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The two sides of CEO pay injustice

A power law conceptualization of CEO over and underpayment

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Abstract

Purpose – The purpose of this study was to examine the extent to which chief executive officers (CEOs) deserve the pay they receive both in terms of over and underpayment.

Design/methodology/approach – Rather than using the traditional normal distribution view in which CEO performance clusters around the mean with relatively little variance, the authors adopt a novel power law approach. They studied 22 industries and N = 4,158 CEO-firm combinations for analyses based on Tobin's Q and N = 5,091 for analyses based on return on assets. Regarding compensation, they measured the CEO distribution based on total compensation and three components of CEO total pay: salary, bonus, and value of options exercised.

Findings – In total, 86 percent of CEO performance and 91 percent of CEO pay distributions fit a power law better than a normal distribution, indicating that a minority of CEOs are producing top value for their firms (i.e. CEO performance) and a minority of CEOs are appropriating top value for themselves (i.e. CEO pay). But, the authors also found little overlap between CEOs who are the top performers and CEOs who are the top earners.

Implications – The findings shed new light on CEO pay deservingness by using a novel conceptual and methodological lens that highlights systematic over and underpayment. Results suggest a violation of distributive justice and offer little support for agency theory's efficient contracting hypothesis, which have important implications for agency theory, equity theory, justice theory, and agent risk sharing and agent risk bearing theories.

Practical implications – Results highlight erroneous practices when trying to benchmark CEO pay based on average levels of performance in an industry because the typical approach to CEO compensation based on averages significantly underpays stars and overpays average performers.

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Originality/value – Results offer new insights on the extent of over and underpayment. The findings uncover an extremely large non-overlap between the top earning and top performing CEOs and to an extent far greater in magnitude than previously suggested.

Keywords Justice, Power, Firm performance, Corporate governance, Agency theory, Executive compensation, CEO pay, CEO performance, Chief executive officers, CEOs

Paper type Research paper

Resumen

Objetivo – El objetivo de nuestro estudio fue examinar si los directores ejecutivos (CEOs) merecen la remuneración monetaria que reciben.

Metodología – En lugar de utilizar el enfoque tradicional que asume que la distribución del rendimiento de CEOs sigue la curva normal (con la mayoría de CEOs agrupados en torno a la media y relativamente poca variación), adoptamos un enfoque diferente basado en la ley de potencia. Incluimos 22 industrias y N = 4.158 combinaciones de CEO-firma para análisis basados en *Tobin's Q* y N = 5.091 para análisis basado en la rentabilidad de los activos. En cuanto a la remuneracion, medimos distribuciones basadas en la remuneración total y tres componentes del pago completo a los CEOs: salario, bonos, y el valor de las opciones ejercitadas.

Resultados – 86% de las distribuciones de rendimiento de CEOs y el 91% de las distribuciones de pago de los CEO se aproximan mejor a una distribución de ley de potencia que a una distribución normal. Esto indica que una minoría de los CEOs produce un valor muy superior para sus empresas (es decir, el rendimiento CEO) y una minoría de los CEOs apropia valor superior para sí mismos (es decir, pago de los CEO). Sin embargo, encontramos muy poco solapamiento entre aquellos CEOs que se desempeñan mejor y los CEOs que ganan más.

Implicaciones – Nuestros hallazgos usando una conceptualización y metodología novedosas ponen en relieve que a muchos CEOs se les paga demasiado y que a muchos no se les paga suficiente (en comparación con su desempeño). Los resultados sugieren una violación de los principios de justicia distributiva y no apoyan la hipótesis de "contratación eficiente," y tienen implicaciones para para la teoría de la agencia, de la equidad, de la justicia, y de la distribución de riesgos.

Implicaciones prácticas – Los resultados destacan las prácticas erróneas con respecto a la distribución de compensación a CEOs que se basan en los niveles medios de rendimiento en una industria. Estas prácticas llevan a no pagar suficiente a los directivos "estrella" y pagar demasiado a los directivos con desempeño medio.

Originalidad/valor – Los resultados ofrecen nuevas perspectivas sobre la relación entre desempeño y compensación de CEOs y que los que se desempeñan mejor no son los que reciben más pago, y viceversa. Estas diferencias son mucho más grandes de que lo que se creía anteriormente.

Palabras clave – Directores ejecutivos (CEOs), Compensación de ejecutivos, Desempeño de las empresas, Teoría de la agencia, Teoría de la justicia, Equidad, Poder

Tipo de artículo – Trabajo de investigación

Resumo

Objetivo – O objetivo do nosso estudo foi examinar se os CEOs merecem a compensação monetária que recebem.

Metodologia – Em vez de utilizar a abordagem tradicional que assume que a distribuição do desempenho do CEO segue a curva normal (com a maioria dos CEOs agrupados em torno da média e relativamente pouca variação), adotamos uma abordagem diferente com base num enfoque inovador da lei de potência. Incluímos 22 indústrias e N = 4.158 combinações de CEO-empresa para análise baseada no Q de Tobin e N = 5091 para análise baseado na rentabilidade dos ativos. Em relação à compensação, medimos as distribuições de CEO com base no total de compensação e três componentes do pagamento total dos CEOs: salário, bônus e o valor das opções exercidas.

Resultados – 86% do desempenho do CEO e 91% das distribuições de pagamento do CEO correspondem a uma lei de potência melhor do que uma distribuição normal, indicando que uma minoria de CEOs está produzindo valor superior para suas empresas (ou seja, desempenho do CEO) e uma minoria de CEOs se apropriando do valor superior para si próprios (isto é, o salário do CEO). Mas, também encontramos pouca sobreposição entre CEOs que tem os melhores desempenhos e os CEOs que tem as maiores ganancias.

Implicações – Nossas descobertas lançam nova luz sobre o merecimento do pagamento do CEO, usando uma nova lente conceitual e metodológica que destaca o excessivo e o baixo pagamento sistemático. Os resultados sugerem uma violação da justiça distributiva e não apoiam a hipótese da contratação eficiente, e tem implicações para a teoria da agência, teoria da igualdade, teoria da justiça e distribuição de riscos.

Implicações práticas – Os resultados destacam práticas errôneas quando se tenta benchmark de remuneração do CEO baseado em níveis médios de desempenho em uma indústria, porque essas práticas levam a não pagar o suficiente aos CEOs "estrela" e pagar em excesso CEOs com desempenho médio.

Originalidade/valor – Os resultados oferecem novas perspectivas sobre a relação entre desempenho e retribuição dos CEOs e que os que desempenham melhor não são os que recebem um pagamento maior, e vice-versa. Estas diferenças são muito maiores do que se pensava anteriormente.

Palavras chave – Diretores executivos (CEOs), Compensação de executivos, Desempenho das empresas, Teoria da agencia, Teoria da justiça, Igualdade, Poder

Tipo de artigo – Trabalho de investigação

The compensation received by chief executive officers (CEOs) is a hotly debated issue in scholarly research, political circles, and the media (Kaplan, 2008a, 2008b; Larraza-Kintana *et al.*, 2011; Murphy, 1986; Walsh, 2008). We suggest that one key impediment to theoretical advancement, as well as sound regulatory policy and practices about executive compensation, is the failure to comprehend the implications following from the power law versus normal shapes of CEO performance and CEO pay distributions. A better understanding of these distributions allows for novel insights regarding distributive justice: whether CEOs receive outcomes (i.e. compensation) that are commensurate with their contributions (i.e. performance). In other words, our study aims at answering the following question: Do CEOs receive the pay they deserve?

We found that the CEO pay distribution (total compensation, as well as salary, bonus, and value of options exercised) exhibits qualities of a power law as opposed to a normal distribution. To offer a visual depiction of differences between power law and normal distributions, Figure 1 includes a generic graph of their shapes (Aguinis and Bradley, 2015). As shown in Figure 1, in a normal distribution, scores cluster around the mean and then fan out into symmetrical tails. By contrast, power law distributions allow for a greater number of extreme values. For example, whereas a value exceeding three standard deviations from the mean is often thought to be an error in a normal distribution (Aguinis *et al.*, 2013), these values are expected in a power law distribution (Vancouver *et al.*, 2016). Moreover, because of the presence of so many extreme scores, power law distributions are typified by unstable means and (quasi) infinite variance.

There seems to be recognition that pay distributions are non-normal because several past studies have used transformations such as the log and natural log aimed at normalizing scores (Fong *et al.*, 2010; Seo *et al.*, 2015). Moreover, a consequence of these data transformations is that they squeeze scores into a normal curve and artificially reduce the observed variance between scores (i.e. differences in observed pay among CEOs). In turn, making CEO compensation scores appear more homogeneous than they actually are may prevent us from gaining a deeper understanding about the deservingness of various levels of compensation. In other words, these transformations mask the true nature of the data and, in addition, relations between pay scores and other variables. By using a power law conceptualization of the CEO pay distribution, we are able to examine differences in pay across CEOs, as they actually exist. Our results provide evidence that these differences are much larger than previously thought, thus offering novel insights about theories addressing the CEO pay deservingness question.

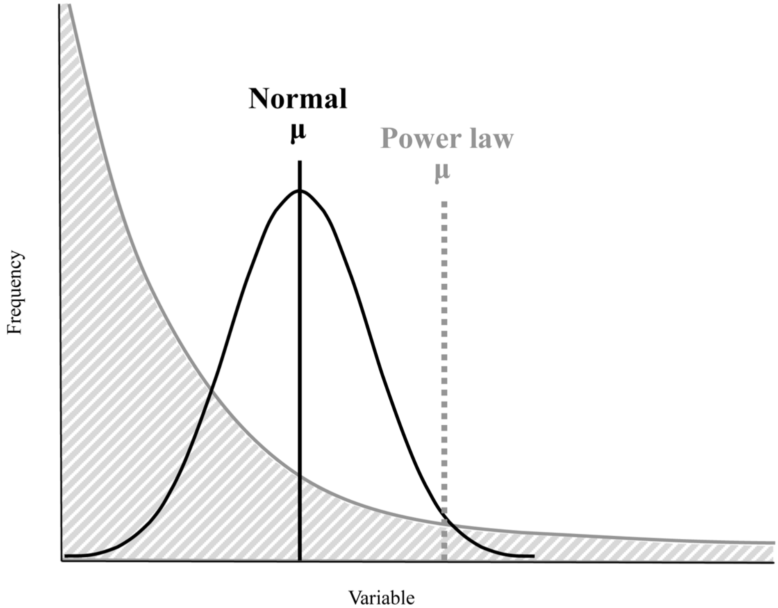

Figure 1.
Generic normal distribution overlaying a generic power law distribution (μ = mean)

As a second way to gain a deeper understanding of the CEO pay deservingness issue, we analyzed the degree to which the CEO performance distribution also exhibits qualities of a power law. Similar to our conceptualization of the CEO pay distribution, this approach allowed us to understand differences in CEO performance as they actually exist and without applying data transformations that artificially reduce observed differences among CEOs.

Third, we examined the correspondence (i.e. overlap) between CEO pay and CEO performance distributions to understand the extent to which the top performers are also the top earners. Rather than relying on parametric methods based on the general linear model that makes the untenable normality assumption, we used non-parametric procedures that are appropriate when assumptions of the general linear model (e.g. normality and linearity) are clearly violated.

Our results uncovered the conformance to a power law rather than a normal distribution for both CEO performance and CEO pay, as well as little overlap between top earners and top performers. The overlap was surprisingly weakest where one would expect it to be greatest: the overlap between the power law incentive and performance distributions. In short, our results indicate the following:

- CEOs at the top of the performance distribution create vastly more value than those at succeedingly lower levels of the performance distribution.
- CEOs at the top of the pay distribution are remunerated far more than those at succeedingly lower levels of the pay distribution.
- There is minimal overlap between the CEO pay and CEO performance power law distributions, thereby suggesting significant scope for both over *and* underpayment.

As we describe in more detail in the Discussion section, our results provide new insights relating to old questions concerning agency theory, equity theory, justice theory, agent risk sharing and agent risk bearing theories, and also executive compensation, governance, and human resource management practices.

Theoretical background

Executive compensation, executive performance, and pay deservedness

Researchers have studied CEO compensation in many different fields (see reviews by Gomez-Mejia, 1994; Gomez-Mejia and Wiseman, 1997; Wowak *et al.*, 2017) by mostly relying on agency theory (Fulmer, 2009). Specifically, an "agency problem" occurs when the interests of a CEO do not align with those of the firm (Goergen and Renneboog, 2011). CEOs may opportunistically manipulate compensation contracts to appropriate as much value as possible for themselves without looking after the interests of their firms (Bebchuk and Fried, 2009; Devers *et al.*, 2007). On the other hand, the presence of CEO-shareholder interest alignment supports the efficient contracting hypothesis that views CEO compensation as a useful governance instrument to create a "common fate" between CEOs and shareholders (Abernethy *et al.*, 2015). According to this view, "top executives are worth every nickel they get" (Murphy, 1986, p. 125). Highlighting the ongoing scholarly controversy regarding CEO compensation, this view has been challenged quite vigorously (Bogle, 2008; Gabaix *et al.*, 2014; Walsh, 2008), and the debate continues unabated among scholars who espouse positions that are in stark contrast with each other (Nyberg *et al.*, 2010 vs Kolev *et al.*, 2017).

Several studies have tested agency theory predictions about alignment, or lack thereof, and its consequences. Regarding the existence of alignment, Tosi *et al.* (2000) conducted a meta-analysis and concluded that alignment was weak because many CEOs are overpaid. However, Nyberg *et al.* (2010) noted that Tosi *et al.*'s (2000) conclusion that CEOs are overpaid may be because of the small number of studies, as well as the inclusion of samples collected in the 1940s; this is when measures of CEO pay included salary and bonus but excluded equity-based pay (i.e. stock options), which is the most typical way of creating alignment. Expanding upon but also challenging Tosi *et al.*'s (2000) conclusions, Nyberg *et al.* (2010) provided evidence suggesting that there is alignment between CEO return (i.e. change in total firm-specific CEO wealth during a given fiscal year) and shareholder return.

A second line of research examining CEO compensation originated in psychology and relies on equity theory (Adams, 1965). Equity theory posits that CEOs compare their pay to that of their peers, and the perception that they are underpaid or overpaid is likely to result in different behavioral responses with important implications for themselves and their firms. For example, Seo *et al.* (2015) reported that CEOs who have a negative relative pay standing are more motivated to make acquisitions and use greater firm complexity as a rationalization to demand higher pay. The equity theory framework was also used by Fong *et al.* (2010), who argued that underpayment leads CEOs to increase firm size to legitimize higher pay.

Incentive alignment: chief executive officer pay and performance

To expand on our earlier discussion of research relying on agency theory, two competing perspectives have dominated the discourse regarding the effectiveness and efficiency of CEO compensation design in aligning CEOs' interests with those of a firm's shareholders. According to classical agency theory, firms design "self-monitoring" contracts that motivate CEOs to act on behalf of principals, thereby addressing the problem of moral hazard in agency relationships (i.e. the absence of incentives to protect shareholders from the negative consequences of managerial agents' behaviors) (Fama, 1980; Fama and Jensen, 1983; Holmstrom, 1979; Jensen and Meckling, 1976). This theoretical perspective is often referred to as the efficient contracting hypothesis, and its proponents endorse the use of equity-based pay (e.g. stock options) as a useful instrument to create a "common fate" between CEOs and shareholders. The argument is that shareholders should be less worried about the magnitude of CEO pay and more concerned with the adoption of equity-based incentives that are conducive to a win-win situation for the principal and agent (Gabaix *et al.*, 2014; Nyberg *et al.*, 2010). Interestingly, the academic endorsement of equity-based pay (Jensen and Murphy, 1990) seems to have been a key contributor to tax breaks that resulted in significant increases in the use of this form of compensation since the beginning of the 1990s. In addition, a large literature has emerged from financial economics examining the characteristics of a purportedly ideal agent–principal contract by using an optimal mix of cash, stock, and options (Core and Guay, 1999; Core *et al.*, 2003; Gao, 2010).

In contrast to the efficient contracting hypothesis, CEO compensation practices have been criticized as leading to excessive payment to CEOs and also lacking alignment with shareholder and societal outcomes. Bebchuk and Fried (2009) challenged the assumption that the agent–principal contract is devised at arms-length between CEOs and boards. Rather, they suggested that CEOs leverage significant power in their negotiations. This leads to perverse incentives, lack of transparency regarding pay-performance alignment, CEO opportunism, lack of board accountability, and ever-increasing CEO pay. Similarly, Deya-Tortella *et al.* (2005) listed a set of maneuvers, such as the timing of news announcements and the manipulation of company reports, which CEOs may use to increase their equity-based pay in a way that may lead to excessive rent extraction from shareholders. Others have criticized the use of stock options because CEOs share disproportionately in the upside of successful risk taking, while shareholders bear the brunt of failed risk. This asymmetry encourages incentives for careless risk taking by CEOs (Hall and Murphy, 2003; Jensen, 2004; Martin *et al.*, 2013; Martin *et al.*, 2015b; Sanders and Hambrick, 2007). Note that this research stream has addressed CEO overpayment, but it is mostly silent about the possible presence of CEO underpayment – the other size of the CEO pay deservingness question.

Next, we offer predictions regarding the shapes of CEO performance and pay distributions. Assessing these predictions allows us to advance our theory-based understanding of CEO pay deservingness and the CEO compensation story – regarding both over and underpayment.

Normal distribution, normality assumption, and data transformations

As is the case for management research in general (Aguinis and O'Boyle, 2014; Delbridge and Fiss, 2013), past empirical work on the relation between CEO performance and CEO pay has relied on the assumption that performance is normally distributed or can be readily transformed to normality with little to no loss of data integrity. Although this assumption is sometimes made explicit (e.g. "In any sample of firms, it can reasonably be assumed that performance will vary normally around a mean," Wiklund and Shepherd, 2011, p. 927), in most cases the assumption is implicit. For example, studies examining the effectiveness of incentive alignment and monitoring usually rely on statistical techniques that assume normality such as ordinary least squares regression. Moreover, the implicit normality assumption becomes evident when researchers discover non-normal data and, subsequently, "fix" distributions through a variety of data manipulation techniques such as the log and other types of data transformations (e.g. Winsorization to decrease the influence of "unexpected" extreme scores or the deletion of extreme scores considered to be undesirable outliers; Aguinis *et al.*, 2013). In other words, observed non-normal data are often "squeezed" into a normal curve.

Power law distribution

Power laws are known to underlie empirical results in many contexts and research domains, such as the finding that about 80 percent of a brand's volume is purchased by about 20 percent of its buyers (Anschuetz, 1997) and that about 80 percent of land is owned by about 20 percent of the population (Pareto, 1897). The shape of the distribution is not just a methodological curiosity. Rather, it has profound implications for theory because it changes how we conceptualize the nature of constructs such as CEO performance and CEO pay. For example, we expect a much larger degree of variability in a power law distribution because a small minority of CEOs would be responsible for producing a disproportionally large amount of value for their firms. Consequently, they could also be awarded a justifiably high amount of pay based on distributive justice rules. Clearly, these implications are consequential for the ongoing scholarly debate on CEO pay deservingness, the CEO compensation story, and practical decisions involved in the design of executive compensation and corporate governance programs.

Chief executive officer performance distribution

Aguinis *et al.* (2016) argued that autonomy and complexity are job-related factors that lead to the presence of power law distributions. In other words, they are "conductors" (i.e. enhancers) of power law distributions – and these are two prominent characteristics of the job of a CEO. First, job autonomy allows CEOs discretion in how they accomplish the tasks, duties, and responsibilities of the job. Job autonomy is likely to lead to power law distributions of performance because it gives individuals flexibility and control over processes that may lead to stratification of CEOs' performance levels (Kohn and Schooler, 1983).

Regarding job complexity, jobs that are more complex are more mentally demanding, difficult to perform, and require higher levels of information processing (Humphrey *et al.*, 2007). Because the CEO's role is complex, there will be more variance in worker performance (Hunter *et al.*, 1990), similar to the effects of autonomy. For this reason, as noted by Aguinis *et al.* (2016), complex jobs (such as those held by academic researchers and software engineers) have long been known to demonstrate a non-normal performance distribution, but this is not the case for less complex jobs often found in the manufacturing sector where there is little variance in outputs. Accordingly, we expect a large degree of CEO performance variability and also expect that a small minority of CEOs will be responsible for producing a disproportionally large amount of value for their firms. In short:

H1. The distribution of CEO performance will fit a power law distribution better than a normal distribution.

Chief executive officer pay distribution

Boards of public corporations are charged with monitoring CEO performance and pay relative to peers in their industry (Murphy, 1999). In fact, in a study involving 100 firms, Bizjak *et al.* (2008) found that 96 firms used benchmarking in the compensation contracting process. If the efficient contracting hypothesis holds (Abernethy *et al.*, 2015), CEO pay levels should exhibit a distribution similar to that of CEO performance which, as predicted in *H1*, should follow a power law. Likewise, under the rules of distributive justice (Kolev *et al.*, 2017), if CEO performance follows a power distribution, CEO pay levels should exhibit an analogous pattern. Finally, the common practice of data transformations to normalize skewed pay scores, as described earlier, provides additional evidence regarding the presence of power law distributions, as transformations are used to normalize non-normal distributions. In short:

H2. The distribution of CEO pay will fit a power law distribution better than a normal distribution.

Overlap of chief executive officer performance and pay distributions

Similarity in the shapes of the CEO performance and CEO pay distributions is a necessary condition to establish evidence regarding CEO pay deservingness from a distributive justice perspective. However, similarity in the shapes of the distributions alone is not a sufficient condition because the CEOs at the top of the (power law) performance distribution may not be the same CEOs at the top of the (power law) pay distribution. The overlap is unlikely to be complete because boards may consider mitigating factors in making compensation decisions such as bad luck, unexpected environmental changes, systematic market risks, and poor choices made by prior CEOs (Gomez-Mejia *et al.*, 2010). Yet, as predicted by the efficient contracting hypothesis, economic rationality, and distributive justice, we expect that if CEO contracting (i.e. the agent–principal contract) practices are fair and efficient, the top performing CEOs should in general also be the top paid CEOs. Thus:

H3. There will be substantial overlap between CEOs positioned at the top of the (power law) performance distribution and CEOs positioned at the top of the (power law) pay distribution.

Compensation structure

The objective of awarding equity to CEOs is to ensure that they share in both the upside and downside of the value they produce, as usually manifested in share price (Jensen and Murphy, 1990). Stock options and bonus payments create strong incentives for the CEO to pursue risk taking opportunities that have the potential to increase the firm's share price (Hall and Murphy, 2003; Jensen, 2004).

In contrast to stock options and bonus payments, which purportedly capture the incentive components of a CEO's pay, the salary distribution is less likely to follow a power law distribution. The reason is that salary is viewed as costing more and providing less upside compared to incentive-based pay (Bebchuk and Fried, 2009, 2010; Jensen, 2004). In fact, salary is generally referred to as "fixed pay" because it is not expected to show much variation over time or exhibit much sensitivity to performance gyrations (Gomez-Mejia *et al.*, 2010). Furthermore, salary differentials among CEOs of firms of similar size in the same industry tend to be much smaller than pay differentials in the form of equity or bonuses (Bebchuk and Fried, 2009; Gabaix *et al.*, 2014). Thus, in terms of understanding the sources of the power law distribution for CEO total compensation, we hypothesize that the distribution of CEO pay in terms of value of options exercised and bonus is more prone than salary to exhibit a power law. In addition, applying the same logic leading to *H3*, we expect greater overlap between top CEO performers and top CEO earners for value of options exercised and bonus compared to salary. In short:

H4. The power law will fit the value of options exercised and bonus distributions better compared to the power law fit of the salary distribution.

H5. There will be greater overlap between CEOs positioned at the top of the (power law) performance distribution and CEOs positioned at the top of the (power law) pay distribution when pay is assessed based on value of options exercised and bonus compared to salary.

Method

Measures and data-analytic approach

Chief executive officer performance. The first step involved in obtaining firm performance data from the Compustat database, and CEO pay data from the Execucomp database, for the period spanning from 1992 to 2012. Our dataset consists of N = 4,158 CEO–firm combinations for analyses based on Tobin's Q and N = 5,091 for analyses based on return on assets (ROA) (this difference in N was because of differential availability of information in the databases). We examined firm performance and CEO pay during the tenure of each separate CEO and excluded the first year of each CEO's tenure. Our variables are taken as an average of the period during which CEOs held their post. Our analysis included all CEOs that populated both the performance and CEO pay variables, respectively, in Compustat and Execucomp across all industry groups. We excluded CEOs whose performance and compensation information were not available in the databases.

Our initial database reflected a firm-level, market-based, and risk-adjusted performance measure: Tobin's Q (Byrd and Hickman, 1992; Carpenter and Sanders, 2002; Coles *et al.*, 2006; Palia, 2000). Also, we used a firm-level and accounting-based performance measure: ROA. Using both market and accounting measures of performance allows us to minimize the impact that manipulation of earnings can have on the integrity of purely accounting-based performance measures (Healy and Wahlen, 1999). Tobin's Q is calculated as: (Market Valuation + Book Value of Total Debt)/Total Assets. ROA is calculated as: Net income/ Total Assets.

As a second step in our data collection effort, recognizing the potentially psychometrically contaminated nature of firm performance as a direct proxy for CEO contributions (Mackey, 2008; Sánchez Marín and Aragón Sánchez, 2003), we implemented procedures in an attempt to control for factors other than the CEO that may affect firm performance. We did so by capturing the residual after controlling for several variables that are known to relate to firm performance directly or indirectly. That is, based on best-practice recommendations regarding the use of control variables (Bernerth and Aguinis, 2016) and as done in previous work differentiating CEO from firm performance (Hambrick and Quigley, 2014; Sanders and Hambrick, 2007), we used the residual scores from these regressions as our measure of CEO performance. Henceforth, we refer to these residual scores as "CEO performance." Control variables included measures of risk (i.e. capital expenditure and R&D), firm size (i.e. total assets), and organizational slack (i.e. cash and short-term investments) (Bromiley, 1991; He and Huang, 2011; Martin *et al.*, 2015a). We also included CEO tenure as an additional control variable given that the longer the time a CEO has been at the helm of the firm, the greater is the opportunity to take initiatives that affect organizational performance. Following this same rationale, and as mentioned earlier, we excluded CEOs with tenure of less than one year given their limited time to influence firm outcomes (Hambrick and Quigley, 2014). The calculation of residual scores did not consider the impact of time (i.e. including past performance as a predictor in the model) because the goal of our study was to understand between-CEO and not within-CEO effects (i.e. we used a between-subjects and not a within-subjects design).

Chief executive officer pay. For total CEO compensation, we used Execucomp's measure of total compensation, which includes salary, cash bonus, other annual payouts, total value of restricted stocks granted, long-term incentive pay payouts, net value of stock options exercised, and all other annual compensation. Total compensation does not include current year stock option grants and the value of options exercised because this would involve double counting. Instead, Execucomp provides two measures of total compensation: the value of stock option grants (based on the Black–Scholes pricing model) and the value of options exercised (based on the market value of exchange traded options). We used the latter because the value of stock option grants (i.e. their value in the year they are granted) is likely to change significantly if and when the options are vested. In addition to total compensation, we conducted analyses using three components of CEO total pay: salary, bonus, and value of options exercised. Greater firm size may be used to justify higher CEO pay (because of higher human capital requirements, operational complexity, and higher asset responsibility; Conyon *et al.*, 2009; Gomez-Mejia *et al.*, 2010). Indeed, firm size is the single most important predictor of CEO pay, accounting for approximately half of its variance (Tosi *et al.*, 2000). Thus, following best-practice recommendations in the use of control variables (Bernerth and Aguinis, 2016), we calculated residual scores by regressing total pay and the pay components on firm size (i.e. total assets). Henceforth, when we refer to total pay, as well as bonus, salary, and the value of options exercised, we are referring to CEO residual pay. Consistent with our approach to measuring CEO performance, we used the average annual value received by CEOs during their tenure.

Data-analytic approach. A distribution could range from exactly normal to extremely non-normal (i.e. very heavy-tailed or skewed). Accordingly, similar to Aguinis *et al.* (2016), we conceptualized the shape of the distribution as a continuous variable.

A value x follows a power law if drawn from the following probability density function (Clauset *et al.*, 2009): $p(x) \propto x^{-\alpha}$, where α is the scaling exponent (i.e. scaling parameter), which is a constant (Maillart and Sornette, 2010). The scaling exponent is calculated using maximum likelihood estimation and based on running a semi-parametric Monte Carlo bootstrap calculation 1,000 times – specifically, the Hill estimator (Hill, 1975). Heavy-tailed distributions are characterized by a slow hyperbolic decay in their tails, and the scaling exponent quantifies the rate of decay. Note that a difference between the aforementioned power law function and the more familiar exponential function is that, in exponential functions, the exponent is the variable and x is constant. The power laws we examine involve the relation between two quantities:

(1) number of CEOs (y-axis) and CEO performance (x-axis); and
(2) number of CEOs (y-axis) and CEO pay (x-axis).

Because α is expressed as an exponent, as α decreases to unity, the tail of the distribution is heavier. Thus, α values closer to unity signal the presence of a greater proportion of extreme CEO performers and extreme CEO earners. For example, a distribution with α = 1.5 has a heavier tail compared to a distribution with α = 2.5 or α = 3.5, as illustrated in Figure 2.

In addition to the size of the scaling exponent, we assessed the extent to which each distribution is likely to conform to a power law with the Kolmogorov–Smirnov (K-S) goodness of fit statistic and its associated p-value (Massey, 1951). The K-S statistic is a non-parametric goodness of fit index similar to chi-square. Like the chi-square statistic, smaller K-S values and higher p-values indicate better conformity to a power law because the null hypothesis is no absolute deviation between the empirically observed distribution and a theoretical power law distribution (Aguinis and Harden, 2009; Clauset *et al.*, 2009). Thus, the K-S statistic can be used to assess the probability that there is a power law underlying each empirically obtained distribution. Note that researchers have loosened the definition of "normally distributed" from a statistical exactitude of zero skew and equal values for the mean, median, and mode to a more general approximation. We take the same strategy in how we refer to a "power law" distribution. Specifically, we use the term "power law" to refer to those heavy-tailed distributions where high performance or high pay is clearly dominated by a small group of CEOs, as shown in Figure 1, where most observations are below (i.e. to the left of) the mean. We used the PLFIT and PLPVA packages in MATLAB 7.10 to

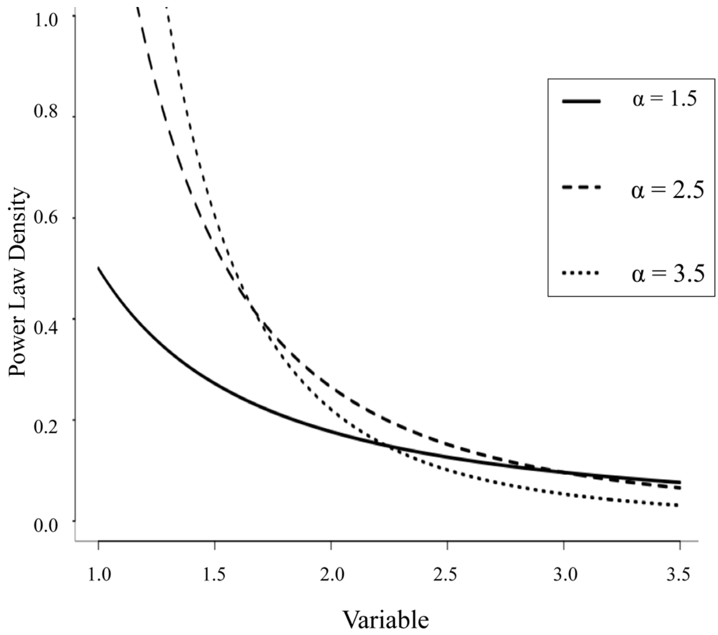

Figure 2.
Probability density function of power law curves with different values for scaling parameter alpha (α) illustrating that alpha values closer to unity are associated with distributions with heavier tails

calculate the scaling exponent α, as well as K-S statistic and its associated p-value, for all CEO performance and pay distributions. Code to conduct these analyses is available at http://tuvalu.santafe.edu/~aaronc/powerlaws/plfit.m and http://tuvalu.santafe.edu/~aaronc/powerlaws/plpva.m

Finally, we also conducted analyses based on the number and percentage of CEOs who were in the top performing and top earning brackets (i.e. the top 1, 5, 10, and 20 percent CEOs in each distribution). This analysis allowed us to understand the relative overlap between CEOs who are producing top value for their firms (i.e. CEO performance) and those who are appropriating top value for themselves (i.e. CEO pay). In addition, as a more formal examination of the overlap between the two distributions, we calculated Kendall's rank correlation coefficient τ to assess the degree of association between CEO performance and CEO pay rankings. Kendall's τ is conceptually identical to a Pearson's r correlation coefficient, and its squared value is similarly interpreted as proportion of variance explained, but Kendall's τ is more appropriate for situations involving ordinal variables with scores that are not necessarily normally distributed.

Results

Table I includes descriptors for distributions of CEO performance based on Tobin's Q and also CEO pay. Table II includes descriptors for distributions of CEO performance based on ROA and also CEO pay. Results are at the industry level of analysis, except the first rows in each of the two tables which show averages across the 22 industry groups. Note that differences in pay-related results between the tables are due to their different sample sizes noted earlier.

H1 predicted that CEO performance would conform to a power law distribution better than to a normal curve. Results in Tables I and II indicate that the mean value for the

Table I.
CEO performance (Tobin's Q) and pay distribution descriptors[a]

Variable	N	median	mean	SD	skew	kurtosis	α	K-S	p
Performance (across industries)	4,158	−0.35	−0.07	1.53	2.13	16.56	3.42	0.13	0.50
Total pay		−2,239	−411.97	6,956	3.22	19.59	2.80	0.13	0.51
Options		−1,755	−408.21	4,872	4.18	28.81	2.74	0.15	0.49
Salary		−43.57	−10.06	327.81	1.10	4.10	5.62	0.12	0.45
Bonus		−270.4	−61.06	942.86	2.78	15.70	2.65	0.15	0.37
Performance (agriculture, forestry, and mining)	185	−0.13	−0.07	0.85	0.73	1.93	3.16	0.11	0.29
Total Pay		−3,629	−1,403	7,954	3.90	17.37	2.09	0.16	0.06
Performance (air travel)	21	−0.16	−0.04	0.72	0.96	0.24	1.63	0.19	0.30
Total pay		−2,814	−596.8	8,047	1.33	1.17	3.22	0.18	0.74
Performance (commercial/retail banking)	38	−0.82	−0.12	1.84	1.54	1.55	7.72	0.17	0.79
Total pay		−924.1	42.32	21,316	0.23	5.13	2.20	0.16	0.58
Performance (basic manufacturing)	182	−0.07	−0.04	0.92	1.07	2.84	3.55	0.13	0.19
Total pay		−956.3	−162.6	2,769	1.54	2.93	5.77	0.13	0.40
Performance (car and related manufacturing)	60	−0.53	−0.31	0.83	1.75	5.34	2.17	0.15	0.32
Total pay		−1,222	−376.9	3,483	2.41	7.44	2.31	0.15	0.37
Performance (chemical manufacturing)	134	−0.21	−0.06	1.03	1.21	3.33	3.31	0.11	0.53
Total pay		−1,119	−232.5	4,402	4.33	28.66	2.20	0.08	0.75
Performance (computer manufacturing)	88	−1.07	−0.34	3.66	6.08	43.75	2.30	0.10	0.95
Total pay		−4,467	−1,765	6,969	2.44	8.00	2.80	0.09	0.81
Performance (consumer goods)	145	−0.25	−0.18	1.19	1.00	3.26	4.28	0.11	0.81
Total pay		−1,192	−122.0	4,750	3.86	20.64	2.80	0.09	0.86
Performance (pharmaceutical and medical)	161	−0.47	0.11	2.87	−1.29	17.44	3.70	0.12	0.41
Total pay		−3,287	−836.0	6,066	1.83	3.18	6.85	0.13	0.71
Performance (resources and build equipment)	741	−0.38	−0.07	1.73	2.64	15.22	2.57	0.08	0.03
Total pay		−1,907	−451.8	5,044	3.69	20.53	2.77	0.07	0.47
Performance (financial non-bank)	337	−0.43	−0.21	1.34	3.16	16.85	3.84	0.10	0.70
Total pay		−2,675	−312.1	7,653	3.59	20.43	2.88	0.11	0.23
Performance (food products)	108	−0.40	0.02	1.50	1.59	3.03	2.35	0.14	0.09
Total pay		−1,523	−194.3	5,028	3.21	16.75	2.87	0.07	0.99
Performance (lumber and pulp)	24	−0.15	−0.17	0.65	0.35	−0.33	2.97	0.16	0.79
Total pay		−1,251	−763.5	1,568	1.25	1.56	2.09	0.19	0.57
Performance (media)	128	−0.31	−0.09	1.58	4.69	36.48	2.37	0.11	0.40

(continued)

Table I.

Variable	N	median	mean	SD	skew	kurtosis	α	K-S	p
Total pay		−4,361	−659.3	11,021	3.35	13.16	1.74	0.11	0.22
Performance (petrol refining and related)	31	−0.10	−0.12	0.65	−0.22	−0.15	3.44	0.16	0.65
Total pay		−3,362	−959.0	7,482	1.39	1.31	3.19	0.17	0.73
Performance (real estate)	49	−0.04	0.04	0.69	0.19	0.28	2.32	0.16	0.11
Total pay		−3,506	−1,263	7,307	2.32	6.31	1.73	0.20	0.10
Performance (retail)	364	−0.37	−0.14	1.47	1.29	2.91	7.41	0.10	0.87
Total pay		−2,060	−459.2	5,498	3.61	17.99	2.07	0.12	0.01
Performance (services excluding comp, air, and bank)	301	−0.40	−0.01	2.12	5.97	60.35	2.97	0.07	0.87
Total pay		−2,101	−704.1	5,074	5.58	53.81	2.71	0.14	0.02
Performance (software, data, and storage)	367	−0.76	0.31	5.25	10.43	140.68	2.43	0.07	0.85
Total pay	366	−4,170	−1,366	10,871	6.27	46.18	1.93	0.06	0.72
Performance (tobacco)	7	−0.35	0.04	1.28	0.72	−1.17	5.25	0.36	0.60
Total pay		347.1	3,999	8,665	0.89	−0.57	2.68	0.22	0.82
Performance (utilities)	291	−0.05	−0.01	0.62	1.69	7.09	2.74	0.09	0.30
Total pay		−1,382	144.6	7,206	8.65	100.56	2.61	0.08	0.82
Performance (other)	397	−0.26	−0.11	0.96	1.23	3.42	2.72	0.10	0.04
Total pay		−1,702	−622.2	4,856	5.20	38.43	2.07	0.08	0.28

Notes: [a]CEO performance scores are residuals from models regressing Tobin's Q on measures of risk (i.e. capital expenditure and R&D), firm size (i.e. total assets), organizational slack (i.e. cash and short-term investments) and CEO tenure. Total pay = salary, cash bonus, other annual payouts, total value of restricted stocks granted, long-term incentive pay payouts, net value of stock options exercised, and all other compensation computed as the annual average across the tenure of each CEO; options = total options exercisable; salary = cash salary; and bonus = cash bonus. Total pay and pay components are based on residuals from models regressing pay on firm size. N = sample size. Compensation N are the same for each distribution except for the industry group "software, data, and storage", where we had one observation that provided salary and bonus data but not the option exercise values. SD = standard deviation; α = scaling exponent (i.e. parameter) of the power law curve (the closer the value to 1.0, the heavier the tail of the distribution); K-S = Kolmogorov–Smirnov goodness of fit statistic (the lower the value, the higher the probability of an underlying power law distribution); and p = statistical significance for the K-S statistic (non-statistically significant results such as $p > 0.05$ suggest a better fit with an underlying power law distribution)

Table II.
CEO performance (ROA) and pay distribution descriptors[a]

Variable	N	median	mean	SD	skew	kurtosis	α	K-S	p
Performance (across industries)	5,091	0.01	0.00	0.18	−0.59	33.49	3.87	0.39	0.47
Total pay		−1,910	−476.3	6,580	3.46	22.95	2.62	0.43	0.48
Options		−1,536	−379.8	4,605	4.54	33.74	8.52	0.56	0.42
Salary		−65.97	−15.68	334.1	1.22	4.91	5.71	0.44	0.51
Bonus		−268.38	−39.54	1,106	3.51	21.18	2.51	0.39	0.42
Performance (agriculture, forestry, and mining)	224	0.01	0.00	0.07	−3.07	18.57	2.79	0.01	0.02
Total pay		−3,268	−1,623	7,252	4.34	21.84	2.09	0.46	0.07
Performance (air travel)	29	0.00	0.00	0.05	0.67	0.33	3.86	0.78	0.81
Total pay		−3,483	−1,534	7,017	1.79	3.03	3.22	0.30	0.76
Performance (commercial/retail banking)	54	−0.02	0.00	0.05	1.29	1.71	4.41	0.09	0.32
Total pay		−627.5	753.3	19,871	0.30	5.45	1.77	0.12	0.30
Performance (basic manufacturing)	232	0.00	−0.01	0.10	1.62	32.70	2.88	0.89	0.69
Total pay		−362.7	−53.72	2,542	1.54	3.65	1.99	0.43	0.01
Performance (car and related manufacturing)	78	0.00	−0.01	0.08	−0.97	1.92	2.63	0.33	0.48
Total pay		−621.7	−124.4	3,219	2.23	7.51	2.44	0.40	0.39
Performance (chemical manufacturing)	171	0.00	0.00	0.06	0.25	3.68	3.10	0.73	0.73
Total pay		−815.4	−167.9	4,015	4.49	32.61	2.31	0.41	0.57
Performance (computer manufacturing)	117	0.03	−0.03	0.19	−1.85	3.43	5.55	0.13	0.60
Total pay		−3,607	−2,007	6,161	2.80	10.99	2.79	0.77	0.89
Performance (consumer goods)	170	−0.01	−0.01	0.08	−0.44	2.11	2.93	0.27	0.41
Total pay		−801.2	−101.8	4,448	4.03	23.20	2.77	0.02	0.91
Performance (pharmaceutical and medical)	188	0.09	0.14	1.80	12.70	167.38	3.04	0.33	0.07
Total pay		−2,465	−862.2	5,657	1.95	4.04	6.85	0.63	0.70
Performance (resources and build equipment)	872	0.03	−0.01	0.24	−9.75	132.97	3.65	0.01	0.01
Total pay		−1,380	−258.5	4,872	3.66	20.66	2.81	0.70	0.54
Performance (financial non-bank)	423	−0.01	0.00	0.07	−2.66	29.62	2.01	0.01	0.00
Total pay		−2,299	−415.1	7,297	3.53	20.46	3.00	0.63	0.30
Performance (food products)	130	−0.01	0.00	0.06	0.19	1.68	3.46	0.00	0.08
Total pay		−1,423	114.3	5,433	3.15	13.98	2.52	0.72	0.56
Performance (lumber and pulp)	29	0.00	−0.01	0.06	−1.75	3.32	5.56	0.68	0.78
Total pay		−534.6	241.6	3,247	2.20	4.57	2.06	0.54	0.57
Performance (media)	163	0.02	−0.01	0.12	−2.94	12.15	3.36	0.79	0.00
Total pay		−4,120	−939.5	10,277	3.61	15.19	1.73	0.32	0.11

(continued)

Table II.

Variable	N	median	mean	SD	skew	kurtosis	α	K-S	p
Performance (petrol refining and related)	41	0.00	−0.01	0.05	−1.03	1.96	4.06	0.97	0.78
Total pay		−4,220	−1,836	6,683	1.81	2.95	3.19	0.05	0.75
Performance (real estate)	57	0.01	0.00	0.07	−0.30	2.27	3.34	0.07	0.62
Total pay		−3,507	−1,562	6,816	2.57	7.99	1.73	0.12	0.11
Performance (retail)	452	0.00	−0.02	0.12	−4.36	36.26	3.90	0.79	0.94
Total pay		−1,539	−414.5	5,239	3.96	21.45	2.10	0.52	0.03
Performance (services excluding comp, air, and bank)	359	−0.01	−0.01	0.11	−3.62	33.63	3.01	0.28	0.30
Total pay		−1,513	−561.8	4,714	5.77	60.24	2.79	0.08	0.06
Performance (software, data, and storage)	404	0.03	−0.02	0.22	−4.97	37.11	10.35	0.11	0.90
Total pay	403	−3,767	−1,301	10,660	6.25	46.15	1.91	0.01	0.51
Performance (tobacco)	9	−0.04	0.02	0.16	0.96	−0.43	5.31	0.56	0.54
Total pay		347.1	2,593	8,693	0.72	−0.24	2.62	0.66	0.83
Performance (utilities)	398	0.00	−0.01	0.09	4.58	94.77	2.50	0.60	0.76
Total pay		−977.4	23.08	6,215	9.92	134.53	2.64	0.66	0.90
Performance (other)	492	0.00	−0.01	0.14	2.45	119.64	3.46	0.17	0.41
Total pay		−1,045	−441.1	4,426	5.44	44.56	2.30	0.85	0.67

Notes: [a]CEO performance scores are residuals from models regressing return on assets (ROA) on measures of risk (i.e. capital expenditure and R&D), firm size (i.e. total assets), organizational slack (i.e. cash and short-term investments), and CEO tenure. Total pay = salary, cash bonus, other annual payouts, total value of restricted stocks granted, long-term incentive pay payouts, net value of stock options exercised, and all other compensation computed as the annual average across the tenure of each CEO; options = total options exercisable; salary = cash salary; and bonus = cash bonus. Total pay and pay components are based on residuals from models regressing pay on firm size. N = sample size. Compensation N are the same for each distribution except for the industry group "software, data, and storage", where we had one observation that provided salary and bonus data but not the option exercise values. SD = standard deviation; α = scaling exponent (i.e. parameter) of the power law curve (the closer the value to 1.0, the heavier the tail of the distribution); K-S = Kolmogorov–Smirnov goodness of fit statistic (the lower the value, the higher the probability of an underlying power law distribution); and p = statistical significance for the K-S statistic (non-statistically significant results such as $p > 0.05$ suggest a better fit with an underlying power law distribution) majority of distributions is higher than the median value. This offers initial evidence that, indeed, the distributions are not normal because extreme scores to the right of the distribution pull the mean in that direction. Moreover, values for skew and kurtosis deviate from 0 to 3, respectively, indicating deviations from normality.

In addition to descriptive statistics, Tables I and II include K-S values, which allow for a more precise and formal statistical test of *H1*. Recall that small K-S values (and p-values larger than 0.05) provide evidence in favor of a power law distribution. Table I shows that, for CEO performance across all industries combined, the K-S value based on Tobin's Q is 0.13 ($p = 0.50$). Table II shows that, also for CEO performance across all industries, the K-S value based on ROA is 0.39 ($p = 0.47$). Thus, results in both tables indicate a better fit of the data with an underlying power law rather than a normal curve. At the industry level of analysis, results in Tables I and II show that 38 of the 44 CEO performance distributions (i.e. 86 percent) provide a better fit with a power law compared to a normal distribution, with p-values greater than 0.05. In short, we found support for *H1*, given that the CEO performance distribution conforms more closely to a power law than normality for the entire population of CEOs and also for most industries.

Although the majority of distributions (38 of the 44 CEO performance distributions) have a better fit with a power law, there are a few industries that did not conform to the power law (i.e. $p < 0.05$ in the far-right column in Tables I and II). These are agriculture, forestry, and mining (ROA); resources and building equipment (Tobin's Q and ROA); financial non-bank (ROA); media (ROA); and other (Tobin's Q). We discuss these findings later.

H2 predicted that CEO pay would conform to a power law curve. The top rows of Tables I and II show that, across all industries, K-S values for total pay, as well as the three pay components (i.e. value of options exercised, salary, and bonus), are small and not statistically significant (with p-values greater than 0.05), suggesting a superior fit of a power law compared to a normal distribution. Tables I and II also show results for total CEO pay within industry categories. At the industry-level of analysis, results for value of options exercised, salary, and bonus were very similar to total pay and, therefore, are not reported in Tables I and II but are available upon request. Overall, results suggest the superior fit of a power law for 40 of the 44 industry-based total pay distributions or 19 of the 22 industries (p-values > 0.05). Thus, 91 percent of the distributions, or 86 percent of the industries, included in our study exhibited a power law distribution for CEO pay. This means that pay differentials among CEOs rise at a rapidly increasing rate at the top of the distribution, and top earners capture a disproportionate amount of total pay across all CEOs. Results using total compensation, as well as the three pay components (i.e. value of options exercised, salary, and bonus), led to the same conclusion regarding the superior fit of the power law distribution. This finding provides evidence regarding the robustness of the results because, if the total compensation measure were not reliable, it would be mathematically impossible to obtain this type of consistent and triangulated pattern in the results (Scandura and Williams, 2000). Related to this same issue, there is a possibility that there are differences between public filings and actual pay, but these differences are not so large as to include random error (i.e. noise) in our data. Otherwise, we would not have been able to obtain the convergent and consistent results we found across various types of pay measures. In short, given the overall power law nature of the distributions, a minority of CEOs usually appropriate a disproportionate amount of the total value. Thus, results offer support for *H2*.

H3 predicted substantial overlap of the top CEO performance and pay distributions based on the efficient contracting hypothesis. The shapes of the CEO performance and CEO pay distributions are similar, but this result does not convey how much the two distributions overlap. In other words, although their shapes are similar, the tails of the distributions may be populated by different subsets of CEOs. Table III (for Tobin's Q) and Table IV (for ROA) show results pertaining to the degree of overlap for the top 1, 5, 10, and 20 percent of CEOs. Specifically, overlap-related results in these tables are based on ranking CEOs across industries by performance and also by pay. The higher the percent in each cell of Tables III and IV, the stronger the evidence that the highest performers are also the highest paid. If CEO pay were truly based on their performance, the values in the cells would be close to 100 percent or at least more than 50 percent such that the top 1, 5, 10, and 20 percent of the most highly performing CEO will mostly be the same individuals as the top 1, 5, 10, and 20 percent of the most highly paid CEOs.

Regarding total pay, results in Table III indicate that only 5 percent of CEOs in the top 1 percent in terms of CEO performance (based on Tobin's Q) are also in the top 1 percent of

	Top 1% performers	Top 5% performers	Top 10% performers	Top 20% performers
Total pay	5%	14%	20%	29%
Fixed pay				
Salary	0%	5%	7%	14%
Incentive-based pay				
Bonus	0%	5%	10%	19%
Value of options exercised (Equity)	10%	20%	27%	36%
N	42	208	416	832

Notes: [a]A perfect overlap between the top performers and the top earners (i.e. efficient contracting hypothesis) would be reflected by 100 percent in each cell. In the very least, the overlap should be more than 50 percent to provide partial support for agency theory's efficient contracting hypothesis. Values based on total pay are not necessarily similar to values based on the three pay components (i.e. salary, bonus, and value of options exercised) because total pay is based on these and other types of pay as well (i.e. salary, cash bonus, other annual payouts, total value of restricted stocks granted, long-term incentive pay payouts, net value of stock options exercised and all other annual compensation)

Table III. Percent of top 1%, 5%, 10%, and 20% of the most highly performing CEOs based on Tobin's Q who are also in the same percent of top earners[a]

	Top 1% performers	Top 5% performers	Top 10% performers	Top 20% performers
Total pay	4%	11%	17%	27%
Fixed pay				
Salary	0%	6%	10%	19%
Incentive-based pay				
Bonus	0%	5%	12%	23%
Value of options exercised (Equity)	6%	15%	20%	30%
N	51	255	509	1,018

Notes: [a]A perfect overlap between the top performers and the top earners (i.e. efficient contracting hypothesis) would be reflected by 100 percent in each cell. In the very least, the overlap should be more than 50 percent to provide partial support for agency theory's efficient contracting hypothesis. Values based on total pay are not necessarily similar to values based on the three pay components (i.e. salary, bonus, and value of options exercised) because total pay is based on these and other types of pay as well (i.e. salary, cash bonus, other annual payouts, total value of restricted stocks granted, long-term incentive pay payouts, net value of stock options exercised, and all other annual compensation)

Table IV. Percent of top 1%, 5%, 10%, and 20% of the most highly performing CEOs based on ROA who are also in the same percent of top earners[a] highest paid. This result is 14, 20, and 29 percent for the top 5, 10, and 20 percent CEO performance, respectively. Table IV, based on ROA, shows even less overlap. Specifically, the top 1, 5, 10, and 20 percent in terms of CEO performance overlap only at 4, 11, 17, and 27 percent with the top 1, 5, 10, and 20 percent of earners. That is, CEOs who increasingly enjoy greater pay advantages relative to their peers as we move toward the top of the pay distribution are generally not the same CEOs as those who deliver the greatest value for their firms. In fact, the degree of mismatch increases as we move toward the tail of the distribution. For instance, by subtracting the top row of Table IV from 100 percent, we show that 96, 89, 83, and 73 percent of those individuals at the top 1, 5, 10, and 20 percent of CEO earners do not fall in the top 1, 5, 10, and 20 percent of the CEO performance distribution.

Analyses at the industry level using Tobin's Q – beyond those shown in Table III – provide additional evidence regarding the large degree of mismatch between CEO performance and pay. For example, in terms of overpayment (i.e. CEOs who are among the top earners but not among the top performers), 25 percent of the CEOs who are in the top 10 percent bracket in terms of total compensation are in the *bottom* 10 percent bracket in terms of performance in the commercial/retail banking industry. This value was 50 percent in lumber and pulp and 13 percent in services (excluding computer, air, and bank). On the other side of the coin, there are many CEOs who are performing at a very high level and yet are not compensated accordingly. For instance, 15 percent of the top 10 percent of CEO performers were in the bottom 10 percent of CEOs by total compensation for chemical manufacturing, 20 percent for real estate, and 14 percent for consumer goods. In sum, the overlap between the distributions of CEO performance and CEO pay is shockingly low – particularly for those CEOs who arguably matter the most: the very best performers and the highest paid. Thus, *H3* is not supported.

Results based on the calculation of Kendall's τ coefficients provided additional empirical evidence regarding the lack of association between CEO performance and CEO pay. First, consider results regarding CEO pay and performance using Tobin's Q. τ^2 values between total pay and performance (indicating proportion of variance in pay explained by performance) were 0.008 for the top 1 percent of the distribution (N = 42), 0.003 for the top 5 percent of the distribution (N = 208), 0.001 for the top 10 percent of the distribution (N = 416), and also 0.001 for the top 20 percent of the distribution (N = 832). z values for all of these coefficients were not statistically significant ($p > 0.01$). Second, coefficients between CEO pay and performance using ROA as the measure of performance were also statistically non-significant (i.e. for all z values, $p > 0.01$). Specifically, τ^2 values between total pay and performance based on ROA (indicating proportion of variance in pay explained by performance) were 0.06 for the top 1 percent of the distribution (N = 51), 0.005 for the top 5 percent of the distribution (N = 255), 0.001 for the top 10 percent of the distribution (N = 509), and 0.000 for the top 20 percent of the distribution (N = 1,018). These results are particularly noteworthy given that many of the sample sizes used in the analyses are in the several hundreds, therefore maximizing statistical power – the probability that an existing relation would be found.

H4 predicted that incentive forms of pay (i.e. value of options exercised and bonus) would follow a power law distribution to a greater extent compared to salary. Overall, and across industries, Table I shows that K-S for salary = 0.12 (p = 0.45), and Table II shows that K-S salary = 0.44 (p = 0.51). Tables I and II also show that these values are very similar to those for options and bonus and, consequently, *H4* is not supported.

Finally, *H5* predicted greater overlap between top CEO performance and pay for value of options exercised and bonus compared to salary. When performance is assessed based on Tobin's Q, Table III shows that none of the top 1 percent performing CEOs are also among the top 1 percent paid CEOs regarding salary or bonus, whereas

10 percent of the top 1 percent performing CEOs are also among the top 1 percent paid CEOs in terms of value of options exercised. So, when comparing salary with value of options exercised (but not salary with bonus), there is a difference in performance-pay overlap regarding the top 1 percent of performers across types of pay, suggesting partial support for *H5*. Similarly, Table III shows that only 5 percent of the top 5 percent performing CEOs are also among the top 5 percent paid CEOs regarding salary or bonus, whereas 20 percent of the top 5 percent performing CEOs are also among the top 5 percent paid CEOs in terms of value of options exercised. Thus, when comparing salary with value of options exercised (but not salary with bonus), there is a difference in performance-pay overlap regarding the top 5 percent of performers across types of pay, once again providing partial support for *H5*. However, Table III shows that while only 7 percent of the top 10 percent of CEO performers are among the top 10 percent of CEOs in terms of salary, this overlap is 10 percent for bonus (1.43 times higher than 7 percent) and 27 percent for value of options exercised (3.86 times higher than 7 percent). *H5* receives additional support when we consider the top 20 percent performing CEOs in Table III. Among the top 20 percent performing CEOs, 14 percent are also among the top 20 percent paid based on salary, but 19 percent if we consider bonus (1.36 times higher than 14 percent), and an even higher 36 percent if we consider value of options exercised (2.57 times higher than 14 percent). As shown in Table IV, results regarding the percent of CEO performance-pay overlap are similar when we consider performance as measured by ROA rather than Tobin's Q.

More formal results based on Kendall's τ coefficients showed a similar pattern. First, consider results using Tobin's Q. Among the top 1 percent CEO performers, τ^2 was 0.032 for bonus, 0.005 for options, and 0.007 for salary; among the top 5 percent CEO performers, these values were 0.003, 0.000, and 0.000, respectively; among the top 10 percent CEO performers, these values were 0.003, 0.001, and 0.002, respectively; and among the top 20 percent CEO performers, these values were 0.001, 0.003, and 0.006, respectively. Results using ROA were substantively similar in that, except for one coefficient, there were no instances where CEO performance explained more than half of 1 percent of variance in CEO pay for any particular type of compensation – fixed or variable.

Overall, relatively speaking, results showed some degree of greater overlap between the distributions of CEO pay and CEO performance when we compare fixed pay (i.e. salary) with one or more incentive forms of pay (i.e. value of options exercised and, at times, bonus). To keep these results in perspective, however, we emphasize that the actual performance-incentive pay overlap in the best scenario is very low. In fact, out of the 32 cells in Tables III and IV, the best one in terms of CEO performance-incentive pay overlap shows that 64 percent (referring to the 36 percent statistic in Table III) of CEOs who are in the top 20 percent of value of options exercised are *not* in the top 20 percent of the Tobin's Q performance distribution. Also, the proportion of variance explained by any type of pay based on either type of performance measure (Tobin's Q or ROA) using Kendall's τ is very small (Bosco *et al.*, 2015). In sum, regarding *H5*, we found that the overlap between top CEO performance and pay for value of options exercised or bonus was only partially greater than the overlap between top CEO performance and salary.

Discussion

For the majority of industries, the key findings are as follows. First, the CEO performance and pay distributions across a diverse set of industries conform to a power law distribution. This result was replicated when using an accounting (i.e. ROA) and a market measure of

CEO performance (i.e. Tobin's Q) and persisted even after considering features of the firms they helm (e.g. firm size and organizational slack).

Second, although the majority of the CEO performance and pay distributions across industries follow a power law, the overlap of the highest performers with the highest earners in terms of total pay is very low. The weak overlap means that CEOs who make disproportionately high performance contributions (e.g. those in the top 10 percent of the performance bracket) are rarely the same CEOs as those who receive disproportionately high pay (e.g. those in the top 10 percent of the pay bracket). These results were replicated by using either ROA or Tobin's Q as the measure of CEO performance. Moreover, Kendall's τ coefficients suggested that there is no association between CEO performance and pay. For example, CEO performance – measured using Tobin's Q or ROA – generally explains less than half of 1 percent of variance in pay as measured using any type of compensation – fixed or variable.

Third, in addition to the finding that total pay follows a power law distribution better than a normal curve, each of the pay components (i.e. salary, value of options exercised, and bonus) also followed a power law distribution. Fourth, similar to results regarding total pay, there was little overlap between the top performers based on ROA or Tobin's Q and the top earners based on each of the three pay components. Kendall's coefficients offered additional evidence regarding this finding. Finally, there was relatively less overlap for salary compared to value of options exercised and, at times, bonus.

Implications for theory and future research

Because of the fundamental differences between a power law and a normal distribution, the discovery that the distributions fit a power law distribution better than a normal distribution will likely change how we theorize CEO performance and pay in future research. For example, heterogeneity of scores in power laws is much greater than in a normal distribution. In fact, the heterogeneity of scores in power law distributions is so large that the variance is often considered "pseudo-infinite." This means that the top performing and top paid CEOs are multiple times higher than the rest, and this result is informative regarding the ongoing debate on high versus low pay dispersion (Shaw, 2014, 2015). For example, consider the ROA value of 1.23 for one of the CEOs included in our study, John J. Legere of Global Crossing. Under a normal distribution of CEO performance, the likelihood of this value given the distribution's mean and SD is a highly unlikely probability of 0.00049. But, Legere is not an unusual case. For example, Joseph F. O'Neill of Orchestra Therapeutics has an ROA score of 24.12. If the underlying distribution is normal, the probability of this value is less than $2.78 * 10^{-308}$ (i.e. 2.78 preceded by 308 zeroes). Now, consider results regarding Tobin's Q. Timothy Koogle, former CEO of Yahoo, has a Tobin's Q value of 38.33, and Glen T. Meakem, former CEO of FreeMarkets, has a Tobin's Q value of 24.69. In spite of their extremely positive performance, there is another CEO who has produced even more positive results: Dennis L. Barsema, CEO of Redback Networks, is associated with a Tobin's Q value of 78.63. Under a normal distribution, the probabilities of these three CEOs' performance levels are $2.17 * 10^{-69}$, $8.62 * 10^{-40}$, and $6.20 * 10^{-287}$, respectively. A conclusion from these results is that if the underlying performance distribution is normal, CEOs such as Legere, O'Neill, Koogle, Meakem, Barsema, and many more should simply "not exist"! In other words, a normal distribution renders them effectively impossible, meaning they are likely to be dismissed (and excluded from analysis) as outliers – yet, the presence of these CEO stars is found in our analysis using both accounting and market-based performance measures.

Second, this new empirical reality uncovered by our results points to the need to revise the theoretical framework and dominant paradigm used to conceptualize CEO pay and performance from a normal to a power law perspective. Indeed, the dominant paradigm appears to be that CEO talent is narrowly dispersed (Gabaix, 2008; Gabaix and Landier, 2008), which has perhaps perpetuated the view that the normality assumption is warranted. Consider the implications of the power law re-conceptualization for research examining the effects of CEO underpayment and overpayment based mostly on equity theory. Routinely, studies examining this issue have transformed pay distributions to minimize skew and normalize scores. For example, Seo *et al.* (2015, p. 1883) noted that "Due to skewness, we used the natural logarithm of the compensation variables." As noted earlier, normalizing scores reduces the variance in the distribution artificially. As a consequence, it is likely that previous research has underestimated the effects of underpayment and overpayment. In fact, our results suggest that all previous studies using CEO pay as the predictor of CEO and firm outcomes are likely to have underestimated effects hypothesized based on equity theory. This way, we pave the way for a fruitful research agenda aimed at investigating the magnitude of this underestimation and the extent to which previously reported results may have to be revisited.

Third, another implication of our results is the overall lack of support for the efficient contracting hypothesis, which is directly related to agency and justice theories. Efficient contracting is captured in a positive CEO pay–performance relation and benchmarking such that CEO pay relative to peers reflects their performance levels, avoiding the possibility that shareholders overpay for their CEO's performance (Bizjak *et al.*, 2008). The poor overlap between the group of highest CEO performers with the group of highest CEO earners suggests that the highest paid are typically not the best performers and vice versa, elucidating a significant failure in the benchmarking dimension of contracting efficiency, as well as a high incidence, of both CEO overpayment and underpayment. For instance, regarding CEO total pay and performance based on Tobin's Q (Table III), only 14 percent of CEOs in the top 5 percent earning bracket are also in the top 5 percent bracket in terms of performance. Moreover, the mismatch between relative standing of CEOs regarding their performance and pay is found for fixed (i.e. salary) and incentive-based pay components (i.e. value of options exercised and, at times, bonus). For example, also regarding Tobin's Q (Table III), only 0 to 10 percent of the top 1 percent earners based on salary, bonus or value of options exercised are also among the top 1 percent performers. As shown in Tables III and IV, results regarding the decoupling between CEO performance and pay were similar when we considered ROA instead of Tobin's Q. This finding was consistent across types of pay even though equity-based incentives should presumably be more closely aligned with value creation (Nyberg *et al.*, 2010). In short, the observed decoupling between top CEO pay and performance seems difficult to justify based on rational economic and distributive justice grounds.

Fourth, our results also suggest additional avenues for future research. For example, what are the mechanisms through which the highest paid CEOs who are not the top performers are able to "game the system"? Some possibilities involve their ability to negotiate a beneficial contract. For example, some CEOs may have excellent negotiation skills, but not a similarly high level of leadership skills, which may be more closely related to CEO performance. Also, as noted by Deya-Tortella *et al.* (2005), some CEOs may be skilled at managing the timing of news announcements and the release of company reports, which they may use to increase their equity-based pay but may not be directly related to CEO performance (Bergh *et al.*, 2016). Another distinct possibility is the use of unrestricted CEO power to extract rents that are not justified by performance (Bebchuk and Fried, 2009), and the use of consultants to legitimize it (Crystal, 1990), particularly when ownership is highly dispersed so that monitoring is weak (Gomez-Mejia *et al.*, 1987; Tosi and Gomez-Mejia, 1989, 1994).

Fifth, our results point to the need for future research to explain a phenomenon that has not received sufficient empirical attention to date: CEO underpayment. For example, what are the factors that prevent top-performing CEOs from not receiving the compensation they deserve based on their superior performance? What is the relative importance of individual-level factors such as CEO negotiation skills compared to contextual factors such as environmental constraints in explaining CEO underpayment? Clearly, researchers, the media, and public in general have focused on CEO overpayment, but our results point to the need for a new research stream focused on CEO underpayment.

Sixth, related to our results and implications regarding efficient contracting, our findings elucidate the extent to which industry matters when drawing conclusions about CEO pay deservingness. Even though the overlap between top performers and top earners was minimal in the top 5 percent across most industries, chemical manufacturing and petroleum industries showed more overlap compared to other industries – with 50 to 57 percent of the top 5 percent performing CEOs (in terms of Tobin's Q) also in the top 5 percent bracket of earners. At the other end of this spectrum are air travel, banking, car manufacturing, lumber and pulp, and tobacco, for which overlap is practically non-existent. These are quite different industries in terms of profitability and growth rates, with the banking industry being unique in terms of the pre-2007 growth that ended disastrously. Although it is difficult to isolate unique features in the firms that contract more efficiently relative from those that do not, industry-specific compensation practices appear to exist. In fact, we observed the smallest degree of overlap in many industries with less munificent environments (reflected by lower growth). These industries include consumer goods, lumber and pulp, and tobacco, all three of which were industries with below-median growth rates (with median annualized sales growth rates during the period of our study being 5, 7 and 5 percent, respectively). In addition to the aforementioned factors, other possible explanations include differences in ownership structure (Gomez-Mejia *et al.*, 2001; Gomez-Mejia *et al.*, 2003), managerial discretion (Hambrick and Finkelstein, 1987), competitive dynamics (Murphy, 1999), systematic risk (Miller *et al.*, 2002), and the presence of interlocking directorates that may favor the CEO (Zona *et al.*, 2017). In short, our results point to a fruitful research agenda aimed at improving our understanding of these observed industry differences.

Finally, our findings lead to a reinterpretation of the large literature on agent risk sharing and risk bearing (see reviews by Devers *et al.*, 2008; Martin *et al.*, 2013). Classical agency theory suggests that shareholders, through their boards, should grant stock and options to coax the CEO out of the risk aversion assumed to be created by their concentrated firm-specific investment of human capital (Holmstrom, 1979). Our results regarding the power law distribution of CEO performance provide an important caveat for the prescription that encouraging agent risk taking is good for shareholders. Specifically, a power law distribution suggests that variation in CEO ability to derive positive returns from risk taking is significantly larger than would have been the case if the performance distribution were normal. An implication is that a minority of CEOs consistently derive positive returns from risk taking, while the majority is far less likely to do so. The large heterogeneity in CEO performance uncovered by the power law distribution prompts us to reconsider blanket prescriptions for the use of incentives to encourage CEO risk-taking – prescriptions that are based on the assumption that CEO risk-taking is beneficial for shareholders (Bebchuk and Fried, 2009, 2010; Holmstrom, 1979; Jensen and Murphy, 1990).

Implications for executive compensation, governance, and human resource management practices

Our study offers new insights into CEO compensation practices. A typical approach to negotiating and designing CEO compensation contracts is for the board's pay committee (usually with the help of compensation consultants) to ascertain the average CEO pay for a particular performance cohort in a given industry. The committee then uses that figure as a reference to estimate CEO capability relative to their peer group and then set CEO pay accordingly (Bogle, 2008; Conyon *et al.*, 2009; Jensen, 2004; Murphy, 1999). This is a reasonable approach if the distribution of CEO performance is normal, meaning that there is relatively little variation across the performance of, for example, those in the top quartile. However, a power law distribution suggests that there is a large amount of variation in the output delivered by CEOs, with the top performers delivering results many multiples better than the average. This implies that the typical approach to CEO compensation based on averages would significantly underpay stars while overpaying average performers. Our results may explain, at least in part, why CEO poaching is a frequent phenomenon and the typical CEO lasts just a few years on the job. After all, information on CEO performance is readily accessible to recruiters and headhunters, making it easy to identify the individuals producing top results.

Moreover, our results point to the need to shift practitioner thinking toward the power law view. Headhunting firms that adopt the power law view, rather than a normal distribution mindset, will be able to more accurately identify CEOs who are not the highest earners but are among the top performers. These are the CEOs that headhunters will be able to proactively approach and tempt with an offer to move to another firm. Similarly, firms will be well served by examining the relation between CEO pay and CEO performance based on a power law perspective to possibly prevent dysfunctional turnover (i.e. the departure of a high performing CEO). In addition to possibly preventing dysfunctional turnover, from a public relations perspective, our results suggest that firms should also embrace a power law perspective to anticipate and prevent possible shareholder disapproval and unwanted media attention. Just as important to knowing whether a top performing CEO is not paid accordingly is identifying top earning CEOs who are not creating commensurate results.

Concluding comments

Our findings shed new light on CEO pay deservingness by using a novel conceptual and methodological lens that highlights systematic overpayment and underpayment. We contributed new insights to the question of whether CEOs deserve their pay based on distributive justice and agency theory. Our results show that CEOs at the top of the performance distribution create vastly more value than those at succeedingly lower levels of the performance distribution, and those CEOs at the top of the pay distribution are remunerated far more than those at succeedingly lower levels of the pay distribution. But, there is little overlap between CEOs who are the top performers and CEOs who are the top earners. In addition, our results provide evidence regarding CEO underpayment. These results suggest a violation of distributive justice and offer little support for agency theory's efficient contracting hypothesis, which have important implications for agency theory, equity theory, justice theory, and agent risk sharing and agent risk bearing theories, as well as executive compensation and governance practices in general. In short, CEOs usually do *not* deserve the pay they receive in that some deserve less (particularly those at the top of the pay distribution), whereas others deserve more – as judged based on their performance levels and a distributive justice perspective that higher performance should be associated with higher pay. We hope our results will pave the way for a fruitful research agenda aimed at further understanding the two sides of CEO pay injustice: Why CEOs who create disproportionately large amounts of value are a different group from the small proportion of CEOs who secure disproportionately large amounts of compensation, and vice versa.

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Further reading

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