

CEO Power, CEO Compensation, and Firm Performance

S M Muyeed Hasan, Yong Jae Shin, and Unyong Pyo*

Abstract

We investigate the impact of CEO power on the relation between CEO compensation and firm performance to find how CEO incentive compensation affects firm performance by reducing agency conflicts between managers and shareholders. We measure the CEO pay slice (CPS) for CEO power and the pay-performance sensitivity (PPS) for CEO incentive compensation. Employing standard control variables, we run multiple OLS regressions and show that PPS increases firm performance at the high level of CPS, but the impact of PPS decreases at the low level of CPS. To resolve the potential endogeneity concerns, we perform robustness checks by adopting instrumental variables in a two-stage least square (2SLS) estimation. We also consider the year-effect and find that our results remain the same as before. The finding implies that considering stand-alone associations of either PPS or CPS with firm performance—a common practice in the literature—will not be appropriate because there is an interaction effect between CEO power and incentive compensation.

Keywords: CEO compensation, Pay-performance sensitivity, CEO pay slice, Firm performance

JEL Classification: G30, G35, J33

I. Introduction

CEO compensation is one of the most debated topics in the literature of corporate finance. In the last few decades, researchers have explored numerous ways to alleviate the agency conflict between the shareholders/owners (principals) and the managers/executives (agents) in modern corporations, and subsequently offered various solutions such as offering equity-based compensation (EBC), long-term incentive plans in the form of stock options, restricted stock grants etc. to CEOs in order to enhance their ownership and attract their commitment to firm performance. However, analyses of such propositions have found mixed results on the efficacy of high compensation packages on firm performance. There exist two viewpoints in general. First, the optimal contracting theory suggests executive incentive contracts to maximize shareholders' value. Second, the rent seeking theory, or the managerial power view of compensation argues that agency conflicts could be worse in lucrative compensation packages, leading to shareholders' value destruction (Bebchuk & Fried, 2006).

A common measure of executive incentives is the pay-performance sensitivity (PPS) - defined as the marginal increase in CEO pay given an incremental effect on firm value - which is

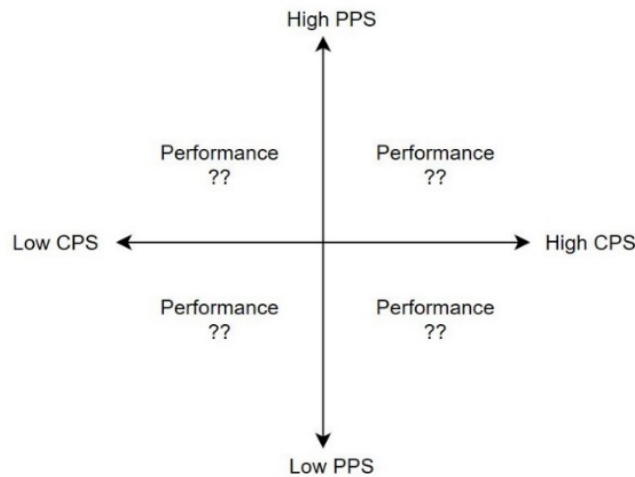
* S M Muyeed Hasan, Manager, Analytics and Decision Science Division, CIBC, 81 Bay Street, Toronto, Ontario, M5J0E7, Canada, Tel: 416-586-6901, sheikhmuyeed@gmail.com; Yong Jae Shin, Professor, Department of Business Administration, Hankyong National University, Anseong, 17579, South Korea, Tel: (031) 670-5226, email: yjshin@hknu.ac.kr; Unyong Pyo, Associate Professor, Department of Finance, Operations, and Information Systems (FOIS), Goodman School of Business, Brock University, St. Catharines, Ontario, L2S3A1, Canada. Tel: (905) 688-5550, x3147, email: upyoy@brocku.ca.

positively associated with firm performance (Jensen & Murphy, 1990). A recent body of literature focuses on executive power, or relative importance of CEOs and supports the rent seeking theory. It considers CEO pay slice (CPS)—the proportion of salary captured by CEO from aggregate compensation of the top-five executives—as a measure of pay-heterogeneity and CEO dominance and finds that it is negatively associated with firm value (Bebchuk et al., 2011). However, the negative association invites concern from researchers, who have found conflicting results based on these instruments. For instance, while studying the association of CEO power to firm value using CEO pay slice as a proxy, some researchers found non-monotonic relations to various agency conflict issues (Chintrakarn et al., 2015; Jiraporn & Chintrakarn, 2013; Lee et al., 2015). In addition, some authors support CEO power in favor of firm riskiness as it improves firm value (Larcker & Tayan, 2012). Mixed results in the literature motivate this study to pursue reasons behind the potential inconsistency with a perspective different from previous studies.

It is important to note that executive power might vary across firms since it connects to the idiosyncratic characteristics of firm factors such as the team structure, compensation practices etc. Incentive compensation appears to be linked with the CEO power as well. In a recent article published in Bloomberg, Melin and Sam (2020) rank top-paid CEOs and segregate their compensation components. They show that incentive compensation packages such as stock options hold a major portion in the CEO compensation contracts. When we study these CEOs to understand their dominance level, we observe that they have a very high level of CPS.¹ The link between powerfulness and incentive payment becomes more prominent when we examine the calculation of the proxies i.e., CPS and PPS. While CPS indicates the pay heterogeneity among top executives, the calculation involves the Black & Scholes value of stock options granted in a given year. On the other hand, Coles et al. (2006) follow Core and Guay (2002) for PPS calculation and consider the sensitivity of stock option portfolios that consist of all the vested and unvested tranches of stock options. Based on (1) the mixed results between CEO dominance and firm performance documented in prior literature, (2) the current industry practice of incentive compensation packages for powerful CEOs, and (3) the nature of the CEO compensation components and their proxies, we posit that PPS being a measure of executive incentives is not separable from CPS, a measure of executive dominance, and thus, argue that their stand-alone associations with firm performance might be inadequate in drawing implications on agency conflicts.

To capture the compensation component, this study simultaneously considers the incentive component measured by PPS and the dominance or the pay-heterogeneity component measured by CPS instead of focusing only on incentives or cash compensation. Ozkan (2011) argues that studies that do not consider the equity-based component of compensation could be criticized and shows that performance-sensitive component of compensation is vital in assessing the association of pay with performance. However, in contrast to our analysis, the author only focuses on UK CEOs and does not consider the executive dominance component that is naturally prevalent in companies. Finally, we also examine the interaction effect between PPS and CPS, which, to the best of our knowledge, has not been considered in prior studies.

¹For instance, Tim Cook of Apple Inc. and Tom Rutledge of Charter Communications Inc. have a CPS of 72% as of 2019.

Figure 1: Prospective interaction between PPS and CPS.

The figure portrays how this study analyzes the interaction effect by considering each quadrant.

The analysis of interaction effect appears crucially important since it proposes answers to questions such as: (1) Is PPS always positively associated with firm performance? (2) Does the negative association of CPS with firm performance always hold? (3) Is it better to have non-dominant CEOs? etc. To understand the effect, we have analyzed CEO compensation from the Execucomp database for the 1992-2019 period. Firm specific data and stock-related information are obtained from Compustat and CRSP, respectively. The analysis of this study is comprised of two parts, each of which examines six OLS models. While Tobin's q as a proxy of firm value is taken as the dependent variable in the first part, the second part considers annual stock returns. We first evaluate stand-alone associations, and then further analyze the interaction effect. Figure 1 portrays how this study analyzes the interaction effect by considering each quadrant. Estimates from the stand-alone cases indicate that PPS shows a positive association to firm performance and CPS shows a negative association to firm performance, both of which are aligned with the literature. However, findings from the interaction effect show that at high level of CPS, changing PPS level from low to high increases firm performance (measured by annual stock returns), but at low level of CPS, influence of PPS on firm performance declines. This indicates that stand-alone association of either executive incentives (PPS) or executive dominance (CPS) to firm performance could be inadequate in understanding the firm performance implications - a contribution of this study to the existing literature. This finding is different in contrast to Lee et al. (2015), where they estimate an optimal level of power and find that power has a nonmonotonic relation to the firm value i.e., non-optimal power such as excess or deficient power of CEO is negatively related to firm performance. This study indicates that while inadequate power (or, importance) of CEO might not lead to strong performance for the firm, excess executive dominance can be managed for better firm performance by granting incentive compensation with high PPS. The high caliber CEOs who have gained importance indicated by their high CPS levels² might not be that bad for the firm, even though their heterogeneous pay structure appears to be linked to firm's value destruction as shown by Bebchuk et al. (2011). Such dominant CEOs might

² For example, Sundar Pichai, chief executive officer (CEO) of Alphabet Inc. and its subsidiary Google LLC, has a CPS of 71% (quite high) as of 2019.

still improve firm performance if provided with an optimal bundle of vested and unvested stock options (which would increase their PPS levels) - especially, may be for extended vesting periods - along with the existing compensation contract. In line with the optimal contracting theory, this study contributes to the existing body of literature that circulates around agency conflict issues by adding new perspectives based on the interaction effect, and opens opportunities for further investigations on the optimal contracts.

We organize the remainder of this study as follows. In Section 2 we review the prior literature and develop hypotheses. Data and methodology are described in Section 3, which is followed by results in Section 4. Section 5 discusses the robustness checks. Finally, Section 6 concludes.

II. Literature review and hypotheses development

Measures to minimize agency conflicts

Firms hire CEOs for the best interest of shareholders: maximizing firm value or shareholders' wealth regardless of size, location, industry, and timeline. However, Jensen and Meckling (1976) argue that these managers do not always follow their mission, but rather seek their own interest by extracting undeserved personal benefits. Deep-rooted in agency conflict, several inefficiencies do not let firms acquire the maximum value that they could potentially achieve. Jensen and Meckling (1976) categorize these inefficiencies into three types of expenditure - bonding costs towards the agents, monitoring expenditure by the principals, and opportunity costs or the residual loss due to the divergence in differential interests between the principal and the agent. To establish an efficient management, shareholders incentivize managers through potentially optimal contracts with equity-based compensation and numerous benefits. These high CEO pays are set on purpose as a motivation to improve firm performance (Edmans & Gabaix, 2009). Dow and Raposo (2005) further show that equity-based CEO compensation is a crucial key to make the interest of managers aligned with that of shareholders. Although it appears that equity-based compensation packages reduce the agency problem, in the last few decades researchers have found mixed results on the impacts of equity-based compensation on better firm performance.

Earlier work on compensation effects focused only on salary and bonus to understand the impact of pay on performance.³ However, since CEOs do not have strong obligation to the firm due to lack of ownership and could make investment decisions destroying firm values by taking pet projects, building empires through personally preferred merger and acquisitions, etc. to pursue own interest, EBC has evolved to ensure CEOs' incentives in the firm (Hölmstrom, 1979; Rajgopal & Shevlin, 2002). Frydman and Jenter (2010) show dramatic increase in compensation that is highly driven by EBCs during the 1970s. However, several studies (Bulan et al., 2010; Demsetz, 1983; Fama & Jensen, 1983; Smith & Stulz, 1985) suggest that even CEO ownership has mixed influence to firm performance. In the early 1990s, stock options became popular in industry practice as an instrument of equity-based CEO pay (Langsam et al., 1997). However, due to several corporate scandals (e.g., backdating in stock option grants), major reforms in the executive compensation were done in the mid-2000s (Bulan et al., 2010). In addition, restricted stock is granted to encourage long-term performance accompanied with other components in the

³ Murphy (1985) criticizes this practice and propose more components of executive compensation such as base salaries, bonuses, total compensation, and deferred compensation.

compensation contracts. Studies based on these several industry practices during this timeline have taken two main directions – the optimal contracting theory and the rent seeking theory.

According to the optimal contracting theory, equity-based compensation would be optimal in incentivizing managers (Fama, 1980; Jensen & Murphy, 1990; Lee et al., 2008; Murphy, 1985). On the other hand, the rent seeking theory suggests that as CEOs influence their own compensation packages, they would pursue their own interest over shareholders' interest (Bebchuk & Fried, 2006). At their own discretion, these CEOs manipulate their compensation packages and look for opportunities to enlarge their undeserved compensation at the expense of other stakeholders such as shareholders and employees. Researchers have explained that overconfidence, powerfulness, dominance, high pay dispersion among top executives, and poor corporate governance might be some of the reasons behind such over-compensation (Bebchuk et al., 2011; Cooper et al., 2016; Hayward & Hambrick, 1997).

Pay-performance sensitivity in reducing agency conflict

Pay-performance sensitivity (PPS) is the dollar change in CEO's wealth associated with a one percent change in the firm's stock price, termed as the compensation delta (Murphy, 2012). Murphy (1985) shows that firm performance measured by shareholders' realized returns has a positive relationship with managerial remuneration. Moreover, considering PPS as a compensation metric and shareholders' return as a measure of firm performance, Jensen and Murphy (1990) show that a CEO's wealth increases \$3.25 for every \$1000 increase in shareholders' wealth, revealing a small, yet positive association between them. Following this finding, the literature shows a big increase in PPS during 1990s in the form of CEO's option holdings (Frydman & Jenter, 2010). The positive association between PPS and firm performance is further supported by several other studies (Pyo & Abedin, 2017; Kaplan, 2012).

On the other hand, the EBC can make agency conflicts worse. For instance, Brick et al. (2012) show that incentive compensation components such as stock option grants make CEOs entrenched and risk averse. Hence, they would put their own interest ahead of shareholders', leading to poor firm performance. To resolve mixed results on EBC, we first consider Tobin's q and then annual stock returns to measure firm performance and analyzes the effect of PPS in the presence of different executive dominance levels. One inherent component of the first two hypotheses is the anticipated influence of dominance level on the association of PPS with firm value.

H1a: The CEO power measured by CPS affects the positive relationship between PPS and firm performance measured by Tobin's q .

H1b: The CEO power measured by CPS affects the positive relationship between PPS and firm performance measured by annual stock returns.

CEO pay slice in aggravating agency conflicts

A recent pool of literature that supports the rent seeking theory focuses on executive power or, relative importance of CEOs. CEO pay slice (CPS), a common measure of pay-heterogeneity and executive dominance, is the proportion of salary captured by CEO from aggregate compensation of the top-five executives (Bebchuk et al., 2011). CPS has been found to have important effects on

firm value controlling for standard control variables.⁴ For instance - high level of CPS leads to a lower firm value (measured by Tobin's q), poorer accounting profitability, and higher rent extraction (Bebchuk et al., 2011). However, dominance or power might differ for each firm and CEO because of the dependency on the idiosyncratic characteristics of factors such as the compensation contract, top management team structure, CEO ownership etc. However, we speculate that this linear negative impact of CPS on firm performance might not hold always. For instance, when performance is recognized and awarded with more long-term incentives (may be bundled with vested and unvested stock options), a dominant CEO—who had previously perceived to be a value destructor—might lead a firm with more confidence/motivation by taking investment decisions to boost stock price as he/she has stock options that are going to vest and increase their values, which would align high executive dominance with strong firm performance. As an extension to the first hypothesis, this is a more discrete approach to assess the interaction effect and examine the impact of higher executive dominance on the assessment of incentives to firm performance, which leads to the second hypothesis.

H2: CEO power positively interacts with PPS for strong firm performance.

Mixed reviews on the impact of CEO pay

The literature also reveals some mixed results on the association of executive pay to firm performance. Gregg et al. (2005) show that there exists a rather weak link between pay and performance of the CEOs in the UK, especially when stock returns are relatively high. Such findings are further supported by Girma et al. (2007). In addition, Cooper et al. (2016) show that incentives offered as excess compensation are negatively related to firm performance. However, it is important to note some vital factors when we examine firm performance relative to CEO pay. For instance, researchers have considered the compensation component in various ways in the past. While some researchers focus on the incentive portions (Cooper et al., 2016; Dow & Raposo, 2005; Rajan & Wulf, 2006), others study the impact of cash, or whole compensation (Chintrakarn et al., 2015; Girma et al., 2007; Gregg et al., 2005). Ozkan (2011) shows a positive association between pay and performance, and emphasizes the importance of including performance sensitive components of compensation such as stock options, stock awards etc. Furthermore, various metrics are used to compute firm performance. For instance, some authors have considered Tobin's q (Bebchuk et al., 2011), while others have preferred stock return or return on assets (Bulan et al., 2010). Finally, the timeline of the sample firms could be related to the conflicting results for the relation between compensation and performance. Literature shows that the practice of remunerating higher incentive compensation packages to top executives started in the 1950s and escalated during 1990s (Langsam et al., 1997). The instruments of incentive compensation have also changed after the 1950s for various reasons (e.g., stock market volatility, corporate scandals etc.) (Bulan et al., 2010). This study offers to simplify these issues by: (1) controlling for PPS and

⁴ Zagonov and Salganik-Shoshan (2018) argue that CPS is inefficient to discern the diverse variations in payment structure of top executives across various organizations. However, in several studies, researchers use similar metrics compared to CPS in order to capture the varied payment structure. Hayward and Hambrick (1997) introduce CEO relative compensation (CRC) to segregate weak CEOs from strong CEOs (where, $CRC \leq 1$ being weak). Furthermore, Chang et al. (2010) study the impact of managerial departure announcements on abnormal stock returns by considering relative total pay (RTP) for compensation measure which is calculated by dividing the CEO pay by the next four manager's pay. Overall, we recognize that higher pay-heterogeneity among the top executives is positively associated with agency problems and thus, note that CPS might be a useful tool to study firm value associations.

CPS simultaneously along with product terms to account for the individual effect and the interaction effect, (2) taking both Tobin's q and stock return to measure firm performance. Additionally, the 1992-2019 time period of this study covers the 1990s introduction of high incentive payment practice as well as the financial crisis of 2008⁵

III. Data and methodology

Data

Compensation data have been collected from the Execucomp database for the 1992-2019 period. Execucomp provides ranked compensation data of the top-level executives. We retain the top five executives' data by eliminating companies (9.5% of the total) which have information on less than five executives. When more than five executives' data are provided, only top five observations are taken for consistency. One integral part of CPS computation is the compensation component. We consider the TDC1 item from the Execucomp database which includes salary, bonus, other annual compensation, stock options (Black & Scholes value) granted that year, total value of restricted stock grant that year, long-term incentive plan, all other total compensation following Bebchuk et al. (2011). Post-2006, Execucomp data format was changed to put up with accounting changes and expanded compensation disclosure requirements imposed by Financial Accounting Standards Board (FASB), and Securities and Exchanges Commission (SEC). We address this issue by applying different methods for PPS calculation for time periods: 1992-2006 and 2006-2019, following Coles et al. (2006). In addition, Execucomp stopped providing volatility and dividend yield information as of 2006 which are needed in the Black-Scholes formula for option valuation. Hence, we calculate the 60-month rolling volatility, and estimate the dividend yield as suggested by Coles et al. (2006). Risk-free rates are retrieved from historical data available at the Federal Reserve for 'treasury constant maturities' selecting the 'annual' series.⁶

Firm specific data and stock-related information are obtained from Compustat and CRSP, respectively, for the same period as discussed above. The final sample size stands at 32,042 CEO-year observations representing 3,518 unique firms (identified by GVKEY in Execucomp) including 7,265 unique CEOs (identified by CO_PER_ROL in Execucomp) after controlling for the data requirements. However, the number of observations in some regressions varies due to data limitation. For instance, lagged values are missing for the year 1992 (the beginning year of the sample).⁷

Variables

Tobin's q —defined as equity at the market value plus bond at the book value (total assets minus equity, both at the book value), the sum divided by total assets at the book value—as a proxy of

⁵ Relevant studies, such as Ozkan (2011) only focuses on UK CEOs for the 1999-2005 time period and does not consider the executive dominance that is prevalent in companies. Coles et al. (2006) study the riskiness in firms' decision making for the 1992-2002 time period and do not examine executive dominance. Bebchuk et al. (2011) study the association of CEO dominance—proxied by CEO pay slice—to firm performance for the 1993-2004 time period, however, do not consider the interaction effect between pay-performance sensitivity and CEO dominance.

⁶ In the annual series, data for 1, 2, 3, 5, 7, and 10-year treasury securities are available. we interpolate the rates to obtain the risk-free rates for 4, 6, 8, and 9 years. If the option maturity is more than 10 years, we use the 10-year rate.

⁷ The Execucomp database starts on Jan 1, 1992.

firm value is used as the dependent variable in the first part of the analysis. We also consider annual stock returns to account for firm performance in the second part of the study.

Pay-performance sensitivity (PPS) or Delta is the dollar increase in the CEO's compensation for a 1% increase in stock price. To estimate PPS, we first calculate stock option values following the method proposed by Core & Guay (2002), which is based on the Black & Scholes (1973) model for European call options modified by Merton (1973) to adjust for the dividend yield. Equation 1 reports the model.

$$\text{Option value} = [Se^{-dt}N(Z) - Xe^{-rT}N(Z - \sigma\sqrt{T})] \quad (1)$$

where $Z = \left[\left\{ \ln\left(\frac{S}{X}\right) + T\left(r - d + \frac{\sigma^2}{2}\right) \right\} / \sigma\sqrt{T} \right]$, N = cumulative probability function for the normal distribution, S = price of the underlying stock, X = strike price of the option, σ = volatility of stock returns over the maturity of the option, r = risk-free interest rate, T = time to maturity of the option in years, d = dividend yield over the maturity of the option.

For the aggregate PPS, we compute the delta for each CEO-year incorporating all the vested and unvested components of stock options in addition to shares owned following Coles et al. (2006), which is based on the "one-year approximation" (OA) method by Core & Guay (2002). The estimation of PPS is in equation 2.

$$\begin{aligned} & \left[\frac{\delta(\text{Option value})}{\delta(\text{Stock price})} \right] * \left(\frac{\text{Stock price}}{100} \right) \\ & = [e^{-dT}N(Z) * (\#Option_{\text{Holding}} + \#Shares_{\text{owned}})] * \left(\frac{\text{Stock price}}{100} \right) \end{aligned} \quad (2)$$

where $Z = \left[\left\{ \ln\left(\frac{S}{X}\right) + T\left(r - d + \frac{\sigma^2}{2}\right) \right\} / \sigma\sqrt{T} \right]$, N = cumulative probability function for the normal distribution, T = time to maturity of the option in years, d = dividend yield over the maturity of the option.

CEO pay slice (CPS) is measured as the fraction of the total compensation (Execucomp item TDC1) of top five executives that is received by the chief executive officer (CEO) (see, Bebchuk et al., 2011). While PPS and CPS are our primary explanatory variables, we include other control variables following the prior literature (Bebchuk et al., 2011; Coles et al., 2006; Core & Guay, 2002; Graefe-Anderson et al., 2018). For instance, market-to-book is defined as the market value of equity divided by its book value. Book leverage is the total debt divided by the book value of total assets.⁸ ROA is the return on assets computed as operating income divided by book value of total assets. R&D is expenditure in research and development divided by total assets. Capex is capital expenditure minus sales of property, plant, and equipment, also divided by total assets.

⁸ Book leverage (rather than market leverage) is used since market leverage might change passively simply because of changes in stock price performance and may not be an active managerial choice (Coles et al., 2006).

Table 1: Summary statistics

Variable	N	Mean	Std Dev	Minimum	Q1	Median	Q3	Maximum
Tobin's q	32,042	1.94	1.50	0.42	1.11	1.46	2.15	17.30
Annual Return	32,042	0.17	0.45	-0.89	-0.09	0.12	0.35	2.74
CPS	32,042	0.38	0.11	0.08	0.31	0.38	0.45	0.71
Delta (PPS) (\$000s)	32,042	1,086	9,666	0.000011	78	208	572	709,830
Lag (CPS)	26,456	0.38	0.11	0.08	0.32	0.39	0.45	0.71
Log (PPS)	32,042	5.35	1.61	-11.40	4.36	5.34	6.35	13.47
Lag {Log(PPS)}	24,441	5.37	1.58	-5.77	4.39	5.35	6.36	13.23
MtB	32,042	3.27	4.48	0.16	1.36	2.12	3.52	52.40
Market cap (\$M)	32,042	6,197	10,173	3	700	1,919	6,047	41,486
Sales (\$M)	32,042	4,889	9,033	28	539	1,464	4,492	47,142
CEO age (years)	32,042	56.12	7.22	28.00	51.00	56.00	61.00	91.00
Leverage	32,042	0.13	0.17	0.00	0.00	0.00	0.25	0.87
ROA	32,042	0.11	0.10	-0.40	0.06	0.12	0.17	0.43
R&D	32,042	0.03	0.06	0.00	0.00	0.00	0.03	1.15
Capex	32,042	0.05	0.05	-0.04	0.01	0.03	0.06	0.44

This table provides descriptive statistics on CEO and firm characteristics for the 1992–2019 sample period. Data on executive compensation, firm specific information and stock prices are obtained from Execucomp, Compustat and CRSP databases respectively. Risk-free rates are obtained from the Federal Reserve. The sample contain data of 32,042 CEO year observations (representing 3,518 unique firms having 7,265 unique CEOs). CEO pay slice (CPS) is the part of the total compensation (TDC1 at Execucomp) of the top-five executives that is collected by CEO. Delta (pay-performance sensitivity) is the dollar change in the executive's wealth for a 1% change in stock price. Tobin's q is defined as equity at the market value plus bond at the book value (total assets minus equity, both at the book value), the sum divided by total assets at the book value. MtB or, market-to-book is the market value of assets divided by their book value. Annual return is the annual stock return. Leverage is total debt divided by total assets. ROA is the return on assets measured as operating income over book value of assets. R&D is the expenditure in research and development divided by assets. Capex is capital expenditure minus sales of property, plant, and equipment, also scaled by assets. The variables have been winsorized at 1st and 99th percentile levels.

Table 2: Sample correlations of key variables

Variables	PPS	CPS	MtB	Market Cap	Sales	CEO age	Leverage	ROA	R&D	Capex
PPS	1									
CPS	<i>0.075</i>	1								
MtB	<i>0.223</i>	0.012	1							
Market Cap	<i>0.537</i>	<i>0.129</i>	<i>0.199</i>	1						
Sales	<i>0.362</i>	<i>0.131</i>	-0.004	<i>0.780</i>	1					
CEO age	<i>0.141</i>	0.008	<i>-0.051</i>	<i>0.070</i>	<i>0.112</i>	1				
Leverage	<i>0.035</i>	<i>0.120</i>	<i>0.130</i>	<i>0.087</i>	<i>0.195</i>	-0.002	1			
ROA	<i>0.173</i>	<i>0.036</i>	<i>0.202</i>	<i>0.134</i>	<i>0.149</i>	-0.005	<i>0.095</i>	1		
R&D	0.003	<i>-0.052</i>	<i>0.212</i>	<i>-0.108</i>	<i>-0.282</i>	<i>-0.108</i>	<i>-0.075</i>	<i>-0.149</i>	1	
Capex	-0.002	<i>-0.043</i>	<i>0.036</i>	<i>-0.062</i>	<i>-0.057</i>	<i>-0.038</i>	<i>0.042</i>	<i>0.352</i>	<i>-0.016</i>	1

This table reports the correlations among sample of main variables adopted in the analysis of the impact and association of executive incentives and executive dominance on firm performance. PPS is the natural log of pay-performance sensitivity; Market Cap is the natural log of market capitalization; Sales is the natural log of annual sales. MtB is market-to-book ratio, which is assets at the market value over those at the book value. Leverage is total debt divided by book value of assets. ROA is the return on assets measured as operating income over assets at the book value. R&D is the expenditure in research and development divided by assets. Capex is capital expenditure net of sales of property, plant, and equipment, also scaled by assets. The sample contains data of 32,042 CEO year observations (representing 3,518 unique firms having 7,265 unique CEOs) for the 1992-2019 time period. Italic numbers indicate 1% level of significance.

Table 1 reports the summary statistics. Overall, the firms in our sample are quite large with a mean (median) market capitalization of \$6,197 (\$1,919) million. The mean (median) values of Tobin's q and annual stock returns are 1.94 (1.46) and 17% (12%), respectively. Mean (median) value of delta is \$1,086,400 (\$208,024), i.e., average CEO wealth changes by \$1,086,000 per 1% change in their firm's stock price. Coles et al. (2006) study pay-performance sensitivity from 1992 to 2002 and find that mean (median) value of delta is \$600,000 (\$206,000). Since 2002, CEOs have been granted very high levels of equity-based compensation, which explains the difference. Mean (median) value of CPS is 0.38 (0.38), which is in accordance with the prior literature.⁹ To avoid scale difference among the variables in the regressions, natural log of delta (i.e., PPS), market capitalization, and sales is taken. All the variables are winsorized at 1st and 99th percentile levels to minimize the effects of outliers.

Table 2 reports the correlations among samples of main variables adopted in the analyses. Most of the correlations are significant at 1% level. 'Sales' and 'Market capitalization' have a correlation coefficient of 0.780, which is strongly positive. The correlation between 'PPS' and 'Market capitalization', 'Sales' and 'PPS' are 0.537 and 0.362, respectively, indicating a moderate degree of correlation. Other correlation values are smaller than 0.362.

Methodology

The relation between CEO incentive compensation and firm value is analyzed in two parts, each of which examines six models. In the first part, Tobin's q as a proxy of firm performance is regressed on PPS, and CPS along with other standard control variables. The second part considers annual stock returns as a measure of firm performance and conducts similar analyses.

Firm value measured by Tobin's q

This is the first part of the analyses and comprises six OLS models, where Tobin's q as a proxy of firm performance is the dependent variable. Other control variables such as market to book ratio, market capitalization, sales, CEO age, leverage, return on asset, research and development, capital expenditure, product term of PPS and CPS, and lagged values of the product term are included along with the two primary explanatory variables: PPS and CPS.

Initially we try to analyze if the prior findings in the literature are held within our framework. Hence, we assess the association of PPS to firm performance. Subsequently, we analyze the two primary explanatory variables together and test if prior findings still stand. Equation 3 reports the model.

$$\begin{aligned} \text{Tobin's } Q_{i,t} = & \beta_0 + \beta_1 \text{PPS}_{i,t} + \beta_2 \text{CPS}_{i,t} + \beta_3 \text{Market to Book}_{i,t} + \beta_4 \text{Market Cap}_{i,t} \\ & + \beta_5 \text{Sale}_{i,t} + \beta_6 \text{CEOAge}_{i,t} + \beta_7 \text{Leverage}_{i,t} + \beta_8 \text{ROA}_{i,t} \\ & + \beta_9 \text{R\&D}_{i,t} + \beta_{10} \text{CAPEX}_{i,t} + \epsilon_{i,t} \end{aligned} \quad (3)$$

⁹ Bechuk et al. (2011) studies 12,011 firm-year observations from 1993 to 2004 and finds mean (standard deviation) CPS of 35% (11.4%). When we replicate, we get mean (standard deviation) CPS of 36% (12.4%) by studying 18,053 firm-year observations for the same time period. The reason behind the difference in the number of firm-year observations for the same sample period might be the addition of data by Execucomp after 2011.

where $PPS_{i,t}$ is the natural log of pay-performance sensitivity and $CPS_{i,t}$ is CEO pay slice of the CEO of firm i in year t respectively; Market to Book $_{i,t}$ is the ratio of market value to book value, Market Cap $_{i,t}$ is the natural log of market capitalization, Sale $_{i,t}$ is the natural log of sales, CEOAge $_{i,t}$ is the age of CEO (in years), Leverage $_{i,t}$ is the book leverage, ROA $_{i,t}$ is the return on asset, R&D $_{i,t}$ is the research and development expenditure, CAPEX $_{i,t}$ is the capital expenditure minus sales of property, plant, and equipment of the firm i in year t ; $\epsilon_{i,t}$ is the error term.

As we add more control variables, we further explore firm value characteristics. We speculate that there is any interaction effect between PPS and CPS and includes the product terms (current and lagged) along with prior control variables. Equation 4 denotes the model.

$$\begin{aligned} \text{Tobin's } Q_{i,t} = & \beta_0 + \beta_1 PPS_{i,t} + \beta_2 CPS_{i,t} + \beta_3 (PPS * CPS)_{i,t} + \beta_4 PPS_{i,t-1} \\ & + \beta_5 CPS_{i,t-1} + \beta_6 (PPS * CPS)_{i,t-1} + \beta_7 \text{Market to Book}_{i,t} \\ & + \beta_8 \text{Market Cap}_{i,t} + \beta_9 \text{Sale}_{i,t} + \beta_{10} \text{CEOAge}_{i,t} + \beta_{11} \text{Leverage}_{i,t} \\ & + \beta_{12} \text{ROA}_{i,t} + \beta_{13} \text{R\&D}_{i,t} + \beta_{14} \text{CAPEX}_{i,t} + \epsilon_{i,t}, \end{aligned} \quad (4)$$

where $(PPS * CPS)_{i,t}$ and $(PPS * CPS)_{i,t-1}$ are the current and lagged values of the product term of pay-performance sensitivity and CEO pay slice of the CEO of firm i in year t . Other variables have the same definitions as above.

Firm performance measured by annual stock returns

We run six OLS regressions to examine the impacts on firm performance considering annual stock returns as the dependent variable. We initially conduct tests if prior findings are held. We add their product terms along with other control variables to examine the potential interaction effects between PPS and CPS. We expect that γ_1 and γ_2 would be statistically significant, and their signs would be positive and negative, respectively. We do not expect any sign regarding γ_3 ; however, we expect the product term to be statistically significant so that we can investigate how they interact with each other. Equation 5 shows the model.

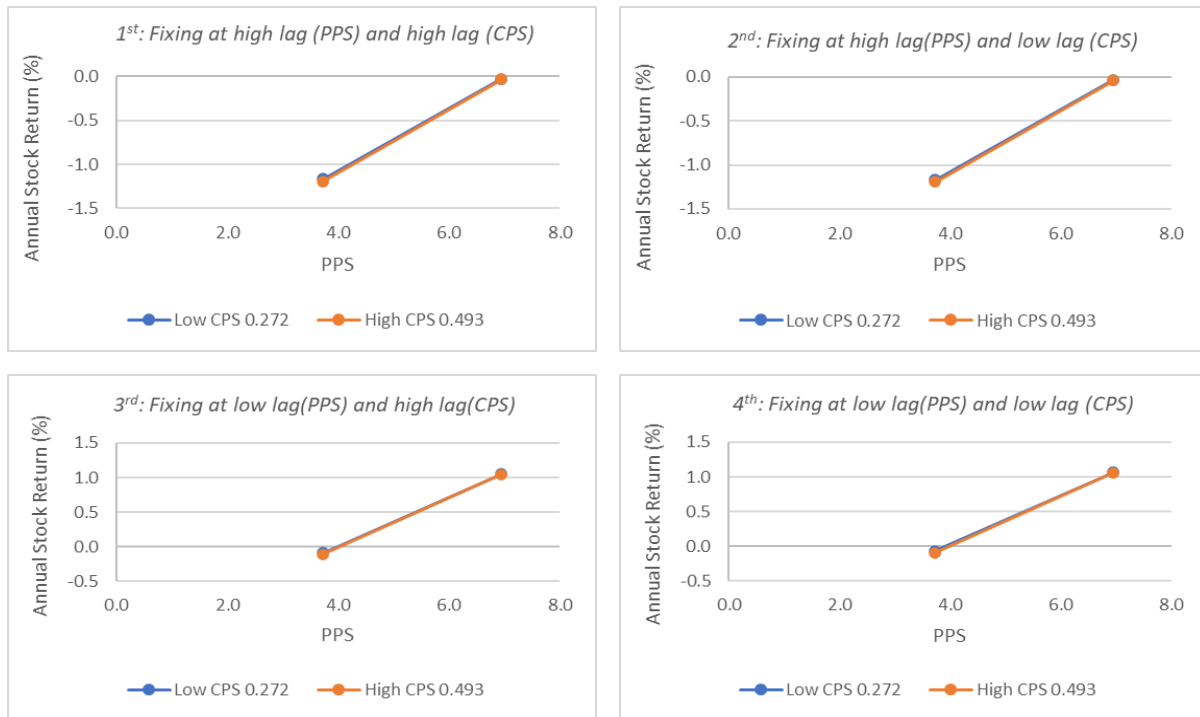
$$\begin{aligned} \text{Stock Return}_{i,t} = & \gamma_0 + \gamma_1 PPS_{i,t} + \gamma_2 CPS_{i,t} + \gamma_3 (PPS * CPS)_{i,t} + \gamma_4 PPS_{i,t-1} \\ & + \gamma_5 CPS_{i,t-1} + \gamma_6 (PPS * CPS)_{i,t-1} + \gamma_7 \text{Market to Book}_{i,t} \\ & + \gamma_8 \text{Market Cap}_{i,t} + \gamma_9 \text{Sale}_{i,t} + \gamma_{10} \text{CEOAge}_{i,t} + \gamma_{11} \text{Leverage}_{i,t} \\ & + \gamma_{12} \text{ROA}_{i,t} + \gamma_{13} \text{R\&D}_{i,t} + \gamma_{14} \text{CAPEX}_{i,t} + \epsilon_{i,t}, \end{aligned} \quad (5)$$

where, the subscript i, t denotes the firm i in year t . All the variables have the same definitions as above.

Main effects vs Interaction effects

Six of the twelve regressions from the two parts of the analyses (column 1, 2, 4 in both Table 3 and 4) show the stand-alone association of PPS and CPS to firm performance measured by Tobin's q and annual stock return. As for the interaction effect, it is important to have both statistically significant product term (i.e., $PPS \times CPS$, in our study) and individual terms (i.e., PPS and CPS) as documented by Balli and Sørensen (2013).

Figure 2: Analyzing the association of PPS with Firm performance.



Portrayed by the four panels in the figure above, the analysis on equation 5 (estimates in column 6 of Table 4) shows that the association of PPS to firm performance in the presence of different current year CPS levels (high and low) remains the same when controlling for certain lagged values of PPS and CPS. X-axis represents PPS which is the natural log of pay-performance sensitivity, and Y-axis represents annual stock returns (in %). Calculations are shown in the table below. This table calculates four different stock returns by fixing the lag terms of high and low PPS, CPS at four different scenarios: (1) high lagged PPS and high lagged CPS, (2) high lagged PPS and low lagged CPS, (3) low lagged PPS and high lagged CPS, (4) low lagged PPS and low lagged CPS.

We examine the impacts of PPS on firm performance in the presence of CPS when PPS and CPS are controlled for the previous year. We first confirm that the estimates (in column 6 of Table 4) satisfy the conditions for the interaction effect suggested by Balli and Sørensen (2013). Hence, we conduct the analysis on interaction effects in equation 5 by fixing the lag terms of PPS, CPS at four different situations: (1) high lagged PPS and high lagged CPS, (2) high lagged PPS and low lagged CPS, (3) low lagged PPS and high lagged CPS, (4) low lagged PPS and low lagged CPS. Calculation is shown in Figure 2. High PPS and CPS (both current and lagged) levels are defined as one standard deviation higher than their median terms while low levels mean one standard deviation lower than their median terms. This assessment evaluates if the relationship of PPS to firm performance remains the same in the presence of different current year CPS levels when controlling for the fixed lagged values of PPS and CPS levels. If the impacts of PPS on firm performance is not affected by the different CPS levels, it would indicate that there is no interaction effect because all of lagged values are controlled. The lines all appear to be the same because there is no interaction effects between CPS and PPS in their lag terms.

We continue investigating the impacts of PPS on firm performance in the presence of CEO dominance when we do not control for fixed levels (high or, low) of lagged values of PPS and CPS, but control for the current levels (high or, low) of PPS, CPS. That is, we examine the impacts of PPS on firm performance in the presence of different CPS levels (high and low) when the PPS

and the CPS is high/low/high-low/low/high for two consecutive years. We start by taking high and low levels of PPS and CPS (and their lagged values) that are one standard deviation away from their median terms and plug them into equation 5 along with the mean values of statistically significant control variables to find four different stock returns. Calculation is shown in Figure 3. To check the marginal change, we further increase the boundary of PPS and CPS (and lagged PPS and CPS) levels by taking them two (also, three) standard deviation away from their median terms, and conduct similar analyses.

IV. Results

Table 3 reports parameter estimates of the six OLS models (column 1-6) that comprise the first part of the analyses. Estimates from the first row in column 1-6 show that PPS is significantly positive to firm performance at the 1% level, being consistent with the literature. In addition, we note that there is no significant relationship between Tobin's q and the lagged values of PPS. We also find that CPS in column 2 and 4 is significant, which shows a negative association to firm value, being consistent with the literature. In addition, estimates from column 4 and 5 (significant at 1%) indicate that lagged value of CPS also has a negative relation to firm value. Overall we note that PPS holds a positive relationship with Tobin's q , while CPS has an inverse relationship, showing consistency with the prior literature.

Regarding the interaction effect, Table 3 shows that the product terms are statistically significant at the 1% level in column 3 and 5, and at the 10% level in column 6. However, CPS is statistically insignificant. Hence, we do not find any significant result to support the first hypothesis (*H1a*) at this point.

Estimates from the second part of the analyses are reported in Table 4. Except for CPS in the second column, we find that while PPS is positively related to stock return performance, CPS is negatively related to it in all cases. The findings are consistent with those in the literature that illustrates such stand-alone relations (e.g., Bebchuk et al., 2011; Graefe-Anderson et al., 2018; Pyo & Abedin, 2017).

Estimates from Table 4 also show that the product terms are statistically significant at the 5%, 1%, and 10% levels in columns 3, 5, and 6, respectively. Confirming an indication for the interaction effect, individual components i.e., PPS and CPS also show significant associations (positive and negative respectively) in column 5 and 6. Analysis of column 6 (that satisfies the conditions for the interaction effect) is conducted to investigate the impacts of PPS levels on firm performance in the presence of different current year CPS levels by fixing the lag terms of high and low PPS, CPS at four different scenarios. The analysis shows that the impacts of PPS on firm performance in the presence of CPS levels (high and low) remain the same (positive, in particular), portrayed by the four panels in Figure 2, which is a strong indication and support for the interaction effect.

Further assessment of column 6 reveals significant interaction effects when fixing the lagged values of (high or low) PPS, CPS similar (i.e., uncontrolled) at their current levels (high or low). Left panel of Figure 3 shows how different current year CPS levels affect the impacts of PPS on firm performance, supporting the second part of the first hypothesis (*H1b*). The graph shows that when CPS is 1 standard deviation (0.11) higher than its median term (0.38), annual stock returns increase from -10.70% to -3.60%, indicating a 66.56% increase because of a rise in PPS (log) from 3.73 to 6.95. However, the graph also indicates that when CPS is 1 standard deviation

lower than its median, annual return changes from -6.60% to -3.30%, which is a 50.62% increase for the given change in PPS levels, confirming the impact of CPS levels and supporting *H1b*.

Table 3: Dependent variable: Tobin's q

	Tobin's q					
	(1)	(2)	(3)	(4)	(5)	(6)
PPS	0.1291*** (13.40)	0.1161*** (30.35)	0.1471*** (14.75)	0.13063*** (13.39)	0.1582*** (10.55)	0.1521*** (9.52)
CPS		-0.4149*** (-8.97)	0.0905 (0.58)	-0.3161*** (-5.31)	0.1393 (0.71)	0.0529 (0.25)
PPS X CPS			-0.0879*** (-3.37)		-0.0765*** (-2.42)	-0.0607* (-1.75)
Lag (PPS)	-0.0093 (-1.03)			-0.0117 (-1.27)	-0.0116 (-1.27)	0.0023 (0.15)
Lag (CPS)				-0.2843*** (-4.87)	-0.2754*** (-4.71)	-0.0664 (-0.34)
Lag (PPS) X Lag (CPS)						-0.0373 (-1.12)
MtB	0.1532*** (106.45)	0.1553*** (122.77)	0.1554*** (122.83)	0.1509*** (104.26)	0.1511*** (104.30)	0.1509*** (104.29)
Market Cap	0.3345*** (49.18)	0.3492*** (57.44)	0.3495*** (57.49)	0.3393*** (49.55)	0.3392*** (49.54)	0.3393*** (49.54)
Sales	-0.4047*** (-61.89)	-0.4205*** (-72.14)	-0.4203*** (-72.09)	-0.4017*** (-61.00)	-0.4014*** (-60.96)	-0.4014*** (-60.95)
CEO Age	-0.0058*** (-7.17)	-0.0073*** (-10.31)	-0.0073*** (-10.27)	-0.0061*** (-7.56)	-0.0061*** (-7.55)	-0.0061*** (-7.55)
Leverage	-0.8578*** (-25.40)	-0.8485*** (-27.60)	-0.8484*** (-27.60)	-0.8082*** (-23.63)	-0.8091*** (-23.65)	-0.8092*** (-23.65)
ROA	4.3267*** (66.70)	4.0641*** (70.90)	4.0631*** (70.89)	4.3587*** (66.62)	4.3566*** (66.59)	4.3566*** (66.59)
R&D	5.0349*** (49.62)	4.8328*** (53.02)	4.8371*** (53.07)	4.9915*** (48.20)	4.9943*** (48.23)	4.9948*** (48.24)
Capex	-0.5118*** (-4.38)	-0.3536*** (-3.42)	-0.3548*** (-3.44)	-0.5585*** (-4.71)	-0.5584*** (-4.71)	-0.5592*** (-4.72)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,441	32,042	32,042	23,975	23,975	23,975
R^2	64%	63%	63%	64%	64%	64%

This table provides parameter estimates from regressing Tobin's q on the explanatory variables for the six OLS models. Presented in parentheses are the t -statistics. Intercepts are not reported. PPS is the natural log of pay-performance sensitivity; Market Cap is the natural log of market capitalization; Sales is the natural log of annual sales. Control variables are explained in data section and summary statistics has been provided in Table 1. Number of observations in the regressions varies due to data limitation. For instance, data are missing for the lagged values of the variables for the year 1992 (the beginning year of the sample). ***, **, * indicate 1%, 5%, 10% level of significance respectively.

Table 4: Dependent variable: Annual stock return

	Annual Return					
	(1)	(2)	(3)	(4)	(5)	(6)
PPS	0.3532*** (91.77)	0.0304*** (16.93)	0.0217*** (4.64)	0.3548*** (90.81)	0.3411*** (56.80)	0.3456*** (54.04)
CPS		0.0973*** (4.48)	-0.0437 (-0.59)	-0.0448** (-1.88)	-0.2722*** (-3.45)	-0.2077** (-2.45)
PPS X CPS			0.0245** (2.00)		0.0382*** (3.02)	0.0264* (1.90)
Lag (PPS)	-0.3429*** (-94.76)			-0.3449*** (-93.49)	-0.3449*** (-93.51)	-0.3554*** (-57.08)
Lag (CPS)				-0.0224 (-0.96)	-0.0268 (-1.15)	-0.1828** (-2.33)
Lag (PPS) X Lag (CPS)						0.0277** (2.08)
MtB	0.0120*** (20.92)	0.0152*** (25.63)	0.0152*** (25.60)	0.0119*** (20.52)	0.0118*** (20.43)	0.0119*** (20.44)
Market Cap	0.0535*** (19.69)	0.0759*** (26.58)	0.0758*** (26.56)	0.0532*** (19.39)	0.0532*** (19.41)	0.0532*** (19.40)
Sales	-0.0603*** (-23.08)	-0.0901*** (-32.93)	-0.0902*** (-32.96)	-0.0595*** (-22.55)	-0.0596*** (-22.60)	-0.0596*** (-22.61)
CEO Age	0.0005 (1.49)	-0.0019*** (-5.77)	-0.0019*** (-5.80)	0.0005* (1.66)	0.0005* (1.65)	0.0005* (1.66)
Leverage	-0.0705*** (-5.23)	-0.1344*** (-9.31)	-0.1344*** (-9.31)	-0.0656*** (-4.79)	-0.0652*** (-4.76)	-0.0651*** (-4.75)
ROA	0.2196*** (8.47)	0.3797*** (14.11)	0.3799*** (14.12)	0.2148*** (8.20)	0.2158*** (8.24)	0.2159*** (8.24)
R&D	-0.1329*** (-3.28)	-0.3804*** (-8.89)	-0.3816*** (-8.92)	-0.1279*** (-3.09)	-0.1294** (-3.12)	-0.1297*** (-3.13)
Capex	-0.2780*** (-5.96)	-0.5751*** (-11.86)	-0.5748*** (-11.86)	-0.2793*** (-5.88)	-0.2793*** (-5.88)	-0.2787*** (-5.87)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,441	32,042	32,042	23,975	23,975	23,975
R ²	34%	11%	11%	34%	34%	34%

	Annual Stock Returns (%)							
	1 st		2 nd		3 rd		4 th	
	Low CPS (0.272)	High CPS (0.493)	Low CPS (0.272)	High CPS (0.493)	Low CPS (0.272)	High CPS (0.493)	Low CPS (0.272)	High CPS (0.493)
Low PPS (3.729)	-1.202*	-1.226	-1.204	-1.228	-0.119	-0.143	-0.102	-0.126
High PPS (6.947)	-0.066	-0.072	-0.069	-0.074	1.017	1.011	1.033	1.028*

Bold face numbers are used to draw Figures 2.

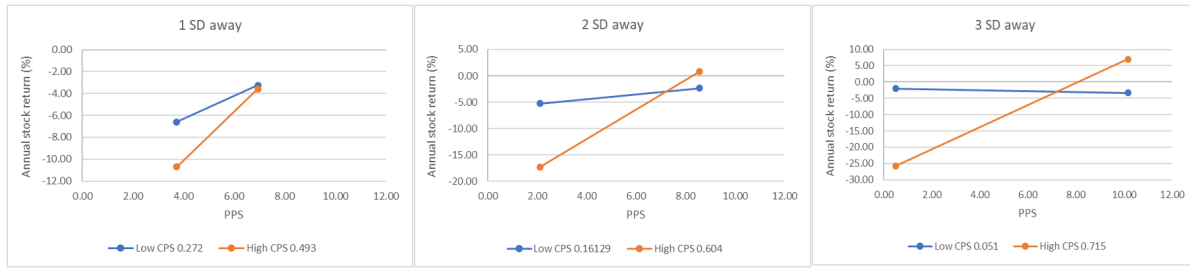
This table reports parameter estimates from regressing annual stock return on the explanatory variables for the six OLS models. Presented in parentheses are the *t*-statistics. Intercepts are not reported. PPS is the natural log of pay-performance sensitivity; Market Cap is the natural log of market capitalization; Sales is the natural log of annual sales. Control variables are explained in data section and summary statistics has been provided in Table 1. Number of observations in the regressions varies due to data limitation. For instance, data is missing for the lagged values of the variables for the year 1992 (the beginning year of the sample). ***, **, * indicate 1%, 5%, 10% level of significance respectively.

We also conduct investigation on column 6 by increasing the ranges of PPS and CPS (and lagged PPS and CPS) levels. That is, taking them two (also, three for extreme cases) standard deviations away from their median levels exposes the interaction effects to be more pronounced. The center panel of Figure 3 portrays that while CPS is fixed at the high level, changing PPS level from low to high increases stock return performance, supporting the second hypothesis (*H2*). On the other hand, CPS is fixed at the low level, the effect of PPS on firm performance diminishes (and opposite in extreme cases). More specifically, for the same increase in PPS (log) from 2.12 to 8.56, we observe two different cases. First, when CPS is two standard deviations higher than its median term (defined as high CPS), stock returns change from -17.3% to 0.80%, showing a 104.45% increase. Second, when CPS is two standard deviations lower than the median (defined as low CPS), stock returns increase from -5.30% to -2.40%, indicating a 54.94% increase. Influenced by CPS levels, the variation in firm performance for the same changes in PPS levels indicates a strong interaction effect. For a more extreme case, when we look into high and low PPS, CPS that are 3 standard deviation away from the medians (right panel of Figure 3), we find that for the same changes in PPS levels, stock returns rather decrease by 65.61% when CPS is low compared to an increase by 127.25% when CPS is high, showing a strong and opposite impact of CPS levels. However, when PPS, CPS are taken 3 standard deviations away from medians to be defined as high (low) PPS, CPS levels, their values stand at 10.16 (0.51) and 0.72 (0.05), respectively, while their maximum (minimum) values are 13.47 (-11.40) and 0.71 (0.08), respectively, in our sample (summary statistics in Table 1). We consider this case to be extreme as the ‘low CPS’ (0.05) is lower than the minimum CPS (0.08) from our sample, and are cautious in suggesting that the extreme CPS levels have opposite effects on the impacts of PPS on firm performance.

In summary, estimates from the stand-alone cases (i.e., without considering the product terms for the interaction effect) from columns 1, 2, 4 in both Table 3 and 4 indicate that PPS shows positive impacts, but CPS shows negative impacts on firm performance, both of which are aligned with the literature. However, considering the potential interaction effects, we need to conduct more analyses as below.

To obtain economic implications from coefficients above, we compute the impacts of incentive compensation in dollar terms on firm performance for two groups: more powerful CEOs and less powerful CEOs. More precisely, an increase of \$966,558 (one-tenth of standard deviation) in PPS for a CEO whose CPS is 0.49 (more powerful CEO) is related to an increase in annual stock returns by 9.50%, whereas an identical increase in incentive amount for a CEO whose CPS is 0.27 (less reflected in 9.50% CEO) is related to an increase in annual stock returns by 6.56%. As the study finds positive impacts of CEO incentive compensation on firm performance, it supports the optimal contracting theory and advocates CEO incentive contracts in maximizing shareholders’ value. However, it illustrates that stand-alone effects of either pay-performance sensitivity or CEO pay slice to firm performance might not be enough in understanding their impacts on firm performance.

Figure 3:



X-axis represents PPS which is the natural log of pay-performance sensitivity, and Y-axis represents annual stock returns (in %). Calculation is shown in the table below. High PPS and CPS (also true for lagged PPS and CPS) levels are defined as one standard deviation higher than their median terms while low levels mean one standard deviation lower than their median terms. To check the marginal effect, we further increase the boundary of PPS and CPS (and lagged PPS and CPS) levels by taking them two (and three) standard deviation away from their median terms. Mean values of other control variables (which are statistically significant) are considered to examine the effect.

Panel B (Figure 3): With current terms and St. Deviations

Current		1 St. Deviation		2 St. Deviation		3 St. Deviation				
		CPS	Low	High	PPS	Low	High	CPS	Low	High
PPS	Low	(3.729)	-6.596	-10.703	(2.120)	-5.265*	-17.265	(0.511)	-2.042	-25.720
	High	(6.947)	-3.257	-3.579	(8.556)	-2.373	0.769	(10.165)	-3.381	7.009

Bold face numbers are used to draw Figures 3.

Putting those values in equation 5 (estimates in column 6 of Table 4), this table calculates stock returns at high and low PPS, CPS levels (which are 2SD away from their median terms). Center panel of Figure 3 portrays that while high level of CPS is present, changing PPS level from low to high improves stock return performance, and at low level of CPS, stock return performance rather starts to decline (declines in the right panel) for the same changes in PPS levels.

V. Robustness

We conduct robustness tests by addressing the potential endogeneity issues in equation 5 that includes the interaction effects. These endogeneity issues could be present due to several factors. First, when we examine firm values affected by changes in CPS, it is important to understand that CPS itself might be affected by components that are also relevant to firm values (Bebchuk et al., 2011). Second, several studies (Gomes & Schmid, 2010; Hu & Gong, 2018) suggest that there a close relation between leverage and stock returns. The stock market also reacts when firms undertake new projects (Bajo et al., 1998; Burton et al., 1999). Jensen and Meckling (1976) exhibit how managers could forego positive NPV projects, provided a limited or no ownership in the firm. Numerous studies (Jensen & Murphy, 1990; Lee et al., 2008; Murphy, 1985) argue that this problem is attenuated when equity-based compensation is granted to these managers. While positive NPV projects increase firm performance represented by positive stock returns, they also increase the leverage of firms (Graefe-Anderson et al., 2018). These issues raise potential concerns on the correlation between leverage, an explanatory variable, and the error term.

Following the suggestion by Wooldridge (2002), we control for the above endogeneity concerns by employing instrumental variables (IV) with a two-stage least square (2SLS) estimation procedure. In the first stage, we introduce IVs which are related to the potential endogenous variables: CPS and leverage, but unrelated to the stock returns, a dependent variable.

Equation 6 and 7 display the first stage of the estimation where CPS and leverage are the dependent variables in two separate OLS models. To account for the endogeneity of CPS, we add industry median CPS (InMedCPS) i.e., median CPS by the four-digit SIC (standard industrial classification) codes as an IV following Bebchuk et al. (2011). To address the endogeneity of leverage, we add Marginal tax rate before interest expense (MTBI) as an IV following Givoly et al. (1992) as employed in Graefe-Anderson et al. (2018). Other control variables follow equation 5.

$$\begin{aligned} \text{CPS}_{i,t} = & \gamma_0 + \gamma_1 \text{PPS}_{i,t} + \gamma_2 (\text{PPS} * \text{CPS})_{i,t} + \gamma_3 \text{PPS}_{i,t-1} + \gamma_4 \text{CPS}_{i,t-1} \\ & + \gamma_5 (\text{PPS} * \text{CPS})_{i,t-1} + \gamma_6 \text{Market to Book}_{i,t} + \gamma_7 \text{Market Cap}_{i,t} \\ & + \gamma_8 \text{Sale}_{i,t} + \gamma_9 \text{CEOAge}_{i,t} + \gamma_{10} \text{ROA}_{i,t} + \gamma_{11} \text{R\&D}_{i,t} \\ & + \gamma_{12} \text{CAPEX}_{i,t} + \gamma_{13} \text{InMedCPS}_t + \gamma_{14} \text{MTBI}_{i,t} + \epsilon_{i,t}, \end{aligned} \quad (6)$$

$$\begin{aligned} \text{Leverage}_{i,t} = & \gamma_0 + \gamma_1 \text{PPS}_{i,t} + \gamma_2 (\text{PPS} * \text{CPS})_{i,t} + \gamma_3 \text{PPS}_{i,t-1} + \gamma_4 \text{CPS}_{i,t-1} \\ & + \gamma_5 (\text{PPS} * \text{CPS})_{i,t-1} + \gamma_6 \text{Market to Book}_{i,t} + \gamma_7 \text{Market Cap}_{i,t} \\ & + \gamma_8 \text{Sale}_{i,t} + \gamma_9 \text{CEOAge}_{i,t} + \gamma_{10} \text{ROA}_{i,t} + \gamma_{11} \text{R\&D}_{i,t} \\ & + \gamma_{12} \text{CAPEX}_{i,t} + \gamma_{13} \text{InMedCPS}_t + \gamma_{14} \text{MTBI}_{i,t} + \epsilon_{i,t}, \end{aligned} \quad (7)$$

where InMedCPS_t is the industry median CPS in the four-digit SIC group in time t ; $\text{MTBI}_{i,t}$ is the marginal tax rate before interest expense of firm i in time t . Other variables have the same definitions as before.

In the second stage, we regress annual stock return on the fitted value of CPS and leverage derived in the first stage. Equation 8 shows the model.

$$\begin{aligned} \text{Stock Return}_{i,t} = & \gamma_0 + \gamma_1 \text{PPS}_{i,t} + \gamma_2 \widehat{\text{CPS}}_{i,t} + \gamma_3 (\text{PPS} * \text{CPS})_{i,t} + \gamma_4 \text{PPS}_{i,t-1} \\ & + \gamma_5 \text{CPS}_{i,t-1} + \gamma_6 (\text{PPS} * \text{CPS})_{i,t-1} + \gamma_7 \text{Market to Book}_{i,t} \\ & + \gamma_8 \text{Market Cap}_{i,t} + \gamma_9 \text{Sale}_{i,t} + \gamma_{10} \text{CEOAge}_{i,t} + \gamma_{11} \widehat{\text{Leverage}}_{i,t} \\ & + \gamma_{12} \text{ROA}_{i,t} + \gamma_{13} \text{R\&D}_{i,t} + \gamma_{14} \text{CAPEX}_{i,t} + \epsilon_{i,t}, \end{aligned} \quad (8)$$

where $\widehat{\text{CPS}}_{i,t}$ is the fitted value of CEO pay slice of the CEO of firm i in time t ; $\widehat{\text{Leverage}}_{i,t}$ is the fitted value of leverage of firm i in year t . Other variables are defined similarly as before.

Table 5 reports parameter estimates from the first stage of the 2SLS estimation of stock return performance. Statistical significance and the signs of the estimates of the IVs confirm that they are indeed strong instruments. For instance, coefficient of InMedCPS is positive and statistically significant at the 1% level in both OLS models. Although MTBI is statistically insignificant when CPS is the dependent variable, it is significantly negative at the 1% level while leverage is the dependent variable. The findings are not unexpected because the purpose of introducing MTBI is to account for leverage, not for CPS.

Estimates from the second stage in Table 6 indicate that prior findings in Table 3 and 4 stay with strong statistical significance. The results show that PPS is positively related to firm performance while the association of CPS is negatively. Both the relations are statistically significant at the 1% level. Most importantly, the product term i.e., the interaction effect, is also significant at the 1% level. Hence, this study suggests that stand-alone relations of either pay-performance sensitivity or CEO power to firm performance is inadequate in understanding the firm value implications. As an additional robustness check, we account for the year-effect and find that these results hold to the same level of significance.

Table 5: Two-stage least square estimation: First stage

	CPS	Leverage
PPS	-0.0550*** (-141.81)	-0.0192*** (-8.15)
PPS X CPS	0.1551*** (453.59)	0.0157*** (7.56)
Lag (PPS)	0.0194*** (36.84)	0.0189*** (5.94)
Lag (CPS)	0.3256*** (50.63)	0.1385*** (3.55)
Lag (PPS) X Lag (CPS)	-0.0550*** (-50.88)	-0.0074 (-1.13)
MtB	-0.0002*** (-3.88)	0.0067*** (21.54)
Market Cap	0.0004* (1.66)	-0.0201*** (-13.04)
Sales	-0.0001 (-0.42)	0.0294*** (19.96)
CEO Age	-0.0001*** (-2.81)	-0.0004** (-2.43)
ROA	0.0091*** (3.55)	-0.0711*** (-4.55)
R&D	-0.0055 (-1.42)	-0.3336*** (-14.29)
Capex	-0.0051 (-1.28)	-0.0412* (-1.69)
<i>InMedCPS</i>	0.0520*** (8.52)	0.4327*** (11.69)
<i>MTBI</i>	-0.0063 (-1.30)	-0.2975*** (-10.09)
Observations	17,901	17,901
R^2	93%	91%

This table reports parameter estimates from the first stage of the two-stage least square estimation of stock return performance. Industry median CPS (*InMedCPS*) i.e., median CPS in the four-digit SIC (standard industrial classification) codes and marginal tax rate before interest deductions (*MTBI*) are used as the instrumental variables (IV) to account for the two potential endogenous variables: CPS and leverage. Presented in parentheses are the t-statistics. Intercepts are not reported. PPS is the natural log of pay-performance sensitivity; Market Cap is the natural log of market capitalization; Sales is the natural log of annual sales. Control variables are explained in data section and summary statistics has been provided in Table 1. ***, **, * indicate 1%, 5%, 10% level of significance respectively.

Table 6: Two-stage least square estimation: Second stage

	Annual Return
PPS	0.4036*** (59.92)
CPS	-5.5913*** (-2.90)
PPS X CPS	0.7362*** (2.85)
Lag (PPS)	-0.5588*** (-10.32)
Lag (CPS)	1.2694** (2.42)
Lag (PPS) X Lag (CPS)	-0.1886*** (-2.48)
MtB	-0.0008 (-0.19)
Market Cap	0.0454*** (4.61)
Sales	-0.0816*** (-11.40)
CEO Age	0.0005 (0.94)
<i>Leverage</i>	1.2751*** (3.47)
ROA	0.2507*** (4.78)
R&D	0.1751** (1.27)
Capex	-0.1599* (-1.90)
Observations	17,901
R^2	26%

This table reports parameter estimates from the second stage of the two-stage least square estimation of stock return performance. CPS and leverage have been instrumented by industry median CPS (InMedCPS) i.e., median CPS in the four-digit SIC (standard industrial classification) codes and marginal tax rate before interest deductions (MTBI). That is, fitted values of CPS and leverage derived in the first stage are plugged into the second stage along with other control variables. Presented in parentheses are the t-statistics. Intercepts are not reported. PPS is the natural log of pay-performance sensitivity; Market Cap is the natural log of market capitalization; Sales is the natural log of annual sales. Control variables are explained in data section and summary statistics has been provided in Table 1. Number of observations in the regression (compared to equation 5 i.e., column 6 of Table 4) varies due to data limitation (missing values of instrumental variables). ***, **, * indicate 1%, 5%, 10% level of significance respectively.

Table 7: Stock Returns Behavior over Potential Interaction Effects in Figure 2 and 3

Annual Stock Returns (%)									
Panel A (Figure 2): With lag terms and 1 standard deviation									
Lag		1 st Interaction		2 nd Interaction		3 rd Interaction		4 th Interaction	
		Low CPS (0.272)	High CPS (0.493)	Low CPS (0.272)	High CPS (0.493)	Low CPS (0.272)	High CPS (0.493)	Low CPS (0.272)	High CPS (0.493)
Low PPS	(3.729)	-1.202*	-1.226	-1.204	-1.228	-0.119	-0.143	-0.102	-0.126
High PPS	(6.947)	-0.066	-0.072	-0.069	-0.074	1.017	1.011	1.033	1.028*
Panel B (Figure 3): With current terms and various standard deviations									
Current		1 St. Deviation		2 St. Deviation			3 St. Deviation		
		CPS (0.272)	Low (0.272)	High (0.493)	PPS (2.120)	Low (0.161)	High (0.604)	CPS (0.511)	Low (0.151)
PPS	Low (3.729)	-6.596	-10.703	(2.120)	-5.265*	-17.265	(0.511)	-2.042	-25.720
	High (6.947)	-3.257	-3.579	(8.556)	-2.373	0.769	(10.165)	-3.381	7.009
Lag terms with corresponding deviations									
Lag		1 St. Deviation		2 St. Deviation			3 St. Deviation		
		LagCPS (0.278)	Low (0.278)	High (0.494)	LagCPS (2.184)	Low (0.170)	High (0.602)	LagCPS (0.599)	Low (0.062)
Lag	Low (3.769)	-0.066	-0.107	(2.184)	-0.053	-0.173	(0.599)	-0.020	-0.257
PPS	High (6.938)	-0.033	-0.036	(8.523)	-0.024	0.008	(10.108)	-0.034	0.070

Bold face numbers are used to draw Figures 2 and 3. Numbers in parentheses and with star (*) are computed as below.

Panel A: Using the summary statistics in Table 1, we compute high and low quantities as below.

1st interaction: Fixing at high lag (log(PPS)) and high lag (CPS): 6.938 and 0.494

2nd interaction: Fixing at high lag (log(PPS)) and low lag (CPS): 6.938 and 0.278

3rd interaction: Fixing at low lag (log(PPS)) and high lag (CPS): 3.769 and 0.494

4th interaction: Fixing at low lag (log(PPS)) and low lag (CPS): 3.769 and 0.278

Current terms: Low log(PPS) = Median log(PPS) – St.Dev(log(PPS)) = 5.3377 – 1.6090 = 3.729

High log(PPS) = Median log(PPS) + St.Dev(log(PPS)) = 5.3377 + 1.6090 = 6.947

Low (CPS) = Median (CPS) – St.Dev(CPS) = 0.3827 – 0.1107 = 0.272

High (CPS) = Median (CPS) + St.Dev(CPS) = 0.3827 + 0.1007 = 0.493

Lag terms: Low lag(log(PPS)) = Median Lag(log(PPS) – St.Dev(lag(log(PPS)))) = 5.3534 – 1.5849 = 3.769

High lag(log(PPS)) = Median Lag(log(PPS) + St.Dev(lag(log(PPS)))) = 5.3534 + 1.5849 = 6.938

Low lag(CPS) = Median Lag(CPS) – St.Dev(lag(CPS)) = 0.3860 – 0.1081 = 0.278

High lag(CPS) = Median Lag(CPS) + St.Dev(lag(CPS)) = 0.3860 + 0.1081 = 0.494

A short form of Eq.(5) is used to illustrate interaction effects

$$\text{Stock Return}_{i,t} = \gamma_1 \text{PPS}_{i,t} + \gamma_2 \text{CPS}_{i,t} + \gamma_3 (\text{PPS} * \text{CPS})_{i,t} + \gamma_4 \text{PPS}_{i,t-1} + \gamma_5 \text{CPS}_{i,t-1} + \gamma_6 (\text{PPS} * \text{CPS})_{i,t-1}$$

Applying coefficients in Column 6, Table 4

$$\text{Stock Return}_{i,t} = 0.3456 \text{PPS}_{i,t} - 0.2077 \text{CPS}_{i,t} + 0.0264 (\text{PPS} * \text{CPS})_{i,t} - 0.3554 \text{PPS}_{i,t-1} - 0.1828 \text{CPS}_{i,t-1} + 0.0278 (\text{PPS} * \text{CPS})_{i,t-1}$$

We compute the stock return for low log(PPS) and low CPS on the 1st, fixing at high lag (log(PPS)) and high lag (CPS): 6.938 and 0.494. The first cell at the 1st interaction: 0.3456 × 3.729 – 0.2077 × 0.272 +

$$0.0264(3.729 \times 0.272) - 0.3554 \times 6.938 - 0.1828 \times 0.494 + 0.0278(6.938 \times 0.494) = -1.202$$

We compute the stock return for high log(PPS) and high CPS on the 4th, fixing at high lag (log(PPS)) and high lag (CPS): 3.769 and 0.278. The last cell at the 4th interaction: 0.3456 × 6.947 – 0.2077 × 0.493 +

$$0.0264(6.947 \times 0.493) - 0.3554 \times 3.769 - 0.1828 \times 0.278 + 0.0278(3.769 \times 0.278) = 1.028$$

Panel B: Using the summary statistics in Table 1, we compute high and low quantities as below.

With 1 Standard Deviation:

Current terms: Low log(PPS) = Median log(PPS) – St.Dev(log(PPS)) = 5.3377 – 1.6090 = 3.729

High log(PPS) = Median log(PPS) + St.Dev(log(PPS)) = 5.3377 + 1.6090 = 6.947

Low (CPS) = Median (CPS) – St.Dev(CPS) = 0.3827 – 0.1107 = 0.272

High (CPS) = Median (CPS) + St.Dev(CPS) = 0.3827 + 0.1007 = 0.493

Lag terms: Low lag(log(PPS)) = Median Lag(log(PPS) – St.Dev(lag(log(PPS)))) = 5.3534 – 1.5849 = 3.769
 High lag(log(PPS)) = Median Lag(log(PPS) + St.Dev(lag(log(PPS)))) = 5.3534 + 1.5849 = 6.938
 Low lag(CPS) = Median Lag(CPS) – St.Dev(lag(CPS)) = 0.3860 – 0.1081 = 0.278
 High lag(CPS) = Median Lag(CPS) + St.Dev(lag(CPS)) = 0.3860 + 0.1081 = 0.494

With 3 Standard Deviation:

Current terms: Low log(PPS) = Median log(PPS) – 3*St.Dev(log(PPS)) = 5.3377 – 3*1.6090 = 0.511
 High log(PPS) = Median log(PPS) + 3*St.Dev(log(PPS)) = 5.3377 + 3*1.6090 = 10.165
 Low (CPS) = Median (CPS) – 3*St.Dev(CPS) = 0.3827 – 3*0.1107 = 0.051
 High (CPS) = Median (CPS) + 3*St.Dev(CPS) = 0.3827 + 3*0.1107 = 0.715
 Lag terms: Low lag(log(PPS)) = Median Lag(log(PPS) – 3*St.Dev(lag(log(PPS)))) = 5.3534 – 3*1.5849 = 0.599
 High lag(log(PPS)) = Median Lag(log(PPS) + 3*St.Dev(lag(log(PPS)))) = 5.3534 + 3*1.5849 = 10.108
 Low lag(CPS) = Median Lag(CPS) – 3*St.Dev(lag(CPS)) = 0.3860 – 3*0.1081 = 0.062
 High lag(CPS) = Median Lag(CPS) + 3*St.Dev(lag(CPS)) = 0.3860 + 3*0.1081 = 0.710

With 2 Standard Deviation:

Current terms: Low log(PPS) = Median log(PPS) – 2*St.Dev(log(PPS)) = 5.3377 – 2*1.6090 = 2.120
 High log(PPS) = Median log(PPS) + 2*St.Dev(log(PPS)) = 5.3377 + 2*1.6090 = 8.556
 Low (CPS) = Median (CPS) – 2*St.Dev(CPS) = 0.3827 – 2*0.1107 = 0.161
 High (CPS) = Median (CPS) + 2*St.Dev(CPS) = 0.3827 + 2*0.1107 = 0.604
 Lag terms: Low lag(log(PPS)) = Median Lag(log(PPS) – 2*St.Dev(lag(log(PPS)))) = 5.3534 – 2*1.5849 = 2.184
 High lag(log(PPS)) = Median Lag(log(PPS) + 2*St.Dev(lag(log(PPS)))) = 5.3534 + 2*1.5849 = 8.523
 Low lag(CPS) = Median Lag(CPS) – 2*St.Dev(lag(CPS)) = 0.3860 – 2*0.1081 = 0.170
 High lag(CPS) = Median Lag(CPS) + 2*St.Dev(lag(CPS)) = 0.3860 + 2*0.1081 = 0.602

Omitting the intercept and error term in Eq.(5), we estimate -5.265%* in Panel B fixing low CPS and low PPS as below.

$$\begin{aligned} \text{Stock Return}_{i,t} &= \gamma_1 \text{PPS}_{i,t} + \gamma_2 \text{CPS}_{i,t} + \gamma_3 (\text{PPS} * \text{CPS})_{i,t} + \gamma_4 \text{PPS}_{i,t-1} + \gamma_5 \text{CPS}_{i,t-1} \\ &\quad + \gamma_6 (\text{PPS} * \text{CPS})_{i,t-1} + \gamma_7 \text{Market to Book}_{i,t} + \gamma_8 \text{Market Cap}_{i,t} + \gamma_9 \text{Sale}_{i,t} \\ &\quad + \gamma_{10} \text{CEOAge}_{i,t} + \gamma_{11} \text{Leverage}_{i,t} + \gamma_{12} \text{ROA}_{i,t} + \gamma_{13} \text{R\&D}_{i,t} + \gamma_{14} \text{CAPEX}_{i,t} \\ \text{Stock Return} &= \gamma_1 \times 2.11961 + \gamma_2 \times 0.16129 + \gamma_3 \times (2.11961 \times 0.16129) + \gamma_4 \times 2.18367 \\ &\quad + \gamma_5 \times 0.16977 + \gamma_6 \times (2.18367 \times 0.16977) + \gamma_7 \times 3.27154 + \gamma_8 \times 7.63634 \\ &\quad + \gamma_9 \times 7.36355 + \gamma_{10} \times 56.12324 + \gamma_{11} \times 0.13166 + \gamma_{12} \times 0.11446 \\ &\quad + \gamma_{13} \times 0.02644 + \gamma_{14} \times 0.04572 \\ -0.05265 &= 0.34564 \times 2.11961 - 0.20773 \times 0.16129 + 0.0264 \times (2.11961 \times 0.16129) \\ &\quad - 0.35539 \times 2.18367 - 0.18278 \times 0.16977 + 0.02779 \times (2.18367 \times 0.16977) \\ &\quad + 0.01185 \times 3.27154 + 0.0532 \times 7.63634 - 0.05964 \times 7.36355 + 0.000537 \times 56.12324 \\ &\quad - 0.06508 \times 0.13166 + 0.21585 \times 0.11446 - 0.12969 \times 0.02644 - 0.27874 \times 0.04572 \end{aligned}$$

VI. Conclusion

Prior literature suggests that pay-performance sensitivity (PPS) as a measure of CEO incentive compensation is positively related to firm performance, while CEO pay slice (CPS) as a measure of CEO power is negatively related to firm value. This study conducts an empirical investigation on CEO pay-for-performance in the presence of CEO power and shows that determining such stand-alone implications might be insufficient in maximizing firm values because of an unexplored interaction effect between CEO pay and CEO power.

This study considers multiple factors from a different perspective compared to prior studies. First, to capture the compensation component it simultaneously considers CEO incentive compensation measured by PPS and CEO power measured by CPS instead of focusing only on incentives or cash compensation. Second, the timeline 1992-2019 is selected for this study to

include the accelerated CEO incentive pay in 1990s and to assess firm performance in terms of stock returns during the 2008 financial crisis. Third, this study analyzes the product term of PPS and CPS to investigate the interaction effects, which have not been considered in prior studies.

Collecting compensation and firm related data from Execucomp and Compustat, respectively, and stock price information from CRSP, this study conducts the analysis in two parts. First, Tobin's q as a proxy of firm performance is regressed on PPS and CPS along with other standard control variables. Second, stock return as a measure of firm performance is considered and similar analyses are performed. Analysis from multiple OLS models suggests that while the high level of CPS is present, changing the PPS level from low to high increases firm value. However, the impact of PPS declines at the low level of CPS. To address the potential endogeneity issues, we conduct robustness tests by employing instrumental variables (IV) with a two-stage least square (2SLS) estimation procedure. Estimates indicate that original findings stay with strong statistical significance. As an additional robustness check, we account for the year-effect and find that the results still stand at the same level of significance. Consistent with the optimal contracting theory, these results contribute to the literature with the interaction effects between CEO incentive pay measured by pay-performance sensitivity and CEO power measured by CEO pay slice, and opens opportunity for further investigations on the characteristics on CEO pay.

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