities with more than 500 shareholders, or if it has registered a public offering of debt securities. Gao and Li (2015) analyze such firms in 1999–2011 and find that CEOs in private firms are paid 30% less than their industry- and size-matched public counterparts. The link between CEO pay and accounting performance is much weaker in private firms, a finding that is robust to restricting the sample to CEOs with small ownership stakes (i.e., to excluding owner-managers). Unsurprisingly, private firms use much less equity-based pay than comparable public firms.[16]

Both public and privately-held U.S. property-liability insurers are required to file executive pay data with state regulators. Ke et al. (1999) collect data on 45 CEOs of private and 18 CEOs of public insurers from 1994–96. They find a positive relationship between profitability and CEO pay for publicly-held insurers but not for private ones. Within private insurers, Ke (2001) provides suggestive evidence that insurers with owner-managers reduce CEO pay when individual tax rates increase relative to corporate tax rates, consistent with tax optimization.

The weak pay-performance sensitivity for private-firm CEOs who are not owner-managers is interesting. Given that private firms cannot use stock prices as performance signals, one might have expected a close link between CEO pay and accounting performance. On the other hand, concentrated owners may substitute monitoring for incentive pay. Owners of privately-held firms are likely to have more direct oversight of

[16] Using Japanese tax return data, Nakazato et al. (2011) report that, after controlling for firm size, public and private company CEOs have similar compensation levels. However, pay is more sensitive to profitability in public than in private firms, consistent with the U.S. evidence.

managers and, at least in some firms, may take important strategic decisions themselves. This reduces the need for incentive pay, and indeed for top-level executive talent in the first place.

An especially interesting group of privately-held firms are those controlled by private equity ("PE") investors. PE portfolio companies have controlling shareholders who provide close monitoring and are often seen as models of good governance (Cronqvist and Fahlenbrach, 2013). Moreover, portfolio companies are frequently large, used to be publicly traded firms or divisions of publicly-traded firms, and often become public firms again as the PE investor exits.

Jackson (2013) and Leslie and Oyer (2013) examine PE-controlled firms that undertake an IPO. IPO firms are required to file a registration statement with the SEC that discloses executive pay for the previous two years. This sampling strategy selects portfolio firms that are unusually successful, and the results may not generalize to more typical portfolio firms. Both studies suggest that CEOs of PE-controlled firms receive similar levels of pay as in matched public firms. However, CEOs of portfolio companies have much stronger equity incentives, both in terms of effective dollar ownership and effective percentage ownership, while earning lower base pay.[17] These differences do not exist before these companies are bought by PE investors, and the differences quickly disappear after portfolio firms undertake an IPO.

Cronqvist and Fahlenbrach (2013) follow 20 leveraged buyout ("LBO") firms that are taken private by PE investors in 2005–07 but are required to continue filing with the SEC because of public debt. After the LBO, CEOs' effective percentage ownership increases by a factor of 2 to 3, regardless of whether CEOs are retained or replaced. However, effective dollar ownership declines, as CEOs treat the buy-out as a liquidity event and cash out some (or in case of turnover all) of their pre-LBO holdings.[18] PE owners do not reduce base salaries or perks for CEOs, and they increase target bonuses and the use of performance-vesting equity. Bonus schemes are redesigned away from qualitative, non-financial, and earnings-based metrics towards cash-flow based metrics. Severance agreements become tougher after LBOs, with unvested stock and options forfeited to a larger extent if a CEO is dismissed.

Based on this limited evidence from heavily selected samples, it appears that PE-controlled firms use more pay-for-performance and stronger equity incentives than comparable public firms. Other private firms, however, seem to have weak pay-for-performance incentives for executives who are not owner-managers. It is an important question whether both compensation models are optimal, which would suggest that

[17] The result that CEOs in PE-controlled firms that undertake an IPO have unusually high ownership percentages is confirmed by Muscarella and Vetsuypens (1990), who study an earlier sample from 1976 to 1987.

[18] Kaplan and Stein (1993) find similar changes in executives' equity incentives around LBOs in the 1980s.

these two sets of firms are very different, or whether some of the observed compensation arrangements are inefficient.

3. THE SHAREHOLDER VALUE VIEW

The rapid rise in executive pay since the 1970s has sparked a lively debate about the determinants of executive pay. One end of the spectrum, analyzed in this section, views CEO pay as the efficient outcome of a labor market in which firms optimally compete for managerial talent. The other end, analyzed in Section 4, views CEO pay as the result of rent extraction by CEOs. Section 5 presents a third view, that institutional factors have contributed significantly to the rise in pay.

The "shareholder value" view proposes that CEO contracts are the outcome of shareholder value maximizing firms that compete with each other in an efficient market for managerial talent. This view broadens what is commonly referred to as the "optimal contracting" view, which typically focuses on the details of bilateral contracts. We use the term "shareholder value" view for two main reasons. First, it emphasizes the need to take into account additional dimensions such as market forces and competitive equilibrium. Second, in reality boards are unlikely to choose the perfectly optimal contract, even if they are concerned with shareholder value rather than rent extraction. One reason is a preference for simplicity, which may restrict them to piecewise linear contracts. The theoretically optimal contract is typically highly nonlinear and never observed in reality; under a strict definition of optimal contracting, this view would be immediately rejected. A second reason is bounded rationality, which may lead to boards not being aware of certain (potentially non-obvious) performance measures that could theoretically improve the contract if included.

We start in Section 3.1 by analyzing theories of the level of pay in a competitive market equilibrium. We then study the sensitivity of pay to performance in a single-firm setting in Section 3.2 and in a market equilibrium in Section 3.3. Section 3.4 discusses relative performance evaluation and other performance signals, Section 3.5 addresses the optimal mix of stock vs. options, and Section 3.6 does the same for debt vs. equity. Finally, Section 3.7 tackles dynamic models and the horizon of pay. For a more extensive analysis of shareholder value theories, please see Edmans and Gabaix (2016) which also includes proofs.

3.1 The level of pay

Models that take the shareholder value view determine the level of CEO pay by deriving optimal contracts (potentially subject to some contracting restrictions) and by endogenizing CEOs' and firms' outside options in a competitive market for talent. The firm's outside option is to hire a different CEO, and the CEO's outside option is to work elsewhere. Hence, what matters for pay is how the current CEO's contribution to firm value compares to that of the next best manager the firm could hire, and how much the CEO could earn in the next best job he could take.

The shareholder value view therefore identifies three mechanisms that might explain the rise in CEO pay since the 1970s. First, the difference between the CEO's contribution to firm value and that of the next best manager may have increased, perhaps because the importance of CEO ability has grown. Second, the CEO's expected earnings in the next best job may have increased, perhaps because CEO skills have become more portable. Third, the CEO's disutility from the optimal contract may have increased, perhaps because risk and effort levels have increased.

In this section, we abstract from agency problems (which we later introduce in Section 3.2) and focus on the pay required to attract the CEO to a firm. We present an assignment model in which firm size determines the demand for CEO talent in Section 3.1.1, introduce alternative and complementary explanations for the level of CEO pay in Section 3.1.2, and confront the models with the evidence in Section 3.1.3.

3.1.1 Assignment models

Assignment models have long been used to model the allocation of workers to tasks (e.g., Sattinger, 1975, 1979; Rosen, 1981, 1982). A typical model specifies the jobs available, the relevant differences among workers, and the technology relating worker and job characteristics to output. Most assignment models assume that workers have full knowledge of all job offers, that employers have full knowledge of all workers' characteristics, that markets are competitive, and that there are no frictions.[19] As a result, the equilibrium assignment of workers to jobs is efficient.

More recently, Gabaix and Landier (2008) and Terviö (2008) have applied assignment models to CEOs. Our exposition follows the tractable market equilibrium model in Gabaix and Landier (2008). A continuum of firms and potential CEOs are matched together. Firm $n \in [0, N]$ has a "baseline" size $S(n)$ and CEO $m \in [0, N]$ has talent $T(m)$. Low n denotes a larger firm and low m a more talented CEO: $S'(n) < 0$, $T'(m) < 0$. n (respectively, m) can be thought of as the rank of the firm (respectively, CEO), or a number proportional to it, such as its quantile of rank (in which case it is in $(0, 1]$).

We consider the problem faced by one particular firm. At $t = 0$, it hires a CEO of talent $T(m)$ for one period. The CEO's talent increases firm value according to

$$V = S(n) + CS(n)^{\gamma} T(m), \tag{1}$$

where C parametrizes the productivity of talent and γ the elasticity with respect to firm size. The multiplicative structure implies that the productivity of talent increases

[19] This differentiates the assignment literature from matching models (Mortensen, 1986) and search models (Jovanovic, 1979; Diamond, 1981; Pissarides, 1984), which feature uncertainty or asymmetric information about job offers or worker characteristics.

with firm size (Rosen, 1982). If $\gamma = 1$ (respectively, $\gamma < 1$), the model exhibits constant (respectively, decreasing) returns to scale. We assume that the productivity of talent C and the elasticity with respect to firm size γ is the same for all firms.

We now determine equilibrium wages, which requires us to allocate one CEO to each firm. Let $w(m)$ denote the equilibrium wage of a CEO with index m. Firm n, taking the market wage of CEOs as given, selects CEO m to maximize its value net of wages:

$$\max_m CS(n)^\gamma T(m) - w(m).$$

The competitive equilibrium is Pareto optimal and involves positive assortative matching: more talented CEOs match with larger firms, where their value added is greater. In equilibrium, $m = n$, and so $w'(n) = CS(n)^\gamma T'(n)$. Let $\underline{w}_N$ denote the reservation wage of the least talented CEO (who is matched to firm $n = N$). We obtain the classic assignment equation (Sattinger, 1993) in the context of CEOs:

$$w(n) = -\int_n^N CS(u)^\gamma T'(u)du + \underline{w}_N. \tag{2}$$

Specific functional forms are required to proceed further. We assume a Pareto firm size distribution with exponent $1/\alpha$: $S(n) = An^{-\alpha}$. Using results from extreme value theory, Gabaix and Landier (2008) use the following asymptotic value for the spacings of the talent distribution: $T'(n) = -Bn^{\beta-1}$. These functional forms give the wage in closed form for the largest firms, taking the limit as $n/N \to 0$:

$$\begin{aligned} w(n) &= \int_n^N A^\gamma BCu^{-\alpha\gamma+\beta-1}du + \underline{w}_N \\ &= \frac{A^\gamma BC}{\alpha\gamma - \beta}\left[n^{-(\alpha\gamma-\beta)} - N^{-(\alpha\gamma-\beta)}\right] + \underline{w}_N \sim \frac{A^\gamma BC}{\alpha\gamma - \beta}n^{-(\alpha\gamma-\beta)}. \end{aligned} \tag{3}$$

To interpret Eq. (3), we consider a reference firm, for instance the median firm in the universe of the top 500 firms. Denote its index n_*, and its size $S(n_*) = An_*^{-\alpha}$. We eventually obtain:

$$w(n) = D(n_*)S(n_*)^{\beta/\alpha}S(n)^{\gamma-\beta/\alpha}, \tag{4}$$

where $D(n_*) = -Cn_*T'(n_*)/(\alpha\gamma - \beta)$ is a constant independent of firm size.[20]

[20] Using $S(n) = An^{-\alpha}$, we have:

$$\begin{aligned} w(n) &= \frac{A^\gamma BC}{\alpha\gamma - \beta}n^{-(\alpha\gamma-\beta)} = \frac{A^\gamma BC}{\alpha\gamma - \beta}\left(\left(A^{1/\alpha}S(n)^{-1/\alpha}\right)\right)^{-(\alpha\gamma-\beta)} \\ &= \frac{A^{\beta/\alpha}BC}{\alpha\gamma - \beta}S(n)^{\gamma-\beta/\alpha} = \frac{\left(S(n_*)n_*^\alpha\right)^{\beta/\alpha}BC}{\alpha\gamma - \beta}S(n)^{\gamma-\beta/\alpha} = \frac{n_*^\beta BC}{\alpha\gamma - \beta}S(n_*)^{\beta/\alpha}S(n)^{\gamma-\beta/\alpha} \end{aligned}$$

which yields Eq. (4).

Eq. (4) gives the CEO's wage in closed form, which yields two clear predictions. First, CEO pay is increasing in firm size: large firms hire the most talented CEOs, who command the highest wages. Moreover, the prediction of Eq. (4) is quantitative: the pay-firm size elasticity should be $\rho = \gamma - \beta/\alpha$. Gabaix and Landier (2008) calibrate using $\alpha = 1$ (a Zipf's law for firms, as in Axtell, 2001) and $\gamma = 1$ (constant returns to scale). Since there is no clear a priori value for β, they set $\beta = 2/3$ to yield the pay-size elasticity of $\rho = 1/3$ that is found empirically (e.g., Roberts, 1956). Baranchuk et al. (2011) extend the model to endogenize firm size and show that the pay-size relationship is stronger when industry conditions are favorable, as talented CEOs are not only paid a greater premium but also optimally grow their firms to a larger size.

Second, pay increases with the size of the average firm in the economy $S(n_*)$. Since a CEO's talent can be applied to the entire firm, when firms are larger, the dollar benefits from a more talented CEO are higher and so there is more competition for talent. This is a similar "superstars" effect to Rosen (1992). Again, the prediction is quantitative. We use constant returns to scale ($\gamma = 1$), the standard benchmark for production functions. Average firm size increased sixfold between 1980 and 2011. When both $S(n_*)$ and $S(n)$ rise by a factor of 6, CEO pay should rise by a factor of $6 \times [\beta/\alpha + (\gamma - \beta/\alpha)] = 6\gamma = 6$, which Gabaix and Landier (2008) show has been the case.

3.1.2 Other shareholder value explanations

The literature offers several other explanations for rising CEO pay that assume shareholder value maximization. One set of studies suggest that the growth in pay results from either increasing demand for CEO talent from sources other than the increase in firm size, or increasing demand for CEO effort (from any source) – not only must the firm directly compensate the CEO for exerting a higher effort level, but also offer stronger incentives to induce this higher effort level, thus requiring greater pay as a risk premium (see Section 3.2). For example, the productivity of managerial effort and talent may have increased because of more intense competition due to deregulation or entry by foreign firms (Hubbard and Palia, 1995; Cuñat and Guadalupe, 2009a, 2009b), improvements in the communication technologies used by managers (Garicano and Rossi-Hansberg, 2006), or a more volatile business environment (Dow and Raposo, 2005). An increase in firm size can also raise the optimal level of CEO effort if the marginal product of effort increases with size (Himmelberg and Hubbard, 2000; Baker and Hall, 2004). Finally, moral hazard problems may be more severe in larger firms, resulting in stronger incentives and greater disutility for CEOs as firms grow (Gayle and Miller, 2009).

An alternative market-based explanation for the growth in CEO pay is an increase in CEOs' bargaining power resulting from a shift in firms' demand from firm-specific to general managerial skills. Such a shift intensifies the competition for talent and thus allows managers to capture a larger fraction of their firms' rents (Murphy and Zábojník, 2004, 2007; Frydman, 2017). This theory predicts an increase in the level of CEO pay, rising inequality among executives within and across firms, and a higher fraction of externally-hired CEOs. The assignment model in the previous section does not include variation in CEOs' bargaining power and ability to extract surplus. Assignment models are typically perfectly competitive, so there is no surplus to bargain on. Modeling bargaining power requires that the CEO's value-added is discretely larger in his current firm than in the next best job, which can be achieved by either making firms and managers discrete or making both firms' needs and CEOs' talents multi-dimensional. Pan (2017) combines both approaches, with firms differing in size, complexity, and R&D intensity and executives matching based on their efficiency, experience, and technical expertise.

A different market-based explanation proposes that the growth in CEO pay is the result of stricter corporate governance and improved monitoring of CEOs by boards and large shareholders. The single-firm model of Hermalin (2005) shows that, if an increase in monitoring raises CEO effort and the risk of dismissal, CEOs demand greater pay as a compensating differential. According to this theory, the observed rise in pay should be accompanied by higher CEO turnover, a stronger link between CEO turnover and firm performance, and more external CEO hires. However, the market equilibrium model of Edmans and Gabaix (2011a) shows that an economy-wide strengthening of governance may not lead to higher pay – while working for one's current firm becomes less attractive, so do the outside options. In Chaigneau and Sahuguet (2017), improved monitoring facilitates the dismissal of CEOs whose (initially unknown) ability turns out to be low. This increases firms' valuation of CEOs with uncertain ability, which in turn raises the market equilibrium pay of all CEOs.

3.1.3 Evidence

In this section, we assess the extent to which the shareholder value view is consistent with the evidence. Theories based on the effect of firm size on the demand for CEO talent find their strongest empirical support in the correlated increases in firm value and CEO pay since the 1970s. As discussed in Section 3.1.1, Gabaix and Landier (2008) show that the growth in the aggregate value of the median S&P 500 firm can explain the entire growth in CEO pay from 1980 to 2003.[21]

However, the data on the firm size-pay relation is not unambiguously consistent with their model. While pay and firm values grew together from 1980 to the present, Frydman and Saks (2010) show that median CEO pay was almost constant between the 1940s and early 1970s, despite firm size increasing over this period. Gabaix and Landier (2008) discuss potential explanations for this discrepancy. One is that the supply

[21] Kaplan and Rauh (2010, 2013) and Kaplan (2012) show that pay has risen even faster in other scalable professions, such as private equity, venture capital, hedge funds, and law.

of talent greatly increased, which creates downward pressure on CEO wages; another is that, in the early period, CEOs tended to be internally promoted rather than externally hired, suggesting that their model does not describe the CEO labor market before 1980. Nagel (2010) raises sample selection and methodological concerns. However, Gabaix et al. (2014) conclude that the results are robust to these changes.[22]

Of course, observing that both firm sizes and CEO pay have trended upwards since 1980 does not imply causality. Even if causal, the positive correlation between pay and firm size cannot be interpreted as definitive evidence for assignment models, since it is also potentially explainable by an (as yet unwritten) rent extraction model (see Section 4). For example, large firms may have more resources, allowing the CEO to extract higher pay.

Looking beyond CEO pay, the frictionless assignment model in Section 3.1.1 is inconsistent with several features of the CEO labor market. First, most CEOs of U.S. public firms are promoted from within the firm, suggesting that firm-specific human capital or other frictions disadvantage outside candidates (Parrino, 1997; Cremers and Grinstein, 2014). Second, CEOs almost never move directly between firms. Cziraki and Jenter (2017) show that fewer than 3% of new CEOs in S&P 500 firms are recruited directly from CEO positions in other firms, indicating that even worse frictions hinder the mobility of incumbent CEOs. Third, Jenter et al. (2017) show that stock prices react positively to deaths of old and long-tenured CEOs, which suggests that these CEO-firm matches are not optimal. Stock prices react negatively to deaths of young CEOs and founders, which points to the existence of firm-specific human capital partially captured by shareholders.

None of these observations negate the usefulness of the competitive assignment model for analyzing the CEO labor market. However, they do suggest that the model needs to be extended to incorporate frictions, such as firm-specific human capital or turnover costs, to become more empirically realistic. Identifying and estimating the size of these frictions is an important future research area (see Section 8). If these frictions are severe, they can create large match-specific rents that a powerful CEO might be able to capture (see Section 4 for a discussion of rent extraction models).

Supportive cross-sectional evidence for a role of talent or ability in CEO pay is provided by Falato et al. (2015). They proxy for ability using a CEO's reputational, career, and educational credentials and find these credentials to be positively related to pay. Engelberg et al. (2013) show that CEO pay increases in the number of personal connections the CEO has to high-ranking executives and directors in other firms, which they interpret as a component of ability, as such contacts likely help him improve firm value. Chang et al. (2010) show that the probability of a departed CEO obtaining

[22] They also provide a "user's guide" on these methodological issues, such as the relevant universe, the available datasets and long-run compensation indices, and the relevant measure of firm size.

another top management position increases in his pay compared to that of other top executives in the previous firm. This is consistent with CEO pay proxying for ability or, at least, for labor market opportunities.

There is also empirical support for theories that explain the rise in CEO pay with a rising value of CEO talent or CEO effort. For example, changes in product markets appear to have increased the demand for CEO talent and raised pay. Hubbard and Palia (1995) and Cuñat and Guadalupe (2009a) document higher pay following industry deregulations, and Cuñat and Guadalupe (2009b) show that pay levels and incentives increase when firms face more import penetration. However, the estimated magnitudes are modest, leaving a large fraction of the rise in CEO pay unexplained.

The alternative explanation that firms' demand for CEO skills has shifted from firm-specific to general managerial ability predicts not only an increase in pay, but also changes in pay dispersion and managerial mobility that are consistent with the evidence. As shown in Section 2.1, recent decades have seen a marked increase in the differences in executive pay between large and small firms, and between CEOs and other top executives. Over the same period, the ratio of new CEOs appointed from outside the firm has risen sharply, top executives have become more mobile across sectors, their business experiences have become more diverse, and the fraction of CEOs with an MBA has risen (Murphy and Zábojník, 2004, 2007; Frydman, 2017). In the largest 500 U.S. firms, external hires as a percentage of all new CEO appointments increased from 15% in the 1970s to 27% during the 1990s (Murphy and Zábojník, 2007) and to 32% during the 2000s (Cziraki and Jenter, 2017).

However, these changes in managers' backgrounds and skills appear to have occurred slowly over time (Frydman, 2017), and the magnitude and timing of the changes may not be large or quick enough to explain the rapid rise in CEO pay since the 1980s. Cross-sectionally, Custódio et al. (2013) find that pay is higher for CEOs with generalist rather than specialist managerial skills, but the differences, even though substantial, are again too small to explain the overall increase in CEO pay.

Hermalin (2005) argues that rising CEO pay is the result of stricter monitoring of CEOs by boards and large shareholders. This view is broadly consistent with the evidence. The fraction of outside directors on boards and the level of institutional stock ownership have increased since the 1970s (Huson et al., 2001), while CEO turnovers have become more frequent (Kaplan and Minton, 2011) and closely linked to firm performance (Jenter and Lewellen, 2017). Although these trends are suggestive, there is no direct evidence that changes in governance caused the surge in CEO pay or that added pressure on CEOs can account for the magnitude of the pay increase. In the cross-section, Peters and Wagner (2014) show that more volatile industry conditions are associated with more CEO dismissals and higher CEO pay, consistent with CEOs being compensated for turnover risk.

3.2 The sensitivity of pay

We now turn from determining the level of pay to the CEO's incentives. As with any survey, we are forced to draw boundaries. We focus on moral hazard, rather than adverse selection, as the moral hazard literature is more extensive. For learning models of CEO contracts, where either the CEO's general ability or his specific match quality with a firm is initially unknown to both sides, we refer the reader to Harris and Holmström (1982), Gibbons and Murphy (1992), Holmström (1999), Hermalin and Weisbach (1998, 2012), Taylor (2010, 2013), Garrett and Pavan (2012), and the survey by Hermalin and Weisbach (2017).

This section considers a single-period moral hazard model; we consider multiple periods in Section 3.7. This setting has been widely covered in textbooks (e.g., Bolton and Dewatripont, 2005; Tirole, 2006) and earlier surveys (Prendergast, 1999), but typically with additive production functions and preferences, and often a binary effort level. We show that multiplicative specifications, which may be particularly relevant for the CEO setting, lead to quite different conclusions for the best empirical measure of incentives and how incentives should vary cross-sectionally between firms.

We start with a standard principal–agent problem applied to an executive compensation setting. The principal (board of directors on behalf of shareholders) hires an agent (CEO) to run the firm. The production function is given by $V(a, S, \varepsilon)$, which is increasing in the CEO's action a and firm size S. Suppressing the dependence on S and ε for brevity, we specialize this to

$$V(a) = S + b(S)a + \varepsilon. \tag{5}$$

We consider an all-equity firm for simplicity and discuss leverage in Section 3.6. The variable $a \in [0, \infty)$ is an action taken by the CEO that improves expected firm value but is personally costly. Examples include effort (low a represents shirking), project choice (low a involves selecting value-destructive projects that maximize private benefits), or rent extraction (low a reflects cash flow diversion). We typically refer to a as "effort" for brevity. The variable ε is mean-zero noise, with interval support on $(\underline{\varepsilon}, \overline{\varepsilon})$, where the bounds may be infinite.[23] Shortly after the CEO takes his action, noise and then final firm value V are realized. Firm value is observable and contractible, but neither effort nor noise are individually observable.

The function $b(S)$ measures the effect of effort on firm value for a firm of size S. One possibility is $b(S) = b$, which yields $V(a) = S + ba + \varepsilon$: an additive production function where the effect of effort on firm value is independent of firm size. This specification

[23] For simplicity, we assume that S is sufficiently large, or the probability of low ε is sufficiently small, that V is non-negative almost surely and so we do not need to complicate the model with non-negativity constraints.

is appropriate for a perk consumption decision, if the amount of perks that can be consumed is independent of firm size. For example, buying a \$10 million corporate jet reduces firm value by \$10 million, regardless of S. Another possibility is $b(S) = bS$, which yields $V(a) = S(1 + ba) + \varepsilon$: a multiplicative production function where the effect of effort on firm value is linear in firm size. Many CEO actions can be "rolled out" across the entire firm and thus have a greater effect in a larger company, such as a change in strategy or a program to improve production efficiency. A multiplicative specification is also appropriate for a rent extraction setting, if there are more resources to extract in a larger firm.

The CEO is paid a wage $c(V)$ contingent upon firm value. We always assume limited liability on the principal ($c(V) \leq V$): she cannot pay out more than total firm value. In some versions of the model we also assume limited liability on the CEO ($c(V) \geq 0$). He has reservation utility of $w \geq 0$ and his objective function is given by[24]:

$$\mathrm{E}[U] = \mathrm{E}\left[u\left(v(c) - g(a)\right)\right]. \tag{6}$$

The function g represents the cost of effort, which is increasing and weakly convex, where $g(0) = 0$. u is the utility function and v is the felicity[25] function that denotes the CEO's utility from cash; both are increasing and weakly concave. g, u, and v are all twice continuously differentiable. The objective function (6) contains functions for both utility and felicity to maximize generality. One common assumption is $v(c) = c$ so that $\mathrm{E}[U] = \mathrm{E}\left[u\left(c - g(a)\right)\right]$, in which case the cost of effort is pecuniary, i.e., can be expressed as a subtraction to cash pay. This is appropriate if effort involves a financial expenditure or the opportunity cost of forgoing an alternative income-generating activity. Another is $u(x) = x$, which yields $\mathrm{E}\left[v(c) - g(a)\right]$, where the cost of effort is separable from the benefits of cash. This specification is reasonable if effort involves disutility, or forgoing leisure or private benefits.

Both of the above specifications represent additive preferences. Effort of a reduces the CEO's utility by $g(a)$ in dollars (utils) in the first (second) specification. A third specification is $v(c) = \ln c$, in which case (6) becomes, after a slight change in notation, $\mathrm{E}\left[u(ce^{-g(a)})\right]$.[26] This specification corresponds to multiplicative preferences, where the cost of effort is increasing in c. Here, private benefits are a normal good: the utility they provide is increasing in consumption, consistent with the treatment of most goods and services in consumer theory. This specification is also plausible under the literal interpretation of effort as forgoing leisure: a day of vacation is more valuable to a richer

24 Note that w refers to the expected wage, while c refers to actual pay.

25 The term "felicity" is typically used to denote one-period utility in an intertemporal model. We use it in a non-standard manner here to distinguish it from the utility function u.

26 With $v(c) = \ln c$, (6) becomes $\mathrm{E}\left[u\left(\ln c - g(a)\right)\right] = \mathrm{E}\left[u\left(\ln ce^{-g(a)}\right)\right]$. We remove the ln as it is a monotonic transformation.

CEO, as he has more wealth to enjoy during it. Thus, the CEO's expenditure on leisure and private benefits rises in proportion to his wealth. Multiplicative preferences are also commonly used in macroeconomic models (e.g., Cooley and Prescott, 1995) to generate realistic income effects. In particular, they are necessary for labor supply to be constant over time as the hourly wage rises.[27]

The principal is assumed to be risk-neutral, since shareholders are typically well-diversified. Her program is given by:

$$\max_{c(\cdot),a} \mathrm{E}\left[V(a) - c(V(a))\right] \text{ s.t.} \tag{7}$$

$$\mathrm{E}\left[u\left(v(c(V(a))) - g(a)\right)\right] \geq w \tag{8}$$

$$a \in \arg\max_{\widehat{a}} \mathrm{E}\left[u\left(v(c(V(\widehat{a}))) - g(\widehat{a})\right)\right]. \tag{9}$$

She chooses the effort level a and contract $c(V)$[28] to maximize (7), expected firm value minus the expected wage, subject to the CEO's individual rationality or participation constraint ("IR", (8)) and incentive compatibility constraint ("IC", (9)).

Consider the first-best benchmark where effort is observable. Let a^* be the effort level that the principal wishes to implement. She can simply direct the CEO to exert effort a^*, and so we can ignore the IC (9). It is easy to show that the CEO is given a constant wage $c(V) = \bar{c}$, as this leads to efficient risk-sharing. The IR (8) yields $\bar{c} \geq w + g(a^*)$. This will bind in the optimal contract, and so the principal maximizes

$$\mathrm{E}\left[V(a^*)\right] - g(a^*) - w. \tag{10}$$

This defines the first-best effort level as

$$g'(a^*_{FB}) = b(S). \tag{11}$$

The principal trades off the marginal increase in firm value from effort, $b(S)$, with the CEO's marginal cost, $g'\left(a^*_{FB}\right)$. Thus, a^*_{FB} maximizes total surplus. In turn, a^*_{FB} is decreasing in the convexity of the cost of effort. It is also increasing in firm size S if $b(S)$ is increasing in S, since effort then has a greater dollar effect in a larger firm.

[27] When the hourly wage rises, working becomes preferable to leisure (the substitution effect). With multiplicative preferences, the rise in the wage increases the agent's labor endowment income and thus demand for leisure (the income effect), which exactly offsets the substitution effect. With additive preferences, there is no income effect, and so leisure falls to zero as the wage increases.

[28] Here, we focus on deterministic contracts, so that there is a one-to-one mapping between firm value V and compensation c. An even more general model allows for stochastic contracts, where firm value of V leads to a random amount c. Gjesdal (1982), Arnott and Stiglitz (1988), and Edmans and Gabaix (2011b) derive sufficient conditions for random contracts to be suboptimal, allowing the focus on deterministic ones.

3.2.1 Risk-neutral agent

We now turn to a setting in which effort is unobservable and the IC (9) must be imposed. We first consider risk neutrality and additive preferences. We have $u(x)=x$ and $v(c)=c$ so the IR (8) and IC (9) specialize to

$$\mathrm{E}\left[c(V)\right]-g(a)\geq w \tag{12}$$

$$a\in\arg\max_{\widehat{a}}\mathrm{E}\left[c(V)\right]-g(\widehat{a}). \tag{13}$$

Grossman and Hart (1983) show that the contracting problem can be solved in two stages, which correspond to the principal's two choice variables. She first chooses the contract $c(V)$ that implements a given action a^* at least cost, and then the optimal a^* taking into account the cost of the contract $c(V)$ needed to implement each action a^*. Starting with the first stage, the first-order condition of the CEO's effort choice (13) is given by

$$\mathrm{E}\left[c'(V)b(S)\right]=g'(a^*). \tag{14}$$

Rogerson (1985), Jewitt (1988), Carroll (2012), and Jung and Kim (2015) give conditions under which the first-order condition is sufficient, and so the IC (13) can be replaced by the first-order condition (14), which greatly simplifies the problem. Throughout this paper, we assume that these conditions are satisfied, so that the first-order approach is valid.

Given risk neutrality and unlimited liability for the CEO, there is no loss of generality in focusing on a linear contract of the form $c(V)=\phi+\theta V$, where ϕ is the fixed wage and θ is the CEO's effective percentage ownership. Then, using (14), in order to implement effort of a^*, the CEO's incentives must be such that, at a^*, the marginal benefit of effort equals the marginal cost:

$$\theta b(S)=g'(a^*). \tag{15}$$

A sizeable empirical literature tries to measure CEOs' incentives to improve firm value, i.e., to exert effort a^*. This is given by the left-hand side of (15), the CEO's marginal benefit from increasing firm value. Eq. (15) shows how the optimal measure of incentives depends on how we specify the CEO's production function. When it is additive ($b(S)=b$), then to implement a given effort level a^*, the firm must set correctly the incentive measure θ, the CEO's *percentage* stake in firm value V. This measure corresponds to the *effective percentage ownership* reported in Section 2.3 – the dollar change in pay for a one dollar change in firm value ("\$–\$ incentives").[29]

[29] The empirical literature focuses on CEOs' percentage *equity* ownership, not their percentage ownership of total firm value (equity plus debt). Gabaix et al. (2014) discuss which measure of firm size is appropriate under different assumptions about the CEO's production function.

Many important CEO actions have a multiplicative, instead of additive, effect on firm value. With a multiplicative production function ($b(S) = bS$), we have $\theta bS = g'(a^*)$, and so the relevant incentive measure is θS, the CEO's *dollar* stake. This measure corresponds to the *effective dollar ownership* reported in Section 2.3 – the dollar change in pay for a one percentage point change in firm value ("\$–% incentives"). Thus, while it is common to assume an additive production function for simplicity, researchers should think carefully about this choice, as it has important implications for the relevant measure of incentives – a point first noted by Baker and Hall (2004).

We now consider multiplicative preferences, as studied by Edmans et al. (2009). In the general objective function (6), their specification corresponds to $u(x) = e^x$ and $v(c) = \ln c$, which yields

$$\mathrm{E}[U] = E\left[ce^{-g(a)}\right].$$

We normalize $a^* = 0$, and so the $t = 0$ stock price (net of CEO pay) is S.[30] We also assume $b(S) = bS$, i.e., a multiplicative production function, so that firm value at $t = 1$ is given by:

$$V(a) = S(1 + ba) + \varepsilon.$$

The IR is given by $E[c|a = a^*] = w$, which yields:

$$w = \left[c|a = a^*\right] = \phi + \theta E\left[V|a = a^*\right] = \phi + \theta S.$$

If the CEO exerts effort a, his utility is:

$$\begin{aligned}\mathrm{E}[U(a)] &= \mathrm{E}\left[c(a)e^{-g(a)}\right] = (\phi + \theta \mathrm{E}[V(a)])\, e^{-g(a)} \\ &= \left(\phi + \theta S(1 + ba)\right) e^{-g(a)} = \left(w + \theta Sba\right) e^{-g(a)} \\ &= w\left(1 + \frac{\theta Sb}{w} a\right) e^{-g(a)} = we^{\ln\left(1 + \frac{\theta Sb}{w} a\right) - g(a)}.\end{aligned}$$

The IC is $a^* \in \arg\max_a \mathrm{E}[U(a)]$. At $a^* = 0$, this yields $\mathrm{E}\left[U'(0)\right] = 0$, i.e.,

$$\frac{\theta S}{w} = \frac{g'(a^*)}{b}. \tag{16}$$

Thus, to implement a given effort level a^*, the firm must set correctly the incentive measure $\frac{\theta S}{w}$, i.e., the CEO's dollar equity stake scaled by his annual pay, or alternatively the fraction of total pay w that is in equity. It corresponds to the percentage change in pay for a one percentage point change in firm value ("%–% incentives", i.e., the elasticity of pay to firm value), as used by Murphy (1985), Gibbons and Murphy (1992), and Rosen (1992).

[30] For simplicity, we assume that initial firm size S is net of the expected wage w.

Using θ^I, θ^{II}, and θ^{III}, respectively, to denote %–%, \$–\$, and \$–% incentives, we have:

$$\theta^I = \frac{\partial c}{\partial r}\frac{1}{w} = \frac{\Delta \ln \text{Pay}}{\Delta \ln \text{Firm Value}} \tag{17}$$

$$\theta^{II} = \frac{\partial c}{\partial r}\frac{1}{S} = \frac{\Delta \$\text{Pay}}{\Delta \$\text{Firm Value}} \tag{18}$$

$$\theta^{III} = \frac{\partial c}{\partial r} = \frac{\Delta \$\text{Pay}}{\Delta \ln \text{Firm Value}} \tag{19}$$

where $r = V/S - 1$ is the firm's stock market return. In our one-period model, the CEO's incentives θ can arises from new grants of stock and options, plus changes in cash pay (salary and bonuses). Thus, these incentive measures are referred to as "pay-performance sensitivity". As discussed in Section 2.3, the vast majority of incentives stem from changes in the value of previously granted stock and options, which swamp changes in cash pay. Replacing flow pay c in the numerator of expressions (17) to (19) with the CEO's wealth W yields analogous expressions for "wealth-performance sensitivity", the change in the CEO's entire wealth (including previously granted stock and options) for a change in firm performance:

$$\Theta^I = \frac{\partial W}{\partial r}\frac{1}{w} = \frac{\Delta \ln \text{Wealth}}{\Delta \ln \text{Firm Value}} \tag{20}$$

$$\Theta^{II} = \frac{\partial W}{\partial r}\frac{1}{S} = \frac{\Delta \$\text{Wealth}}{\Delta \$\text{Firm Value}} \tag{21}$$

$$\Theta^{III} = \frac{\partial W}{\partial r} = \frac{\Delta \$\text{Wealth}}{\Delta \ln \text{Firm Value}}. \tag{22}$$

For example, $\Theta^I = \frac{\partial W}{\partial r}\frac{1}{w}$ is the percentage change in wealth for a one percentage point change in the stock return, scaled by annual pay, which Edmans et al. (2009) call "scaled wealth-performance sensitivity". Section 3.3 below predicts how the three incentive measures should scale with firm size under different assumptions about utility and production functions. Section 3.3.2 reviews the corresponding evidence, which is most consistent with multiplicative utility and production functions.

The table below illustrates how the production and cost functions affect the relevant measure of incentives:

Optimal measure of incentives

Production function	Multiplicative	Additive	Multiplicative
Cost function	Multiplicative	Additive	Additive
PPS measure	$\frac{\%\Delta c}{\%\Delta S}$	$\frac{\$\Delta c}{\$\Delta S}$	$\frac{\$\Delta c}{\%\Delta S}$
WPS measure	$\frac{\$\Delta W}{\%\Delta S}\frac{1}{\$w}$	$\frac{\$\Delta W}{\$\Delta S}$	$\frac{\$\Delta W}{\%\Delta S}$
Empirical measure	$\frac{\$\ \textit{ownership}}{\$\ \textit{total pay}}$	*% ownership*	*\$ ownership*

We now solve for the second stage of Grossman and Hart (1983), i.e., the optimal effort level, returning to the case of additive preferences. If the CEO exhibits unlimited liability, the principal can always adjust fixed pay ϕ so that the participation constraint (12) binds. Thus, his expected pay is $\mathrm{E}[c(V)] = w + g(a^*)$, just as in the first-best, and so the principal's objective function remains (10). As a result, she implements the first-best effort level, defined by (11). Using (11) and (14), the optimal contract satisfies

$$\mathrm{E}\left[c'(V)b(S)\right] = b(S). \tag{23}$$

With a linear contract ($c(V) = \phi + \theta V$), this yields $\theta = 1$ and so the optimal contract is given by

$$c(V) = \phi + V, \text{ where} \tag{24}$$

$$\phi = w + g(a^*) - S - b(S)a^*. \tag{25}$$

The principal effectively "sells" the firm V to the CEO for an up-front fee of $-\phi$, chosen so that the participation constraint (12) binds. Since the CEO benefits one-for-one from any increase in firm value, he fully internalizes the benefits of effort and the first-best effort level a^*_{FB} is achieved. The level of incentives is "one size fits all": regardless of the cost or production function, we have $\theta = 1$.

In the above framework, the effort level a^*_{FB} is endogenous – the principal implements whatever effort level is implied by $\theta = 1$. One simple way to obtain meaningful contracts that do differ across firms is to consider a binary effort decision, $a \in \{\underline{a}, \overline{a}\}$ where the principal implements $\overline{a}$, as in Holmström and Tirole (1997), Edmans et al. (2009), Biais et al. (2010), and the textbook of Tirole (2006). A similar specification is a continuous but bounded action space, $a \in [\underline{a}, \overline{a}]$, where again the principal wishes to implement $\overline{a}$. The upper bound reflects the fact that there may be a limit to the number of actions that a CEO can take to increase firm value. The high effort level $\overline{a}$ represents full productive efficiency, rather than working 24 hours a day. In a cash flow diversion model, full productive efficiency corresponds to zero stealing; in a project selection model, it corresponds to taking all positive net present value ("NPV") projects while rejecting negative-NPV ones; in an effort model, it corresponds to the CEO not deliberately forgoing a value-increasing action because it would involve too much effort. Then, from Eqs. (15) and (16), the optimal incentive level is $\theta b(S) = g'(\overline{a})$ if utility is additive and $\frac{\theta b(S)}{w} = g'(\overline{a})$ if utility is multiplicative.[31] Thus, the optimal level of incentives ($–$, $–%, or %–% depending on the model specification) is increasing in the cost of effort $g'(\overline{a})$. Intuitively, where effort is more costly, stronger incentives are needed

[31] When a is a boundary action, the IC becomes an inequality and a continuum of contracts will implement $a = \overline{a}$. We choose the contract that involves the minimum amount of incentives, as this is optimal for any non-zero level of risk aversion, and so the IC continues to bind.

to implement a given effort level. Incentives are higher in firms with greater agency problems, rather than one size fits all.

The first-best is still achieved in the fixed-action setting. In reality, the first-best cannot be achieved for two reasons. First, the CEO may be subject to limited liability ($c(V) \geq 0$). Under contract (24), the CEO will receive a negative payoff if V is sufficiently low, violating limited liability. Put differently, the CEO may not have enough cash to buy the firm. Innes (1990) shows that the optimal contract is an option on firm value in this case. Second, he may be risk-averse and demand a premium for bearing the risk associated with firm value V. We now analyze this case.

3.2.2 Risk-averse agent

Under the general utility function (6), and returning to general (rather than linear) contracts, the CEO's first-order condition is given by:

$$\mathrm{E}\left[u'(\cdot)\left(v'(c)c'(V)b(S) - g'(a^*)\right)\right] = 0. \tag{26}$$

Even assuming a given implemented action a^*, the contracting problem remains difficult because Eq. (26) only requires the contract to satisfy the CEO's incentive constraint *on average:* The CEO's average expected marginal benefit from effort, $\mathrm{E}\left[u'(\cdot)v'(c)c'(V)b(S)\right]$, must equal the average marginal cost of effort, $\mathrm{E}\left[u'(\cdot)g'(a^*)\right]$. There are many potential contracts that will satisfy this constraint on average. This makes the principal's problem complex as she must solve for the one contract out of this continuum that minimizes the expected wage.

3.2.3 Holmström–Milgrom framework

Holmström and Milgrom (1987, "HM") show that the contracting problem becomes substantially simpler if four assumptions are made. First, the CEO exhibits exponential utility, so $u(x) = -e^{-\eta x}$, where η is the coefficient of absolute risk aversion. Second, the cost of effort is pecuniary, so $v(c) = c$. Third, the noise ε is Normal, i.e., $\varepsilon \sim N(0, \sigma^2)$. Fourth, they consider a multi-period model where the CEO chooses his effort every instant in continuous time. Under these assumptions, HM show that the optimal contract is linear, i.e., $c = \phi + \theta V$, and that the problem is equivalent to a single-period static problem. The intuition is that a linear contract subjects the CEO to a constant dollar incentive pressure irrespective of the history of past performance, and a constant dollar incentive pressure equates to a constant utility incentive pressure since exponential utility removes wealth effects. This result suggests that incentives should be implemented purely with stock, and not non-linear instruments such as options.

If we also assume a quadratic cost function ($g(a) = \frac{1}{2}ga^2$) for simplicity, the principal's problem becomes:

$$\max_{a^*,\phi,\theta} \mathrm{E}[V - c] \tag{27}$$

$$\text{s.t. } \mathrm{E}\left[-e^{-\eta\left[c-\frac{1}{2}ga^{*2}\right]}\right] \geq -e^{-\eta w} \tag{28}$$

$$a^* \in \arg\max_a \mathrm{E}\left[-e^{-\eta\left[c-\frac{1}{2}ga^2\right]}\right]. \tag{29}$$

Substituting for $c = \phi + \theta V$ and $V = S + b(S)a + \varepsilon$, the CEO's objective function simplifies to:

$$-e^{-\eta\widehat{c}(a)}, \tag{30}$$

where $\widehat{c}(a) = \phi + \theta\left(S + b(S)a\right) - \frac{1}{2}ga^2 - \frac{\eta}{2}\theta^2\sigma^2$ indexes his utility from the contract. It comprises the expected wage $\phi + \theta\left(S + b(S)a\right)$, minus the cost of effort $\frac{1}{2}ga^2$, minus the risk premium $\frac{\eta}{2}\theta^2\sigma^2$ that the CEO requires. This risk premium is increasing in the CEO's risk aversion η, risk σ^2, and incentives θ. From (30), the CEO's first-order condition is given by

$$a^* = \frac{\theta b(S)}{g}. \tag{31}$$

His effort choice is independent of risk σ^2 and risk aversion η, since noise is additive. It is also independent of the fixed wage ϕ, since exponential utility removes wealth effects. Thus, ϕ can be adjusted to satisfy the CEO's participation constraint without affecting his incentives.

Setting the participation constraint (28) to bind, evaluating the expectation on the left-hand side, and equating the exponents yields

$$\phi + \theta E[V] - \frac{1}{2}ga^{*2} - \frac{\eta}{2}\theta^2\sigma^2 = w.$$

Substituting in (31) yields

$$E[c] = \phi + \theta E[V] = w + \frac{\left(\theta b(S)\right)^2}{2g} + \frac{\eta}{2}\theta^2\sigma^2. \tag{32}$$

From (27), the principal's objective function is $E\left[S + b(S)a^* - c\right]$. Substituting in (31) and (32) yields an objective function of

$$S + \frac{\theta}{g}\left[b(S)\right]^2 - w - \frac{\left(\theta b(S)\right)^2}{2g} - \frac{\eta}{2}\theta^2\sigma^2.$$

The first-order condition with respect to θ yields

$$\frac{[b(S)]^2}{g} - \frac{\theta b(S)^2}{g} - \eta\theta\sigma^2 = 0$$

and so the optimal level of incentives is

$$\theta = \frac{1}{1 + g\eta\left(\frac{\sigma}{b(S)}\right)^2}. \tag{33}$$

Optimal incentives θ are a trade-off between two forces. A sharper contract increases effort $a^* = \frac{\theta b(S)}{g}$ and thus firm value, but also increases disutility $\frac{1}{2}ga^{*2}$ and the risk premium $\frac{\eta}{2}\theta^2\sigma^2$. Thus, θ is decreasing in risk aversion η and risk σ^2 as these augment the required risk premium. The effect of the cost of effort g is more nuanced. On the one hand, fixing a^*, the required incentives are $\theta = \frac{a^* g}{b(S)}$ and increase in g. On the other hand, when effort is costlier to implement (g is higher), the optimal effort level a^* is lower. The second effect dominates: when effort is costlier, an increase in θ leads to a smaller rise in effort, and so the optimal θ falls. (Since the benefit of effort $b(\cdot)$ has the opposite effect of the cost of effort g, we discuss only the latter throughout.) Eq. (33) also highlights that the relevant measure of risk for determining incentives depends on the production function. With a multiplicative production function ($b(S) = S$), the relevant measure of risk is $\frac{\sigma}{S}$, the volatility of the firm's percentage returns; with an additive production function it is σ, the volatility of the firm's dollar returns.

To find fixed pay ϕ, we set the participation constraint to bind ($\widehat{c}(a) = w$). This yields

$$\phi = w - \theta S - \frac{1}{2}\frac{(\theta b(S))^2}{g} + \frac{\eta}{2}\theta^2\sigma^2 \ .$$

The comparative statics for ϕ are ambiguous. On the one hand, a higher cost of effort g, higher risk aversion η, and higher risk σ^2 increase the required fixed pay ϕ as a compensating differential (i.e., to ensure the IR remains satisfied). On the other hand, these changes also reduce the optimal level of incentives (from (33)), which lowers the risk premium.

The HM framework is attractive for a number of reasons. First, it derives (rather than assumes) a linear contract as being optimal. Second, it solves for not only the optimal contract to implement a given effort level, but also the optimal effort level, i.e., both stages of Grossman and Hart (1983). Third, the fixed salary ϕ does not affect the CEO's effort choice. Thus, changes in reservation utility can be simply met by varying ϕ, without changing incentives. However, HM stress that a number of assumptions were necessary for their linearity result: exponential utility, a pecuniary cost of effort, Normal noise, and continuous time. Hellwig and Schmidt (2002) show that linearity continues to hold in discrete time under two additional assumptions: the principal does not observe the time path of profits (only the total profit in the final period), and the CEO can destroy profits before he reports them to the principal.[32]

3.2.4 Fixed target action

In HM, the effort level $a^* = \frac{\theta b(S)}{g}$ is chosen endogenously. As described in Section 3.2.1, an alternative specification is for the action space to be bounded above by $\overline{a}$ and the principal to implement a fixed target action $\overline{a}$. The optimal contract is now $\theta b(S) = g\overline{a}$, which leads to very different empirical implications. The level of incentives $\theta b(S)$ arises from the desire to induce effort $\overline{a}$, and not any trade-off with disutility or risk. Thus, only the first effect of g exists – a higher cost of effort raises the incentives required to induce $\overline{a}$ – and so incentives are increasing in g, in contrast to HM. They are also increasing in the target effort $\overline{a}$, but independent of η and σ^2, since the contract is not determined by any trade-off with these parameters. Consistent with this, the cross-sectional correlations shown in Section 2.3.2 and prior studies (surveyed in Section 3.2.5) suggest that the empirical relationship between risk and incentives is complex and ambiguous.

If the fixed action model accurately represents reality, it has the attractive practical implication that incentives do not depend on the CEO's risk aversion, which is typically hard to observe. In addition, we now have unambiguous predictions for how increases in risk σ^2 and risk aversion η affect the level of pay. There is now only the direct effect, that pay rises as a compensating differential, but no indirect effect because these parameters do not affect the optimal effort level. Consistent with this, the evidence in Section 2.1.1 shows a strong positive correlation between volatility and the level of pay.

Whether the endogenous or fixed action model is more realistic depends on the setting. In many cases, the endogenous action case is more accurate as principals choose to implement less-than-full effort to save on wages. For example, a factory boss may only require a production operative to work an eight-hour day, to avoid paying overtime. However, for CEOs, a fixed action may be more appropriate. Edmans and Gabaix (2011b) show that, if CEO effort has a multiplicative effect on firm value, implementing full productive efficiency $\overline{a}$ is optimal if the firm is large enough. (The result holds for any unboundedly increasing function $b(S)$.) The benefits of effort are a function of firm size; the cost of effort (a higher wage to compensate for risk and disutility) is a function of the CEO's reservation wage w. Thus, if S is sufficiently large compared to w, the benefits of effort dominate the trade-off and it is optimal to induce full productive efficiency regardless of g, η or σ^2. For example, in a \$10bn firm, if implementing effort level $\overline{a} - \xi$ rather than $\overline{a}$ reduces firm value by only 0.1%, this translates into \$10m. If the CEO's salary is \$10m, then even if salary can be reduced by 50% by allowing the

[32] See Edmans and Gabaix (2016) for a discussion of the role played by the first three assumptions.

CEO to exert only $\bar{a} - \xi$, implementing $\bar{a}$ remains optimal. The fixed action model more likely applies to CEOs than rank-and-file employees, who have a more limited effect on firm value.

The overall point that we would like to stress is not that one model is superior to the other. Different models apply to different scenarios. Rather, we wish to highlight how a contracting model's empirical implications hinge critically on the assumptions – whether we specify multiplicative versus additive production or preference functions, or a fixed versus endogenously chosen action. Sometimes, researchers may assume a binary action space or additive functions out of convenience, but these modeling choices can lead to vastly different predictions.

3.2.5 Evidence

We now turn to tests of the empirical predictions of these models.

Level of incentives. Section 2.3.1 shows CEOs' and other top executives' effective percentage ownership ($–$ incentives) in the 50 largest U.S. firms for 1936–2005 and in S&P 500 firms for 1992–2014. The level of percentage ownership is small throughout. The typical S&P 500 CEO has an effective percentage ownership of only 0.37% in 1992, which decreases to 0.34% by 2014. Jensen and Murphy (1990a), who measure incentives in large publicly traded U.S. firms from 1974 to 1986, find an average ownership percentage of 0.325%. Motivated by traditional additive models, they interpret this stake as too low to be reconciled with optimal contracting, and thus conclude that CEOs are "paid like bureaucrats". However, to make this assessment, we need to compare this stake to the sensitivity predicted by a model. Even if we assume an additive model (and so $–$ incentives are relevant), theory predicts that incentives should be $\frac{g\bar{a}}{b(S)}$ or $\frac{1}{1+g\eta\left(\frac{\sigma}{b(S)}\right)^2}$, but parameters such as the cost of effort g are difficult to quantify. Haubrich (1994) suggests that the magnitudes found in Section 2.3.1 and by Jensen and Murphy (1990a) can be optimal if the CEO is sufficiently risk-averse, but attaches wide confidence intervals to his conclusion given the difficulties in calibration.

If CEO effort has a multiplicative effect on firm value, it is dollar ownership ($–% incentives), rather than percentage ownership, that is relevant. Section 2.3.1 also reports CEOs' and other executives' effective dollar ownership. Even though executives' percentage ownership is small, their dollar ownership is large – the effective dollar ownership of the median S&P 500 CEO was $19 million in 1992 and $67 million in 2014. This means that CEOs stand to gain millions from good firm performance and lose millions from poor performance, a point first made by Hall and Liebman (1998). High dollar ownership and low percentage ownership suggest that CEOs are well motivated to take actions with a multiplicative effect on firm value (e.g., reorganizing the firm), but badly motivated to take actions with additive effects (e.g., refraining from consuming perks). Edmans et al. (2009) suggest that these additive actions are best corrected via direct monitoring, rather than incentives.

Cross-sectional variation in incentives. Given the difficulties of quantifying parameters such as g to calculate the optimal level of incentives, incentive theories are typically tested instead in terms of their cross-sectional predictions – whether they vary with parameters such as S, g, η and σ^2 as predicted. It is important for empirical tests to study the precise measure of incentives predicted by the theory. For example, if the theory is a multiplicative model that predicts how the dollar equity stake θS varies with g, η, and σ^2, studying the percentage stake θ is not a valid test of the model as these parameters vary with firm size S. Similarly, depending on the production function, the relevant measure of risk may be the volatility of the firm's percentage returns or of its dollar returns.

We start with HM's prediction that incentives θ are decreasing in risk σ. While Lambert and Larcker (1987), Aggarwal and Samwick (1999a), and Jin (2002) find a negative relationship, Core and Guay (1999), Oyer and Schaefer (2005), and Coles et al. (2006) document a positive one, and Garen (1994), Yermack (1995), Bushman et al. (1996), Ittner et al. (1997), Conyon and Murphy (2000), Edmans et al. (2009), and Cheng et al. (2015) show either no relationship or mixed results. The mixed results arise, in part, because of differences in the measurement of incentives (effective percentage versus dollar ownership) and risk (Aggarwal and Samwick, 1999a and Jin, 2002 study the volatility of dollar returns; the other papers study percentage returns).

Our own empirical analysis in Section 2.3.2 confirms the mixed results. We find a positive correlation between percentage volatility and CEOs' percentage ownership, a negative correlation between dollar volatility and percentage ownership, and no correlation between percentage volatility and dollar ownership (once we control for stock return performance and industry). Thus, the evidence points to a fairly weak relationship between risk and incentives. The fixed action model of Section 3.2.4 provides a potential explanation: risk is second-order compared to the benefits of effort – it is incentive considerations, not risk considerations, that determine the slope of the contract.

Alternatively, volatility might be correlated with other firm characteristics that affect the optimal level of incentives. For example, Smith and Watts (1992) argue that growth opportunities make it difficult for shareholders to know the value maximizing strategy and thus to know whether executives are choosing it. Shareholders might react by increasing executives' equity incentives in growth firms, which tend to also have high volatility. In the same vein, Demsetz and Lehn (1985) and Prendergast (2002) argue that more risky and uncertain environments increase shareholders' monitoring costs. Hence, if incentives and monitoring are substitutes, volatility might reduce the optimal level of monitoring and increase the optimal level of incentives.

The prediction that θ is decreasing in risk aversion η is harder to test as risk aversion is unobservable. Becker (2006) uses data on CEO wealth, available in Sweden, as a (negative) proxy for risk aversion under the assumption of decreasing absolute risk aversion. As predicted, he finds that wealth is positively related to both percentage ownership ($–$ incentives) and dollar ownership ($–% incentives), although the results are only significant at the 10% level.[33] However, wealth can affect incentives through channels other than risk aversion. In the Edmans and Gabaix (2011b) fixed action model, the contract is not driven by a trade-off with risk aversion. Higher wealth instead reduces the CEO's marginal utility from money, and so greater incentives are required to induce him to work.

Cross-sectional variation in pay levels. The theories also make predictions for expected pay $E[c]$, usually measured as the level of pay in empirical studies. Firm risk and the cost of effort have an ambiguous effect on the level of pay in the HM model, but increase it in the fixed action model due to the required compensating differential. Garen (1994) shows that salaries are insignificantly increasing in firm risk as measured by dollar volatility, and insignificantly decreasing in percentage volatility. Cheng et al. (2015) find a significant positive relationship between total pay and percentage volatility for financial firms. Our empirical analysis in Section 2.1.1 shows a strong positive relationship between volatility and pay for all firms.

Greater agency problems in large firms may necessitate higher equity incentives and thus more pay as a risk premium (Gayle and Miller, 2009). Our analyses in Sections 2.1.1 and 2.3.2 confirm that firm size is strongly positively related to both CEO pay levels and their effective dollar ownership. Conyon et al. (2011) and Fernandes et al. (2013) compare CEO pay in the U.S. to the rest of the world and argue that the pay premium to U.S. CEOs is justified by their greater equity exposure. Similarly, the structural estimation of Gayle et al. (2015) suggests that risk premia can explain over 80% of the pay differential between small and large firms. Risk premia differences arise in their model both because large firms require greater incentives to address moral hazard, but also because stock returns are a poorer signal of effort in large firms. It is an open question whether pay differentials between small and large firms are mostly due to stronger incentives in larger firms, as argued by Gayle et al. (2015), or due to talent matching, as argued by Gabaix and Landier (2008).

[33] HM assume constant absolute risk aversion utility, so risk aversion is independent of wealth. Sannikov (2008) allows for general utility functions, and thus for absolute risk aversion to decrease in wealth, and generally predicts that incentives fall with risk aversion by the same intuition as in HM.

3.3 Incentives in market equilibrium

3.3.1 Theory

Section 3.2 has taken the reservation wage w as given. We now endogenize w using the assignment model of Gabaix and Landier (2008) to study how CEO incentives vary across firms in market equilibrium. We use the Edmans et al. (2009) framework of a risk-neutral CEO, multiplicative preferences and a fixed target action, as in Section 3.2.1, with $a^* = \overline{a}$. We will show that even this simple model leads to predictions consistent with empirical findings. (Edmans and Gabaix, 2011a extend the model to risk aversion.)

From (16), we have $\theta = \frac{\Lambda w}{S}$ where $\Lambda = g'(a^*)$. The fixed salary ϕ is chosen so that the IR binds, i.e., $\phi = w - \theta S = w(1 - \Lambda)$. Thus, the CEO in firm n is given a fixed salary ϕ^*, and θS worth of shares, with:

$$\theta_n S_n = w(n)\Lambda, \tag{34}$$

$$\phi_n = w(n)\left(1 - \Lambda\right), \tag{35}$$

where $w(n)$ is given by Eq. (4) from Section 3.1.1. Thus, a fraction Λ of the equilibrium wage is paid in equity, and the remainder is paid in cash.

We can now solve for the three incentive measures in Eqs. (17)–(19) in terms of model primitives:

$$\theta^I = \Lambda \propto S^0 \tag{36}$$

$$\theta^{II} = \Lambda \frac{w}{S} \propto S^{\rho-1} \tag{37}$$

$$\theta^{III} = \Lambda w \propto S^{\rho}. \tag{38}$$

Eq. (16) earlier suggested that, in a multiplicative model, the correct incentive measure is θ^I (%–% incentives) since it determines the implemented effort level. Eq. (36) illustrates a related advantage: in a multiplicative model, θ^I is independent of firm size and thus comparable across firms of different size. This comparability is useful. For example, a non-activist investor who believes that incentives are not fully priced in the market may wish to invest in a stock with high CEO incentives; an activist investor may wish to target a firm with low incentives. However, if the CEO of a large firm has \$2m of equity and the CEO of a smaller firm has \$1m of equity, we cannot conclude which CEO is better incentivized as dollar equity holdings optimally increase with firm size. Comparability is also valuable for boards or compensation consultants undertaking benchmarking analyses.

While %–% incentives should be independent of size, with $\rho = \gamma - \beta/\alpha = 1/3$ as in Gabaix and Landier (2008), Eq. (37) shows that \$–\$ incentives (i.e., the effective percentage ownership) should have a firm-size elasticity of $\rho - 1 = -2/3$. If effort has a multiplicative effect on firm value, it has a higher dollar effect in a larger firm, and so a lower percentage stake is needed to induce effort. In addition, Eq. (38) shows that \$–% incentives (i.e., the effective dollar ownership) should have an elasticity of $\rho = 1/3$. Larger firms hire more talented CEOs who command higher wages. Since the benefits of shirking are higher, given multiplicative preferences, a higher dollar equity stake is needed to induce effort.

In addition to how incentives scale with firm size, Eqs. (36) and (37) also have implications for the absolute level of incentives. \$–\$ incentives (effective percentage ownership) are given by $\theta^{II} = \theta^{I} \frac{w}{S}$. Since firm size S is substantially larger than the CEO's wage w, \$–\$ incentives should be low. Especially for large firms, the dollar benefits of effort are likely to be much greater than the disutility cost to the CEO, and so only a small equity stake is needed to induce effort.

3.3.2 Evidence

In a multiplicative model, CEO effort has a larger dollar effect in a bigger firm, so a smaller percentage equity stake is required to induce effort. A negative correlation between firm size and CEOs' effective percentage ownership has been documented by Jensen and Murphy (1990a), Garen (1994), Schaefer (1998), Baker and Hall (2004), and many others. Edmans et al. (2009) quantitatively predict a firm-size elasticity of $-2/3$, consistent with their empirical estimate of -0.61. Similarly, Edmans et al. (2009) find that %–% incentives are independent of firm size, and that effective dollar ownership (\$–% incentives) has a size-elasticity of 0.39, close to the predicted value of 1/3. These results suggest that a model with multiplicative utility and production functions can quantitatively explain the size-scalings of incentives.

Our own analysis in Section 2.3.2 finds a less negative firm-size elasticity of CEOs' percentage ownership of about -0.35, and a more positive firm-size elasticity of CEOs' dollar ownership of about 0.55. There are two reasons for these differences: First, our analysis includes large-cap, medium-cap, and small-cap firms, while Edmans, Gabaix, and Landier's estimates are for the largest 500 firms in each year only, consistent with the model's use of extreme value theory. Second, we measure CEOs' percentage ownership as percentage of equity, while Edmans, Gabaix, and Landier measure it as percentage of aggregate firm value. Hence, the differences suggest that CEOs' effective dollar (percentage) ownership increases less fast (decreases faster) with firm size for larger firms, and that these firm-size elasticities change with corporate leverage.

3.4 Additional performance signals and relative performance evaluation

The informativeness principle of Holmström (1979) states that any signal that is incrementally informative about the CEO's effort should be included in his contract. This result has two implications: First, signals correlated with performance components *unrelated* to the CEO's actions can be used to remove noise and improve the informativeness of the performance measure. Second, the use of signals that are directly correlated with CEOs' actions, such as accounting earnings or sales, can improve incentive contracts. We discuss both mechanisms in this section.

3.4.1 Relative performance evaluation: theory

When deducing executive actions from firm performance, the principal should ignore, or filter out, performance components caused by factors beyond the executive's control, such as the state of the overall economy (Holmström, 1979, 1982; Diamond and Verrecchia, 1982). Hence, if CEOs' performance is affected by common exogenous shocks, CEOs should be evaluated on the basis of their performance relative to their peer group. Peer performance is informative about the degree to which high firm value V is due to high effort or due to good luck and allows filtering luck from the performance signal.

Motivated by evidence showing at best incomplete relative performance evaluation ("RPE") in executive pay, the literature has proposed several theories that explain incomplete benchmarking as an efficient contracting outcome. Aggarwal and Samwick (1999b) argue that the desire to soften competition in oligopolistic industries generates compensation contracts that place positive weight on rival firm performance. Hansen and Lott (1996) and Antón et al. (2017) suggest that investors who own stakes in multiple firms in the same industry strengthen this effect. Jin (2002), Jenter (2002), and Garvey and Milbourn (2003) suggest that benchmarking performance against industry peers or the market is unnecessary if executives can trade the industry or market index. Barro and Barro (1990) and Himmelberg and Hubbard (2000) propose that the marginal product of CEO talent and effort, and therefore CEOs' equilibrium pay, covaries positively with industry and market conditions. Oyer (2004) suggests a model where adjusting compensation contracts is costly and executives' outside opportunities are correlated with market conditions. Paying executives with standard, nonindexed equity instruments allows the value of their pay to vary with their outside opportunities, saving on renegotiation costs. Dye (1992) and Gopalan et al. (2010) argue that not indexing an executive to industry performance induces him to choose the firm's industry exposure optimally. In Hoffmann and Pfeil (2010) and DeMarzo et al. (2012), a positive shock indicates high future profitability and makes termination more inefficient. As a result, the optimal contract offers the CEO higher promised utility, thus rewarding him for luck. DeMarzo and Kaniel (2016) and Liu and Sun (2016) show that, when executives have relative wealth concerns, it is optimal for firms to pay them for general industry upswings to ensure that their pay does not lag their industry peers.

While Holmström (1979, 1982) derives the optimality of RPE under no contracting constraints, a second set of papers shows that real-world constraints on contracting may lead RPE to be no longer optimal. For example, a preference for simplicity can lead to the use of piecewise linear contracts – indeed, cash, stock, and options are typically used in practice.[34] Dittmann et al. (2013) study the effect of indexation when contracts are restricted to these instruments and show that the indexation of options can destroy incentives. Since an indexed option is in the money only if the stock price rises high enough to outperform the benchmark, indexation is tantamount to increasing the strike price of the option and reducing the drift rate of the underlying asset. Both effects reduce the option's delta and thus incentives. To preserve incentives, additional equity must be given, and their calibration shows that full indexation of all options would increase compensation costs by 50% on average. If firms choose the optimal proportion of options to index, average compensation costs would only fall by 2.3%, and 75% of firms would choose zero indexation. They show that indexing stock also has little benefit. The optimal contracting model of Chaigneau et al. (2017a) shows that reducing the volatility of the performance measure, through indexation or any other means, can lower the CEO's incentives. With limited liability, the CEO is paid zero if performance is below a threshold, and a positive and increasing amount above the threshold. Thus, if the performance measure ends up below the threshold, the CEO does not gain from marginal improvements in performance. If the threshold is high (e.g., the CEO has out-of-the-money options), a fall in volatility lowers incentives because it reduces the likelihood of beating the threshold and being rewarded for marginal increases in effort.

3.4.2 Relative performance evaluation: evidence

The evidence on the use of RPE in executive pay is mixed. One the one hand, a long list of studies shows that CEO pay and changes in CEO wealth are affected by industry and market performance and other shocks that are beyond CEOs' control (Murphy, 1985; Coughlan and Schmidt, 1985; Antle and Smith, 1986; Gibbons and Murphy, 1990; Janakiraman et al., 1992; Garen, 1994; Aggarwal and Samwick, 1999a, 1999b; Murphy, 1999; Bertrand and Mullainathan, 2001). The strongest evidence against RPE comes from studies of CEO wealth changes, which are driven by revaluations of stock and option holdings. Because the equity granted to executives are not indexed against any peer group, CEO wealth is strongly affected by exogenous shocks to equity values.[35]

On the other hand, several studies provide evidence that RPE against specific peer groups is in fact used in CEO pay contracts. Albuquerque (2009) argues that relevant peers are not only firms in the same industry, but also those of similar size. When defining firms according to both industry and size, she finds significant evidence for RPE. Rather than assuming a peer group, Lewellen (2015) hand-collects the peers that firms report as their primary product market competitors in their 10-Ks, and also finds evidence for RPE. Even more directly, Gong et al. (2011) study the explicit use of RPE

[34] See Gabaix (2014) for a sparsity-based model where agents have a preference for simplicity.

[35] CEO firing decisions also appear to be affected by industry and market performance (Jenter and Kanaan, 2015).

in compensation contracts, based on the disclosure of peer firms and performance measures mandated by the SEC in 2006. They find that 25% of S&P 1,500 firms explicitly use RPE. Bettis et al. (2016) find that 48% of firms granting performance-based equity in 2012 used at least one relative performance metric. De Angelis and Grinstein (2017) show that, among firms using RPE, 88% measure the rank performance of the CEO relative to peers. Most empirical studies instead measure the difference between firm and peer performance, implicitly assuming that contracts are concerned with absolute peer-adjusted performance. Using a rank-based specification, they find significant evidence of RPE.[36]

Hence, a mixed picture emerges: RPE is explicitly used in many executive contracts, and many firms filter the performance of *specific* peer groups when measuring performance for compensation purposes. However, many large and obvious exogenous shocks (e.g., market returns, oil prices) are not filtered out, and so CEO pay, and especially CEO wealth, remain heavily (and seemingly unnecessarily) exposed to forces beyond CEOs' control. It is an open question to what extent, if any, this exposure is a sign of inefficient contracting.

3.4.3 Additional performance signals: theory

Stock returns are an attractive measure of executive performance because equity valuations are forward-looking. If investors are well-informed and markets efficient, then stock prices should reflect the effect of managers' current actions on expected long-term value creation. The informativeness principle, however, implies that optimal contracts should utilize any other signal that is incrementally informative about executives' actions. Even if stock price maximization is the principal's objective, stock prices are an extremely noisy measure of executives' actions and performance. This noise implies that there are benefits to supplementing stock prices with other signals, such as accounting numbers, in executive contracts (Lambert and Larcker, 1987). Intuitively, even if stock prices aggregate information about firm values efficiently, they are likely to aggregate information about managers' actions inefficiently and inconsistently (Paul, 1992; Bushman and Indjejikian, 1993; Lambert, 1993; Feltham and Xie, 1994; Core et al., 2003b).

The informativeness principle was derived assuming no constraints in contracting. Chaigneau et al. (2017b) show that with limited liability, the optimal contract might

[36] In addition, De Angelis and Grinstein (2017) examine the motives for RPE. The standard agency explanation, based on the informativeness principle, argues that RPE is used to filter out exogenous shocks, in which case RPE-based awards should be paid in cash; in contrast, they find that they are typically given in stock. The authors analyze a typically understudied motive, based on labor market and retention motives rather than moral hazard: relative performance reveals the CEO's talent, and so higher pay is necessary to retain him (Gibbons and Murphy, 1990). Consistent with this hypothesis, they find that RPE awards vest over time, and so are only paid if the CEO remains with the firm, and are also more prevalent where CEO talent is more transferable.

ignore signals that are informative about CEO effort. If the stock price is sufficiently low, it is sufficiently likely that the CEO has shirked, so he is fired and paid zero. Even if a signal provides incremental information that the CEO has shirked, it cannot be used to reduce his pay further. Thus, signals only have value where constraints on contracting do not bind. If a contract is driven by constraints (as in Innes, 1990), a signal could be informative almost everywhere yet not be used in the contract.

Banker and Datar (1989) identify necessary and sufficient conditions on the joint probability distribution of performance signals such that the optimal incentive contract is based on a linear combination of those signals. They predict that the relative weight on each performance measure is determined by how much noise the measure contains and by how sensitive it is to the CEO's actions. A signal's sensitivity is the extent to which its expected value changes with the CEO's action, adjusted for the correlation with other signals that also change with the action. In the optimal contract, the relative weight on each signal is proportional to the ratio of this sensitivity to the signal's conditional variance, i.e., proportional to the performance measures' "signal-to-noise" ratio.

3.4.4 Additional performance signals: evidence

Performance signals other than stock returns are widely used in executive pay. Many top executives participate in bonus plans whose payouts are a function of one or more measures of accounting performance, such as earnings per share, operating income, or sales (Murphy, 1999, 2000; De Angelis and Grinstein, 2015; see also Section 2.3.4). In addition, the use of performance-based equity, whose vesting depends on firm performance, has increased rapidly in recent years. Accounting-based performance metrics are used more frequently than stock-price based metrics in these grants, and the use of accounting metrics has increased over time (Bettis et al., 2016; see also Section 2.3.3).

Lambert and Larcker (1987), Sloan (1993), and Ittner et al. (1997) examine whether the relative use of stock price and accounting measures of performance in CEO pay is related to the level of "noise" in those signals. Consistent with the predictions of Banker and Datar (1989), CEO pay is relatively more strongly related to stock price performance, and less strongly to accounting performance, if the variance of accounting performance is high relative to the variance of stock returns. However, these studies focus on pay-performance sensitivities instead of wealth-performance sensitivities. Core et al. (2003b) find that, in contrast to the prior literature, and inconsistent with the predictions of Banker and Datar (1989), changes in CEO wealth are relatively more sensitive to stock prices if the stock return variance is high relative to the variance of accounting performance.

De Angelis and Grinstein (2015) examine the performance metrics used in performance-based cash and equity awards by S&P 500 firms. Most awards are based on accounting performance measures, usually income- or sales-based measures. Larger firms and firms with more growth opportunities rely more heavily on stock price-based measures, while more mature firms rely more heavily on accounting-based measures. They interpret these patterns as firms choosing performance measures that are more informative of CEO effort. For example, in growth firms, CEO effort is more likely to be reflected in forward-looking stock price changes than in year-end accounting numbers.

3.5 Stock vs. options

The models of Section 3.2 predict that executives' wealth should be sensitive to the stock price, but generally do not specify whether this sensitivity should be provided by stock or options (or any other instrument). The trade-off is as follows. On the one hand, $1 of options provide a higher delta (i.e., a higher wealth-performance sensitivity) than $1 of stock. On the other hand, options pay off in "high" states of the world in which risk-averse executives' marginal utility is low, which causes the ex-ante incentives created per unit of delta to be smaller for options than for stock (Jenter, 2002). Moreover, since option values are more volatile, $1 of options is worth less to the executive than $1 of stock, rendering them less effective in meeting the executive's participation constraint. Which considerations dominate is a quantitative question. Hall and Murphy (2002), Jenter (2002), and Dittmann and Maug (2007) answer it by calibrating a standard agency model with constant relative risk aversion utility and lognormal firm value[37] and find that the disadvantages of options dominate, suggesting that the optimal contract should use only stock and no options. Moreover, when Dittmann and Maug (2007) drop the restriction that the contract must be piecewise linear (i.e., consist of salary, stock, and options), they find that the optimal nonlinear contract is concave. Using a different model, Holmström and Milgrom (1987) predict linear contracts, which again suggests that incentives should be implemented purely with stock, and not nonlinear instruments such as options. The intuition is that a linear contract subjects the CEO to a constant incentive pressure irrespective of the history of past performance (see Section 3.2.3).

In contrast to both frameworks, option compensation is widespread in the U.S. and many other countries (see Sections 2.2.1 and 2.4). The use of options can be justified if the CEO affects firm risk in addition to effort, by inducing him to take value-adding risky projects. In Smith and Stulz (1985), the CEO takes a single action that reduces risk via hedging. If the CEO is risk averse, he will naturally hedge, but if given stock options he may not, since their convexity counterbalances the concavity of the CEO's utility function. In their model, hedging does not reduce firm value, and may even increase it if there are bankruptcy costs, so option compensation is not optimal. In Edmans and Gabaix (2011a), actions that the CEO undertakes to increase firm value

[37] Moral hazard models with constant relative risk aversion utility and lognormal firm value have also been studied by Lambert et al. (1991), Hall and Murphy (2000), Himmelberg and Hubbard (2000), Hall and Knox (2004), and Oyer and Schaefer (2005).

also increase firm risk, such as risky positive-NPV projects. Thus, it is optimal for the firm to grant the CEO a convex contract to induce efficient risk-taking. Dittmann et al. (2017) calibrate a model where the CEO chooses both effort and risk, and show that it can explain the mix of stock and options found empirically.

However, Carpenter (2000) and Ross (2004) show theoretically, and Lewellen (2006) numerically, that options may not increase the manager's risk-taking incentives: while an option has "vega" (positive sensitivity to volatility), it also has "delta" (positive sensitivity to firm value). Thus, a risk-averse manager may wish to reduce volatility in the value of the firm and thus his options. Shue and Townsend (2017a) evaluate this theoretical debate empirically by showing that increases in options have a positive causal effect on risk taking (see Section 6.2.2).

Option compensation can also be an optimal response to executives' behavioral biases or to executives having non-standard preferences. The calibration of Dittmann et al. (2010) demonstrates that the observed use of options can be rationalized by realistic levels of CEO loss aversion, since options provide downside protection. Chaigneau et al. (2017) show that options can be optimal if the agent is sufficiently prudent (captured by the negative of the ratio of the third and second derivatives of his utility function). Prudence implies a preference for positive skewness, and convex contracts increase the skewness of the distribution of pay. Gervais et al. (2011) consider an overconfident CEO, i.e., one who overestimates the precision of his private signal on investment opportunities. Overconfidence counters risk aversion, because an overconfident manager overestimates the amount of risk that his signal eliminates. Thus, a mildly overconfident manager needs a less convex contract (fewer options) to induce risk. However, when overconfidence becomes sufficiently high, another force starts to dominate – since the manager has confidence in his signal (and thus that he will make correct investment decisions), he overestimates the possibility of right-tail realizations and thus overvalues options. The firm's optimal response is to give the CEO more options to exploit his overvaluation.[38] Consistent with this theory, Humphery-Jenner et al. (2016) measure overconfidence by the extent to which the CEO holds deep in-the-money options after they have become exercisable, and find that more overconfident managers receive more options. However, this result is also consistent with managers having a preference for options for reasons other than overconfidence (e.g., probability weighting or other mechanisms generating a preference for skewness), which leads to them both preferring to hold onto options after they become exercisable, and preferring to be compensated with options rather than other instruments.[39]

[38] Bergman and Jenter (2007) make a related argument in the context of option compensation to employees – firms award employees more options when they overvalue them, although due to sentiment rather than overconfidence in a private signal.

[39] Spalt (2013) uses a calibrated model to argue that probability weighting can explain option grants to non-executive employees.

3.6 Debt vs. equity

3.6.1 Theory

The models in Section 3.5 consider "good" risk-taking that improves firm value. However, the CEO may also have incentives to engage in "bad" risk-taking that reduces firm value. In particular, in a levered firm, an equity-aligned manager may undertake a risky project even if it is negative-NPV, because shareholders benefit from the upside but have limited downside risk due to limited liability (Jensen and Meckling, 1976). Anticipating this, creditors will demand a high cost of debt and/or tight covenants, to the detriment of shareholders.

A potential solution to such risk-shifting is to compensate the CEO with debt as well as equity (Edmans and Liu, 2010). Such debt is referred to as "inside" debt, as it is owned by the manager rather than outside creditors. Previously proposed remedies for risk-shifting include bonuses for achieving solvency, or salaries and private benefits that are forfeited in bankruptcy (e.g., Brander and Poitevin, 1992). These instruments are sensitive to the incidence of bankruptcy, but if bankruptcy occurs, they pay zero regardless of liquidation value. In contrast, inside debt yields a positive payoff in bankruptcy, proportional to the recovery value. Thus, it renders the manager sensitive to firm value in bankruptcy, and not just to the incidence of bankruptcy – exactly as desired by creditors – and thus reduces the cost of raising debt, to the benefit of shareholders. Interestingly, they show the optimal debt-to-equity ratio for the CEO is typically not the firm's debt-to-equity ratio. While equating the ratios minimizes risk-shifting, an equity (debt) bias is optimal to induce effort if effort pays off more in solvency (bankruptcy) states.

For future research, it would be interesting to model the trade-off between inducing executives to take "good" risks and discouraging them from taking "bad" risks. In Smith and Stulz (1985), the firm is unlevered, so there are no risk-shifting concerns; as a result, the contract contains options but no debt. In Edmans and Liu (2010), the CEO is risk-neutral, so there is no problem of inducing him to take "good" risk; the contract contains debt, but not options. To our knowledge, no existing study incorporates both leverage and risk aversion into a model of effort choice and risk-taking, to determine the optimal mix of salary, stock, options, and debt.

3.6.2 Evidence

Many CEOs hold a substantial amount of inside debt through defined benefit pensions and deferred compensation (Sundaram and Yermack, 2007; Wei and Yermack, 2011). These are unsecured obligations that yield an equal claim with other creditors in bankruptcy, and thus constitute inside debt.[40] For example, Sundaram and Yermack (2007) report that GE's Jack Welch had over $100 million of inside debt when he retired in 2001. In banks and other financial institutions, the alignment of executives with debt has gathered pace since the recent financial crisis. In 2010, American International Group tied 80% of highly paid employees' pay to the price of its bonds, and 20% to the price of its stock; UBS and Credit Suisse have since started paying bonuses in bonds; and Royal Bank of Scotland pays most of its deferred compensation in bonds.

Because inside debt is an endogenous choice variable, establishing its causal effect on executive behavior is a challenge. Using defined benefit pensions and deferred compensation as a measure of inside debt, Sundaram and Yermack (2007) find a positive correlation between executives' debt-alignment and firms' distance to default. After an increase in mandated disclosure, bond prices increased and equity prices decreased at the revelation of significant inside debt holdings by CEOs (Wei and Yermack, 2011). Inside debt is also associated with lower stock return volatility, R&D expenditures, and financial leverage (Cassell et al., 2012), and with lower bond yields and fewer covenants (Anantharaman et al., 2014). However, without credible instruments for inside debt, interpreting these correlations is difficult. Finally, Campbell et al. (2016) provide suggestive evidence that shareholder value rises when a CEO's inside debt level moves closer to those at peer firms with similar characteristics. However, without knowing why firms deviated from their peers in the first place, this result is also difficult to interpret.

3.7 Dynamic models and the horizon of pay

Many of the moral hazard models discussed so far are static, one-period models. In reality, CEOs are employed for several years, and there is uncertainty about when the employment relationship will end. A dynamic setting leads to additional questions, such as how to spread the rewards for good performance over time, how the level and sensitivity of pay vary over time, and when the CEO quits or is fired. While there are a number of dynamic models, all with their own particular frameworks, they tend to share several general results.

To illustrate some of the forces, we present a simple example from Edmans et al. (2012), which is a tractable model that yields closed-form solutions.[41] We first consider a model in which the CEO has log utility with no discounting, works for three periods, and then immediately retires. We assume that the implemented action a_t^* is a constant a^* across periods, and we normalize the marginal cost of effort $g'(a^*)$ to 1. Defining r_t

[40] For defined benefit pensions and deferred compensation to be inside debt, it is important that firms do not shield these claims from creditors by, e.g., funding bankruptcy-remote trusts (Bebchuk and Jackson, 2005).

[41] Like almost all dynamic contracting models, we assume that the principal can commit to the contract.

as the firm's stock return in period t, the optimal contract is given by

$$\begin{aligned} \ln c_1 &= \frac{r_1}{3} + \kappa_1, \\ \ln c_2 &= \frac{r_1}{3} + \frac{r_2}{2} + \kappa_2, \\ \ln c_3 &= \frac{r_1}{3} + \frac{r_2}{2} + \frac{r_3}{1} + \kappa_3, \end{aligned} \tag{39}$$

where κ_t is a constant. An increase in r_1 increases log consumption (i.e., utility) not only in the current period, but also all future periods – it rises by $\frac{r_1}{3}$ in all periods. In addition, the pay-performance sensitivity $\theta_t = \frac{\partial \ln c_t}{\partial r_t}$ increases over time, from 1/3 to 1/2 to 1/1. The total lifetime reward for effort is a constant 1 in all periods.

We next consider the case in which the CEO still works for three periods, but lives for five periods. The optimal contract is now

$$\begin{aligned} \ln c_1 &= \frac{r_1}{5} + \kappa_1, \\ \ln c_2 &= \frac{r_1}{5} + \frac{r_2}{4} + \kappa_2, \\ \ln c_3 &= \frac{r_1}{5} + \frac{r_2}{4} + \frac{r_3}{3} + \kappa_3, \\ \ln c_4 &= \frac{r_1}{5} + \frac{r_2}{4} + \frac{r_3}{3} + \kappa_4, \\ \ln c_5 &= \frac{r_1}{5} + \frac{r_2}{4} + \frac{r_3}{3} + \kappa_5. \end{aligned} \tag{40}$$

Since the CEO takes no action from $t = 4$, his pay does not depend on r_4 or r_5. However, it depends on r_1, r_2, and r_3 as his earlier efforts affect his wealth, from which he consumes. The possibility of private saving changes the constants κ_t, but not any other features of the contract.

This example illustrates forces that are at work in many dynamic models:

Deferred reward. A high stock return in a particular period boosts the CEO's income not only in that period, but also in all future periods. Since the CEO is risk averse, it is efficient to spread out the reward for good performance (or punishment for poor performance) across all future periods – including post-retirement – to achieve consumption smoothing. This result was first derived by Lambert (1983) and Rogerson (1985) who consider a two-period model, and is featured in the multi-period model of Edmans et al. (2012).

Increasing incentives. The sensitivity θ_t of current income c_t to the current stock return r_t generally increases over time. The mechanism behind this result varies across models. In Gibbons and Murphy (1992), the CEO's motivation to exert effort stems not only from financial incentives, but also reputational concerns. As he approaches retirement, career concerns weaken, and so financial incentives must strengthen. In the adverse selection model of Garrett and Pavan (2015), implementing high effort in low-productivity workers requires paying higher compensation to high-productivity workers to deter them from mimicking the former. These informational rents are greatest at the start of the relationship, and so the principal optimally implements low effort early on and high effort later, which entails a rising sensitivity over time. In Edmans et al. (2012), the lifetime reward for effort (increase in utility due to higher income in the current and all future periods) must be sufficient to induce effort. As the CEO approaches retirement, there are fewer periods over which to spread this lifetime reward, and so the reward in the current period must be higher.[42] For example, in the contract in (39), if the CEO increases r_1 by 1, he is rewarded by an increase in his lifetime utility by 1; this is achieved by increasing his utility by 1/3 in each of periods 1, 2, and 3. If he increases r_3 by 1, there are no future periods over which to spread out his reward, so his utility rises by 1 in period 3.

Private saving. Some dynamic models allow for the CEO to engage in private saving. This creates additional complexity since, by saving, the CEO can achieve a different consumption profile from the income profile provided by the contract. In standard models without private saving (e.g., Rogerson, 1985), the optimal wage profile is front-loaded, but such a profile will induce the CEO to save to insure himself against future income shocks; moreover, such insurance may in turn reduce effort incentives. Edmans et al. (2012) show that permitting private saving does not affect the sensitivity of pay to performance θ_t (as it depends only on the marginal cost of effort and number of periods until retirement), but does affect the level of pay (the intercept κ_t). When private saving is possible (i.e., the principal cannot observe the CEO's saving decision), the growth rate of consumption is higher than when it is impossible. This faster upward trend means that the contract effectively saves for the CEO, removing the need for him to do so himself. Moreover, the growth rate is increasing in the risk to which the CEO is exposed, and thus his incentives θ_t and firm volatility σ. Since θ_t rises over time, this means the growth rate of consumption increases, and hence pay accelerates over time.[43] He (2012) similarly finds that the wage profile must be back-loaded to deter private saving, in contrast to the front-loaded profile of Rogerson (1985). He also finds

[42] The only case in which this does not happen is an infinite horizon model, in which the number of future periods does not change with t, and so incentives are constant.

[43] Lazear (1979) has a back-loaded wage pattern for incentive, rather than private saving considerations (the agent is risk-neutral in his model). If wages increase with tenure, the agent exerts effort to avoid being fired and ensure he receives the high future wages. Similarly, in Yang (2009), a back-loaded wage pattern induces agents to work to avoid the firm being shut down.

that pay does not fall upon poor performance but exhibits a permanent rise after a sufficiently good performance history.[44]

3.7.1 Short-termism

Edmans et al. (2012) also extend the model to allow the CEO to engage in short-termism (in addition to effort and private saving), and study how this possibility affects the optimal contract. Short-termism is broadly defined to encompass any action that increases current returns at the expense of future returns – scrapping positive-NPV investments that reduce short-term performance (Stein, 1988), taking negative-NPV projects that boost short-term performance, earnings management, and accounting manipulation. Consider the case in which action $m_t \geq 0$ increases the current return to $r_t' = r_t + M(m_t)$ and reduces the next-period return to $r_{t+1}' = r_{t+1} - m_t$, where $M'(0) \in [0, 1)$ is related to the marginal inefficiency of myopia and $M''(\cdot) < 0$. If the firm is sufficiently large, the principal will wish to implement zero manipulation. The contract in (40) now changes to:

$$\begin{aligned}
\ln c_1 &= \frac{r_1}{5} + \kappa_1, \\
\ln c_2 &= \frac{r_1}{5} + \frac{r_2}{4} + \kappa_2, \\
\ln c_3 &= \frac{r_1}{5} + \frac{r_2}{4} + \frac{r_3}{3} + \kappa_3, \\
\ln c_4 &= \frac{r_1}{5} + \frac{r_2}{4} + \frac{r_3}{3} + \frac{M'(0) r_4}{2} + \kappa_4, \\
\ln c_5 &= \frac{r_1}{5} + \frac{r_2}{4} + \frac{r_3}{3} + \frac{M'(0) r_4}{2} + \kappa_5.
\end{aligned} \tag{41}$$

Even though the CEO retires at the end of $t = 3$, his income depends on r_4, otherwise he would have an incentive to boost r_3 at the expense of r_4. Thus, the CEO should retain equity in the firm even after retirement. This result is also found by Marinovic and Varas (2016). For the general case in which manipulation reduces the return H periods into the future, the CEO should be sensitive to firm returns for H years after retirement. This result formalizes the argument of Bebchuk and Fried (2004), who advocate escrowing the CEO's equity to deter him from inflating the stock price before retirement and then cashing out. Deferring equity until after retirement is also recommended by the April 2016 U.K. Corporate Governance Code and already practiced by some companies such as Kingfisher and Unilever.

[44] This downward rigidity is also predicted by Harris and Holmström (1982), but through a quite different channel. Their model features two-sided learning about the agent's ability rather than moral hazard. Downward rigidity in wages insures the agent against negative news about his ability, while wage rises after positive news ensure that he does not quit.

The sensitivity to r_4 depends on the inefficiency of manipulation $M'(0)$; in the extreme, if $M'(0) = 0$, myopia is impossible and there is no need to expose the CEO to returns after retirement. Because there is no discounting, there is no incentive to inflate earnings at $t = 1$ or $t = 2$. The negative effect of myopia on future returns reduces the CEO's lifetime utility by more than the positive effect on current returns increases it. With discounting, incentives increase even faster over time than in the absence of a myopia problem. The higher sensitivity to future returns ensures that myopia causes the CEO to lose enough in the future to counterbalance the effect of discounting.

While Edmans et al. (2012) and Marinovic and Varas (2016) highlight the benefits of long vesting horizons in combating myopia, lengthening vesting periods is not costless. First, doing so exposes the CEO to more risk outside his control. Second, Laux (2012) shows theoretically that, if the CEO forfeits unvested equity upon dismissal, he may engage in myopic actions to avoid the risk of dismissal until his equity has vested. Third, Brisley (2006) demonstrates that if unvested equity ties up a significant portion of the CEO's wealth within the firm, he may turn down risky, value-creating projects.

Several other models feature the possibility of a myopic action and argue that it justifies the low dollar-dollar incentives found in Section 2.3. Benmelech et al. (2010) assume that equity incentives vest in the short-term. As a result, the CEO may conceal information that investment opportunities have declined to keep the current stock price high, even though disclosing such information would allow him to efficiently disinvest. In a similar vein, Peng and Roell (2008, 2014) and Goldman and Slezak (2006) demonstrate that high-powered incentives can encourage the manager to expend firm resources to manipulate the stock price upwards, again under the assumption that any equity granted vests in the short-term. However, these unintended consequences of incentive contracts can potentially be avoided by granting equity with long vesting horizons.

3.7.2 Termination

While the CEO's retirement date is fixed in Edmans et al. (2012), other dynamic models allow for an endogenous end date. The threat of termination upon poor performance provides additional effort incentives in DeMarzo and Sannikov (2006), DeMarzo and Fishman (2007), Biais et al. (2007), He (2012), and Sannikov (2008).[45] The first four models feature limited liability for the agent, which reduces the principal's ability to punish poor performance financially, thus leading to a role for termination. In some

[45] Termination after poor performance is typically not subgame-perfect, so dynamic moral hazard models assume that the firm can commit to terminate the CEO. Learning models predict subgame-perfect termination after poor performance, as such performance signals low managerial quality (e.g., Jovanovic, 1979; Harris and Holmström, 1982; Murphy, 1986; Gibbons and Murphy, 1992; Hermalin and Weisbach, 1998; Taylor, 2010; Garrett and Pavan, 2012; Chaigneau and Sahuguet, 2017).

cases, such as Sannikov (2008), termination also arises after very good performance as the CEO becomes too expensive to incentivize.

Models where termination provides effort incentives imply that the CEO should be given the lowest possible wage (typically zero) upon termination, to maximize effort incentives. However, other models predict that severance pay can be optimal. In Almazan and Suarez (2003), severance pay induces the CEO to leave voluntarily when a more able replacement is available; in Inderst and Mueller (2010), it deters the CEO from entrenching himself by concealing negative information that would lead to his dismissal. For example, severance pay (in the form of a golden parachute) can induce the CEO to accept a takeover bid, which typically yields a substantial premium to shareholders but causes the CEO to lose his job. Manso (2011) shows that downside protection from severance pay can induce the CEO to explore new technologies rather than merely exploit existing ones. In He (2012), severance pay is part of a back-loaded wage pattern that is robust to private savings.

3.7.3 Evidence

Deferred reward. Boschen and Smith (1995) and our own analysis in Section 2.1.1 show that current firm performance has a much greater effect on the NPV of future pay than current pay. These findings are consistent with theories predicting that firm performance should affect future as well as current pay due to consumption smoothing considerations.

Incentives and tenure. Gibbons and Murphy (1992) find that incentives rise with tenure, although they study pay-performance sensitivity rather than wealth-performance sensitivity. This result is consistent with both consumption smoothing and career concerns falling with tenure. Our empirical analysis in Section 2.3.2 shows that both CEOs' effective dollar ownership and their effective percentage ownership increase with tenure.

Level of pay and tenure. Murphy (1986), Graham et al. (2017), and our own analysis in Section 2.1.1 show that pay increases with tenure, consistent with models that predict a backward-loaded wage pattern to remove incentives for private saving. The common practice of seniority-based pay is also consistent with this prediction, as is the observation that stock prices react positively to the unexpected deaths of long-tenured CEOs (Salas, 2010; Jenter et al., 2017). However, to our knowledge, predictions that the growth rate of pay depends on the level of incentives θ and firm risk σ are as yet untested.[46]

[46] The positive association between pay and tenure may also result from tournament-based incentives (e.g., Green and Stokey, 1983). Tournament "winners" are rewarded by both longer tenure and high pay, and this high pay is not exclusively due to ability or productivity, but a reward for winning the tournament.

Determinants of CEO horizon. Edmans et al. (2012) predict that firms in which the CEO has greater scope to engage in myopia should have longer vesting periods and also more rapidly increasing incentives over time. Gopalan et al. (2014) develop a measure of executive pay duration and find, consistent with the first prediction, that incentives have longer horizons in firms with more growth opportunities and greater R&D intensity.[47] Section 6 reviews the evidence on the effect of incentive horizons on behavior.

Termination. The evidence reviewed in Section 2.3.5 shows that forced CEO turnovers become more frequent as stock returns and accounting performance decline. However, the economic magnitudes are modest, leading Jensen and Murphy (1990a, 1990b) and others to conclude that dismissals are not an important source of CEO incentives. Jenter and Lewellen (2017) attempt to estimate the number of CEO turnovers caused by bad performance directly from the turnover-performance relationship. Their estimates suggest that around half of CEO turnovers in public U.S. firms are "performance-induced", i.e., would not have occurred had performance been better. Without reference to a model, it is impossible to assess whether the observed turnover-performance sensitivities are optimal, and we are unaware of any moral hazard model that yields quantitative predictions for the optimal rate of firing.[48]

4. THE RENT EXTRACTION VIEW

The shareholder value view assumes that executive pay is decided directly by shareholders, or by their well-incentivized or monitored representatives (directors). In contrast, the rent extraction view argues that both the level and structure of pay are decided by the executives themselves (in conjunction with a complicit board) to maximize the amount that they can extract without inviting intervention by activist investors or corporate raiders (Bertrand and Mullainathan, 2001; Bebchuk et al., 2002; Bebchuk and Fried, 2003, 2004).

The rent extraction view starts with the observation that, in practice, executive pay is set by the board of directors and its compensation committee. This creates another agency problem, as directors on the compensation committee have their own agenda and may have incentives to curry favor with executives. In theory, market forces – including the market for corporate control, capital markets, product markets, and the managerial labor market – impose constraints on how much value destruction directors

[47] Gopalan et al. measure pay duration as the weighted average vesting period of each pay component, calculated analogously to the duration of a bond.

[48] Taylor (2010) estimates a model with learning about CEO ability but no moral hazard and concludes that the low rate of dismissals can only be justified by a substantial non-pecuniary cost of firing CEOs.

(and executives) can allow from rent extraction. However, the constraints from market forces can be loose and permit large deviations from efficient contracting (Bebchuk et al., 2002), since many firms are effectively insulated from the market for corporate control, have little need for outside capital, and have executives with no desire for a career beyond their current job.

The cost to shareholders may be far greater than the direct cost of inflated compensation. If contracts provide insufficient incentives to exert effort or refrain from empire-building, or induce short-termism and manipulation (see Sections 2.3.3 and 2.3.4), the losses to firm value can be large. In contrast, median CEO pay in the S&P 500 in 2014 was $10.1 million, which is only 0.03% of the value of the median S&P 500 firm (see Section 2.1).

4.1 Theory

Most of the arguments in favor of the rent extraction view are empirical; there are very few theories formally modeling rent extraction through executive pay. A notable exception is Kuhnen and Zwiebel (2009). In their model, the manager can extract hidden pay, but doing so reduces profits and thus shareholders' assessment of the manager's ability, which may lead to him being fired. Rent extraction survives in equilibrium because firing is costly and because any replacement CEO is also expected to extract rents. The model predicts that hidden pay is increasing in production uncertainty (since it is easier to disguise low profits as resulting from bad luck) and the manager's outside option (since firing is less of a concern). It is decreasing in uncertainty about the manager's ability, as then profits have a greater effect on shareholders' assessment of his ability and thus their firing decision. Kuhnen and Zwiebel find qualitative support for these predictions, measuring hidden pay with options, restricted stock, and other annual pay that is not salary and bonus.

While not models of rent extraction, Acharya and Volpin (2010) and Dicks (2012) show that, when firms compete in the managerial labor market, one poorly-governed firm permitting its executives to extract rents can affect executive pay (and governance) in other firms. By improving executives' outside option, rent extraction in one firm imposes a negative externality on other firms.[49] This channel is also predicted by Gabaix and Landier (2008), who study the equilibrium of their assignment model when some firms over-pay, while others are efficient. They find a potentially large "contagion" effect of the high-paying firms on the whole market.

[49] In Section 7.1, we explore under which circumstances such externalities can justify regulation of executive pay.

4.2 Compensation for non-performance

Shareholder value models suggest that high pay can be justified either because it attracts productive and scarce managerial talent, or as ex-post reward for strong performance. Proponents of the rent extraction view, however, argue that high pay, and large increases in pay, are often unrelated to performance.

Pay-for-luck. Bebchuk and Fried (2004) view the absence of (complete) RPE in executive pay as a key piece of evidence in support of the rent extraction view. Standard stock and option grants fail to filter out stock price increases due to industry and market movements, and thus unrelated to managers' performance, in apparent contradiction to the predictions of optimal contracting models (see Section 3.4). However, simply letting exogenous performance elements affect executive pay, while holding its expected value constant, would lower, not increase, the utility of a risk-averse executive. In order for "pay for luck" to benefit managers, it needs to be asymmetric, exposing pay more strongly to good luck than to bad.

Bertrand and Mullainathan (2001) document three instances of pay for luck – oil prices affecting the pay of oil CEOs, exchange rates affecting pay in import-affected industries, and general industry shocks affecting pay. They find some evidence for asymmetry. Garvey and Milbourn (2006) provide more evidence that positive shocks to industry performance affect CEO pay more strongly than negative ones. On the other hand, CEOs are more likely to be fired after bad industry or bad market performance, which indicates that some CEOs are penalized for bad luck (Jenter and Kanaan, 2015).

Bertrand and Mullainathan find more pay for luck when the firm lacks an outside blockholder who owns at least 5%, while Garvey and Milbourn find more pay for luck when corporate governance, measured by the Gompers et al. (2003) index, is weaker. These correlations suggest that pay for luck is a means of rent extraction. However, Section 3.4 surveyed several justifications for the non-universality of RPE that are consistent with shareholder value maximization. Moreover, firms controlled by private equity investors, usually viewed as firms with better governance, do not use more RPE than other firms (Cronqvist and Fahlenbrach, 2013; Jackson, 2013; Leslie and Oyer, 2013), which suggests that it may not be universally optimal.

Severance pay. Departing CEOs frequently receive severance payments, also called "golden handshakes" (see Section 2.2.2). Ex-ante separation agreements, signed when CEOs are hired, are common and typically equivalent to two years of cash pay (Rusticus, 2006). The ex-post payments made to departing CEOs are frequently higher than specified in the ex-ante contract (Yermack, 2006b; Goldman and Huang, 2015). Their use is especially prevalent among dismissed rather than retiring CEOs, and thus appears to reward CEOs for failure. The need to "bribe" a poorly performing CEO to step down weakens ex-ante incentives and suggests that CEOs have considerable power vis-a-vis their board of directors (Bebchuk and Fried, 2003).

While golden handshakes are common, they are usually moderate in value, even though large outliers exist. In a sample of U.S. large-cap firms from 1996–2002, Yermack (2006b) finds mean discretionary (contracted) severance pay of $4.5 million ($0.9 million); the respective maximums are $121.1 and $36.1 million. Critics of severance payments for CEOs usually quote the size of the entire pay package received at departure. However, a closer look at the data shows that much of this final compensation is not "severance pay", i.e., not compensation for loss of employment, but instead items such as already vested and deferred restricted shares, vested unexercised options, and accrued pension benefits, which were promised and contractually obligated to the CEO under any circumstances.[50]

Severance payments are inconsistent with shareholder value models in which the threat of termination alleviates moral hazard (see Section 3.7.2). To maximize ex-ante incentives, the CEO should be given the lowest possible wage (typically zero) upon termination. However, other shareholder value theories surveyed in Section 3.7.2 rationalize severance pay, for example to induce CEOs to reveal negative information or to explore risky new technologies. It is an open question whether these forces can justify the more extreme realizations of severance pay observed in the data.

Pay for acquisitions. CEOs appear to be rewarded simply for the act of undertaking an acquisition, regardless of whether the acquisition creates value for shareholders. CEO pay tends to increase after bank mergers, even if the acquirer's stock price declines (Bliss and Rosen, 2001). Across all industries, acquirer CEOs receive cash bonuses for deal completion, and these bonuses are unrelated to the acquirer's deal announcement return, but positively related to deal size and measures of CEO power (Grinstein and Hribar, 2004). For example, in 2000, Chase Manhattan CEO William Harrison was paid a $20 million bonus for negotiating the acquisition of J.P. Morgan, even though the negotiations only took three weeks, and Chase's stock price subsequently dropped by one third.

CEOs also receive larger stock and option grants after an acquisition than before (Harford and Li, 2007). For poorly performing acquirers with weak boards, new equity grants completely offset the negative effect of poor post-deal performance on CEO wealth. As a result, CEO wealth is insensitive to bad post-deal performance, but remains sensitive to good performance.

[50] For example, out of Henry McKinnell's much-criticized $180 million severance package from Pfizer, $78 million was deferred compensation ($67 million contributed plus $11 million interest), $82 million was the present value of his pension plan, and $8 million was from stock options. Thus, only an incremental $11 million was due to the loss of employment. We thank David Yermack for this example.

Option repricing. Some firms react to falls in their stock price by lowering strike prices of previously granted executive options, or by canceling and reissuing options with lower strike prices.[51] In a sample of U.S. public firms from 1992–95, Brenner et al. (2000) find that 1.3% of executives with options experience such a "repricing" event per year. In the vast majority of cases, the strike price is lowered to the current stock price, which appears to reward executives for failure. This concern is reinforced by the observation that firms reprice in response to poor firm-specific performance, not just in response to poor industry or market performance (Chance et al., 2000; Carter and Lynch, 2001). Moreover, implicit agreements to reprice options upon a stock price fall make option packages more valuable than reported to shareholders (see Section 4.3). On the other hand, the effort incentives of deep out-of-the-money options are weak, and repricing can restore incentives (Acharya et al., 2000). The evidence also suggests that option repricing is correlated with lower subsequent executive turnover, consistent with increased retention effects (Carter and Lynch, 2004; Chen, 2004).

Following changes in the NYSE and Nasdaq listing standards in 2003, listed companies must obtain shareholder approval of option repricings unless specifically permitted by the underlying plan. Plans that authorize repricing are rare, however, because Institutional Shareholder Services ("ISS"), the leading proxy advisory firm, recommends against shareholder approval of such plans. As a result, option repricing has become less frequent and changed in nature. Traditional repricings replace each option by a more valuable new option, while more recent "value-for-value" exchanges replace underwater options by a smaller number of at-the-money options of the same total value. Moreover, recent repricings explicitly exclude directors and top-5 executives, again in accordance with ISS voting guidelines, and are less likely after poor firm-specific performance (Gulen and O'Brien, 2017). These changes suggest that the prior practices were not in shareholders' interest.

Incentive rigging. Even if pay appears to be related to performance ex-post, this correlation may arise because the executive opportunistically chose the performance measure on which he appears the strongest. Morse et al. (2011) argue that CEOs often know in advance on which measure their performance will look best and use their influence over the board to slant incentive contracts.[52] They measure "incentive rigging" by the sensitivity of pay to the maximum of industry-adjusted return on assets

[51] In December 1998, the Financial Accounting and Standards Board imposed an accounting charge for repriced options, but firms could circumvent the rule by canceling options and reissuing new ones more than six months afterwards. Indeed, many firms canceled underwater options and reissued at-the-money options exactly six months and one day later (Gulen and O'Brien, 2017).

[52] For example, Home Depot's 2004 proxy statement stated that CEO Robert Nardelli's long-term incentives would be based on 3-year stock returns, but after the stock price plummeted, the 2005 proxy stated that his pay would now be based on earnings.

and industry-adjusted stock returns, controlling for the sensitivity of pay to these performance measures individually. The magnitude of rigging is economically large and accounts for 10% to 30% of CEOs' pay-performance sensitivity. Rigging is positively correlated with CEO power, measured by the proportion of inside directors, the proportion of the board appointed by the CEO, and the CEO's ownership of stock and exercisable options, and negatively correlated with shareholder rights as measured by Gompers et al. (2003).

Hedging. A significant number of executives uses derivatives to hedge at least some of the risk in their stock and option holdings (Bettis et al., 2001; Jagolinzer et al., 2007; Bettis et al., 2015). These hedging transactions are equivalent to short-selling company stock and thus undo executives' ownership incentives (Bebchuk and Fried, 2004). ISS has a policy of voting for any shareholder proposal that prohibits executives from hedging company stock, and many prominent firms have adopted such prohibitions (Bebchuk and Fried, 2010).

Once grants have vested, a reduction in equity exposure can be achieved by simply selling equity, which raises the question why executives use derivatives to hedge. One explanation is that executives are trying to defer the capital gains taxes associated with an outright sale. Alternatively, executives might use hedging to avoid the negative signal associated with a sale. Hedging transactions, even though reported in the footnotes of annual reports, are more opaque than outright sales.

Using hand-collected data, Bettis et al. (2015) and Jagolinzer et al. (2007) show that executives who use hedges reduce their equity exposures by about 30% on average. Hedge transactions are initiated prior to poor stock price performance, which suggests that executives use them to opportunistically trade on inside information. There is no evidence that hedging is correlated with personal income tax rates, which suggests that tax optimization is not the main motive (Bettis et al., 2015).

4.3 Hidden compensation

The rent extraction view predicts that rent extraction should occur through forms of pay that are less observable or more difficult for shareholders to value. Bebchuk et al. (2002) and Bebchuk and Fried (2004) argue that managerial rent extraction is constrained by the level of "outrage" a pay arrangement generates among shareholders and other stakeholders. Outrage causes embarrassment and reputational harm to executives and directors, and may reduce the firm's reputation among employees and customers. To avoid this outrage constraint, firms are expected to use pay practices that obscure the level of executive compensation.

The use of "stealth" compensation is a challenge for the shareholder value view. If executive pay were efficiently designed and competitive, there would be no need to disguise it from shareholders.[53] Even though most forms of compensation, including perks, pensions, and severance pay, can be part of an optimal contract, hiding these compensation elements from shareholders is suggestive of rent extraction (Bebchuk and Fried, 2004; Kuhnen and Zwiebel, 2009). Camouflaging an optimal contract may, however, be optimal to avoid attracting negative attention from politicians, the media, or other stakeholders who have motivations other than shareholder value maximization.[54]

Option compensation. Stock options can be a means of camouflaging pay if directors or shareholders do not fully understand their cost. Murphy (2002) and Hall and Murphy (2003) argue that directors, shareholders, and possibly even executives themselves systematically underestimate the cost of option compensation. When a company grants options, the economic cost equals what outside investors would pay for the grant. However, the firm incurs no cash outlay, and before U.S. accounting rules changed in 2004, there was no charge to accounting earnings for at- or out-of-the-money options (see Section 5.2). These factors might have made the perceived cost of option compensation much lower than its economic cost and allowed executives to camouflage their rent extraction.

Several pieces of evidence are consistent with Murphy's (2002) "perceived cost" hypothesis. Until 2004, at-the-money options were the dominant form of equity compensation for executives (see Section 2.2.1 and Murphy, 1999). It is difficult to conceive of an optimal contracting model in which the optimal strike price always coincides perfectly with the current stock price and does not vary with the contracting environment (Nohel and Todd, 2004; Chaigneau et al., 2017b). In fact, several models surveyed in Section 3.5 predict the use of restricted stock, i.e., an optimal strike price of zero, in incentive contracts. However, under the pre-2004 accounting rules, both restricted stock and in-the-money options would have reduced reported earnings. Hence, firms almost uniformly chose the lowest strike prices possible that did not create an accounting charge.

After U.S. accounting rules changed in December 2004, so did executive pay. The new rules require options' economic value to be expensed and effectively put the accounting treatment of options and restricted stock on an equal footing (see Section 5.2). Subsequently, the use of option compensation fell (Hayes et al., 2012) and restricted stock has replaced options as the most popular form of equity compensation (see Sec-

[53] Hidden compensation could be reconciled with value maximization if some shareholders are unaware of the need to offer high pay levels to attract talented CEOs.

[54] Negative press coverage of CEO pay appears to be associated with reductions in option grants (Kuhnen and Niessen, 2012), but not with reductions in overall pay (Core et al., 2008).

tion 2.3.3). This suggests that an important reason for the prior popularity of options was their favorable accounting treatment.[55]

Even after the change in accounting rules, there is evidence that the "fair values" of option grants firms report and, after 2004, expense, are understated. Option valuation requires the use of an option pricing model, and firms have considerable discretion over the choice of model and model inputs. Even though firms can use this discretion to increase the accuracy of their option valuations (Hodder et al., 2006), there is considerable evidence that firms use it opportunistically to understate values (Aboody et al., 2006; Bartov et al., 2007). Observed opportunism is greater for firms with weaker corporate governance and higher executive pay; it also increased after option expensing became mandatory (Choudhary, 2011).

Spring loading and backdating options. During the 1990s and early 2000s, firms inflated the value of executive option grants through widespread spring loading and option backdating. Yermack (1997) shows that stock prices tend to rise right after option grants and concludes that executives are awarded options before the release of good news (so-called "spring loading"). Subsequent research suggests that firms actively manipulate the disclosure of information around CEO option awards, delaying the release of good news and accelerating the disclosure of bad news (Aboody and Kasznik, 2000; Chauvin and Shenoy, 2001).

If the stock price increases after reported grant dates resulted from executives being awarded options before predicted increases in stock prices, these increases should be idiosyncratic rather than systematic – executives and directors can likely predict stock returns in their own company, but not the overall market. However, Lie (2005) shows that the stock price increases are systematic, inconsistent with spring loading but consistent with backdating – selecting the grant dates ex post to minimize the strike price of at-the-money options and maximize their value to executives (see also Heron and Lie, 2007; Narayanan and Seyhun, 2008).[56] Such backdating appears to have been widespread, affecting approximately 30% of firms from 1996 to 2005 (Heron and Lie, 2009).

These practices are correlated with weak corporate governance. Bebchuk et al. (2010) show that opportunistic option timing is associated with a minority of independent directors on the board, the absence of an outside blockholder on the compensation

[55] The steep stock market decline in the early 2000s likely also contributed to the decline of option pay. For behavioral reasons, managers appear to be more willing to accept options after the market has done well (Hall and Murphy, 2003; Bergman and Jenter, 2007; Murphy, 2013).

[56] Backdating constitutes both accounting fraud and tax evasion. Before FAS 123R became effective in 2006, firms were required to expense options only if they were in the money; in addition, Section 162(m) of the Internal Revenue Code counts options against the $1 million tax deductibility threshold for non-performance pay only if they are in the money. Thus, by disguising in-the-money options as being out of the money, firms avoided both accounting and tax charges.

committee, longer CEO tenure (a proxy for entrenchment), and higher overall CEO pay. Grants to independent directors were also opportunistically timed, and opportunistic timing for independent directors is associated with opportunistic timing for CEOs and also higher CEO pay. Moreover, CEOs who benefit from opportunistic option timing are also more likely to engage in financial misstatements and earnings manipulation (Biggerstaff et al., 2015). Hence, option timing and backdating appear to be the result of more general governance breakdowns.

The Sarbanes–Oxley Act of 2002 required firms to report option grants within two days of the alleged grant date, which almost completely eliminates the scope for backdating. Subsequently, the abnormal stock return patterns around option grants became much weaker, providing further evidence that they were previously due to backdating (Heron and Lie, 2007). However, more recent evidence suggests that firms continue to manipulate the disclosure of earnings and other information around CEO option awards (Daines et al., 2016).

Performance-based equity. After 2004, performance-based equity grants have replaced options as the most popular form of equity compensation (see Section 2.3.3). Their complexity creates considerable scope for rent extraction. Determining the ex-ante values of performance-based equity grants, especially of grants using accounting metrics, is difficult, which leaves board members and shareholders in the dark about how much value is transferred to executives (Walker, 2016). The heterogeneity of performance-based grants also hampers comparisons of these plans across firms, making benchmarking executive pay more difficult. Firms report varying levels of detail about performance metrics and payoff functions, with at least some firms making their grants almost completely opaque to outsiders.

At this point, there is no evidence that firms use performance-based equity to understate the level of executive pay. Bettis et al. (2016) apply their own valuation models to performance-based grants. Even though they find large discrepancies with the grant-date fair values reported by firms, they also show that companies on average overstate values. Their analysis is, however, restricted to firms that reveal sufficient information to value their grants, so their sample might be biased towards less opportunistic firms. Given the evidence that firms understate the values of conventional option grants, it would be surprising if the greater opacity afforded by performance-based equity were not exploited.

Perks. Perks encompass a wide variety of goods and services provided to executives, including corporate jets, club memberships, and personal security, and perks can be a significant portion of CEO pay. They were largely hidden from shareholders until the SEC increased its disclosure requirements in 2006. Because of insufficient disclosure, perks (together with pensions and severance pay) have often been labeled "stealth" compensation that may allow executives to extract rents surreptitiously (Jensen and Meckling, 1976; Jensen, 1986; Bebchuk and Fried, 2004).

The available evidence indicates that at least some perk consumption is a reflection of managerial excess. When firms first disclose that CEOs use company aircraft for personal reasons, their stock price falls by an average of 1.1%, and subsequently underperforms benchmarks by 4% per year (Yermack, 2006a). Firms that did not previously report perks reduced them by 34% once disclosure became mandatory in 2006 (Grinstein et al., 2015). Perks appear to be a more general signal of weak corporate governance, as reductions in firm value upon the revelation of perks substantially exceed their actual cost (Yermack, 2006a; Grinstein et al., 2015). For example, the mean incremental cost of personal use of company aircraft in Yermack (2006a) is $65,200, but the 4% per year underperformance translates into $300 million annually.

However, perks may also arise from optimal contracting. Providing perks is optimal if the cost of acquiring goods and services that the manager desires is lower for the firm (Fama, 1980), if perks allow the manager to consume out of pre-tax income, or if they aid managerial productivity (Rajan and Wulf, 2006). For example, a corporate jet can ensure that a CEO arrives at a meeting refreshed and thus able to negotiate effectively. Rajan and Wulf (2006) provide evidence that perks are used consistently with their productivity-enhancement hypothesis, e.g., to help the most productive employees save time. The extent to which some perks are justified by the efficient mechanisms proposed by Fama (1980) or Rajan and Wulf (2006) or by tax savings remains an open question.

Pensions. Defined benefit pensions are a significant portion of pay for many executives (see Section 2.2.2). Because defined benefit pensions tend to be unsecured and unfunded claims against the firm, they can be justified as a form of "inside debt" that mitigates risk-shifting by aligning executives with other unsecured creditors (see Section 3.6). However, in part because SEC disclosure rules did not require firms to report the actuarial values of executive pensions before 2006, Bebchuk and Fried (2004) argue that they are a form of stealth compensation.

Studies based on hand-collected data and own estimates of value during the pre-2006 reporting regime suggest that defined benefit pension claims were often large (Bebchuk and Jackson, 2005; Sundaram and Yermack, 2007). Since 2006, firms are required to disclose both the present value of executives' accumulated pension benefits and its year-to-year change. Subsequently, the use of defined benefit pension plans declined from 48% of S&P 1,500 CEOs in 2006 to only 36% in 2012 (Cadman and Vincent, 2015). However, concurrent with the expanded disclosures were the effective dates of regulations requiring balance sheet recognition of pension plans and increased insurance premiums for underfunded plans. It is therefore unclear whether the decline in executive pension plans was caused by the expanded disclosure requirements.

Using the newly-available pension data, Stefanescu et al. (2017) provide evidence that executives opportunistically game their defined benefit pension plans to extract more value. Executives with pension plans receive unusual one-off increases in pensionable bonuses one year before a pension plan freeze and one year before retirement. When executives are eligible to retire, discount rates used to calculate lump-sum benefit distributions are lowered. These changes are more likely in firms with weaker governance, suggesting that they are not in shareholders' interest.

Severance pay. Section 4.2 surveyed the evidence for and against interpreting severance pay as rent extraction. Additional support for the rent extraction interpretation comes from the fact that firms frequently grant severance pay in forms that are difficult for outsiders to observe, such as last-minute enhancements to pension plans and consulting contracts (Yermack, 2006b; Goldman and Huang, 2015). The consulting contracts are often in the form of retainers, and thus paid even if the former CEO provides no actual work for the firm. Some CEOs continue to be provided with perks after their departure (Bebchuk and Fried, 2004), such as access to corporate apartments, jets and cars, home security services, and financial planning.[57] If severance pay were consistent with shareholder value maximization (see Section 3.7.2), it is unclear why it would be given in these opaque forms.

4.4 Corporate governance

The rent extraction view predicts that executive pay will be higher and less sensitive to performance in firms in which managers have relatively more power (Bebchuk and Fried, 2003). A large empirical literature tries to show that compensation practices that seemingly favor executives at the expense of shareholders are most prevalent when corporate governance is weak. The Achilles heel of this research program is that governance is itself the outcome of choices by executives, directors, and shareholders, whose choices are affected by (often unobservable) firm and industry characteristics. If these characteristics also affect CEO pay, then the observed correlations between governance and pay are not causal. This does not mean that governance does not have causal effects on pay – it almost certainly does. However, it does mean that the observed correlations are different from those effects.

To complicate things further, several of the shareholder value models surveyed in Section 3 imply that "bad governance" can be the optimal outcome of shareholder value

[57] In the first year after Jack Welch retired as CEO from General Electric, he received approximately $2.5 million in perks, which included unlimited access to GE aircraft, exclusive use of a furnished New York City apartment, unrestricted access to a chauffeured limousine, a leased Mercedes Benz, office space in New York City and Connecticut, the services of professional estate and tax advisors, the services of a personal assistant, communications systems and networks at Welch's homes, and bodyguard security for various speaking engagements.

maximization. In Hermalin and Weisbach (1998), the board and the CEO negotiate over both CEO pay and the identity of new directors. More able CEOs have more bargaining power and gradually fill the board with less effective directors. In several of the dynamic contracting models surveyed in Section 3.7, the optimal pay profile is back-loaded – the optimal dynamic contract effectively saves for the CEO. As a result, the CEO earns more than his outside option in later years. The firm must ex-ante commit to "overpay" later, and allowing the CEO to gradually entrench himself might be one way of doing so. Hence, forcing a governance improvement onto a firm could, at least in theory, reduce its value.

Boards. A number of studies find that various measures of board ineffectiveness are associated with pay practices that favor the CEO (Hallock, 1997; Core et al., 1999; Fahlenbrach, 2009; Armstrong et al., 2012). The level of CEO pay tends to increase in board size (negatively related to the pressure an individual director faces to monitor), the number of outside directors serving on more than three boards (negatively related to their capacity to monitor), and the number of outsiders appointed by the CEO (negatively related to their independence). CEO pay also tends to be higher when the board is staggered (reducing directors' accountability), when the CEO is chairman of the board (and thus has more power), and when there are board interlocks, where CEO A serves as director on the board of CEO B and vice-versa. Consistent with ineffective large boards, CEOs' wealth-performance sensitivity decreases in board size (Yermack, 1996; Fahlenbrach, 2009). On the other hand, the CEO wealth-performance sensitivity is higher when the CEO is chairman and with less independent boards, consistent with monitoring and incentives being substitutes (Fahlenbrach, 2009). Studies of the link between pay levels and the structure of the remuneration committee, especially the presence of non-independent directors, tend to find no effect (Daily et al., 1998; Newman and Mozes, 1999; Vafeas, 2003; Anderson and Bizjak, 2003; Conyon, 2006, 2014).

Several recent studies use three changes to board structures resulting from additions to the NYSE and Nasdaq listing rules – that boards have a majority of independent directors and that the nominating and compensation committees be entirely independent – as a "quasi-experiment" to study a variety of outcome variables.[58] Because the assignment of firms to the control group (firms already in compliance) and the treatment group (firms that needed to make changes) is not random, this research design hinges on the assumption that the two sets of firms are not exposed to different shocks, which would be incorrectly attributed to the treatment. The results for CEO pay are mixed:

[58] The changes were proposed in 2002, approved by the SEC in November 2003, and came into effect in 2004. See, among others, Chhaochharia and Grinstein (2009), Duchin et al. (2010), Guthrie et al. (2012), Banerjee et al. (2015), and Guo and Masulis (2015).

Chhaochharia and Grinstein (2009) find that treated firms reduced CEO pay, that the effect was particularly large for firms with low institutional ownership concentration and no outside blockholders, and that the effect was mostly driven by the overall board independence requirement. Guthrie et al. (2012), on the other hand, show that the overall reduction in CEO pay was almost entirely due to only two outliers, and that the committee independence requirements in fact increased CEO pay once the outliers are removed.

Blockholders and institutional investors. Outside blockholders, who can potentially monitor the CEO (see Edmans, 2014 and Edmans and Holderness, 2017 for surveys), are associated with compensation practices that seemingly favor shareholders. CEO pay is lower in the presence of an outside blockholder who owns a stake of at least 5% (Core et al., 1999) or a stake larger than the CEO's (Cyert et al., 2002). The fraction of equity compensation in total pay decreases with the total percentage stake held by outside blockholders, which suggests that blockholders and incentive pay are substitute governance mechanisms (Mehran, 1995).

Institutional investors are likely to be better monitors than retail investors, as they typically have greater expertise and large stakes that make monitoring worthwhile. Consistent with this intuition, Hartzell and Starks (2003) find that institutional ownership concentration predicts both lower CEO pay levels and higher pay-performance sensitivities. Fahlenbrach (2009), on the other hand, shows that wealth-performance sensitivities are decreasing in institutional ownership concentration and in the percentage of equity held by pension funds, and argues that monitoring and incentives are substitutes.

Private equity investors hold very large stakes, both as a percentage of company equity and as a percentage of their own portfolios. They usually have board representation and take an active role in corporate governance. Based on small and heavily self-selected samples (see Section 2.5), the evidence suggests that private equity-controlled firms pay their executives at similar levels as comparable public firms, but use more pay-for-performance and stronger equity incentives (Cronqvist and Fahlenbrach, 2013; Jackson, 2013; Leslie and Oyer, 2013).

Anti-takeover provisions and shareholder rights. If the threat of a hostile takeover constrains rent extraction by executives, reducing this threat through anti-takeover provisions should increase executive pay. Moreover, certain provisions, such as staggered boards, reduce shareholder rights beyond the takeover context, leading to an even more positive effect on pay. Consistent with increased rent extraction, CEO pay levels rise after a firm adopts anti-takeover charter amendments (Borokhovich et al., 1997). Gompers et al. (2003) develop a broad index of anti-takeover provisions and restrictions on shareholder rights. Their "anti-takeover index" is positively correlated with more asymmetric performance benchmarking (Garvey and Milbourn, 2006), higher levels of CEO pay and lower wealth-performance sensitivities (Fahlenbrach, 2009), and more rigging of incentive contracts towards favorable performance metrics (Morse et al., 2011).

Firms' decisions to adopt anti-takeover provisions are endogenous, and hence the correlations between provisions and pay are unlikely to equal their causal effects. The staggered introduction of laws restricting hostile takeovers across U.S. states between 1985 and 1997 generates more exogenous variation in takeover threats.[59] Bertrand and Mullainathan (1999) compare changes in CEO pay before and after the laws between firms incorporated in affected states and firms in other states. Firms without a blockholder show about a 5% increase in CEO pay after anti-takeover laws are adopted, whereas firms with a blockholder show almost no increases in pay but instead an increase in the sensitivity of CEO pay to accounting performance. This is consistent with more rent extraction in firms without large shareholders, and with a substitution of compensation incentives for takeover threats in firms with large shareholders.

4.5 Peer groups

A compensation peer group should be the set of firms with which a company is competing in the executive labor market, which usually means firms in the same industry and/or of similar size and complexity. The use of peer groups in setting executive pay has become both more prevalent and more transparent in recent years. This can be consistent with shareholder value if it helps to determine the market level of pay, rent extraction if boards choose highly-paid peers to justify high pay at their firm, or neither if boards simply copy contracts at other firms.

From 2006, the SEC requires U.S. firms to disclose the composition of any peer groups used to determine pay. Before mandatory disclosure, Bizjak et al. (2008) select a random sample of 100 S&P 500 firms in 1997. Reading the compensation committee reports, they find that 96 firms used peer groups to set pay, but firms typically did not disclose the identity of these groups. They thus estimate hypothetical peers using size and industry benchmarks, and find that, over 1992–2005, CEOs with pay below the median peer received larger raises than CEOs above the median. This is consistent with benchmarking taking place, but also with idiosyncratic shocks to CEO pay being reversed over time. Consistent with shareholder value rather than rent extraction, they show that the likelihood that a below-median CEO receives a pay increase is higher if the CEO's tenure is short and performance is good (consistent with learning models),

[59] So-called Business Combination Laws were adopted by 33 U.S. states and were upheld by the U.S. Supreme Court in 1987. Karpoff and Wittry (2017) discuss challenges in using these laws as source of exogenous variation in takeover threats.

and if industry sales growth is high, unemployment is low, and the firm is in a high-tech industry (consistent with a tight labor market).

The SEC's 2006 disclosure rules made it possible to study the actual peer groups chosen. Even though peers appear to be selected mainly based on sensible criteria (e.g., of similar size and in the same industry), there is evidence that some firms are opportunistic and choose highly-paid peers (Faulkender and Yang, 2010; Bizjak et al., 2011). There is some disagreement about the exact mechanism – Faulkender and Yang (2010) argue that firms choose peers with unusually high pay given their characteristics, while Bizjak et al. (2011) argue that firms tend to choose larger peers that pay more to due to their size. Both studies agree that the choice of peer group predicts pay: controlling for firm and CEO characteristics, the median pay across peer firms has additional explanatory power. Notably, almost no firm benchmarks to below the median of the peer group, with more than 30% of firms choosing a higher percentile.

The high pay justified by choosing a highly-paid peer group (or a high percentile) could be consistent with either shareholder value (if high pay was necessary to attract or retain a given CEO) or rent extraction. Consistent with the latter, the choice of highly-paid peers increases in the CEO's tenure (used as a proxy for entrenchment) and the busyness of a firm's directors (the number of other boards they sit on), and is more prevalent if the CEO is also the chairman (Faulkender and Yang, 2010). In contrast, Albuquerque et al. (2013) argue that the choice of highly-paid peers is a reward for CEO talent. They first calculate the pay difference between actually chosen peers and a group of hypothetical peers matched on firm characteristics. Next, they regress this difference on proxies for CEO talent and poor governance and find that both predict the excess pay of the actual peers. Finally, they show that the fitted value from the talent proxies has better explanatory power for CEO pay than the fitted value from the governance proxies.

The requirement to disclose peer groups after 2006 might have reduced opportunistic behavior, especially since the first set of disclosed peers was likely chosen before the more stringent disclosure rules were announced. Faulkender and Yang (2013) study the change in peer groups from 2006–09 and, contrary to expectations, find that the selection of highly-paid peers increased in firms with low institutional, director, and CEO ownership, busy and large boards, or where shareholders had previously complained about pay. Such changes did not occur passively due to peers becoming more highly compensated; instead, these firms actively added highly-paid peers and dropped lowly-paid ones. If the strategic selection of peer groups is a result of rent extraction, these results suggest that disclosure alone is insufficient to deter opportunism.

4.6 Conclusion

There is little doubt that rent extraction describes individual cases of outrageous executive pay. Systematic evidence consistent with the rent extraction view comes from observing that (at least some) firms go to great length to hide pay from shareholders, that (at least some) executives are rewarded for non-performance, and that executive pay tends to be lower when corporate governance is stronger.

A potent criticism of the rent extraction view is that it is unable to explain the large increase in CEO pay since the 1970s. There is no evidence that corporate governance has weakened over the past 40 years; instead, most indicators show that shareholders have been empowered and governance strengthened over this period (Holmström and Kaplan, 2001; Hermalin, 2005; Kaplan, 2008). It is, however, possible that the desire or ability of managers to extract rents emerged only as social norms against unequal pay weakened. Piketty and Saez (2003) argue that such a shift in social norms helps explain the rise in CEO pay and the widening income inequality in the past three decades, and Levy and Temin (2007) relate this change in norms to the dismantling of institutions and government policies that prevented extreme pay outcomes from World War II to the 1970s.[60] On the other hand, Kaplan and Rauh (2010, 2013) point out that pay has increased even faster in other high-skill professions such as private equity, venture capital, hedge funds and law, where pay is less disclosed, making social norms less important.

5. INSTITUTIONAL INFLUENCES

In addition to the shareholder value and rent extraction views, a third perspective is that legal and institutional constraints and practices are important determinants of executive pay. These include tax policy, accounting and disclosure rules, and the use of peer groups, compensation consultants, and proxy advisors. Unlike the shareholder value and rent extraction views, which contradict each other, institutional influences overlay both views. Under the rent extraction view, managers extract rents subject to an "outrage constraint" (Bebchuk and Fried, 2004), and try to do so in ways that are hidden from shareholders due to accounting and disclosure rules. Under the shareholder value view, boards set contracts that maximize value taking into account, for example, the differential tax treatment of different compensation instruments.

This section explores some of the legal and institutional influences on executive pay. Given space constraints, we only discuss selected examples of how institutional forces have shaped pay; for a more comprehensive discussion, we recommend Murphy (2013). The Appendix presents a "user's guide" to legislation, disclosure requirements, accounting treatments, and tax treatments of pay.

[60] However, Frydman and Molloy (2011) suggest that changes in the high tax rates prevalent during this period had at most modest short-run effects on executive pay.

5.1 Legislation and taxation

The starkest way in which governments can affect executive pay is through outright banning of instruments or practices. For example, executive options used to be banned in many countries, with both Japan and Korea legalizing options only in 1997 (Kato et al., 2005). In the U.S., the Sarbanes–Oxley Act of 2002 banned loans from companies to executives, in part as a response to one high-profile case: Dennis Kozlowski of Tyco forgiving his own loan (Murphy, 2013). Independently of the merits of such bans, their introductions and rescissions offer opportunities for empirical research on the costs and benefits of the banned practices.

Changes in taxation have been the main channel through which the legislator has shaped executive pay in the United States. In 1993, the Clinton administration implemented Section 162(m) of the Internal Revenue Code, which limited the tax deductibility of pay for top-five executives of public firms to $1 million per executive and year. "Qualified" performance-based pay was not subject to this limit. This tax change (combined with changes to disclosure rules around the same time) appears to have had large effects (Perry and Zenner, 2001): First, it slowed the growth of salaries that were already above, at, or close to $1 million. Second, it led to a substitution towards other compensation categories, with total pay actually increasing. The categories that increased the most were those that counted as "qualified", for which the law required that "the compensation received must be based solely on an increase in the value of the stock after the grant date".

This rather arbitrary definition had an apparently decisive effect on firms' choice of compensation instruments. At-the-money options, formula-driven bonuses, and restricted stock with performance-based vesting are typically counted as qualified and came to dominate U.S. executive pay during the 1990s and 2000s. In fact, the surge in executive pay between 1993 and 2000 is almost entirely a surge in at-the-money options (see Section 2.2.1).

Simple restricted stock with time-based vesting does not count as "qualified" under Section 162(m), since such stock still has value even if the stock price falls. This may explain why, after new accounting rules made options less attractive from 2004 (see Section 5.2), options were replaced by performance- rather than time-vesting equity (see Section 2.3.3). The definition of "qualified" performance-based pay also offers an explanation for the lack of indexed options or options on indexed stock, despite the potential benefits of relative performance evaluation (see Section 3.4): Indexed options are not "qualified", since they may pay out without an increase in the stock price, if the index falls.[61]

[61] Effective from 2005, another tax rule (Section 409A), aimed at reining in improper tax-deferral of compensation by executives, makes issuing in-the-money or indexed options even more expensive (Walker, 2016). Income from most conventional at- or out-of-the-money options is not taxed until the option is

5.2 Accounting

Firms' choices of compensation instruments are also affected by accounting rules. Holding the economic cost of executive pay constant, firms tend to choose the instrument that minimizes the charge to accounting earnings. Even though standard economics suggests that only actual costs matter and accounting charges are irrelevant, there are several reasons why firms care about reported earnings – executives might receive bonuses that increase in earnings, shareholders might be confused about the distinction between economic costs and accounting charges, or executives and board members might themselves be confused (see the "perceived cost" hypothesis discussed in Section 4.3).

Arguably the most striking example of accounting affecting pay is the treatment of options in the U.S. From October 1972, APB Opinion No. 25 required the grant-date value of restricted stock and the intrinsic value – rather than fair value – of options to be amortized over the vesting period. Thus, there was no accounting charge for at-the-money or out-of-the-money options, but a charge for in-the-money options and restricted stock. While FAS 123 (issued in October 1995) recommended that firms expense the fair value of options, this was not required, and non-expensing firms only had to disclose them in a footnote. Thus, options remained "free" from an accounting perspective, in that no accounting expense was incurred at either their granting, vesting, or exercise.

After long and contentious debates, FAS 123R, issued in December 2004, required firms to expense the grant-date fair value of options over the vesting period (using an option pricing model chosen by the firm), effective for the first interim or annual reporting period beginning after June 15, 2005. This leveled the playing field between restricted stock and at-the-money options.[62] The use of options fell from 39% of total CEO pay in S&P 1,500 firms prior to FAS 123R (2002–4) to 22% afterwards (2005–8) (Hayes et al., 2012). In addition, FAS 123R also required firms to expense options granted prior to June 15, 2005 that had not yet vested, leading to one-third of firms accelerating the vesting of options (Choudhary et al., 2009). This strongly suggests that firms care about the earnings impact of executive pay, even if the economic cost is unchanged.

The surge in option compensation during the 1990s thus came at a time when tax policies made performance-based pay advantageous (see Section 5.1) and when accounting rules allowed at-the-money options (but not restricted stock) to be granted without an earnings charge. After the advent of option expensing in 2005, option compensation declined and was gradually replaced by performance-vesting equity, which

exercised. Under Section 409A, compensation from in-the-money or indexed options is taxed at vesting, instead of at exercise, and is subject to an additional 20% penalty tax.

[62] Even though the accounting treatment of restricted stock and at-the-money options is similar after 2005, at-the-money options continue to receive a more favorable tax treatment (see Section 5.1).

continues to receive more favorable tax treatment than restricted stock (see Section 5.1). These developments support the view that changes in tax and accounting rules have been the main driver of changes in the composition of U.S. executive pay during the 1990s and 2000s.

The non-expensing of at-the-money options prior to 2006 may have had further consequences. Murphy (2013) argues that, because the Financial Accounting Standards Board ("FASB") did not require firms to expense the fair value of options and the SEC only required the number of options to be reported, many boards focused on the number of options granted, rather than their value. As a result, many firms granted the same number of options each year, even though the value of an at-the-money option is increasing in the stock price. This led to a strong correlation between grant-date pay levels and the stock market (Hall and Murphy, 2003). Shue and Townsend (2017b) argue that this rigidity in option grant numbers can explain overall time trends in pay. When stock prices rise, the value of options increases, which, together with downward rigidity in salaries and bonuses, might have led to pay levels rising in the 1990s and early 2000s. After firms started to report and expense the grant-date value of options, they were less likely to grant the same number each year, which may explain why pay levels did not increase during the mid-2000s stock market boom.

5.3 Compensation consultants

Boards and their compensation committees often use consultants to guide them on the level and design of pay. Critics contend that compensation consultants suffer conflicts of interest and contribute to the rise and alleged poor design of CEO pay (Bebchuk and Fried, 2004). For example, they might recommend high pay to increase the probability of being hired again, or to win mandates for other services, such as pension or tax advice. In the U.S., the SEC does not require compensation consultants to be independent, but its 2006 disclosure rules required firms to disclose the role and identity of all consultants; in 2009 it expanded the rule so that, if firms spend more than $120,000 on other services from their compensation consultants, they must disclose the aggregate fees paid for compensation consulting and other services. The Dodd–Frank Act (2010) stipulates that compensation committees can only hire consultants after taking into account their independence, and required firms to disclose the nature of any conflicts and how such conflicts are being addressed.

The evidence on the relationship between consultants and pay is mixed. In the first year after the 2006 disclosure rules required U.S. firms to reveal the use of compensation consultants, 78% of S&P 1,500 firms used at least one consultant (of which 17% use two or more), and another 9% purchased compensation surveys prepared by consultants (Murphy and Sandino, 2010). While using consultants is associated with higher executive pay, this difference becomes insignificant when controlling for corporate governance (Armstrong et al., 2012). Hence, higher pay might be caused by differences in firm characteristics, not by using consultants. Consistent with this idea, firms with ex-ante higher and more complex CEO pay are more likely to hire a compensation consultant (Murphy and Sandino, 2015).

Looking directly for potential conflicts of interest, neither Cadman et al. (2010) nor Armstrong et al. (2012) find higher pay or lower pay-performance sensitivities for clients of multi-service consultants, defined as consultants that also offer other services, such as pension and tax advice. However, using actual data on other services provided by compensation consultants, Murphy and Sandino (2010) show that CEO pay is higher in U.S. and Canadian firms if other services are provided, and that pay is higher in Canadian firms when the fees paid to consultants for other services are large relative to those for compensation advice. While this correlation is suggestive of conflicts of interest, they also find that CEO pay is 13% higher in U.S. firms if the consultant works for the compensation committee rather than management, inconsistent with the idea that consultants recommend higher pay to curry favor with managers. In the U.K., Conyon et al. (2009), after confirming that compensation consultants are associated with higher pay, find no evidence that pay is higher when consultants provide other services.

The 2009 SEC rules, which require firms to disclose fees paid to consultants for both compensation and other services, caused a restructuring of the consulting industry. Partners from several large, multiservice consulting firms left and created new, specialized firms offering only compensation advice. Chu et al. (2017) show that the market share of such specialist consultants increased from 35% in 2006 to 70% in 2012. Notably, the client firms most likely to switch from a multiservice consultant to the related newly spun-off specialist consultant are firms where CEO pay is high and the board is more likely to be under the CEO's influence.

5.4 Proxy advisory firms

Another important institutional influence on executive pay are the recommendations of proxy advisory firms. Proxy advisors supply voting recommendations to institutional investors on how to vote their shares on executive pay, director elections, mergers and acquisitions, and other shareholder votes. Institutional Shareholder Services ("ISS") is the largest proxy advisor and a dominant player, with approximately 1,600 institutional investor clients in 2016, while Glass Lewis ("GL") is the closest competitor. The importance of proxy advisors for U.S. executive pay increased in 2003, when the SEC required mutual funds to disclose the procedures behind their voting behavior, and again in 2011, when the Dodd–Frank Act led to the SEC implementing a non-binding say-on-pay vote (see Section 7.2). Proxy advisors typically provide a quantitative and qualitative analysis of executive pay plans, structured around certain categories (e.g., pay for performance, disclosures), assign a rating for each category, and issue an overall voting recommendation (Ertimur et al., 2013).

Proxy advisor support has a large effect on the likelihood of say-on-pay votes succeeding. Before 2012, ISS used to only undertake a deeper analysis of compensation policies for firms with 1- and 3-year total shareholder returns below the industry median. Malenko and Shen (2016) exploit this rule for a regression discontinuity analysis: Falling narrowly below this cutoff led to greater scrutiny and a 15% increase (from 10% to 25%) in the probability of a negative ISS recommendation. The negative recommendation in turn led to a 25% reduction in say-on-pay voting support. This suggests that many institutional investors effectively outsource their voting decisions to proxy advisors.

Proxy advisors have been criticized for blanket policies recommending or discouraging certain pay practices. For example, both ISS and GL recommend clawbacks and bonuses dependent upon predetermined formulas (rather than discretion), and recommend against tax gross-ups for golden parachutes, restricted stock without performance-based vesting, and single-trigger change-of-control arrangements.[63] While likely desirable in many settings, these practices are unlikely to be universally optimal. Larcker et al. (2015) show that firms change their compensation policies prior to say-on-pay votes in a manner consistent with proxy advisor recommendations, particularly if the firm is likely to receive a negative proxy advisor recommendation in the absence of a policy change, if directors had received below-median support at the previous annual meeting, and if the firm has above-median ownership by dispersed investors. Such changes are met by negative stock market reactions, suggesting that the desire to win proxy advisor support leads firms to cater to their policies rather than implement optimal pay structures.[64]

In contrast, Ertimur et al. (2013) paint a more positive picture. They find that proxy advisor recommendations are not necessarily "one-size-fits-all" – the presence of certain compensation policies does not automatically translate into negative recommendations; instead, proxy advisors take into account the rationale provided by the firm, the severity of the issue, and the quality of the overall compensation plan. Moreover, an "against" recommendation is less likely to lead to a negative vote for shareholders with large holdings. This suggests that large investors do their own research instead of blindly following advisors. Notably, there is considerable heterogeneity in proxy advisors' say-on-pay vote recommendations: among firms with an "against" recommendation from at least one of ISS and GL, the proxy advisors agree only 17.9% of the time.

[63] In such arrangements, acquisition or change of control leads to the executive's stock immediately vesting. The alternative is double-trigger, whereby stock only vests upon acquisition or change of control if the executive is also terminated.

[64] ISS has also been criticized for conflicts of interest stemming from selling both proxy voting services to investors and consulting services to firms (Li, 2017).

6. THE "EFFECTS" OF EXECUTIVE COMPENSATION

Much of the debate about executive compensation focuses on the determinants of pay, in particular the extent to which it is driven by shareholder value or rent extraction considerations. An arguably even more important question is the effects of pay. Theory has relatively clear predictions. The models of Section 3.2 suggest that higher incentives should increase firm value gross of CEO pay. Section 3.5 predicts that, controlling for delta, options should cause CEOs to take more risk, whereas Section 3.6 predicts that debt-like pay should cause CEOs to manage their firms more conservatively. Section 3.7 suggests that short-horizon incentives should lead CEOs to take short-term actions. Moreover, setting *any* dimension of pay – the level, sensitivity, stock vs. option mix, debt vs. equity mix, or horizon – closer to its optimum should increase firm value net of CEO pay.

However, while the theoretical predictions are relatively clear, empirically showing that executive pay has causal effects is extremely difficult. Compensation arrangements are the endogenous outcome of a complex process involving the executive, board, compensation consultants, and the managerial labor market. As a result, they are inevitably correlated with a huge number of observable and unobservable firm, industry, and executive characteristics. This makes it impossible to interpret any observed correlation between executive pay and firm outcomes as a causal relationship. For example, CEO pay and firm performance may be correlated because pay affects performance, because firm performance affects pay, or because an unobserved firm or CEO characteristic affects both.

Identifying causal effects of pay on firm behavior or performance requires instrumental variables or natural experiments that create quasi-random variation in executive pay. Given the nature of the pay-setting process, there are very few valid instruments that affect pay without also affecting the outcome variable of interest through some other channel (thus violating the exclusion restriction). In this section, we discuss earlier observational studies that do not show causality, and highlight a number of recent studies that identify causal effects of pay by exploiting regulatory changes, discontinuities, or institutional frictions in the pay-setting process. However, measuring the causal effects of pay on behavior and performance remains one of the most important challenges of this literature and an open question for future research.

6.1 The effects of equity incentives on firm value

The effect of managers' ownership incentives on firm value is one of the fundamental questions in compensation research. A sizeable literature, going back to Morck et al. (1988), relates firm value, usually measured as Tobin's Q, to executives' equity incentives (McConnell and Servaes, 1990; Mehran, 1995; Agrawal and Knoeber, 1996; Himmelberg et al., 1999; Demsetz and Villalonga, 2001; Habib and Ljungqvist, 2005;

Kim and Lu, 2011). The results are mixed. Most studies find a positive correlation between executives' equity incentives and firm values, at least at low levels of effective ownership, with some evidence that the correlation weakens or even turns negative at high ownership levels. One interpretation of this pattern is that increases in managerial equity holdings initially improve incentives but subsequently lead to managerial entrenchment (Morck et al., 1988). However, this pattern is not robust across studies, and several papers fail to find any relationship between firm value and executives' equity stakes (e.g., Agrawal and Knoeber, 1996; Himmelberg et al., 1999; Demsetz and Villalonga, 2001).

These correlations are in any case difficult to interpret. Even though the models of Section 3.2 suggest that higher incentives should increase firm value gross of CEO pay, this does not imply a positive cross-sectional relationship between equity incentives and firm values. If firms set incentives optimally, the derivative of value with respect to incentives should be zero for a particular firm. Cross-sectional differences in incentives between firms are then caused by differences in the fundamental inputs to that optimization process – executive, firm, or labor market characteristics – that themselves have effects on firm value (Demsetz, 1983; Demsetz and Lehn, 1985). As a result, any empirical correlation between equity incentives and firm values is a mix of the causal effect of incentives and of differences in fundamentals. Observational studies cannot distinguish between the two, and the observed correlations might even have the opposite sign of the causal effect.

Unfortunately, valid instruments for managerial ownership are extremely difficult to find, because all known determinants of ownership likely either directly drive firm value or are correlated with other drivers of value. Take CEO age, which has been used as an "instrument" for ownership. Even if CEO age does not directly affect firm value, whatever drives cross-sectional variation in age may do so. For example, poor governance may make it more likely that a firm has an old CEO, and also reduce firm value; alternatively, trouble in the firm's business model may lead to a firm retaining an old CEO, and also reduce firm value.

An analogy with lab experiments is instructive. In a lab experiment, the researcher controls the variation in the treatment (e.g., ownership) and is able to randomize it at will. With an instrumental variable, the instrument is supposed to achieve a similar randomization, but is not controlled by the researcher. It is therefore crucial to identify the mechanism that creates variation in the instrument, to then argue that whatever moves the instrument does not affect the outcome variable, except through its effect on ownership (the treatment). Papers often claim validity of an instrument by arguing that it does not directly affect the outcome of interest, but this alone is insufficient, since what moves the instrument may also move the outcome variable.

6.2 The effects of executive pay on behavior

A second set of studies investigates the relationship between executive pay and firm behavior. We organize this section by the aspect of firm behavior examined.

6.2.1 The effects of pay on manipulation and short-term behavior

Any incentive scheme creates incentives to manipulate the performance metric(s). Manipulation often involves short-termism – inflating current performance at the expense of long-term value – but can also entail smoothing performance over time, especially if the incentive scheme is concave. Even though any incentive contract is prone to be exploited, manipulation often stems from nonlinearities and discontinuities in performance measurements or payoff functions (see Sections 2.3.3, 2.3.4, and 3.7.1), which can also create opportunities for causal identification. First, any incentive scheme that measures performance at one point in time, instead of over an extended period, invites short-termism. Second, floors, caps, jumps, and other nonlinearities in the mapping from performance into payoffs create incentives to manipulate. Finally, even without discontinuities and nonlinearities, incentive schemes based on performance metrics different from long-term shareholder value (e.g., based on sales or profits) invite increases in these metrics unrelated or negatively related to shareholder value (Kerr, 1975).

Manipulation typically takes one of two forms. The less damaging type leaves the firm's operating and investment policies unchanged but manipulates the performance measure, for example by overstating accruals, booking sales into a different period, or strategically timing news releases. The more damaging type changes the firm's operating and investment policies to boost short-term performance, for instance by cutting R&D or advertising.

A large literature examines the link between executives' equity ownership incentives and manipulation. Based on observational studies, there appears to be a positive correlation between stock and option holdings and earnings manipulation (Cheng and Warfield, 2005; Bergstresser and Philippon, 2006; Burns and Kedia, 2006; Efendi et al., 2007; Peng and Röell, 2008; Johnson et al., 2009). However, there is disagreement about which part of CEOs' equity incentives is the culprit, with some studies linking manipulation to option (but not stock) holdings, others linking manipulation to stock (but not option) holdings, and again others linking it to unrestricted (but not restricted) stock. Moreover, the evidence of a link between equity incentives and accounting irregularities is not unanimous. Erickson et al. (2006) find that executives' equity incentives are unrelated to accusations of accounting fraud by the SEC, whereas Armstrong et al. (2010) find that CEO equity incentives have, if anything, a modestly negative effect on restatements, SEC enforcement releases, and class action lawsuits. Interpreting these observational studies is difficult – ownership incentives and manipulation are both endogenous choice variables.

Theoretically, it is sensitivity to *short-term* performance that is most likely to induce manipulation. A direct measure of CEOs' short-term incentives is the quantity of equity scheduled to vest in a given period, because CEOs sell a large chunk of equity when it vests (Edmans et al., 2017a, 2017b). The quantity of vesting equity depends on equity grants made several years prior and is thus likely exogenous to the current contracting environment. Empirically, the amount of equity scheduled to vest in a quarter is correlated with cuts in R&D and capital expenditure growth, positive analyst forecast revisions, positive earnings guidance, and a greater likelihood that the firm announces earnings that beat analyst forecasts by a narrow (but not wide) margin (Edmans et al., 2017a). This suggests that short horizons encourage CEOs to prioritize short-term earnings over long-term investment. Moreover, CEOs release significantly more news in months in which equity is scheduled to vest, and reallocate it away from the prior and subsequent month (Edmans et al., 2017b). This increased disclosure arises for discretionary (but not non-discretionary) news, and for positive (but not neutral or negative) news.

Achieving as-good-as-random variation in the length of vesting periods across firms or executives is usually impossible. However, Ladika and Sautner (2016) study the adoption of FAS 123R, which required U.S. firms to expense unvested options starting from either 2005 or 2006, depending on their fiscal year end. To avoid a reduction in earnings, some firms accelerated the vesting of outstanding options before the rule came into effect, and the timing of this acceleration depends on their fiscal year end, which is likely exogenous to investment opportunities. Accelerated vesting, instrumented using fiscal year ends, led to a fall in both R&D and capital expenditure. Accelerating firms' stock prices initially rose but subsequently fell, consistent with short-term stock price manipulation.

Executives benefit from temporarily lower stock prices in periods in which they expect to receive at-the-money options, because doing so reduces the options' strike price. Aboody and Kasznik (2000), Chauvin and Shenoy (2001), and Daines et al. (2016) exploit the fact that many firms grant options on roughly the same day each year, so the grant date in a particular year is predetermined by last year's date. Consistent with manipulation, such scheduled awards are preceded by negative abnormal returns and the release of more negative news, while more positive news is released after the award. A concern is that all three studies use actual grants instead of predicted grants, even though firms endogenously choose each year whether to remain on the fixed schedule. Consequently, at least some of the return and news patterns around grants may not be due to manipulation but due to firms opportunistically changing the grant schedule.

Equity grants and holdings are far from the only source of manipulation incentives. The payoff structures of performance-based equity grants (Section 2.3.3) and of conventional bonus plans (Section 2.3.4) feature caps, floors, targets, and jumps that make manipulation likely. Unsurprisingly, earnings-based bonus plans have been linked to earnings manipulation (Healy, 1985; Holthausen et al., 1995; Guidry et al., 1999). The intensity and direction of the manipulation depends on where pre-manipulation earnings are relative to the bonus scheme's cap and floor. For cash and equity grants contingent on accounting metrics, Bennett et al. (2017) find significant clustering of performance just above both the target and the threshold performance levels. This is consistent with executives taking short-term actions to meet their performance goals, but also going no further to avoid ratcheting up future goals. Executives appear to use both accruals and cuts to discretionary expenditures (R&D, SG&A) to meet their goals, and manipulation appears to be worse for grants that pay off in cash (i.e., for conventional bonus plans) than for performance-based equity grants. For performance-based equity, Bizjak et al. (2015) find evidence of real earnings manipulation (cuts in R&D, advertising, and SG&A) in years in which earnings-based grants expire.

In closing, we note that virtually any incentive contract has unintended consequences and causes manipulation of the performance measure. It is important to stress that this does not imply that incentive contracts are worse than no incentive contract. The incentives to manipulate can be minimized by avoiding nonlinearities and discontinuities in both the measurement of performance and in the mapping of performance into payoffs.

6.2.2 The effects of pay on risk taking

Virtually every element of pay affects executives' incentives to take risk. Even simple shares in a levered firm are options on firm value and may increase risk, especially if the firm is close to bankruptcy, or decrease it if the executive is sufficiently risk-averse. Section 3.5 explained that the effect of options is similarly ambiguous: while an option has "vega" (positive sensitivity to volatility), it also has "delta" (positive sensitivity to firm value), which may induce a risk-averse manager to reduce volatility. Caps and floors and other nonlinearities in bonus schemes and performance-based equity can either increase or decrease risk-taking incentives (see Sections 2.3.3 and 2.3.4), and debt-based pay reduces them (see Section 3.6).[65]

Empirical studies typically measure a CEO's incentives to take risk using his *equity* vega – the sensitivity of his stock and options to changes in stock return volatility. The equity vega of a share is zero, so this measure collapses to the vega of his options. However, if managers' actions affect overall firm values rather than equity values, the correct measure of risk-taking incentives in a levered firm is the sensitivity to *asset* volatility (asset vega), which Chesney et al. (2017) measure. Finally, we are not aware of any attempt to measure the risk-taking incentives that stem from non-equity pay; doing so may be a fruitful area for future research.

[65] Johnson and Tian (2000) calculate the risk-taking incentives from performance-based options.

While pay-induced manipulation is typically negative for long-run value, pay-induced risk-taking may either increase or decrease firm value. Diversified shareholders are unconcerned by idiosyncratic risk and charge the market price for exposure to systematic risk. An undiversified executive, on the other hand, may turn down positive-NPV projects that increase risk, in which case an increase in risk-taking incentives would be positive for firm value. In contrast, excessively convex schemes can cause executives to choose negative-NPV projects that increase volatility.

Observational studies typically confirm the theoretical prediction that stronger equity incentives (higher "delta") are associated with less risk-taking, while convex equity incentives (higher "vega") are associated with more (see, for example, Agrawal and Mandelker, 1987; DeFusco et al., 1990; Tufano, 1996; Guay, 1999; Rajgopal and Shevlin, 2002; Lewellen, 2006; Coles et al., 2006; Armstrong and Vashishtha, 2012). However, it is again difficult to interpret these correlations as causal. For example, firms whose business strategies require executives to choose high risk will optimally compensate with convex instruments.

Moving towards causal identification, Hayes et al. (2012) exploit the fact that FAS 123R required options to be expensed after 2005 or 2006. As predicted, after 2006, firms across the U.S. used fewer options but did not decrease risk in either investment or financial policies. However, since the regulatory change affected all firms, the insignificant results could arise because other economy-wide factors changed in 2006 that increased risk-taking incentives, offsetting any reduction from the fall in option compensation. Identifying regulatory changes that affect only some firms within an economy would be promising, as it would allow construction of both a treatment and control group.

Studying changing incentives for the same executive over time, Shue and Townsend (2017a) exploit the fact that options are granted according to multi-year plans. In fixed number (value) plans, the executive receives the same number (value) of options each year within a cycle. This feature motivates two instruments. The first uses fixed value plans alone and exploits the fact that, at the start of a new cycle, there is a discrete increase in the value of option grants, on average. The authors thus use the predicted first year of a new fixed value cycle as an instrument. The second uses both fixed number and fixed value plans. When stock returns are high, the value of fixed-number grants rises, but (by definition) the value of fixed-value grants is unaffected. They compare risk taking between fixed number and fixed value firms; to ensure that stock returns are unaffected by the CEO, they study industry returns. Using both instruments, the authors find that exogenous increases in options are associated with greater risk-taking.[66]

[66] Consistent with a positive causal effect of options on risk taking, Gormley et al. (2013) show that firms reduce option compensation when shareholders desire a reduction in risky investments. Similarly, Akins et al. (2017) find that, when creditors have control due to a loan covenant violation, option compensation falls.

6.2.3 The effects of pay on policies, profitability, and executive retention

Other studies link executive pay to a variety of corporate policies, acquisitions, profitability, and executive retention. Early studies focus on accounting-based long-term incentive plans. The introduction of such plans is followed by increases in capital investment (Larcker, 1983) and profitability (Kumar and Sopariwala, 1992). More recent studies investigate the correlation of stock and option holdings with a variety of outcomes. Equity incentives have been associated with better operating performance (Core and Larcker, 2002), more and better acquisitions (Datta et al., 2001; Cai and Vijh, 2007), larger restructurings and layoffs (Dial and Murphy, 1995; Brookman et al., 2007), and more voluntary liquidations (Mehran et al., 1998). Options are also linked to lower dividends (Lambert et al., 1989) and to a shift from dividends to share repurchases (Fenn and Liang, 2001; Kahle, 2002), likely because options are not usually dividend protected. Again, these correlations do not imply causal relationships – for example, firms about to undertake acquisitions or restructurings may increase equity pay to boost incentives.

Turning to executive retention, shorter-duration contracts are correlated with more CEO turnover (Gopalan et al., 2015). Suggestive of a causal effect of vesting requirements on retention, CEO turnover increases after previously granted option or stock grants vest. Further evidence of a causal effect comes from Jochem et al. (2016), who study accelerated vesting caused by the introduction of option expensing in 2005 and 2006 (similar to Ladika and Sautner, 2016). The accelerated vesting led to voluntary CEO turnover rising from 6% to 19% per year.

Shareholders sometimes submit proposals to the annual shareholders' meeting that advocate that a firm implement long-term incentives, either in the form of restricted stock, restricted options, or long-term incentive plans. To estimate the effects of such long-term incentives, Flammer and Bansal (2017) use a regression discontinuity design that compares proposals that narrowly pass to those that narrowly fail. Narrowly passing a proposal increases long-term operating profitability and sales growth. Performance declines slightly in the short-run, consistent with a long-term orientation involving short-run sacrifices. The market reaction to a successful proposal is positive, suggesting that the long-run benefits outweigh the short-run costs. Successful proposals are also associated with increases in innovation and measures of corporate social responsibility.

6.2.4 The effects of employment contracts

Fixed-term employment contracts can affect executive horizons and create discontinuous changes in horizons around contract termination dates. Cziraki and Groen-Xu (2016) hand-collect employment contracts for S&P 1500 CEOs and find that approximately one quarter are fixed-term (i.e., have an explicit termination date), with the remainder being at-will. Dismissing a CEO before the termination date is more expensive than not renewing a contract; indeed, they find that turnover odds fall by 30% from the year just before a renewal to just after, and the sensitivity of turnover to performance also falls.

Since the termination date is determined at the start of the contract, which is several years in advance (modal length of 3 years, with some contracts lasting over 10 years), it is arguably uncorrelated with current investment opportunities. However, if executives are concerned about being let go at the end of the current contract, they might change their behavior as the termination date comes close. Consistent with this intuition, Cziraki and Groen-Xu (2016) find that an approaching termination date is associated with lower stock return volatility, lower idiosyncratic risk, and lower investment. González-Uribe and Groen-Xu (2016) show that greater time-to-expiry is associated with higher-quality innovation – one additional year remaining on the CEO's contract is associated with 6.5% more annual citations per patent. Similar results arise when using a 2002 U.K. regulation that shortened CEO employment contracts. In the same vein, Liu and Xuan (2016) show that impending contract expirations are associated with earnings manipulation and the withholding of negative news, but also with higher acquisition announcement returns. Hence, approaching contract renewal dates might have both positive and negative incentive effects.

7. POLICY IMPLICATIONS

The perception that executive pay includes substantial rent extraction, or simply the perception that high levels of pay are "unfair", has led to many commentators proposing either pay regulations or changes to best practices. This section critically evaluates many of the policy proposals that have been suggested and, in some cases, already been implemented (see the Appendix).

7.1 The role for regulation

Before evaluating specific policies, we introduce a framework to identify the circumstances under which regulation is desirable. Before deciding whether to intervene, we propose that regulators ask the following questions:

What is the market failure? If shareholders (or their board representatives) are empowered, informed, and motivated, if boards are acting in shareholders' interest, and if shareholders' objective function is aligned with social welfare, there is no role for intervention. Because shareholders bear both the direct cost of pay and the losses from inefficient incentives, they should choose optimal contracts. Thus, regulation can only be beneficial when there are market failures.

The main cause of market failures is externalities, i.e., effects of firms' compensation choices on third parties. One set of potential externalities is on rival firms competing for executive talent. In Bénabou and Tirole (2016), competition causes firms to offer high incentives to attract able managers, but high incentives induce managers to shirk on unincentivized tasks. A compensation committee will internalize the effect of high incentives on the CEO's willingness to undertake unincentivized tasks, but not how high incentives force rival firms to also offer high incentives. Similarly, Acharya and Volpin (2010) and Dicks (2012) show that if one firm overpays its executives (e.g., due to poor governance), other firms must do so also to remain competitive, even if they are well-governed. Bereskin and Cicero (2013) find evidence of such contagion. Changes in Delaware case law around 1995 strengthened firms' ability to resist hostile takeovers, which in turn led to CEO pay rising by 33% in Delaware-incorporated firms with a staggered board and no external blockholder. In turn, pay in non-Delaware-incorporated industry rivals rose by 34%.

A second set of potential externalities is on other stakeholders. Shareholders might intentionally choose contracts that induce executives to improve shareholder value at the expense of other stakeholders, for example by mistreating workers, expropriating bondholders via risk-taking, or polluting the environment. Usually, costs imposed on others are charged back to the firm (and thus shareholders) through, e.g., higher wages or higher interest rates. In case of an externality, this feedback mechanism is broken. For example, bondholders in too-big-too-fail banks might not raise interest rates when executives are increasing risk because they expect a (taxpayer-funded) bailout if the bank fails. Even though externalities on other stakeholders can justify regulating pay, addressing the harmful actions directly (e.g., through restrictions on bank risk taking) may often be more effective.

Social welfare depends not only on total surplus (efficiency) but also its distribution (equality). Thus, a third externality of high executive pay is on income inequality. However, given that top executives are only a very small proportion of the total population, the effect of their pay on overall inequality is likely to be small. Kaplan and Rauh (2010, 2013) show that, in the U.S. (the country where executive pay is highest), executive pay has risen more slowly than pay in other occupations such as private equity, venture capital, hedge funds and law, and has contributed little to the overall rise in income inequality. In the U.K., Bell and van Reenen (2014) show that most of the gains at the top of the income distribution have gone to finance professionals. Thus, to the extent that inequality is a concern, it may be better addressed by an income or wealth tax, which is much broader than a regulation targeted at top executives alone.

In addition to externalities, a market failure also arises if shareholders or boards are unable to implement the contract that maximizes shareholder value, for example because shareholders are inattentive or ineffective. This makes excessive pay a symptom of a more general corporate governance problem within the firm, which may manifest in many other negative outcomes.[67] Thus, the optimal response may be to address the

[67] For example, Biggerstaff et al. (2015) find that option backdating is a symptom of more general corporate culture issues.

underlying cause of poor governance, such as dispersed ownership or non-independent boards.

Overall, it is unlikely that the "textbook" scenario in which shareholders are fully engaged and perfectly aligned with social welfare, and boards are perfectly aligned with shareholder value, holds in all cases. Market failures do exist. However, identifying the market failure should still be a necessary condition before regulating pay, and will highlight the areas in which a regulatory approach is likely to be effective or counterproductive.

Are pay regulations the best response to market failure? Even if there is a market failure, it is not clear that pay regulations will be able to address it. Regulators are typically less well informed than boards and shareholders about the firm, the performance of the CEO, and the managerial labor market in which the firm is hiring. If the problem is that boards are captured by the CEO, or shareholders are dispersed, then strengthening governance through board independence requirements or guidelines, or granting activist shareholders proxy access, can be a better solution than regulating pay. If the problem is a divergence between shareholder value and social welfare caused by externalities from CEO actions, it may again not be pay that should be regulated. Changing executives' behavior by regulating pay is often less effective than directly curtailing the activity that causes the harm to others.

Do the benefits of regulation exceed the costs? While market failures inevitably exist, regulation to address them may itself be costly and have unintended consequences. Regulation is usually one-size-fits-all and cannot be adapted to a firm's particular circumstances. As a result, regulation may hamper well-intentioned boards more than it constrains captured ones. For example, a ban on severance pay for top executives harms firms in which severance pay is efficient (see Section 3.7.2).

Regulations are also frequently circumvented, and doing so can result in even more inefficient pay practices. Section 5 discusses several interventions (some implemented by regulators, others advocated by shareholders) which, although well-intentioned, both increased the level of pay and reduced its link with performance. Murphy (2012) describes how the history of executive pay regulation is filled with unintended consequences and concludes that "with few exceptions, the regulations have generally been either ineffective or counterproductive."

There are other ways to reform pay besides hard regulation. The government can set policy guidelines rather than prescriptions, which can either be "soft" recommendations or "hard" comply-or-explain principles. Under both forms, companies have the option to deviate from the guidelines if doing so would be optimal for their particular circumstances. Introducing such guidelines can still be valuable if benchmarking or standardization of contracts makes it otherwise difficult to deviate from an inefficient status quo. Similarly, shareholders can themselves issue guidelines for firms that they own stakes in, as is done by some large institutional investors (e.g., the Norwegian sovereign wealth fund).

7.2 Potential areas for reform

We now describe and evaluate several specific regulations that have been proposed or implemented, in part using the above framework.

Disclosure. Mandating greater pay disclosure aims to empower shareholders. Given detailed information, shareholders can decide whether the current contract is optimal, and act against it if appropriate. Another rationale is to "name and shame" firms that adopt suboptimal compensation policies (typically interpreted as high CEO pay) and encourage customers, employees, or other stakeholders to walk away from such firms.

The required level of pay disclosure has been increasing over time (see the Appendix). The U.S. requires publication of the main pay components for the three highest paid executives of public firms since 1934. These disclosure requirements were expanded in 1978, 1992, 2006, and 2010, usually in response to perceived abuses (Murphy, 2012). Other countries introduced detailed disclosure requirements or comply-or-explain recommendations in the 1990s and 2000s (Canada in 1993, the U.K. in 1995, New Zealand in 1997, Ireland and South Africa in 2000, and Australia in 2003). In 2003, the European Commission recommended detailed executive pay disclosure for public firms to its EU member states.

The evidence on the effects of disclosure on executive pay is mixed. Firms that lobbied against the 1992 tightening of U.S. disclosure rules had positive stock returns when the new rules were adopted, suggesting that the rules addressed a governance problem for these firms (Lo, 2003). CEO pay tends to become more closely linked to performance following improved disclosure (Park et al., 2001). However, if anything, pay levels rise (Park et al., 2001; Balsam et al., 2016; Gipper, 2016; Mas, 2016), potentially because executives can more easily see what their peers receive. For example, the increased disclosure of perks due to the SEC's 1978 rules was followed by a marked increase in the use of perks. Disclosure also means that CEO pay becomes a public matter affected by politicians, the media, and trade unions, who may have objectives far different from shareholder or stakeholder value (Murphy, 2012).

Say on pay. Say-on-pay rules empower shareholders by giving them a binding or advisory vote on executive pay. The effectiveness of say-on-pay depends on the prevalence of rent extraction by executives, on how engaged and informed shareholders are, and on the details of the say-on-pay rule (see the Appendix).

The U.K. was the first to adopt say-on-pay legislation, requiring in 2002 that firms hold an annual non-binding vote on the directors' remuneration report. From October 1, 2013, the U.K. split the report into two parts. The first is the forward-looking policy report, which stipulates how the firm will determine pay in the future – for example, how pay will be linked to performance metrics, and the existence of any exit payments. Here, companies are required to adopt a binding vote at least once every three years. The second is the backward-looking implementation report that describes how the board determined realized pay over the past year, for which the vote continues to be annual and non-binding. A negative vote on the implementation report requires the company to have a binding vote on its remuneration policy the following year. In the U.S., there is a single remuneration report. Section 951 of the Dodd–Frank Act led to the SEC implementing a non-binding say-on-pay vote for executives effective from January 21, 2011. The Netherlands (2004), Australia (2005), Sweden (2006), Norway (2007), Denmark (2007), and Switzerland (2014) have adopted binding votes. The EU's Shareholder Rights Directive, approved in March 2017, requires a binding vote on the policy report for executives every three years (article 9A), and a non-binding vote on the implementation report every year (article 9B).

Despite considerable public support, say-on-pay remains controversial (Larcker et al., 2012). First, shareholders usually have less information than directors. Awards are sometimes based on subjective performance measures, which may be business sensitive or difficult to communicate to shareholders. Moreover, many shareholders have small stakes and thus insufficient incentives to analyze nuanced features of pay; they may thus focus on headline figures such as pay levels that may be less important to firm value. Even if shareholders recognize their relative ignorance, institutional investors may be pressured to vote on pay decisions since such votes are publicly disclosed. As a consequence, boards may make inefficient changes to executive pay to cater to ill-informed or inattentive shareholders. Consistent with this concern, Kronlund and Sandy (2016) find that, in years in which U.S. firms have say-on-pay votes, they improve the optics of pay (reducing salaries and golden parachutes) but worsen more hidden dimensions (increasing pensions), causing overall pay to be higher. Alternatively, shareholders may outsource their say-on-pay voting decisions to proxy advisory firms, with potentially negative consequences for shareholder value (see Section 5.4).

Second, say-on-pay may unintentionally increase pay levels to compensate for the risk that shareholders overturn the contract that executives have agreed with the board. Third, say-on-pay may divert monitoring away from other firm policies (e.g., innovation and corporate social responsibility), which may have greater effects on both shareholder value and society. In particular, if say-on-pay votes are public and likely to be scrutinized, institutional investors may overly focus on pay votes at the expense of less visible forms of monitoring.

Despite these concerns, the evidence is supportive of say-on-pay creating shareholder value. Cuñat et al. (2016) study shareholder proposals to adopt say-on-pay in U.S. firms over 2006–2010, before it became mandatory in 2011. Their regression discontinuity design shows that narrowly passing a proposal to adopt say-on-pay leads to a 4% increase in market value and improvements in profitability and labor productivity, although neither the level nor structure of pay changes. Thus, the effect of a positive vote may be to make executives realize that their future behavior may be subject to discipline, rather than the vote itself constraining pay.

Turning to mandatory say-on-pay votes, the House of Representatives' passage of the U.S. say-on-pay bill was associated with positive event-study returns, but only for firms with high abnormal CEO pay and low wealth-performance sensitivity (Cai and Walkling, 2011). In the U.K., Ferri and Maber (2013) find positive event-study returns to the introduction of say-on-pay legislation for firms with high abnormal CEO pay, particularly if this was combined with poor recent performance. The law was followed by a rise in pay-performance sensitivity (they do not study wealth-performance sensitivity) but no decrease in the level of pay.

These earlier results are based on single-country analyses; since the say-on-pay law affects all firms, there is usually no clean control group. Correa and Lel (2016) improve on this with a difference-in-differences approach using 38 countries over 2001–2012, of which eleven passed say-on-pay laws during that period. The laws are associated with CEO pay levels falling by 7%, pay-performance sensitivity rising by 5% (they do not study wealth-performance sensitivity), and firm values increasing by 2.4%. Advisory say-on-pay laws are associated with greater pay reductions and increases in pay-performance sensitivity than binding laws, although the authors stress that these conclusions are tentative since the nature of laws classified as "advisory" or "binding" differs across countries. A potential explanation is that investors are more reticent to vote against a pay package if a negative vote is binding and thus likely to cause greater disruption in a firm, in particular if there is no clear remedy to a negative binding vote.

Pay ratios. Concerns about income inequality has led politicians, regulators, and pressure groups to focus on the pay gap between CEOs and rank-and-file employees. Section 953(b) of the 2010 Dodd–Frank Act, implemented August 5, 2015 but placed on hold in February 2017, requires that U.S. firms disclose the total pay for the CEO, the total pay for the median employee excluding the CEO, and the ratio of these two numbers.[68]

There are several concerns with such a disclosure, which is likely to direct public anger at the wrong firms and have a number of unintended consequences. First, even if executive pay is set efficiently with no rent extraction, pay ratios vary widely across firms. The shareholder value theories in Section 3.1 suggest that the ratio's numerator – CEO pay – is determined by the CEO's value added and his outside options. Hence,

[68] The EU's Shareholder Rights Directive (approved in March 2017) initially proposed mandating a similar disclosure, but this proposal was eventually dropped.

a high ratio might indicate a talented CEO with a high market value.[69] Frydman and Papanikolaou (2017) show that shocks to technology can cause changes in pay ratios. When investment opportunities improve, it is optimal to increase executive pay to attract skilled managers who can exploit such opportunities, which in turn causes pay ratios to rise.

The ratio's denominator – median employee pay – depends on the labor market for rank-and-file employees, which varies considerably between firms. For example, the pay ratio is lower in investment banks than in supermarkets, not because investment bank CEOs are poorly paid but because rank-and-file bankers are relatively scarce and thus well-paid. Median employee pay varies even within an industry, as it depends on each firm's capital–labor ratio, franchising policy, and other strategic decisions. For example, it is lower in InterContinental Hotels than in Hilton, because the former franchises its hotels while the latter does not. Hence, a low ratio might indicate a firm that has outsourced its manual workers, or replaced them by machines.

Second, a focus on pay ratios, and social pressure to lower them, is likely to have a number of unintended consequences. The numerator – CEO pay – can be lowered while preserving the CEO's expected utility by, e.g., shortening vesting periods and making the CEO's pay safer and less sensitive to performance. Such changes are likely to reduce shareholder value. In order to avoid spikes in pay ratios, firms will have to further curtail CEO pay-performance sensitivities. Median employee pay does not vary much with firm performance, so high pay-performance sensitivities result in high pay ratios whenever performance is high.

The denominator – median employee pay – can be artificially increased by substituting capital for labor, outsourcing low-wage workers, or hiring part-time rather than full-time employees if only the latter are considered in the ratio.[70] Firms may also shift employee compensation away from non-pecuniary forms (such as on-the-job training, flextime working policies, and superior working conditions) towards salary. Hence, social pressure to lower pay ratios is likely to lead to more automation, more outsourcing, and less pleasant work environments for low-wage employees.

Restrictions on specific forms of executive pay. Regulators, politicians, and pressure groups have proposed, and in some cases implemented, restrictions on specific forms of executive compensation, such as bonuses or stock-based pay. As a means to

[69] The limited available evidence suggests that within-firm pay inequality is positively correlated with operating performance and firm valuations (Faleye et al., 2013; Mueller et al., 2017).

[70] In response to concerns that calculating the pay of the median employee is difficult for firms with many business units and no centralized payroll system (Murphy, 2012), Section 953(b) of Dodd–Frank gives firms discretion on how to calculate the median – including the option to exclude employees in countries in which data privacy laws or regulations hinder gathering of compensation information – which in turn gives them significant latitude to manipulate the ratio.

restrain the level of executive pay, such restrictions are bound to fail. Boards can always substitute a different (and usually less efficient) form of pay to provide the executive with the same level of compensation.[71] As a means to change executives' incentives and behavior, the restrictions described below appear to be ill-targeted and to have costly unintended consequences.

Restrictions on golden handshakes. On March 3, 2013, 68% of Swiss voters approved the writing of the *Abzocker* (rip-off) reform into the Swiss constitution. Among other practices, the reform bans all forms of compensation on departure (such as golden handshakes). Support for the reform significantly increased after Novartis CEO Daniel Vasella's lucrative non-compete contract upon departure was released in February 2013, suggesting that it was at least in part a reaction to one particular case.

Payments on departure can be a form of rent extraction, especially if they occur in forms not easily visible to shareholders (see Section 4.3). However, in many cases, severance pay can improve shareholder value by, for example, motivating CEOs to accept a valuable takeover bid, innovate, or leave without putting up a fight (see Section 3.7.2). A blanket prohibition is therefore costly. The benefits are limited to at most the departure payment itself, which is a small percentage of firm value (see Section 2.2.2).

Restrictions on stock-based pay. The EU's Shareholder Rights Directive stipulates that "the value of shares does not play a dominant role in the financial performance criteria" and that "share-based remuneration does not represent the most significant part of directors' variable remuneration", although exceptions are allowed where the remuneration policy includes a "clear and reasoned explanation as to how such an exception contributes to the long-term interests and sustainability of the company" (see the Appendix).

Restrictions on stock-based compensation have a variety of motivations. First, stock-based pay might cause executives to focus on short-term stock prices at the expense of long-term value creation. However, this is not a problem of stock *per se*, but of insufficient holding requirements. The solution is not to replace stock with fixed salaries (which provide no incentives) or bonuses (which incentivize only the performance measures being rewarded), but to extend the vesting period of equity.

Second, the stock price might be a poor measure of performance, either because it is not directly controllable by the executive, or because it focuses too narrowly on shareholder value. Neither concern is convincing. When assessing executive performance, boards already combine stock prices with subjective performance evaluation and accounting metrics, which the executive can more easily affect. More importantly, the long-run stock price captures all of the channels through which the CEO and other

[71] Israeli lawmakers went further and on March 29, 2016, passed a law that restricts executive compensation in banks, insurance companies, and investment managers to 35 times the salary of the lowest paid employee. Remarkably, the average announcement return for the 20 affected firms appears to have been positive, consistent with the law reigning in rent extraction (Abudy et al., 2017).

top executives improve shareholder value (e.g., profits, growth, innovation, restructuring) or destroy value (Jensen, 2001; Edmans, 2016). Hence, the generality of a stock price target is an advantage, not a disadvantage. Any narrow target (or set of targets) will fail to capture the complexity of the CEO's job, and will lead to inattention to non-targeted dimensions. The existence of an almost all-encompassing performance measure is a critical distinction between CEOs and other workers (e.g., doctors and teachers), where studies have shown incentive pay may backfire due to lack of such a measure.

Lengthening vesting periods, clawbacks, and malus. The concern that pay contracts may cause executives to focus on short-term performance at the expense of long-run value is both widespread and theoretically justified (see Section 3.7.1). Several remedies have been proposed and sometimes implemented, all with the goal of lengthening executives' horizons. To justify regulatory intervention, it must be that shareholders are unable (or unwilling) to implement these changes themselves.

One obvious remedy is to lengthen the vesting period of equity. The optimal vesting period will vary between companies; for example, it will be higher in young companies in growing industries, for which long-term investment is more important. Moreover, the vesting period can be lengthened beyond the executive's retirement, as suggested by Eq. (41) in Section 3.7.1.[72] Such deferral may deter short-term manipulation, encourage the executive to take long-term investments that will pay off after his departure, and encourage succession planning. Survey evidence indicates that many firms do not have a CEO succession plan (Heidrick & Struggles, 2010), confirmed by the often haphazard succession processes after a CEO dies in office (Jenter et al., 2017). While lengthening vesting periods may require a higher level of pay to compensate for the greater risk, this is likely to be vastly outweighed by the benefits of superior decisions. Note, however, that longer vesting periods may have other costs, as discussed in Section 3.7.1.

A second remedy is to claw back executives' bonuses upon exceptional events. In the U.S., the Sarbanes–Oxley Act of 2002 and the Dodd–Frank Act of 2010 define these exceptional events as accounting restatements.[73] The first SEC settlement forced William McGuire, the former CEO and Chairman of UnitedHealth, to repay his employer $468 million after backdating options. In the U.K., these events can include

[72] There are two ways in which deferral of equity beyond retirement occurs in practice. The first is through equity vesting after the executive's retirement (and no accelerated vesting at retirement). The second is through introducing an *additional* requirement for an executive to hold a minimum amount of shares post-retirement. For example, Unilever requires its CEO to hold at least five times salary in shares for one year after retirement, and half that amount two years post-retirement. The current (April 2016) U.K. Corporate Governance Code recommends that firms consider implementing this second approach.

[73] More recently, the SEC has been enforcing clawbacks even if the executive in question was not personally charged for the accounting fraud: in 2011, the SEC clawed back $2.8 million from Maynard Jenkins, the former CEO of CSK Auto Corporation, even though he was not charged.

fraud or other misconduct: in 2013, Barclays clawed back £300 million in staff bonuses following fines for Libor fixing and mis-selling of payment protection insurance. However, clawbacks are not triggered by general poor performance and so do not deter non-fraudulent short-termist actions, such as cutting R&D to boost earnings. Moreover, they may be more difficult to implement than lengthening vesting periods. For example, the executive may have spent the bonus or transferred it to a relative, making the clawback difficult.

A third remedy is to implement bonus-malus systems, whereby bonuses are not immediately paid out but held in escrow and subsequently forfeited if poor performance comes to light. Such a system is easier to implement than clawbacks, since the bonus is not paid out prematurely, but typically requires a discretionary decision for forfeiture to occur.[74] In contrast, the value of unvested equity automatically falls once poor performance comes to light.

8. DIRECTIONS FOR FUTURE RESEARCH

We start with potential avenues for future empirical analysis, before turning to ideas for theoretical research. Some are shared with Edmans and Gabaix (2016).

Private firms, non-U.S. firms, and other employees. Most empirical studies have been focused on top executives in public firms in the U.S., given the availability of the ExecuComp and similar datasets. More research on the pay of executives in private firms who are neither owner-managers nor related to controlling shareholders would be particularly useful (see Section 2.5). Since private firms are likely closer to the shareholder value benchmark, due to the presence of a concentrated shareholder, comparing them with otherwise similar public firms might allow assessment of whether pay in public firms represents rent extraction. At the same time, differences in the contracting environment should create interesting differences in optimal contracts between public and private firms. For example, in a private firm, the controlling shareholder's ability to directly monitor the CEO may reduce the required level of incentive pay.

A second fruitful direction would be to study international data and analyze the determinants of cross-country differences in CEO pay (see Section 2.4). Countries differ widely in corporate ownership, corporate governance, taxes, regulation, and executive hiring practices, but relatively little is known about how these characteristics relate to executive pay. Conyon et al. (2011) and Fernandes et al. (2013) are useful steps in this

[74] Hypothetically, forfeiture could be based on a non-discretionary formula (e.g., a performance measure falling below a pre-specified threshold). However, in practice, this does not occur. Boards prefer to retain discretion to apply malus in a wide range of events, such as misconduct, mis-statements, or reputational damage, which may not necessarily trigger performance falling below the threshold.

direction. Moreover, while data on CEO wealth (an important determinant of both risk aversion and the private benefits from shirking) is typically unavailable in the U.S., it is sometimes available in other countries (see, e.g., Becker, 2006).

Third, most research on executive compensation studies the pay of the CEO only. ExecuComp and similar databases report the pay of the five most highly-paid executives, allowing some papers to compare the CEO's pay to the remainder of the top management team, although such research is still relatively scarce.[75] Fewer papers still have obtained proprietary pay data for mid-level managers and rank-and-file employees (e.g., Mueller et al., 2017; Faleye et al., 2013). This allows comparisons of pay levels and incentives across the hierarchy within a given firm. The determinants of differences in pay and incentives within the top management team and across the corporate hierarchy are ripe topics for future research.

Descriptions, correlations, and causality. Executive pay is a field in which descriptive statistics are often highly illuminating (see, e.g., Jensen and Murphy's, 1990a and Hall and Liebman's, 1998 seminal work on quantifying CEO incentives). Much more descriptive works remains to be done – on pay components not reported in compensation tables, on the details of performance-based equity and cash grants, on the details of executive employment contracts, and on pay practices in private firms, for executives other than the CEO, and in countries other than the U.S.

Even more can be learned by careful analyses of how endogenously chosen compensation contracts differ across settings. We know surprisingly little about how pay practices vary across industries, firms of different sizes, firms at different stages of their life cycle, and firms with different technologies, organizational structures, and other fundamentals. Exogenous shocks to the determinants of compensation contracts – e.g., shocks to technologies, competition, the availability of information, or risk – allow us to observe how pay practices endogenously adapt to changes in the contracting environment. This type of research is most useful when it is firmly grounded in the theories surveyed in Sections 3, 4, and 5 and when it confronts model predictions with evidence.

Identifying the causal effects of executive pay on firm value, behavior, and performance is both important and difficult (see Section 6). It usually requires instruments or natural experiments that create as-good-as-random variation in pay practices. We have highlighted a number of recent studies that cleverly exploit regulatory changes, discontinuities, or institutional frictions in the pay-setting process to achieve identification. However, measuring the causal effects of executive pay remains one of the most important challenges of this literature.

[75] For example, Kale et al. (2009) study tournament incentives among top executives; Bebchuk et al. (2011) use the CEO's pay relative to the top executive team as a measure of CEO power, and Bushman et al. (2016) study synergies within the top management team.

Estimating dynamic incentives. Aside from the limited evidence in Boschen and Smith (1995), very little is known about the effects of current performance on the future path of compensation and turnover. Studying such longer-run effects might change our view of incentives, in particular because the effects of performance in different periods may well be interactive, rather than additive. The increasing popularity of performance-based equity and cash grants, which often feature payoffs that are non-linear functions of multi-year performance, should have made such interactions more important. A proper accounting for the dynamic effects of current performance on future pay and turnover might even change the commonly accepted view that executives' incentives are almost entirely driven by their stock and option holdings (Jensen and Murphy, 1990a).

Testing shareholder value models. Recent years have seen the development of new shareholder value models of executive pay (see Section 3), often with predictions that have not yet been tested. This is certainly the case for assignment models (Section 3.1.1), models of incentives in market equilibrium (Section 3.3), and dynamic contracting models (Section 3.7). For example, dynamic moral hazard models offer predictions for how the level of pay and incentives evolve with tenure, how this evolution is affected by risk, and how the optimal horizon of incentives is determined.

Structural estimation. Structurally estimating assignment, learning, or (dynamic) moral hazard models allows researchers to study questions that are difficult to answer with reduced-form approaches. For example, within the chosen model, a structural estimation allows quantification of important determinants of the optimal contract that are otherwise difficult to measure empirically, such as the CEO's risk aversion, cost of effort, ability to engage in manipulation, and desire for consumption smoothing. Relatedly, it can permit counterfactual analyses, such as the effect on firm value of changes in these parameters, or how the possibility of manipulation changes the contract.

An advantage of reduced form approaches is that the data can be compared to the predictions of several models. The advantage of a structural estimation is that it confronts one specific model much more seriously with the data. However, the structural estimation must ignore any forces that affect the data but are not in the model. This is a serious concern in executive compensation, as pay arrangements are likely the result of many forces – shareholders' desire to maximize value, executives' desire to maximize rents, and the influence of legislation, taxation, accounting policies, and social pressures.

It is nevertheless useful to model a subset of these forces and assess how well they alone can explain the data. However, there likely is another combination of forces that could have been modeled and would have fit the data equally well, and there are likely aspects of the data the current models cannot match. Formal tests of a model's qualitative and quantitative predictions can highlight where the theory fails, thus opening doors to future research.

We now move to open theoretical questions.

Rent extraction theories. There is a striking lack of theories of the rent extraction view of pay. Aside from Kuhnen and Zwiebel (2009), we are unaware of any models where the manager, rather than shareholders, set pay. Writing such a model, and in particular studying the extent to which it can *quantitatively* (as well as qualitatively) explain various features of the data, would be valuable. Especially interesting would be a model that allows for a horse-race between the rent extraction and shareholder value views.

Adding frictions to assignment models. Most models of the assignment of executives to firms are frictionless and perfectly competitive (e.g., Gabaix and Landier, 2008; Terviö, 2008). Taken literally, this would predict frequent reassignments of CEOs to different firms and external poachings to be much more common than internal promotions. It would be fruitful to extend these models to take into account real-world frictions, such as firm-specific human capital, imperfect competition, match-specific surpluses, and turnover and search costs, and then to calibrate such a model to study the extent to which an assignment model with frictions can jointly explain both the high levels of pay and the relatively infrequent CEO mobility.

Dynamic market equilibrium models. Most models of incentives in market equilibrium are static. It would be useful to add a dynamic moral hazard problem where incentives can be provided not only through contracts, but also by the threat of firing or the promise of being hired by a larger firm. This would, among other things, analyze how contracting incentives interact with hiring/firing incentives. These different incentive channels may conflict with as well as reinforce each other. For example, the "deferred reward" principle, discussed in Section 3.7, argues that the reduction in CEO pay caused by poor performance should be spread out over all future periods, to achieve consumption smoothing. However, the CEO may quit if future expected pay is low, reducing consumption smoothing possibilities.[76]

Complementarities. Most theories of CEO pay are single-agent models, but CEOs work in teams where complementarities between agents exist. As a result, their contracts affect firm value not only directly through affecting the CEO's effort, but also indirectly because the CEO's effort level affects the optimal effort level chosen by workers. This consideration in turn affects the optimal contract for the CEO. Separately, a team setting allows the study of the relative wages of the CEO and other employees.[77]

[76] The dynamic moral hazard models of DeMarzo and Sannikov (2006), DeMarzo and Fishman (2007), and Biais et al. (2007) assume risk neutrality, and so consumption smoothing is a non-issue.

[77] Edmans et al. (2013) analyze these issues within a CEO setting; Che and Yoo (2001), Kremer (1993), Winter (2004, 2006, 2010), and Gervais and Goldstein (2007) analyze contracting under production

Combining generality with tractability. There has been substantial theoretical progress on continuous-time agency models which allow for the contracting problem to be solved with few assumptions. However, their empirical predictions are typically less clear, given the absence of analytical solutions, and because numerical solutions depend on the parameters chosen. Future research may be able to identify clearer implications of these models, in particular comparative statics on how incentives and turnover-performance sensitivity should differ across firms.

Ex-post settling up. Contracting models assume that the principal and agent decide on the relevant performance measures and a contract at the start of the employment relationship. However, there is evidence that the performance measures may be renegotiated ex post (e.g., Morse et al., 2011), and that more than half the CEOs of S&P 500 firms do not have an explicit employment contract (Gillan et al., 2009). It would be interesting to study the optimal contract if the CEO and firm wait until performance has been realized before negotiating a sharing rule, and under what circumstances such an implicit contract can be sustained.

Behavioral theories. Most theories of CEO pay are rational. Incorporating behavioral considerations has been successful in other fields of corporate finance and could be similarly fruitful here. Baker and Wurgler (2013) divide the behavioral corporate finance literature into two fields – managers who are irrational or have non-standard utility functions, and rational managers exploiting inefficient markets. As an example of the former, Dittmann et al. (2010) argue that incorporating loss aversion can explain the observed mix of stock and options, while standard utility functions cannot. As an example of the latter, Bolton et al. (2006) show that contracts that emphasize short-term performance may be a rational response to speculative markets. Other behavioral phenomena that could be incorporated into compensation models include bounded rationality, probability weighting, overconfidence (overweighting private signals and underweighting public signals), and optimism (overestimating one's own managerial ability or firm quality).[78]

We finally turn to open questions for both theoretical and empirical research.

The supply of CEO talent. We now have quantitative theories for the level of pay and "demand" side, given the supply of talent. However, we know relatively little on the "supply" side. Given the substantial pay premium that executives command over other skilled professions (e.g., medicine or law), it would be interesting to study empirically

complementarities in general principal–agent settings. Matveyev (2017) provides evidence of positive assortative matching of executives by ability across firms, suggesting the importance of complementarities.

[78] Gervais et al. (2011) and Otto (2014) show that, respectively, overconfidence and optimism cause CEOs to overestimate future performance and to overvalue incentive compensation.

the extent to which this premium results from limited supply, and if so, explore theoretically why supply remains so limited – why more people do not enter the business profession. A related topic is to understand better the nature of the scarcity of CEO talent, e.g., whether it stems from innate skills, experience, lack of succession planning, and so on.

Combining learning and moral hazard. While learning models (listed at the start of Section 3.2 but otherwise outside the scope of this survey) have generally been developed and tested independently of moral hazard ones, theories that combine both learning about ability and moral hazard, or empirical studies that analyze the relative importance of learning versus moral hazard for observed contracts, would be valuable.

9. CONCLUSION

This paper has surveyed the theoretical and empirical literature on executive compensation. Throughout the survey, we have attempted to emphasize the following three points. First, executive compensation is likely driven by many factors – boards and shareholders' attempts to maximize firm value, executives' attempts to maximize their own rents (perhaps in conjunction with entrenched boards and inattentive shareholders), and institutional forces such as legislation, taxation, accounting policies, and social pressures. No one perspective can explain all of the evidence, and a narrow attachment to one perspective will distort rather than inform our view of executive pay.

Second, the conclusions of an executive compensation study can be sensitive to assumptions. For theoretical models, the conclusions can hinge on seemingly innocuous features of the modeling setup, often made for tractability or convenience; for empirical analyses, the conclusions can hinge on the measure of incentives used, the time period studied, or the treatment of outliers. Thus, researchers should think very carefully about these modeling and measurement choices, and always explore robustness to alternative specifications.

Third, despite decades of research on executive pay, there are very many open questions, making it a ripe area for future research. Even seemingly fundamental questions, such as the causal effect of pay on firm outcomes, and pay practices outside the U.S., in private firms, and for executives below the CEO, remain largely unanswered. Executive pay interacts with other topics such as board and shareholder structure, income inequality, and political economy, and these interactions also open avenues for further investigation. The changing nature of compensation practices, such as the recent rise in performance-vesting equity, new regulations, such as say-on-pay, and recent disclosure requirements, such as on executive pensions, open the door to new empirical studies. Ripe topics for theoretical research include incorporating rent extraction, behavioral factors, additional frictions, and dynamics into market equilibrium models. We hope that this review will help stimulate this research and look forward to learning from it.

APPENDIX A. INSTITUTIONAL DETAIL

This appendix provides an overview of institutional features that affect executive compensation. The main focus is on the U.S., but we also discuss the U.K. and Europe.

A.1 U.S.

This section describes up to four institutional features that may affect any given compensation practice: legislation, disclosure requirements, accounting treatment, and tax treatment. Some of the institutional details are taken from the excellent surveys by Murphy (2012, 2013) to which we refer the reader for further detail. We do not aim to be comprehensive here, but to describe the most important elements for economists (as opposed to lawyers or accountants) to understand executive compensation.

Before we start, we list the main laws, disclosure requirements, and bodies that pertain to executive compensation:

- Regulation S-K of the Securities Act of 1933 ("Regulation S-K") lays out reporting requirements for various SEC filings issued by public firms.
- The Securities Exchange Act of 1934 ("1934 Act") created the SEC to enforce U.S. federal securities laws. Section 14(a) of the 1934 Act requires a firm to file a proxy statement when soliciting shareholder votes, e.g., for the annual shareholders' meeting. SEC regulation §240.14a-101 Schedule 14A stipulates the information required in a proxy statement; as a result, a proxy statement is often referred to as a Schedule 14A, and a definitive proxy statement is filed using SEC Form 14A. This information includes disclosure of executive compensation as required by certain items of Regulation S-K. The SEC subsequently made major amendments to its disclosure rules in 1978, 1992, and 2006, and minor amendments in other years (such as 2002 and 2009).
  - Note that Section 14(a) of the 1934 Act is different from Section 14A of the same act, which was newly added by Dodd–Frank and concerns shareholder approval of executive compensation.
- The Sarbanes–Oxley Act of 2002 ("Sarbanes–Oxley"), effective from July 30, 2002, was primarily focused on accounting reform, but contained some legislation relevant to executive compensation.
- In August 2002 and October 2002, the NYSE and Nasdaq respectively proposed changes to their listing rules to the SEC, to strengthen corporate governance standards for listed companies. These rules were approved in November 2003.
- The Dodd–Frank Wall Street Reform and Consumer Protection Act of 2010 ("Dodd–Frank") was primarily focused on Wall Street reform and consumer pro-

tection, but most of its executive compensation rules applied to all listed firms. The executive compensation items involved several additions to the 1934 Act, e.g., of Section 10C ("compensation committees") and of Section 14A ("shareholder approval"). In turn, many of these additions required the SEC to increase listing and disclosure requirements.

- Accounting standards were initially set by the Accounting Principles Board ("APB"), which was replaced in 1973 by the FASB. The FASB issues Financial Accounting Standards ("FAS") for public and private companies and non-profit organizations. Effective from July 1, 2009, the FASB established Accounting Standards Codification ("ASC"), which integrated the hundreds of existing accounting standards under 90 broad topics; thus, one new ASC typically integrates several FASs. The relevant ASCs for executive compensation are given in Table A.1:

Table A.1 Accounting standard codification reference

FAS	ASC Topic
FAS 43	ASC 710 Compensation General
FAS 112	ASC 712 Compensation – Nonretirement Postemployment Benefits
FAS 87; 88; 106; 112; 132(R); 158	ASC 715 Compensation – Retirement Benefits
FAS 123(R)	ASC 718 Compensation – Stock Compensation

- The Internal Revenue Code ("IRC") is the domestic portion of federal tax law.

General

- *Disclosure*:
  - From 1934 to 1978, the SEC required publicly-listed firms to disclose the compensation (including salaries, bonuses, stock, and options) of the three highest-paid executives in the annual proxy statement.[79] Starting in 1942, the SEC required companies to disclose some executive pay data in a table, rather than just in narrative form, and expanded the tabular disclosure in 1952. Proxy statements for firms with December year ends are typically issued in March or April, giving rise to "Shareholder Springs" where shareholders sometimes voice their opposition to compensation.
  - The 1978 Disclosure Rules extended individual pay disclosure from the top-three executives to the top-five (typically the CEO plus four other highest-paid executives) and expanded the information in the Summary Compensation Table ("SCT").

[79] There may be other, non-executive employees who are paid more than the three highest-paid executives. An executive is defined as an officer in charge of a principal business unit, division, or function, or any other officer who performs a policy making function.

- The 1992 Disclosure Rules required an even more detailed SCT, summarizing the major components of pay received by the CEO, CFO and other top-three executives over the past three years. Separate tables are required for the number of awarded options and stock appreciation rights ("SARs"),[80] for exercises and end-of-year holdings of options and SARs, and for long-term incentive plans ("LTIPs").
  * Previously, compensation was disclosed mainly through narrative descriptions, with only limited information in the SCT; the 1992 rules mandated much more extensive tabular disclosure for clarity. Standardization of the tables aimed to promote comparability between years and across firms.
  * However, the value of options granted did not need to be disclosed, so there was no total compensation number.
- The 2006 Disclosure Rules required:
  * The SCT to contain the value of new option grants (plus changes in pension value and any above-market interest or preferential dividends on nonqualified deferred compensation[81]), thus leading to a total compensation number for the first time.
  * A new Compensation Discussion and Analysis section, describing the firm's overall compensation policy and objectives.
  * A new Pension Benefits Table containing the present value of accumulated pension benefit, plus payments during the current year.
  * A new Nonqualified Deferred Compensation Table containing the value of accumulated deferred compensation, plus contributions, earnings, and withdrawals during the current year.
  * A new Director Compensation Table, similar in format to the SCT but for directors.
- Prior to 2006, firms separately reported "annual bonuses" and "payouts from long-term performance plans". Under the 2006 rules, both annual cash bonuses from short-term incentive plans and long-term performance bonuses are considered "non-equity incentive compensation" if they are based on pre-established

[80] A SAR gives an executive a bonus that depends on the increase in the stock price over a specified period of time, similar to an option. They became popular after December 1976, when the SEC exempted SARs from the short-swing rule (Section 16(b) of the 1934 Act), which required executives to return profits from trading the company's shares within a period of less than six months. This effectively required executives to hold shares for six months after option exercise. In May 1991, the SEC allowed the six-month holding period to begin on the option grant date, not the exercise date, and so SARs virtually disappeared.

[81] An interest rate is deemed to be above-market if it exceeds 120% of the applicable federal long-term rate. Dividends are considered to be preferential if they earn a higher rate than dividends on the company's common stock.

performance targets. If they are not based on pre-established targets, they are considered "discretionary bonuses".

– The main effects of Dodd–Frank, passed in 2010, on disclosure requirements were:
  * Section 953(a) added Section 14(i) to the 1934 Act, which mandates the SEC to adopt rules requiring disclosure of the link between realized pay and financial performance, including stock price performance. To implement it, the SEC proposed the addition of Item 402(v) to Regulation S-K on April 29, 2015. This rule has not yet been adopted.
  * Section 953(b) led to the SEC adding Item 402(u) to Regulation S-K on August 5, 2015. This rule requires firms to disclose the ratio of the CEO's total pay to the median total pay for all other employees. It was due to be implemented for fiscal years beginning on or after January 1, 2017 but is currently being reconsidered.
  * Section 955 added Section 14(j) to the 1934 Act, which mandates the SEC to adopt rules requiring the disclosure of whether company policies allow directors and employees to hedge any fall in the stock price. To implement it, the SEC proposed the amendment of Item 402(b) and the addition of Item 407(i) to Regulation S-K, on February 9, 2015. This rule has not yet been adopted.

The main compensation tables that need to be disclosed following the 2006 Disclosure Rules are as follows (Tables A.2–A.8):

Table A.2 Summary compensation table

Name and principal position	Year	Salary ($)	Bonus ($)	Stock awards ($)	Option awards ($)	Non-equity incentive plan compen-sation ($)	Change in pension value and non-qualified deferred compen-sation earnings ($)	All other compen-sation ($)	Total ($)
a	b	c	d	e	f	g	h	i	j

- *Tax*:
  – Section 162(m) of the IRC, implemented in 1993 in accordance with a pre-election promise by Bill Clinton, stipulates that compensation (including salaries, restricted stock with time-based vesting, in-the-money options, and discretionary bonuses) in excess of $1 million for the CEO and the four highest-paid executives other than the CEO is not tax-deductible for public firms. "Qualified" performance-based compensation, which meets certain rules (e.g., payments contingent on the attainment of objective performance goals that were

Table A.3 Grants of plan-based awards table

		Estimated future payouts under non-equity incentive plan awards			Estimated future payouts under equity incentive plan awards						
Name	Grant date	Threshold ($)	Target ($)	Maximum ($)	Threshold ($)	Target ($)	Maximum ($)	All other stock awards: number of shares of stock or units (#)	All other option awards: number of securities underlying options (#)	Exercise or base price of option award ($/Sh)	Grant date fair value of stock and option awards
a	b	c	d	e	f	g	h	i	j	k	l

Table A.4 Outstanding equity awards at fiscal year-end table

	Option awards					Stock awards			
Name	Number of securities underlying unexercised options (#) exercisable	Number of securities underlying unexercised options (#) unexercisable	Equity incentive plan awards: number of securities underlying unexercised unearned options (#)	Option exercise price ($)	Option expiration date	Number of shares of units of stock that have not vested (#)	Market value of shares or units of stock that have not vested (#)	Equity incentive plan awards: number of unearned shares, units or other rights that have not vested (#)	Equity incentive plan awards: market or payout value of unearned shares, units or other rights that have not vested ($)
a	b	c	d	e	f	g	h	i	j

Table A.5 Option exercises and stock vesting table

Name	Option awards number of shares acquired on exercise (#)	Value realized on exercise ($)	Stock awards number of shares acquired on vesting (#)	Value realized on vesting ($)
a	b	c	d	e

Table A.6 Pension benefits table

Name	Plan name	Number of years credited service (#)	Present value of accumulated benefit ($)	Payments during last fiscal year ($)
a	b	c	d	e

approved by shareholders) is not subject to this limit. This category generally includes shareholder-approved at-the-money options, out-of-the-money options, restricted stock with performance-based vesting, and formula-driven bonuses.

Table A.7 Non-qualified deferred compensation table

Name	Executive contributions in last FY ($)	Registrant contributions in last FY ($)	Aggregate earnings in last FY ($)	Aggregate withdrawals/ distributions ($)	Aggregate balance at last FY ($)
a	b	c	d	e	f

Table A.8 Director compensation table

Name	Fees earned or paid in cash ($)	Stock awards ($)	Option awards ($)	Non-equity incentive plan compensation ($)	Change in pension value and non-qualified deferred compensation earnings ($)	All other compensation ($)	Total ($)
a	b	c	d	e	f	g	h

– In March 2015, the IRS required a per-employee limit (approved by shareholders) on the maximum number of stock options and SARs to qualify for this exemption.

Stock and options

- *Legislation and listing requirements*:
  – The short-swing rule (Section 16(b) of the 1934 Act) requires executives to return profits from buying and selling (or selling and buying) the company's shares within a period of less than six months.
    ∗ *Stock*. Any stock held for at least six months is therefore exempt from this rule.
    ∗ *Options*. Prior to May 1991, the SEC counted the exercise of an option as the date of stock acquisition, thus effectively requiring executives to hold shares for six months after option exercise. As a result, the executive pays cash on the exercise date, but cannot recoup this cash (via stock sales) for six months. From May 1991, the SEC counts as the stock acquisition date the grant date, rather than the exercise date, thus effectively removing the holding requirement.
  – With effect from July 2003, NYSE and Nasdaq listing rules require shareholder approval of all equity compensation plans (with certain exceptions). AMEX listing rules followed suit in October 2003.

- *Disclosure*:
  - The 1992 Disclosure Rules required:
    - *Stock*. The SCT to contain the value of newly-granted restricted stock awards, plus the aggregate value of shares held by the executive in a footnote. No disclosure was required upon vesting.
    - *Options*:
      - The SCT to contain the number of options granted in the current year, but not their value; as a result, there was no single number for total compensation.
      - An Option/SAR Grant Table to contain grant-by-grant information on the number, maturity date, and strike price for options and SARs granted over the year, plus either the Black–Scholes grant-date value or the potential value of the options under the assumption that stock prices grow at 5% and 10% annually. The company could choose which valuation method to use.[82]
      - An Option/SAR Exercise Table to contain the aggregate number and value of shares acquired under option and SAR exercises in the current year. It also contains year-end option and SAR holdings, which include the aggregate number and intrinsic value across all exercisable options/SARs, and the same information across all unexercisable options/SARs, but not grant-by-grant information. The SEC's 2002 amendments also required the disclosure of the weighted average strike price.
  - The 2006 Disclosure Rules required:
    - Column (e) of the SCT to report the fair value of new stock grants and column (f) to report the fair value of new option grants (as determined under FAS 123R, described below), with the assumptions underlying the calculations in a footnote. Both amounts are included in total compensation (column (j)), providing for the first time a single number for total compensation.
    - A new Outstanding Equity Awards at Fiscal Year-End Table that includes the aggregate amount of outstanding unvested shares and grant-by-grant information on the number, strike price and maturity date of each outstanding option award. The vesting schedule and any performance-based hurdles are discussed in narrative disclosure following the table.
      - As for already-vested equity, Item 403 of Regulation S-K requires firms to report total beneficial stock ownership (both vested and unvested) of officers and directors in the proxy statements (Item 6 of Schedule 14A).
    - A new Grants of Plan-Based Awards Table that includes the number of new shares awarded, plus (to replace the old Option/SAR Grant Table) the grant

[82] Murphy (1996) found that two-thirds of firms chose the latter.

date, number of options, strike price, and grant-date fair market value of each new option grant.[83] The vesting schedule and any performance-based hurdles are discussed in narrative disclosure following the table. The table (and accompanying narrative disclosure) also report:

- · The incremental value from any repricing of a previously-awarded option, plus narrative description of the repricing.
- · Additional columns disclosing (i) the closing market price on the grant date if it exceeded the strike price, (ii) the date the compensation committee approved the grant if different from the grant date.

∗ A new Option Exercises and Stock Vested Table that includes the number of previously-granted shares that vested over the year and their value realized upon vesting, plus (to replace the old Option/SAR Exercise Table) the number of previously-granted options that were exercised over the year, plus their value realized upon exercise.

– Section 403 of Sarbanes–Oxley amended Section 16(a) of the 1934 Act, requiring executives to disclose new stock and option grants, exercises, and repricings, within two business days. Previously, they reported new grants to the SEC on Form 5, due 45 days after year-end, or Form 4, due 10 days after month-end.

- *Accounting*:
  - – Issued in October 1972, APB Opinion No. 25 requires the grant-date value of restricted stock and the intrinsic value of options to be amortized over the vesting period.[84] Thus, there was no accounting charge for at-the-money or out-of-the-money options.
  - – Issued in October 1995, FAS 123 recommended, but did not require, firms to expense the fair market value of options granted over the vesting period. Non-expensing firms had to disclose this value in a footnote.
  - – Issued in December 2004, FAS 123R required firms to expense the grant-date fair market value of options over the vesting period (using an option pricing model chosen by the firm), effective for the first interim or annual reporting period beginning after June 15, 2005. The rule also required firms to expense options granted prior to June 15, 2005 that had not yet vested, leading to many firms accelerating the vesting of options.

[83] The original rules, approved in July 2006, did not require the grant-date fair market value of stock and option awards, but the SEC amended the rules in December 2006 to add a new column to disclose this value based on FAS 123R.

[84] It also required equity with performance-based vesting conditions to be marked to market (variable accounting), with additional charges in each reporting period reflecting changes in the stock price. FAS 123(R) (now subsumed by ASC 718) removed this mark-to-market requirement, with all equity grants now being subject to fixed accounting.

- *Tax*:
  - *Stock*:
    - Restricted stock is taxable as ordinary income for the executive and tax-deductible for the firm upon vesting (Section 83(a) of the IRC).[85]
    - Unrestricted stock is taxable for the executive and tax-deductible for the firm upon granting.
    - Upon subsequent sale of the stock, the executive pays capital gains tax on the difference between the stock price upon sale and the stock price upon vesting. He pays the long-term capital gains tax rate if he sells more than 12 months after vesting, else the short-term rate.
  - *Options*:
    - Most options are "unqualified" and taxable upon exercise (not upon vesting). The gains from exercise (difference between the stock price and strike price) are taxable as ordinary income for the executive and tax-deductible for the firm.
    - The Economic Recovery Tax Act of 1981 created a class of Incentive Stock Options ("ISOs", often referred to as "qualified" or "statutory" stock options) which carry certain restrictions.[86]
      - Gains from ISOs are taxed as capital gains when the stock purchased upon exercise is eventually sold; the gain is calculated as the difference between the sale price and the strike price
      - Since the capital gains tax rate is typically lower than the income tax rate, ISOs are tax advantageous for the employee, but not tax deductible for the employer. They are common for middle management (where the $100,000 limitation is not binding) and for firms without taxable profits, but very rare for top executives.

Severance pay

- *Legislation and disclosure*:
  - The 2006 Disclosure Rules require firms to disclose all contractual severance payments in the event of any form of termination (e.g., dismissal, retirement, change of control) and how the payment differs by termination event.
  - Section 951 of Dodd–Frank added Section 14A(b) to the 1934 Act. This rule requires firms soliciting votes to approve a merger, going-private transaction, or

[85] However, Section 83(b) allows the employee to choose to be taxed upon granting (rather than vesting) of the stock, in which case the employer can also obtain the tax deduction upon receipt.

[86] For example, they are limited to $100,000 per executive per year (calculated as the stock price multiplied by the number of options on the grant date). To maximize tax benefits and qualify for the long-term capital gains tax rate, the executive needs to hold the stock for at least one year after the exercise date and two years after the grant date.

third-party tender offer to disclose any golden parachutes (severance payments that apply upon the above changes of control) and, in certain circumstances, conduct a non-binding shareholder vote. The SEC implemented the new disclosure requirements by adding Item 402(t) to Regulation S-K on January 25, 2011.

- *Accounting.* FAS 88, FAS 112, and FAS 146 (now subsumed by ASC 712) stipulate that a voluntary termination benefit must be recognized when the employee accepts the termination offer. An involuntary termination benefit must be recognized once it becomes probable.
- *Tax*:
  - Section 280G of the IRC stipulates that, if a golden parachute exceeds three times base compensation, the excess above base compensation (not three times base compensation) is non-deductible to the employer. Base compensation is defined as the executive's average taxable gross income received from the firm over the most recent five years (and thus includes gains from option exercises).
  - If a golden parachute exceeds three times base compensation, Section 4999 of the IRC imposes a 20% excise tax (in addition to income tax) on the excess above base compensation (not three times base compensation), payable by the recipient.
  - All severance payments are subject to income tax by the recipient.

Pensions

- *Legislation*: The Employee Retirement Income Security Act of 1974 ("ERISA") has established reporting obligations and minimum standards for participation, vesting and funding for both defined benefit ("DB") and defined contribution ("DC") pension plans.
- *Disclosure*: The 2006 Disclosure Rules require the following for both DB and DC pensions:
  - Column (h) of the SCT discloses the annual increase in the present value of pension benefits (aggregated with any above-market interest or preferential dividends on non-qualified deferred compensation). This amount is included in total compensation (column (j)). Previously, these changes did not need to be disclosed.
  - An additional Pension Benefits Table that includes, plan by plan, the present value of accumulated benefits and the payments during the year under each plan.
- *Accounting*: For DC plans, firms are required to expense the annual pension contribution. For DB plans, firms are required to expense the pension cost, which incorporates the service and interest cost, expected return on plan assets, amortization of prior service cost, and actuarial gains and losses. The relevant FASs (87 and 158) are now subsumed under ASC 715.

- *Tax*:
  - Executive pensions comprise two components:
    - ∗ For the qualified component, the annual contribution is tax-deductible for the firm and taxable for the executive only upon payment. Section 401(a) of the IRC sets out the requirements for qualified pension plans, and Section 415 gives the limits on the annual benefits and annual contributions. Due to these limits, the bulk of executive pensions are non-qualified.
    - ∗ For the non-qualified component (known as the Supplemental Employee Retirement Plan or "SERP"), Section 409A of the IRC stipulates that the pension benefits are tax-deductible for the firm only upon payment, in contrast to qualified plans (where it is immediately tax-deductible). Benefits are taxable for the executive upon payment, similar to qualified plans.

Deferred compensation

- *Disclosure*: The 2006 Disclosure Rules require the following:
  - Column (h) of the SCT discloses any above-market interest or preferential dividends on non-qualified deferred compensation (aggregated with the increase in the present value of pension benefits). This amount is included in total compensation (column (j)). Previously, these earnings were included in Other Annual Compensation, aggregated with items such as perks.
  - An additional Nonqualified Deferred Compensation Table that includes executive and company contributions, earnings, withdrawals, and the year-end balance of any deferred compensation.
- *Accounting*: Since 1967, APB Opinion No. 12 has required deferred compensation expenses to be amortized over the period until which the employee is fully eligible to receive the benefits.
- *Tax*:
  - Deferred compensation is non-qualified, and thus typically neither tax-deductible for the firm nor taxable for the employee until payment.
  - Section 409A of the IRC restricts withdrawals from deferred compensation accounts to pre-determined dates or events (such as death, disability, change in control, or emergencies), prohibits the acceleration of withdrawals, and prevents executives from receiving severance-related deferred compensation until six months after termination. If a deferred compensation plan satisfies the Section 409A requirements, an executive is taxed when plan distributions are made. If it does not, the executive pays tax when the deferred amounts vest (even if they are not distributed until a subsequent year), plus an additional excise tax of 20% and interest on the amount payable.

Clawbacks

- *Legislation and disclosure*:
  - Section 304 of Sarbanes–Oxley requires firms, in the event of a financial restatement due to misconduct, to claw back CEOs' and CFOs' bonuses, equity-based pay and profits on stock sales over the last twelve months.
  - Section 954 of Dodd–Frank added Section 10D to the 1934 Act. To implement it, the SEC proposed Rule 10D-1 on July 1, 2015, which forces national securities exchanges and associations to establish listing standards that require listed companies to adopt, disclose, and implement a clawback policy. The proposed rule broadens clawback policies to all executives, and stipulates the terms and amount of clawbacks. Upon a financial restatement due to a material error, an executive must repay that portion of any incentive compensation received during the three prior years that would not have been received based on the restated accounts. The clawback is to be "no fault", i.e., apply regardless of whether the executive was responsible for the restatement, and even if there is no misconduct.

Perks

- *Legislation*: Section 402 of Sarbanes–Oxley amended Section 13 of the 1934 Act to prohibit all personal loans to executives and directors. Other forms of perks are generally not prohibited.
- *Disclosure*:
  - The 1978 Disclosure Rules first mandated the disclosure of perks. If total perks exceeded $10,000, the total amount had to be reported as a column in the SCT (aggregated with other types of additional compensation, such as insurance payments), but individual perks did not need to be disclosed.
  - The 1992 Disclosure Rules changed the disclosure threshold to the lower of $50,000 or 10% of the executive's salary plus bonus. Perks were again aggregated with other additional compensation items in the Other Annual Compensation column. Firms must identify and quantify any individual perk that exceeds 25% of total perks in a footnote.
  - The 2006 Disclosure Rules lowered the threshold from $50,000 to $10,000. If total perks exceed $10,000, firms must identify each perk, regardless of its amount; perks that exceed the greater of $25,000 or 10% of total perks must be quantified in a footnote.
- *Accounting*: APB Opinion No. 28 requires that firms expense perks.
- *Tax*: The IRC of 1954 stipulated that executives report perks as income. However, few executives did so, because firms did not disclose perks, and so the Internal Revenue Service ("IRS") was unable to enforce their taxation. The 1978 disclosure rule helped the IRS to enforce taxation.

Say-on-pay and shareholder proposals

- *Legislation and disclosure*:
  - Prior to 1992, the SEC had prohibited shareholder proposals on executive pay from being included in firms' proxy materials, on the basis that executive pay was part of a firm's ordinary business (the "ordinary course of business exemption"). The SEC's definition of "ordinary business" has changed over time, and in 1992 it announced that proposals about executive compensation would no longer be automatically disallowed. Also in 1992, the SEC amended its proxy rules to make it easier for shareholders to communicate with each other and to publish their voting positions on shareholder and management proposals.
  - From 1992, shareholders are allowed to propose non-binding resolutions on executive pay, and firms are required to include submitted proposals in their proxy statements.[87]
  - Section 951 of Dodd–Frank added Section 14A(a) to the 1934 Act. Starting with the first annual shareholders' meeting on or after January 21, 2011, firms are required to conduct a non-binding shareholder vote on executive compensation at least once every three years, and an additional non-binding "frequency" vote at least once every six years to determine whether the say-on-pay vote will occur every one, two, or three years. Section 14A(a) also requires firms to disclose the outcome of both votes, and whether such votes are binding (as Item 24 in the proxy filing). Because of Dodd–Frank, the SEC also added Item 402(b)(1)(vii) to Regulation S-K, requiring firms to disclose whether and how they have considered the results of the most recent say-on-pay vote in determining current compensation.

Compensation committees and compensation consultants

- *Legislation and disclosure*:
  - Legislation does not require compensation consultants to be independent, as long as any conflicts are taken into account when selecting consultants and disclosed (see below).
  - The NYSE listing rules, approved in November 2003, required firms to have a compensation committee that comprises solely of independent directors.[88] The Nasdaq listing rules, also approved in November 2003, were similar but less stringent: If there was a separate compensation committee, it had to be fully

[87] This is different from a say-on-pay vote, which automatically occurs at a given frequency and is to approve a pay report. Instead, a shareholder resolution is an action initiated by shareholders. See Ertimur et al. (2011) for a study of such resolutions.

[88] Sarbanes–Oxley required the audit committee to be independent, but imposed no requirement on compensation committees.

independent, but firms were not required to have compensation committees – if there was none, compensation can be determined by a majority of independent directors. A 2013 change to the Nasdaq listing rules requires firms to have a compensation committee consisting of at least two independent directors.

- The 2006 Disclosure Rules required firms to disclose the role and identity of all consultants who provided advice on director and executive compensation, and whether they were engaged directly by the compensation committee or by management.
- In 2009, the SEC expanded the disclosure requirements through Item 407(e)(3)(iii) of Regulation S-K. If firms spend more than $120,000 on other services from their compensation consultants, they must disclose the fees paid for both compensation and other services. However, they were not required to disclose the nature of these other services.
- Section 952 of Dodd–Frank added Section 10C to the 1934 Act, which expanded the definition of compensation committee independence, stipulated that compensation committees can only hire consultants after taking into account their independence, and added disclosure requirements relating to consultants' potential conflicts. To implement the latter, the SEC added Item 407(e)(3)(iv) to Regulation S-K on June 20, 2012, requiring firms to disclose the nature of any conflicts of interest with compensation consultants (e.g., the consultant providing other services) and how the conflict is being addressed.

Peer groups

- *Disclosure:*
  - The 1992 Disclosure Rules required firms to include a line graph comparing the company's 5-year stock return with the returns on both a broad market index and an industry or peer group index. However, firms had flexibility to report whether they used peer groups to determine pay, and were not required to disclose the composition of any peer group used.
  - The 2006 Disclosure Rules required firms to disclose whether they engaged in any benchmarking of any material element of compensation, identify the benchmark and, if applicable, its components (including the composition of peer groups).
  - Section 953(a) of Dodd–Frank added Section 14(i) to the 1934 Act, requiring disclosure of the relationship between executive compensation and firm financial performance. To implement it, the SEC proposed the addition of Item 402(v) to Regulation S-K on April 29, 2015. This rule, not yet adopted, requires a firm to report its total shareholder return and that of its selected peer group in a table.

A.2 The U.K.

General

- The Companies Act of 2006 applies to all U.K. firms, although it sets out different rules for different firms (e.g., private and public firms).
- The Financial Conduct Authority applies additional requirements for firms listed on the London Stock Exchange (LSE).
  - The LSE has two markets:
    - The first is the Main Market, where two listings are possible: for a Standard listing, firms need only meet EU harmonized standards; for a Premium listing, they need to meet the U.K.'s listing rules.
    - The second is the Alternative Investment Market, which has a simplified regulatory environment and is targeted at smaller firms.
  - Premium listed firms must also adhere to the U.K. Corporate Governance Code, which was first introduced in 1992 by the Cadbury Committee and is now produced by the Financial Reporting Council. This code is "comply or explain" – firms have the option not to comply with certain elements, but they must disclose why.
- *Legislation*:
  - From 2002, Section 241A of the Companies Act 1985 (which was superseded by Section 439 of the Companies Act 2006) required U.K.-incorporated firms listed on the LSE Main Market (or in a state in the European Economic Area, on the NYSE, or Nasdaq) to hold an annual non-binding say-on-pay vote on the directors' remuneration report.
  - From 2013, Section 421 of the Companies Act 2006 required the directors' remuneration report to contain a separate, forward-looking section on remuneration policy, and Section 439A mandated firms to hold a binding vote on this "policy report" at least once every three years. Firms continue to have to hold an annual, non-binding vote on the other, backward-looking parts of the remuneration report (the "implementation report").
  - The Financial Conduct Authority Listing Rule 9.4.1 requires that directors' share schemes and long-term incentive plans must be approved by shareholders in a binding resolution at the annual general meeting. Unlike say-on-pay, which applies to the entire pay policy, this rule specifically applies to directors' share schemes.
  - The U.K. Corporate Governance Code (Provision D.2.4) recommends a binding shareholder vote on approval of new long-term incentive schemes and significant changes to existing schemes.
  - Section 188 of the Companies Act 2006 requires a shareholder resolution to approve a provision that guarantees a director's employment for more than two years (reduced from five years under the Companies Act 1985, Section 319).

  - Section 217 of the Companies Act 2006 mandates shareholder approval of termination payments (payments for loss of office), except payments that the company is legally required to make due to existing obligations and pensions under Section 220.
  - Section 226C of the Companies Act 2006 requires that no payment for loss of office may be made to a director of a U.K.-quoted firm, unless the payment is consistent with the approved directors' remuneration policy, or was approved by a shareholder resolution.
- *Disclosure:*
  - Under the Companies Act 1985, firms had to report the sum of salary and bonus of the highest paid U.K. director (but not his identity), the total emoluments all of directors, and the number of directors within various pay bands.
  - Following the influential Greenbury Report (1995), the London Stock Exchange amended its listing rules in December 1995 to require more detailed disclosure of director compensation. The new listing rules also required that the board's remuneration committee consist exclusively of non-executive directors.
  - The Directors' Remuneration Report Regulations 2002 (which amended the Companies Act 1985) required all U.K.-incorporated firms listed on the LSE Main Market (or in a state in the European Economic Area, on the NYSE, or Nasdaq) to include a detailed report on directors' remuneration in the annual report. This regulation was subsequently replaced by Section 420 of the Companies Act 2006, which requires the same level of disclosure.

A.3 European Union

- Article 9a and 9b of the Shareholder Rights Directive 2007/36/EC were amended on July 8, 2015, proposing that member states adopt rules for the directors' remuneration policy and directors' remuneration report, respectively.
- Article 9a proposes the following:
  - Shareholders shall have a binding vote on the directors' remuneration policy at least every three years, and firms shall pay only in accordance with this policy. Upon a no vote, the firm may pay according to its existing policy (or, if no such policy exists, existing practices) for up to one year while the new policy is being reworked.
    * Member States may change the votes to advisory.
  - The remuneration policy shall explain:
    * The financial and non-financial performance criteria (including, where appropriate, corporate social responsibility) used to determine pay;
    * How the pay and working conditions of employees were taken into account when determining the policy on director pay;
    * The duration of contracts and any termination payments;

    * Deferral periods, vesting periods, post-vesting retention periods, and claw-back provisions.
  - Share-based remuneration shall not represent the most significant part of directors' variable pay, except where remuneration policy includes "a clear and reasoned explanation as to how such an exception contributes to the long-term interests and sustainability of the company."
- Article 9b proposes the following:
  - Firms shall disclose, in their directors' remuneration reports:
    * Total compensation, how it is linked to long-term performance, and how the financial and non-financial performance criteria were applied.
    * The relative change in executive director pay over the last three years, and its relation to both general company performance and the change in the average employee pay over the same period.
  - Shareholders shall have an annual advisory vote on the remuneration report.

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