The Boundary Conditions of Optimal Contracting and Managerial Entrenchment: A Simultaneous Two-Equation Vector Autoregression with Exogenous Variables Approach for Chief Executive Officer Compensation and Firm Performance

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ABSTRACT

We apply the vector autoregression with exogenous variables (VARX) approach to integrate the optimal contracting theory, the managerial entrenchment theory, the principal-agent theory, the contextual criteria theory, and the upper echelon theory. Based on this new approach, we discover two middle ground conditions between the boundary of managerial entrenchment and optimal contracting, where CEO non-entrenchment or entrenchment cannot be explained by the managerial entrenchment theory or optimal contracting theory alone. For example, some CEOs are not entrenched when the agency problem is not mitigated, while others are entrenched when the agency problem is mitigated. The results imply that merely mitigating the agency problem cannot prevent managerial entrenchment. However, not mitigating the agency problem at all leads to managerial entrenchment. We recommend the boards look at other non-financial means and social approaches (e.g., value- and culture-based trainings, performance recognition, goodwill and friendship building events, pay transparency increase, smooth flow of information among stakeholders, value-adding managerial investments, oversight committee) to minimize the impact of managerial entrenchment on both firm performance and CEO compensation. In addition, we recommend the boards take on the approaches unique to their own firms and their CEOs to address managerial entrenchment.

KEYWORDS

Firm Market Value, CEO Pay, Simultaneous Two-Equation Time Series Matrix System, Full Information Maximum Likelihood Estimation, VARX Methodology

INTRODUCTION

For many decades, researchers have debated on the relationship between firm performance and CEO compensation. Theories are developed and empirical studies are conducted, however the results are still inconsistent (Frydman & Jenter, 2010). There is a constant contention on whether high performance actually leads to high CEO compensation and whether this set of relationship is strong enough, in other words, in fact exists in the real world situation. On one hand, market-based optimal contracting scholars (Kaplan, 2008) argued that CEO pay is determined by the market factors and CEO is indeed paid for performance though not efficiently. On the other hand, managerial entrenchment scholars (Jensen & Meckling, 1976; Shleifer & Vishny, 1989; Tosi, et al., 2000) contended that CEOs

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overpower the boards of directors and manipulate compensations to their own benefit, and that managerial power outweighs the effect of firm performance on CEO pay.

To shed new lights on the contention between managerial entrenchment and optimal contracting, this study incorporates the optimal contracting theory (Tosi & Gomez-Mejia, 1989; Kaplan, 2008), the managerial entrenchment theory (Jensen & Meckling, 1976; Shleifer & Vishny, 1989; Miller, et al., 2002), the principal-agent theory (Tosi & Gomez-Mejia, 1994), the contextual criteria theory (Gomez-Mejia & Wiseman, 1997), and the upper echelon theory (Hambrick & Mason, 1984) in a two-equation vector autoregression system with exogenous variables (VARX) (Zellner & Palm, 1974; Tiao & Box, 1981; Shi, 2014, pp.36–51). Utilizing this novel VARX model for CEO compensation and firm performance (Figure 1), we study and answer the following two research questions (RQs).

RQ1: Under the contingencies of contextual criteria and upper echelon, what happens to the relationship between firm performance and CEO compensation when the agency problem is mitigated (i.e., CEO ownership is positively and significantly tied to firm performance)?
RQ2: Under the contingencies of contextual criteria and upper echelon, what happens to the relationship between firm performance and CEO compensation when the agency problem is not mitigated (i.e., CEO ownership is not positively and significantly tied to firm performance)?

The remainder of this study is structured as follows. In Section 2, we review the relevant CEO compensation and CEO studies. In Section 3, we describe the research gaps and how this study contributes to the extant literature. Section 4 depicts the theoretical framework followed by hypotheses development. Section 5 is devoted to the VARX methodology, research model and estimation method and Section 6 to data and variables. We analyze the empirical results in Section 7. We discuss the theoretical implications in Section 8 and the managerial implications in Section 9. Lastly, we conclude this study in Section 10.

THEORETICAL BACKGROUND

In the past few decades, a number of studies have been conducted on CEOs (i.e., CEO effects) and their remuneration. CEO compensation continues to be a heated topic (Frydman & Jenter, 2010). Although close, researchers are still trying to piece together the puzzle of why CEO pay is high, what drive up CEO pay, the seemingly simple yet controversial relationship between firm performance and CEO pay, and the context determining firm performance, CEO strategic decisions and CEO pay. So far, attentions have been concentrated on the relationship among firm performance, CEO discretionary decisions and CEO pay, on the causality of firm performance and CEO pay (i.e., which one is the precedent), on the determinants of CEO pay, on the contingent factors (or contextual criteria) affecting firm performance, managerial discretions and CEO pay, and on the endogeneity and modeling issue of firm performance, managerial discretions, and CEO pay.

THE CAUSE-AND-EFFECT RELATIONSHIP BETWEEN FIRM PERFORMANCE AND CEO COMPENSATION

Kaplan (2008) argued that positive firm performance leads to higher CEO pay, however CEOs are not getting paid optimally due to market inefficiency. Lin and Shi (2020) found that the positive relationship between firm performance and CEO pay is dependent on the appropriate strategic choices that CEOs make. On the contrary, Hogan and McPheters (1980) and Finkelstein and Boyd (1998) found insignificant and negative relationship between firm performance and CEO pay. Tosi, et al. (2000) showed a weak relationship between firm performance and CEO pay based on a meta-analysis.

Based on the OLS estimation of a fixed-effect panel model, Zoghlami (2021) discovered that higher CEO compensation significantly leads to higher performance (proxy ROA and ROE) in listed French firms. Zoghlami (2021) examined the effect of CEO pay on firm performance, but overlooked the simultaneity existing between firm performance and CEO pay. The panel dataset was estimated using fixed effect ordinary least squares (OLS) (p.150), which could lead to misleading interpretations without comparing with two-stage least squares (2SLS) and three-stage least squares (3SLS) estimation results (Shi, et al., 2021). In addition, Zoghlami (2021) ran the estimation for the aggregated firm-year sample (155 French Eurolist A companies from 2009 to 2018, p.146). This one size fits all treatment for the panel data (i.e., one model for all the firms across the years) overlooked the contemporaneous correlations between the error terms in the equation system (i.e., seemingly unrelated regressions), autocorrelation within the time series, and distinctiveness or similarity between the companies.

According to the 2SLS estimation of a simultaneous equations model, Smirnova and Zavertiaeva (2017) found that higher total CEO pay results in higher firm performance (proxy ROA) and higher firm performance leads to higher total CEO pay in European companies. However, Smirnova and Zavertiaeva (2017) only reported two-stage least squares estimation (pp.669–670) that has a serious drawback leading to biased inconsistent coefficient estimates as pointed out by Shi, et al. (2021). Shi and de Jong (2020) showed via the instrumented probit model that the firm performance is a strong endogenous variable. We find that many CEO compensation studies overlooked the endogenous nature of both firm performance and CEO pay as well as the uniqueness of CEO pay practices at the firm level. In these studies, the simple treatment of panel dataset (i.e., estimation using aggregated firm-year sample), estimation without using 2SLS and 3SLS, and ignoring of simultaneity are problematic. We believe that these are the main causes for inconsistent and insignificant results regarding the relationship between firm performance and CEO pay, which lead to the continuing contentious debate between the school of optimal contracting and the school of managerial entrenchment. Without a detailed comparative analysis of CEO pay and firm performance at the firm level (i.e., analyzing firms and corresponding CEO compensations one by one over the years), it is difficult to understand how CEOs are motivated by pay differently or similarly between the firms.

Integrating the optimal contracting theory, the managerial entrenchment theory, and the upper echelon theory via a simultaneous equations system estimated by 3SLS, Shi, et al. (2021) uncovered the positive feedback loops between firm performance and advertising intensity and between firm performance and CEO pay under the contingencies of CEO's tenure, ownership, age, firm size, risk, and industry. Although Shi, et al. (2021) implemented a simultaneous equations model for the cause-and-effect simultaneity between firm performance and CEO compensation, the simultaneous temporal effects of firm performance on CEO pay and of CEO pay on firm performance were not addressed under the contingencies of both contextual criteria (Gomez-Mejia & Wiseman, 1997) and upper echelon (Hambrick & Mason, 1984). Shi, et al. (2021) used a cross-sectional dataset (p.127).

FACTORS THAT AFFECT FIRM PERFORMANCE AND CEO COMPENSATION

Hambrick and Mason's (1984) upper echelon theory posited that younger managers tend to generate more profits compared to their older counterparts, and that longer-tenured managers are less likely to embrace changes and innovation needed to increase performance. The theory argued that manager's characteristics affect strategic choices and firm performance levels (Hambrick & Mason, 1984). Miller (1991) and Barker and Mueller (2002) showed that longer tenure prevents CEOs from making risky decisions necessary to grow the organization. Quigley and Hambrick (2015) found that firm outcomes have been significantly influenced by CEOs over the last 60 years. Kim and Lu (2011) discovered that high CEO ownership leads to low firm value. Jensen and Meckling (1976) and Shleifer and Vishny (1989) argued that high ownership reduces firm value because it is used to entrench CEOs themselves and exert power over the board. On the contrary, Lilienfeld-Toal and Ruenzi (2014) found that owning more than 10% of outstanding shares results in high firm value. Based on the estimation of a fixed-effect OLS model (p.196), Lee (2009) argued that large firm size leads to high firm performance and that high beta risk results in low firm performance. Zoghlami (2021) found that smaller firm size and greater CEO's age lead to higher performance (proxy ROA, ROE, and Tobin's q) in listed French firms. Based on a simultaneous equations model, Smirnova and Zavertiaeva (2017) showed that substantial sales growth, less CEO leverage (proxy a ratio of total debts to shareholder's funds), and smaller firm size result in higher ROA in European firms.

Gomez-Mejia and Wiseman (1997) contended that contextual criteria such as CEO's characteristics (e.g., age, tenure), managerial behavior (e.g., ownership), firm size, and market condition (e.g., volatility) affect CEO pay. Shi, et al. (2021) found these contextual criteria to be influential in determining the simultaneous relationships among R&D intensity, advertising intensity, firm performance and CEO compensation. Hogan and McPheters (1980) showed that greater CEO's age, longer CEO tenure (i.e., years as chief executive officer), and higher firm sales (i.e., a proxy for firm size) attributed to high CEO pay. Finkelstein and Boyd (1998) found that larger firm size significantly leads to higher CEO compensation. Lin and Shi (2020) theorized that CEO pay is fundamentally driven by the high intensity of firm coopetition (i.e., simultaneous competition and collaboration). In a simultaneous equations model, Smirnova and Zavertiaeva (2017) showed that shorter CEO's tenure (i.e., years as CEO), shorter firm age (i.e., years in the firm), and larger firm size attribute to higher total CEO pay.

RESEARCH GAPS AND CONTRIBUTIONS

From the literature review, there are five prominent CEO compensation and CEO theories standing out, namely the optimal contracting theory (Tosi & Gomez-Mejia, 1989; Kaplan, 2008), the managerial entrenchment theory (Jensen & Meckling, 1976; Shleifer & Vishny, 1989; Miller, et al., 2002), the principal-agent theory (Tosi & Gomez-Mejia, 1994), the contextual criteria theory (Gomez-Mejia & Wiseman, 1997), and the upper echelon theory (Hambrick & Mason, 1984).

Both the optimal contracting and the managerial entrenchment theories explain the effect of firm performance on CEO compensation. However, models built upon these two theories have not considered the temporal effect of CEO compensation on firm performance (i.e., the impact of prior CEO pay on current firm performance), simultaneously along with the temporal effect of firm performance on CEO compensation (i.e., the impact of prior firm performance on current CEO pay). At the same time, these models are static rather than dynamic. The autocorrelation in the time series of CEO compensation and firm performance have not been considered (i.e., the effect of prior CEO pay on current CEO pay, the effect of prior firm performance on current firm performance). Lacking considerations of autocorrelation and the simultaneous temporal effects of firm performance on CEO compensation and of CEO compensation on firm performance are the first research gap we find.

Although the agency problem is considered in CEO compensation studies, it has not been considered simultaneously with the issue of managerial entrenchment in the same model. For example, the relationship between CEO ownership and firm performance is modeled separately from the relationship between CEO ownership and CEO compensation and the relationship between firm performance and CEO compensation. Lacking consideration of the simultaneity among CEO ownership, firm performance, and CEO compensation is the second research gap we find.

The contextual criteria theory explains the effects of CEO and firm characteristics on CEO compensation, while the upper echelon theory explains the influence of CEO characteristics on firm performance. However, these two theories are rarely considered in the same model for the joint effects of CEO and firm characteristics on both CEO compensation and firm performance, simultaneously along with the cause-and-effect simultaneity between firm performance and CEO compensation. Lacking consideration of the simultaneity between firm performance and CEO compensation under the contingencies of contextual criteria and upper echelon is the third research gap we find.

To bridge the above research gaps, we apply a two-equation vector autoregression with exogenous variables (VARX) model (Figure 1). This VARX model considers the dynamic temporal effects of prior CEO pay and prior firm performance on both current CEO pay and current firm performance, the impact of CEO ownership on both CEO pay and firm performance, the joint effects of CEO and firm characteristics on both CEO pay and firm performance, and the contemporaneous correlation between the error terms of the CEO pay equation and the firm performance equation (Eqs. 1 to 4). We make contributions to the extant literature by: (1) integrating five prominent CEO compensation and CEO theories in a novel VARX model; (2) addressing previous modeling issues together in a coherent equations system: the simultaneity and endogeneity of firm performance and CEO compensation, the autocorrelation in the time series of firm performance and CEO compensation, and the contemporaneous correlations of the error terms in a simultaneous equations system; (3) making discoveries of two middle ground conditions between the boundary of managerial entrenchment and optimal contracting (Table 5).

HYPOTHESES DEVELOPMENT

THEORETICAL FRAMEWORK AND SUMMARY OF HYPOTHESES

Figure 1 and Table 1 summarize the relationships among CEO pay, firm performance, CEO's characteristics (e.g., tenure, age, ownership), and firm characteristics (e.g., size, risk). The hypotheses are developed in the following sections.

THE EFFECT OF FIRM PERFORMANCE ON CEO PAY

Kaplan (2008) showed strong evidence that CEOs are indeed paid for performance, but not efficiently due to market inefficiency. Lin and Shi's (2020) seemingly unrelated regression model indicated that the peer-pay bias is one of the reasons, which causes pay inefficiency. The positive relationship between firm performance and CEO pay is supported by the agency theory that ties firm performance closely with CEO pay. The theory suggests that CEO is paid to reflect the best interests of shareholders and stakeholders (Tosi & Gomez-Mejia, 1989). This implies that higher performance leads to high pay. Therefore, Hypothesis 1A is constructed as follows:

Hypothesis 1A (H1A): High prior firm performance leads to high current CEO pay.

On the contrary, Jensen and Meckling (1976) and Shleifer and Vishny (1989) argued that CEO entrenches oneself by utilizing manager-specific investments that make the CEO costly to be replaced but not necessarily value-maximizing in order to get high pay. In a meta-analysis, Tosi, et al. (2000) found that firm performance is very weakly linked to CEO pay. Hence, Hypothesis 1B is given by:

Hypothesis 1B (H1B): The relationship between prior firm performance and current CEO pay is not strong.

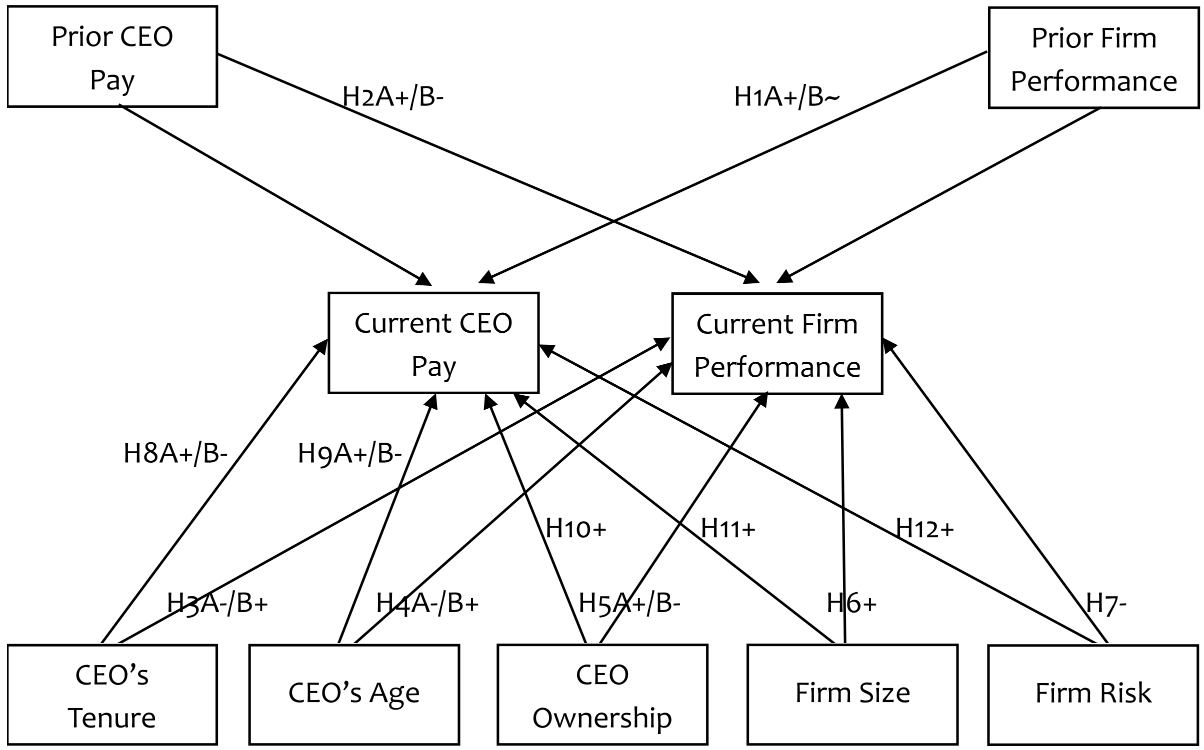

Figure 1. Theoretical Framework for a Two-Equation System of the Temporal CEO Pay-Firm Performance Vector Autoregression Model with Exogenous Variables
Notes: "+" denotes positive relationship; "-" denotes negative relationship; "~" denotes insignificant relationship

Table 1. Summary of Hypotheses

Endogenous	Predetermined and Exogenous						
Current CEO Pay	**Prior Firm Performance**	**Prior CEO Pay**	**CEO's Tenure**	**CEO's Age**	**CEO Ownership**	**Firm Size**	**Firm Risk**
Increase	*Increase H1A*		*Increase H8A; Decrease H8B*	*Increase H9A; Decrease H9B*	*Increase H10*	*Increase H11*	*Increase H12*
Not Significant	*Not significant H1B*						
Current Firm Performance							
Increase		*Increase H2A; Decrease H2B*	*Decrease H3A; Increase H3B*	*Decrease H4A; Increase H4B*	*Increase H5A; Decrease H5B*	*Increase H6*	*Decrease H7*

THE IMPACT OF CEO PAY ON FIRM PERFORMANCE

Herzberg, et al. (1959) motivation-hygiene theory posited that low pay causes dissatisfaction with the job, consequently leading to poor performance. Maslow (1943, 1954) contended that individuals are motivated by both basic physiological (e.g., shelter, food, safety) and more advanced psychological and economic needs (e.g., esteem, love, career advancement, self-actualization). If not paid adequately or at least on par with the norm, CEO will feel less respected by the peers, be less confident about the performance, become pessimistic about future career prospects, and thus will perform poorly on the job. Moreover, in a managerial setting, the Hawthorne effect (Roethlisberger & Dickson, 1939; Mayo, 1946, 1975; Gillespie, 1991) suggests that CEO will work much harder if one feels being paid more attention by the upper management. The expectancy theory (Vroom, 1964; Oliver, 1974) implies that persons behave accordingly to what they are expecting. Combining both the Hawthorne effect and the expectancy theory together, we argue that CEO's performance will be low if the CEO is not expecting a pay raise or even expecting a pay cut, based on past pay records. On the contrary, CEO will perform well if the CEO is expecting a pay raise. The above analysis suggests to test the following Hypothesis 2A:

Hypothesis 2A (H2A): High prior CEO pay results in high current firm performance.

Conversely, a counter argument can be made that a CEO will work much harder and perform better in hope to raise one's compensation in the future if CEO's pay is penalized for prior poor performance. This calls for the test of Hypothesis 2B:

Hypothesis 2B (H2B): Low prior CEO pay leads to high current firm performance.

THE INFLUENCE OF CEO'S CHARACTERISTICS ON FIRM PERFORMANCE

Hambrick and Mason (1984) asserted that a longer-tenured manager is unlikely to welcome innovation and changes, because one is afraid that one's status quo and stability would be violated, in other words, one's authority and power would be threatened by new things. Shleifer and Vishny (1989) contended that a longer tenured CEO invests in manager-specific projects to make oneself much costlier to get replaced rather than to maximize firm's value. In addition, Miller (1991) and Barker and Mueller (2002) stated that the growth of the company is hindered by the risk-averse longer-tenured CEO. Thus, we build the Hypothesis 3A as follows:

Hypothesis 3A (H3A): Current firm performance increases as CEO's tenure decreases.

On the contrary, Miller, et al. (1982) claimed that longer tenure gives a CEO sufficient time to influence the organizational structure and environment. We further argue that longer tenure gives a CEO enough experience, personal network, and connection to operate the organization more efficiently and effectively. Garcia-Blandon, et al. (2019) found that a longer-tenured CEO has stronger financial performance. Hence, we test Hypothesis 3B below:

Hypothesis 3B (H3B): Current firm performance increases as CEO's tenure increases.

Hart and Mellons (1970), Child (1974), and Hambrick and Mason (1984) suggested that a younger manager is likely to generate greater firm growth and more firm profit compared to their elder counterparts. Bertrand and Mullainathan (2003) observed a negative relationship between manager's age and firm performance. Therefore, Hypothesis 4A is summarized by:

Hypothesis 4A (H4A): Current firm performance increases as CEO's age decreases.

But Zoghlami (2021) showed that elder CEO's age helps to boost firm performance in listed French firms. Accordingly, this calls for the test of Hypothesis 4B:

Hypothesis 4B (H4B): Current firm performance increases as CEO's age increases.

Tosi and Gomez-Mejia (1994) asserted that CEO ownership is a mechanism that ties CEO's (agent's) financial interest directly to firm's (principle's) interest, that is, performance on the market. Based on the principal-agent theory, a CEO will likely to make rational business decisions and unlikely to take risky actions, if the CEO owns substantial part of the company. The agency theory is supported by Lilienfeld-Toal and Ruenzi's (2014) finding that CEO's owning more than 10% of outstanding shares leads to higher firm value. Consequently, we test Hypothesis 5A:

Hypothesis 5A (H5A): Current firm performance increases as CEO ownership increases.

Conversely, managerial entrenchment scholars (Jensen & Meckling, 1976; Shleifer & Vishny, 1989) argued that CEO ownership is used to power the CEO and legitimize the reason for higher pay even if firm performance is low. Welbourne and Cyr (1996) showed that high CEO ownership negatively affects firm performance at all levels of risk. Consequently, it calls for testing the Hypothesis 5B as follows:

Hypothesis 5B (H5B): Current firm performance increases as CEO ownership decreases.

THE EFFECT OF FIRM'S CHARACTERISTICS ON FIRM PERFORMANCE

Both firm size and risk affect firm performance. Utilizing fixed effects models to estimate a panel dataset of 7158 public firms in the U.S. from 1987 to 2006, Lee (2009) found that larger firm size positively and significantly leads to higher firm performance. Although statistically insignificant, higher beta risk may result in lower firm performance. According to the resource-based view (RBV) (Barney, 1991), larger firms have more abundant financial, informational, relational, organizational, legal, and human resources, and thus are more capable of creating and sustaining rare, valuable, and hard-to-imitate competitive advantage. Arrow (1962) stated that smaller firms are less likely to embrace innovation due to the lack of financial resources, inability to protect the property rights, and high risk of failure. By comparison, Galbraith (1952) argued that larger firms are better at absorbing the risk associated with large projects. Schumpeter (1942) asserted that larger firms are more motivated to innovate because they can effectively protect their investments from immediate imitation. Based on the analysis, Hypotheses 6 and 7 can be established:

Hypothesis 6 (H6): Current firm performance increases as firm size increases.
Hypothesis 7 (H7): Current firm performance increases as firm risk decreases.

THE INFLUENCE OF CEO'S CHARACTERISTICS ON CEO PAY

Managerial entrenchment scholars (Jensen & Meckling, 1976; Shleifer & Vishny, 1989; Miller, et al., 2002) argued that tenure, age, and ownership help a CEO to exert power over the board of director. In particular, CEO's tenure and age are associated with experience, network, connection, and social status which are used to legitimize the reasons for higher pay. High CEO ownership also positively influences board's decision on pay. Hogan and McPheters (1980) discovered that elder and longer-tenured CEOs are paid significantly more than their younger and shorter-tenured counterparts. Therefore, we test the hypotheses below:

Hypothesis 8A (H8A): Current CEO pay increases as CEO's tenure increases.

Hypothesis 9A (H9A): Current CEO pay increases as CEO's age increases.
Hypothesis 10 (H10): Current CEO pay increases as CEO ownership increases.

Conversely, the upper echelon theory (Hambrick & Mason, 1984) suggested that younger CEOs are more likely to generate higher profit and greater firm growth and longer-tenured CEOs are reluctant to bring about innovation and changes to evolve the organization because they are afraid of their status quo would otherwise be violated (Miller, 1991; Barker & Mueller, 2002). In other words, younger and shorter-tenured CEOs perform better, and consequently get higher pay. Smirnova and Zavertiaeva (2017) found that CEOs are paid more if they stay shorter in the executive position. Thus, we test the following hypotheses:

Hypothesis 8B (H8B): Current CEO pay increases as CEO's tenure decreases.
Hypothesis 9B (H9B): Current CEO pay increases as CEO's age decreases.

THE EFFECT OF FIRM'S CHARACTERISTICS ON CEO PAY

As noted in Ungson and Steers (1984) and Lin and Shi (2020), CEOs in larger firms are more likely to lose the job due to complexity of the organization and associated high risk, therefore they ask for higher pay to compensate such risk. Hill and Phan (1991) further asserted that it becomes harder for CEOs to find another better paying or equally paying executive job if they lose the current job. In essence, demanding higher pay is CEO's way of hedging against potential pay decrease or pay loss in an unpredictable and inefficient market. Moreover, the managerial entrenchment theory implies that CEOs use high risk to legitimize the reason for higher pay (Jensen & Meckling, 1976; Shleifer & Vishny, 1989; Miller, et al., 2002). In three related empirical studies, Hogan and McPheters (1980), Finkelstein and Boyd (1998), and Smirnova and Zavertiaeva (2017) discovered that larger firm size significantly attributes to higher CEO pay. Consequently, Hypotheses 11 and 12 can be summarized as follows:

Hypothesis 11 (H11): Current CEO pay increases as firm size increases.
Hypothesis 12 (H12): Current CEO pay increases as firm risk increases.

THE VARX APPROACH, RESEARCH MODEL, AND ESTIMATION METHOD

We employ a simultaneous two-equation VARX (1) model with exogenous variables to examine the temporal causality loops between firm performance and CEO compensation and between CEO compensation and firm performance, both of which are affected by CEO's characteristics (e.g., tenure, age, ownership) and firm characteristics (e.g., size, risk) as hypothesized in Section 4. In particular, we are interested in how CEO pay responds to a shock in firm performance, at the same time, how firm performance reacts to the change in CEO pay in the short-run and the long-run. The simultaneous two-equation VARX (1) model in matrix form is described below:

$$\begin{bmatrix} y_{1,t} \\ y_{2,t} \end{bmatrix} = \begin{bmatrix} \beta_{1,0} \\ \beta_{2,0} \end{bmatrix} + \begin{bmatrix} \beta_{1,1} & \beta_{1,2} \\ \beta_{2,1} & \beta_{2,2} \end{bmatrix} \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \end{bmatrix} +$$
$$\begin{bmatrix} \beta_{1,3} & \beta_{1,4} & \beta_{1,5} & \beta_{1,6} & \beta_{1,7} \\ \beta_{2,3} & \beta_{2,4} & \beta_{2,5} & \beta_{2,6} & \beta_{2,7} \end{bmatrix} \begin{bmatrix} X_{1,t} & X_{2,t} & X_{3,t} & X_{4,t} & X_{5,t} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{bmatrix} \quad (1)$$

Equation (1) can be transformed into Equation (2) in structural form:

$$y_{1,t} = \beta_{1,0} + \beta_{1,1}y_{1,t-1} + \beta_{1,2}y_{2,t-1} + \beta_{1,3}X_{1,t} + \beta_{1,4}X_{2,t} + \beta_{1,5}X_{3,t} + \beta_{1,6}X_{4,t} + \beta_{1,7}X_{5,t} + \varepsilon_{1,t}$$
$$y_{2,t} = \beta_{2,0} + \beta_{2,1}y_{1,t-1} + \beta_{2,2}y_{2,t-1} + \beta_{2,3}X_{1,t} + \beta_{2,4}X_{2,t} + \beta_{2,5}X_{3,t} + \beta_{2,6}X_{4,t} + \beta_{2,7}X_{5,t} + \varepsilon_{2,t} \quad (2)$$

where t = 1 to 22 (from 1992 to 2013), $y_{1,t} = Ln\_TCE_t$ (the natural logarithm of total CEO pay), $y_{2,t} = Ln\_MVA_t$ (the natural logarithm of firm market value), $X_{1,t} = TEN_t$ (CEO's tenure), $X_{2,t} = AGE_t$ (CEO's age), $X_{3,t} = OWN_t$ (value of shares owned by the CEO, excluding stock options), $X_{4,t} = Ln\_SAL_t$ (the natural logarithm of sales), $X_{5,t} = VOL_t$ (volatility or beta risk), and $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$ are the random error for the first and second equations in the simultaneous two-equation VARX (1) system.

In order to keep the observations stationary before estimation, both endogenous variables (e.g., $y_{1,t} = Ln\_TCE_t$ and $y_{2,t} = Ln\_MVA_t$ need to be differenced for once, which are denoted as:

$$d\_Ln\_TCE_t = \Delta^{1d}y_{1,t} = y_{1,t} - y_{1,t-1} = Ln\_TCE_t - Ln\_TCE_{t-1}$$
$$d\_Ln\_MVA_t = \Delta^{1d}y_{2,t} = y_{2,t} - y_{2,t-1} = Ln\_MVA_t - Ln\_MVA_{t-1}$$

Then, based on Equations (1) and (2), the corresponding Equation (3) in matrix form and (4) in structural form are ready for estimation:

$$\begin{bmatrix}\Delta^{1d}y_{1,t}\\ \Delta^{1d}y_{2,t}\end{bmatrix} = \begin{bmatrix}\beta_{1,0}\\ \beta_{2,0}\end{bmatrix} + \begin{bmatrix}\beta_{1,1} & \beta_{1,2}\\ \beta_{2,1} & \beta_{2,2}\end{bmatrix}\begin{bmatrix}\Delta^{1d}y_{1,t-1}\\ \Delta^{1d}y_{2,t-1}\end{bmatrix} +$$
$$\begin{bmatrix}\beta_{1,3} & \beta_{1,4} & \beta_{1,5} & \beta_{1,6} & \beta_{1,7}\\ \beta_{2,3} & \beta_{2,4} & \beta_{2,5} & \beta_{2,6} & \beta_{2,7}\end{bmatrix}[X_{1,t} \quad X_{2,t} \quad X_{3,t} \quad X_{4,t} \quad X_{5,t}] + \begin{bmatrix}\varepsilon_{1,t}\\ \varepsilon_{2,t}\end{bmatrix} \quad (3)$$

$$\Delta^{1d}y_{1,t} = \beta_{1,0} + \beta_{1,1}\Delta^{1d}y_{1,t-1} + \beta_{1,2}\Delta^{1d}y_{2,t-1} + \beta_{1,3}X_{1,t} + \beta_{1,4}X_{2,t} + \beta_{1,5}X_{3,t} + \beta_{1,6}X_{4,t} + \beta_{1,7}X_{5,t} + \varepsilon_{1,t}$$
$$\Delta^{1d}y_{2,t} = \beta_{2,0} + \beta_{2,1}\Delta^{1d}y_{1,t-1} + \beta_{2,2}\Delta^{1d}y_{2,t-1} + \beta_{2,3}X_{1,t} + \beta_{2,4}X_{2,t} + \beta_{2,5}X_{3,t} + \beta_{2,6}X_{4,t} + \beta_{2,7}X_{5,t} + \varepsilon_{2,t} \quad (4)$$

The two-equation VARX (1) system is estimated together (or jointly) by full information maximum likelihood (FIML) method to take into account the simultaneity, the cross-equation contemporaneous correlations of the error terms, the nonlinearity, and the temporal effect. The estimation results of a simultaneous equations system would be biased, if ordinary least squares (OLS) were applied instead of seemingly unrelated regression (SUR), two-stage least squares (2SLS), or three-stage least squares (3SLS) (Lin & Shi, 2020; Shi, et al., 2021). Theoretically and empirically speaking, 3SLS is more efficient and accurate compared to 2SLS (Theil & Boot, 1962; Theil, 1971; Kmenta, 1997). FIML is asymptotically equivalent to 3SLS when the error terms are normally distributed, however FIML costs more computer power than 3SLS.

DATA AND VARIABLES

SAMPLE FIRMS

We use the 27 Dow-Jones firms between 1992 and 2013 as our sample. Thus, there are 594 observations in the final dataset. Three Dow-Jones companies, Goldman Sachs (GS), Travelers (TRV), and Visa (V) are dropped because CEO pay or firm data does not exist before 1999, 1995, and 2007. Table 2 summarizes the sample firms. In addition, current U.S. dollars are transformed to inflation-adjusted 2010 U.S. dollars.

Table 2. Sample Firms

Stock Ticker	Firm	Industry (Sector)
AXP	*American Express Company*	*Credit Services (Financial Services)*
BA	*The Boeing Company*	*Aerospace & Defense (Industrials)*
CAT	*Caterpillar Inc.*	*Farm & Heavy Construction Machinery (Industrials)*
CSCO	*Cisco Systems, Inc.*	*Communication Equipment (Technology)*
CVX	*Chevron Corporation*	*Oil & Gas Integrated (Energy)*
DD	*DuPont de Nemours, Inc.*	*Chemicals (Basic Materials)*
DIS	*The Walt Disney Company*	*Entertainment (Communication Services)*
GE	*General Electric Company*	*Specialty Industrial Machinery (Industrials)*
HD	*The Home Depot, Inc.*	*Home Improvement Retail (Consumer Cyclical)*
IBM	*International Business Machines Corporation*	*Information Technology Services (Technology)*
INTC	*Intel Corporation*	*Semiconductors (Technology)*
JNJ	*Johnson & Johnson*	*Drug Manufacturers—General (Healthcare)*
JPM	*JPMorgan Chase & Co.*	*Diversified Banks (Financial)*
KO	*The Coca-Cola Company*	*Beverages—Non-Alcoholic (Consumer Defensive)*
MCD	*McDonald's Corporation*	*Restaurants (Consumer Cyclical)*
MMM	*3M Company*	*Specialty Industrial Machinery (Industrials)*
MRK	*Merck & Co., Inc.*	*Drug Manufacturers—General (Healthcare)*
MSFT	*Microsoft Corporation*	*Software—Infrastructure (Technology)*
NKE	*Nike, Inc.*	*Footwear & Accessories (Consumer Cyclical)*
PFE	*Pfizer Inc.*	*Drug Manufacturers—General (Healthcare)*
PG	*The Procter & Gamble Company*	*Household & Personal Products (Consumer Defensive)*
T	*AT&T Inc.*	*Telecom Services (Communication Services)*
UNH	*United Health Group Incorporated*	*Healthcare Plans (Healthcare)*
UTX	*United Technologies*	*Aerospace & Defense (Industrials)*
VZ	*Verizon Communications Inc.*	*Telecom Services (Communication Services)*
WMT	*Walmart Inc.*	*Discount Stores (Consumer Defensive)*
XOM	*Exxon Mobil Corporation*	*Oil & Gas Integrated (Energy)*

Note: The source for industry and sector is Yahoo Finance.

VARIABLES

ENDOGENOUS VARIABLES

The natural logarithm of total CEO pay that is differenced once ($d\_Ln\_TCE_t$) and the natural logarithm of firm performance that is differenced once ($d\_Ln\_MVA_t$) are the two endogenous variables involved in the VARX (1) equations system (Eqs. 3 and 4). Total CEO compensation (TCE) is composed of salary, bonus, other annual pay, total value of restricted stock grants, total value of stock options granted calculated by Black-Scholes, long term incentive pay (LTIP), and all other total pay. Firm performance (MVA) is measured by firm market value that is less prone to CEO's manipulation for higher pay (Murphy, 2012).

PREDETERMINED VARIABLES

The one-year-lag of $d\_Ln\_TCE_t(\Delta^{1d}y_{1,t-1} = y_{1,t-1} - y_{1,t-2} = Ln\_TCE_{t-1} - Ln\_TCE_{t-2})$ and the one-year-lag of $d\_Ln\_MVA_t(\Delta^{1d}y_{2,t-1} = y_{2,t-1} - y_{2,t-2} = Ln\_MVA_{t-1} - Ln\_MVA_{t-2})$ are the predetermined variables.

EXOGENOUS VARIABLES

As discussed in Section 4, we find that there are five prominent factors that influence CEO pay and firm performance simultaneously, namely, CEO's tenure (TEN_t), age (AGE_t), CEO ownership (OWN_t), firm size (Ln_SAL_t), and firm risk (VOL_t). CEO's tenure is measured by the time that the CEO has stayed on the executive position. CEO ownership is calculated by the value of the outstanding shares owned by the CEO, excluding stock options. The natural logarithm of firm sales (Ln_SAL_t) is utilized as a proxy for firm size. Firm risk is the beta risk or the market risk of the firm.

SOURCES OF THE DATA USED

The Wharton Research Data Services (WRDS) provides us with the sample data needed for CEO pay, return on assets, CEO's tenure, age, CEO ownership, the number of employees, and beta risk. Our data sources consist of the "Annual Compensation of Execucomp" dataset from the "Compustat Quarterly Updates" database, the "Company Financial of Execucomp, Fundamentals Annual of North America" dataset from the "Compustat Monthly Updates" database, and the "Beta Deciles of Stock/Portfolio Assignments" dataset from the "Center for Research in Security Prices (CRSP)" database.

SUMMARY STATISTICS

Table 3 describes the mean and the standard deviation for the endogenous and the exogenous variables in the simultaneous two-equation vector autoregression model (Eq.2). Among the sample firms, we find that IBM CEO is paid the most, while MSFT CEO is paid the least. Exxon Mobil's market value is the highest, whereas Nike's market value is the lowest. Nike CEO's tenure is the longest, while JPMorgan Chase CEO's tenure is the shortest. Caterpillar CEO is the eldest, while Microsoft CEO is the youngest. CEO owns the most shares in Microsoft, whereas CEO owns the least shares in Chevron. In addition, Walmart is the largest in terms of firm size, while Nike is the smallest. JPMorgan Chase carries the most firm risk or volatility, whereas Procter & Gamble carries the least risk.

Table 3. Mean and Standard Deviation for the Endogenous and Exogenous Variables

	Ln_TCE	Ln_MVA	TEN	AGE	OWN	Ln_SAL	VOL
AXP	*9.971* *(0.608)*	*10.840* *(0.512)*	*2362.000* *(1496.000)*	*56.820* *(3.319)*	*1020.000* *(536.500)*	*10.290* *(0.155)*	*1.364* *(0.361)*
BA	*8.954* *(0.722)*	*10.730* *(0.408)*	*1787.000* *(1052.000)*	*60.270* *(3.180)*	*242.500* *(201.700)*	*10.970* *(0.309)*	*1.011* *(0.395)*
CAT	*8.992* *(0.565)*	*10.240* *(0.533)*	*1354.000* *(790.400)*	*61.090* *(2.068)*	*162.400* *(94.730)*	*10.360* *(0.394)*	*1.329* *(0.338)*
CSCO	*9.574* *(1.465)*	*11.330* *(1.173)*	*3389.000* *(1998.000)*	*55.680* *(5.507)*	*1681.000* *(1632.000)*	*9.577* *(1.313)*	*1.395* *(0.435)*
CVX	*9.249* *(0.473)*	*11.530* *(0.589)*	*2074.000* *(1118.000)*	*58.000* *(2.911)*	*114.600* *(69.060)*	*11.550* *(0.708)*	*0.774* *(0.300)*
DD	*9.075* *(0.482)*	*10.860* *(0.323)*	*1728.000* *(1059.000)*	*56.910* *(3.221)*	*445.500* *(159.900)*	*10.520* *(0.235)*	*1.057* *(0.264)*
DIS	*9.591* *(1.314)*	*10.940* *(0.361)*	*4073.000* *(2229.000)*	*57.230* *(3.715)*	*6440.000* *(7013.000)*	*10.280* *(0.379)*	*1.083* *(0.258)*
GE	*9.917* *(0.811)*	*12.520* *(0.526)*	*4186.000* *(2012.000)*	*56.270* *(5.750)*	*3740.000* *(4606.000)*	*11.830* *(0.237)*	*1.154* *(0.341)*
HD	*9.259* *(1.120)*	*11.110* *(0.566)*	*2334.000* *(2171.000)*	*59.270* *(4.049)*	*11175.000* *(14950.000)*	*10.800* *(0.639)*	*1.321* *(0.407)*
IBM	*9.989* *(0.573)*	*11.870* *(0.505)*	*1778.000* *(1063.000)*	*55.860* *(2.713)*	*430.000* *(363.300)*	*11.540* *(0.056)*	*0.863* *(0.232)*
INTC	*9.259* *(0.476)*	*11.730* *(0.659)*	*1845.000* *(1078.000)*	*59.000* *(3.101)*	*1643.000* *(1268.000)*	*10.400* *(0.437)*	*1.147* *(0.270)*
JNJ	*9.421* *(0.723)*	*11.870* *(0.515)*	*2281.000* *(1302.000)*	*57.730* *(3.120)*	*419.100* *(353.200)*	*10.660* *(0.397)*	*0.684* *(0.397)*
JPM	*9.749* *(0.860)*	*11.290* *(0.838)*	*1316.000* *(784.800)*	*57.500* *(4.240)*	*2343.000* *(2126.000)*	*10.990* *(0.615)*	*1.502* *(0.334)*
KO	*9.777* *(0.686)*	*11.850* *(0.274)*	*2076.000* *(2049.000)*	*59.640* *(3.935)*	*18983.000* *(31485.000)*	*10.240* *(0.228)*	*0.677* *(0.299)*
MCD	*9.227* *(0.328)*	*10.870* *(0.405)*	*1757.000* *(1271.000)*	*56.450* *(6.724)*	*410.400* *(329.400)*	*9.846* *(0.276)*	*0.756* *(0.267)*
MMM	*9.167* *(0.508)*	*10.880* *(0.276)*	*1346.000* *(908.400)*	*59.360* *(3.553)*	*161.200* *(90.510)*	*10.040* *(0.132)*	*0.811* *(0.196)*
MRK	*9.324* *(0.473)*	*11.690* *(0.400)*	*1832.000* *(1112.000)*	*60.320* *(3.030)*	*391.100* *(433.700)*	*10.360* *(0.394)*	*0.792* *(0.322)*
MSFT	*6.837* *(0.313)*	*12.230* *(0.844)*	*3801.000* *(1944.000)*	*46.500* *(6.494)*	*377500.000* *(197000.000)*	*10.230* *(0.881)*	*0.939* *(0.258)*
NKE	*8.622* *(0.754)*	*9.773* *(0.580)*	*7088.000* *(4912.000)*	*58.500* *(4.543)*	*53291.000* *(53039.000)*	*9.543* *(0.425)*	*0.923* *(0.357)*
PFE	*9.748* *(0.540)*	*11.840* *(0.700)*	*1404.000* *(924.500)*	*58.500* *(3.609)*	*1138.000* *(831.700)*	*10.390* *(0.643)*	*0.893* *(0.316)*
PG	*9.473* *(0.641)*	*11.730* *(0.451)*	*1467.000* *(850.900)*	*59.090* *(2.893)*	*315.400* *(232.700)*	*10.990* *(0.242)*	*0.608* *(0.320)*
T	*9.925* *(0.582)*	*11.630* *(0.634)*	*2913.000* *(1783.000)*	*55.140* *(5.751)*	*748.800* *(563.400)*	*10.880* *(0.752)*	*0.756* *(0.285)*
UNH	*9.521* *(0.854)*	*10.240* *(0.814)*	*2693.000* *(1629.000)*	*52.910* *(4.780)*	*2558.000* *(4303.000)*	*10.330* *(1.137)*	*0.999* *(0.671)*

Table 3. Continued

	Ln_TCE	Ln_MVA	TEN	AGE	OWN	Ln_SAL	VOL
VZ	*9.637*	*11.420*	*1604.000*	*58.500*	*523.000*	*10.990*	*0.694*
	(0.659)	*(0.520)*	*(1066.000)*	*(3.051)*	*(703.600)*	*(0.685)*	*(0.234)*
WMT	*9.335*	*12.120*	*2106.000*	*59.000*	*1872.000*	*12.450*	*0.854*
	(0.937)	*(0.491)*	*(1166.000)*	*(3.491)*	*(1215.000)*	*(0.526)*	*(0.414)*
XOM	*9.916*	*12.560*	*2171.000*	*59.950*	*1291.000*	*12.420*	*0.682*
	(0.699)	*(0.484)*	*(1265.000)*	*(3.786)*	*(1153.000)*	*(0.398)*	*(0.350)*

Note: Standard deviations are in the parentheses.

In the first place, we can observe that Nike CEO has the longest tenure, but the firm size is the smallest and the firm market value is the lowest. This is consistent with Hambrick and Mason's (1984) assertion that longer-tenured CEOs are unlikely to embrace changes and innovations. It is in line with Shleifer and Vishny's (1989) finding that longer-tenured CEOs invest in manager-specific projects to entrench themselves instead of to maximize firm value. Moreover, the result is consistent with Miller's (1991) and Barker and Mueller's (2002) claim that longer-tenured CEOs are risk-averse, and thus are reluctant to grow the company.

In the second place, we find that Microsoft CEO is the youngest and owns the largest amount of shares, but gets the lowest pay. This only partially supports the managerial entrenchment theory that CEOs use their age to overpower the board of director, and consequently obtain higher pay (Jensen & Meckling, 1976; Shleifer & Vishny, 1989; Miller, et al., 2002); however, it does not confirm the use of substantial ownership to get higher pay. Conversely, this finding contradicts the upper echelon theory that younger CEOs generate higher profit, and thus are paid more (Hambrick & Mason, 1984; Miller, 1991; Barker & Mueller, 2002).

In the third place, we discover that JPMorgan Chase CEO has the shortest tenure, but the company is the most risky in terms of volatility. It is consistent with both the finding that longer-tenured CEOs are risk-averse, hindering the growth of the company (Miller, 1991; Barker & Mueller, 2002) and the upper echelon theory that longer-tenured managers are less likely to pursuit changes for violation of their status quo and stability (Hambrick & Mason, 1984).

DISCUSSION OF THE EMPIRICAL RESULTS AND TESTING OF THE HYPOTHESES

Table 4 presents the FIML coefficient estimates of the simultaneous two-equation VARX model (Eq.4). In this section, we test the hypotheses developed in Section 4 on the Dow-Jones firms listed in Table 2.

For American Express (AXP), we find that the relationship between prior firm performance and current CEO pay is insignificant (b=-0.109, p=0.688), which supports H1B not H1A. This finding suggests the presence of managerial entrenchment. Moreover, current CEO pay increases as CEO's tenure decreases (b=-0.001, p=0.001), CEO's age increases (b=0.228, p=0.004), CEO ownership decreases (b=-0.001, p=0.000), and firm size increases (b=6.236, p=0.000). The results support H8B, H9A, and H11; but H8A, H9B, and H10 are not supported. It implies that AXP CEO uses elder age and large firm size to overpower the board and legitimize the reasons for higher pay. Simultaneously, current firm performance increases as prior CEO pay decreases (b=-0.618, p=0.000). Hence, H2B is supported not H2A. Current firm performance increases as CEO's tenure decreases (b=-0.000, p=0.017), CEO's age increases (b=0.203, p=0.000), CEO ownership increases (b=0.001, p=0.001), and firm risk decreases (b=-0.686, p=0.002). Thus, H3A, H4B, H5A, and H7 are supported whereas H3B, H4A, and H5B are not.

Table 4. Full Information Maximum Likelihood Coefficient Estimates for Vector Autoregression CEO Pay-Firm Performance Model

Firms	Variables Endogenous	Predetermined and Exogenous $d\_Ln\_TCE_{t-1}$	$d\_Ln\_MVA_{t-1}$	TEN_t	AGE_t	OWN_t	Ln_SAL_t	VOL_t
AXP	$d\_Ln\_TCE_t$	-0.261 (0.140)	-0.109 (0.688)	-0.001 (0.001)***	0.228 (0.004)***	-0.001 (0.000)***	6.236 (0.000)***	-0.184 (0.559)
	$d\_Ln\_MVA_t$	-0.618 (0.000)***	-0.638 (0.001)***	-0.000 (0.017)**	0.203 (0.000)***	0.001 (0.001)***	-1.537 (0.104)	-0.686 (0.002)***
BA	$d\_Ln\_TCE_t$	-0.271 (0.241)	0.193 (0.707)	0.000 (0.987)	0.004 (0.948)	0.001 (0.520)	-0.135 (0.779)	-0.932 (0.008)***
	$d\_Ln\_MVA_t$	0.014 (0.921)	-0.060 (0.845)	-0.000 (0.651)	0.050 (0.176)	-0.001 (0.258)	-0.137 (0.633)	-0.123 (0.558)
CAT	$d\_Ln\_TCE_t$	-0.322 (0.045) **	0.771 (0.000)***	0.000 (0.832)	0.075 (0.233)	-0.002 (0.034)**	0.275 (0.265)	0.339 (0.015)**
	$d\_Ln\_MVA_t$	-0.410 (0.007)***	-0.281 (0.145)	0.000 (0.426)	-0.015 (0.797)	-0.001 (0.188)	-0.080 (0.729)	0.344 (0.009)***
CSCO	$d\_Ln\_TCE_t$	-0.220 (0.268)	0.345 (0.435)	0.000 (0.632)	-0.059 (0.672)	-0.000 (0.780)	-1.219 (0.045)**	-2.045 (0.039)**
	$d\_Ln\_MVA_t$	0.034 (0.721)	-0.017 (0.935)	0.001 (0.017)**	-0.197 (0.004)***	-0.000 (0.945)	-0.985 (0.001)***	-0.967 (0.043)**
CVX	$d\_Ln\_TCE_t$	-0.346 (0.108)	-0.464 (0.062)*	-0.000 (0.228)	0.051 (0.491)	0.001 (0.038)**	-0.073 (0.292)	0.112 (0.495)
	$d\_Ln\_MVA_t$	0.090 (0.654)	-0.678 (0.003)***	-0.000 (0.280)	0.054 (0.435)	0.001 (0.023)**	-0.040 (0.533)	0.053 (0.730)
DD	$d\_Ln\_TCE_t$	-0.612 (0.001)***	0.273 (0.405)	-0.000 (0.611)	0.049 (0.508)	-0.000 (0.502)	0.528 (0.571)	-0.075 (0.852)
	$d\_Ln\_MVA_t$	-0.085 (0.468)	0.030 (0.883)	-0.000 (0.001)***	0.103 (0.023)**	0.000 (0.657)	-1.012 (0.079)*	-0.068 (0.783)
DIS	$d\_Ln\_TCE_t$	-0.573 (0.003)***	-0.228 (0.856)	-0.000 (0.811)	0.110 (0.632)	-0.000 (0.656)	-2.724 (0.275)	-0.206 (0.908)
	$d\_Ln\_MVA_t$	0.019 (0.611)	-0.208 (0.379)	-0.000 (0.763)	0.012 (0.790)	0.000 (0.673)	-0.171 (0.716)	-0.678 (0.044)**
GE	$d\_Ln\_TCE_t$	-0.459 (0.052)*	0.973 (0.128)	0.001 (0.210)	-0.329 (0.253)	-0.000 (0.895)	-0.760 (0.551)	-0.403 (0.498)
	$d\_Ln\_MVA_t$	0.121 (0.252)	0.056 (0.846)	-0.000 (0.668)	0.048 (0.713)	0.000 (0.874)	-0.641 (0.262)	0.066 (0.803)
HD	$d\_Ln\_TCE_t$	-0.526 (0.003)***	1.063 (0.080)*	0.000 (0.055)*	-0.291 (0.009)***	-0.000 (0.075)*	-0.400 (0.563)	0.578 (0.456)
	$d\_Ln\_MVA_t$	-0.150 (0.023)**	0.137 (0.541)	-0.000 (0.711)	-0.010 (0.813)	0.000 (0.281)	-0.324 (0.203)	-0.506 (0.076)*
IBM	$d\_Ln\_TCE_t$	-0.271 (0.194)	0.719 (0.244)	0.000 (0.315)	-0.179 (0.222)	0.000 (0.779)	-2.329 (0.549)	-0.209 (0.790)
	$d\_Ln\_MVA_t$	0.103 (0.119)	-0.134 (0.493)	-0.000 (0.673)	0.095 (0.041)**	-0.001 (0.029)**	2.197 (0.073)*	0.435 (0.078)*
INTC	$d\_Ln\_TCE_t$	-0.872 (0.000)***	-0.287 (0.126)	0.000 (0.896)	0.106 (0.048)**	-0.000 (0.083)*	-1.034 (0.005)***	-0.589 (0.151)
	$d\_Ln\_MVA_t$	0.044 (0.839)	-0.408 (0.103)	0.000 (0.350)	0.007 (0.922)	-0.000 (0.625)	-0.439 (0.365)	-0.273 (0.617)
JNJ	$d\_Ln\_TCE_t$	-0.364 (0.098)*	-0.247 (0.760)	-0.000 (0.360)	0.246 (0.085)*	-0.001 (0.018)**	-0.206 (0.650)	0.948 (0.085)*
	$d\_Ln\_MVA_t$	-0.030 (0.551)	-0.039 (0.837)	0.000 (0.003)***	-0.100 (0.002)***	-0.000 (0.524)	-0.090 (0.389)	-0.084 (0.507)

Table 4. Continued

Firms	Variables Endogenous	$d\_Ln\_TCE_{t-1}$	$d\_Ln\_MVA_{t-1}$	TEN_t	AGE_t	OWN_t	Ln_SAL_t	VOL_t
JPM	$d\_Ln\_TCE_t$	-0.460 (0.009)***	0.322 (0.616)	0.001 (0.305)	-0.455 (0.221)	-0.001 (0.198)	-0.605 (0.448)	-1.384 (0.064)*
	$d\_Ln\_MVA_t$	-0.009 (0.885)	-0.191 (0.424)	-0.001 (0.301)	0.185 (0.181)	0.000 (0.310)	0.205 (0.490)	0.040 (0.885)
KO	$d\_Ln\_TCE_t$	-0.124 (0.525)	2.636 (0.017)**	0.000 (0.297)	-0.017 (0.758)	-0.000 (0.192)	-1.212 (0.175)	-0.022 (0.983)
	$d\_Ln\_MVA_t$	-0.039 (0.291)	-0.228 (0.279)	0.000 (0.334)	0.004 (0.676)	0.000 (0.811)	0.200 (0.239)	-0.064 (0.747)
MCD	$d\_Ln\_TCE_t$	-0.563 (0.002)***	0.147 (0.677)	-0.000 (0.244)	-0.005 (0.770)	0.000 (0.556)	-0.826 (0.192)	-0.554 (0.158)
	$d\_Ln\_MVA_t$	-0.014 (0.893)	0.025 (0.906)	0.000 (0.017)**	-0.005 (0.606)	-0.000 (0.559)	0.691 (0.064)	0.455 (0.049)**
MMM	$d\_Ln\_TCE_t$	-0.684 (0.000)***	-0.451 (0.318)	0.000 (0.358)	-0.051 (0.165)	0.003 (0.046)**	0.866 (0.277)	0.277 (0.531)
	$d\_Ln\_MVA_t$	0.010 (0.898)	-0.417 (0.090)*	0.000 (0.334)	-0.017 (0.389)	0.000 (0.736)	0.311 (0.474)	0.300 (0.213)
MRK	$d\_Ln\_TCE_t$	-0.305 (0.017)**	0.768 (0.000)***	0.000 (0.844)	0.025 (0.328)	-0.001 (0.017)**	-0.043 (0.775)	0.349 (0.015)**
	$d\_Ln\_MVA_t$	0.044 (0.808)	-0.341 (0.070)*	-0.000 (0.258)	-0.013 (0.714)	0.000 (0.608)	-0.012 (0.953)	0.278 (0.172)
MSFT	$d\_Ln\_TCE_t$	-0.310 (0.100)	-0.147 (0.182)	0.000 (0.303)	-0.040 (0.113)	-0.000 (0.282)	0.275 (0.224)	-0.095 (0.580)
	$d\_Ln\_MVA_t$	0.129 (0.632)	-0.095 (0.544)	0.000 (0.000)***	-0.071 (0.050)*	-0.000 (0.486)	0.491 (0.127)	0.096 (0.695)
NKE	$d\_Ln\_TCE_t$	-0.700 (0.000)***	0.231 (0.401)	-0.000 (0.019)**	0.137 (0.016)**	0.000 (0.900)	-1.578 (0.002)***	-0.152 (0.753)
	$d\_Ln\_MVA_t$	-0.158 (0.087)*	0.093 (0.593)	0.000 (0.311)	-0.010 (0.784)	-0.000 (0.008)***	-0.285 (0.385)	-0.625 (0.041)**
PFE	$d\_Ln\_TCE_t$	-0.080 (0.615)	0.319 (0.015)**	0.000 (0.001)***	-0.038 (0.008)***	-0.000 (0.097)*	-0.072 (0.518)	0.010 (0.954)
	$d\_Ln\_MVA_t$	-0.023 (0.919)	-0.273 (0.147)	0.000 (0.009)***	0.030 (0.142)	-0.000 (0.025)**	0.020 (0.902)	-0.190 (0.432)
PG	$d\_Ln\_TCE_t$	-0.663 (0.000)***	0.951 (0.018)**	0.000 (0.986)	0.038 (0.333)	-0.000 (0.540)	-1.051 (0.006)***	-0.745 (0.072)*
	$d\_Ln\_MVA_t$	-0.167 (0.053)*	-0.334 (0.191)	0.000 (0.619)	-0.018 (0.461)	0.001 (0.037)**	0.004 (0.987)	0.240 (0.362)
T	$d\_Ln\_TCE_t$	-0.548 (0.000)***	-0.100 (0.703)	-0.000 (0.995)	0.059 (0.833)	-0.000 (0.103)	0.009 (0.977)	-1.311 (0.000)***
	$d\_Ln\_MVA_t$	0.067 (0.635)	-0.185 (0.442)	-0.002 (0.044)**	0.508 (0.047)**	0.000 (0.078)*	0.424 (0.130)	-0.073 (0.764)
UNH	$d\_Ln\_TCE_t$	-0.207 (0.322)	-1.039 (0.022)**	-0.000 (0.935)	0.102 (0.531)	0.000 (0.566)	-0.578 (0.476)	0.325 (0.469)
	$d\_Ln\_MVA_t$	0.106 (0.230)	-0.319 (0.095)*	-0.000 (0.335)	0.200 (0.004)***	-0.000 (0.195)	-1.060 (0.002)***	-0.375 (0.047)**
UTX	$d\_Ln\_TCE_t$	-0.492 (0.005)***	0.353 (0.355)	0.000 (0.878)	-0.153 (0.699)	0.001 (0.007)***	-1.288 (0.293)	-0.204 (0.555)
	$d\_Ln\_MVA_t$	0.124 (0.239)	-0.068 (0.771)	0.001 (0.324)	-0.221 (0.356)	0.000 (0.932)	-0.931 (0.210)	-0.185 (0.378)

Table 4. Continued

Firms	Variables Endogenous	Predetermined and Exogenous $d\_Ln\_TCE_{t-1}$	$d\_Ln\_MVA_{t-1}$	TEN_t	AGE_t	OWN_t	Ln_SAL_t	VOL_t
VZ	$d\_Ln\_TCE_t$	-0.509 (0.008)***	-0.230 (0.669)	-0.000 (0.731)	0.040 (0.562)	-0.000 (0.660)	-0.372 (0.242)	-0.928 (0.107)
	$d\_Ln\_MVA_t$	0.180 (0.027)**	-0.209 (0.364)	0.000 (0.104)	-0.029 (0.329)	-0.000 (0.146)	0.064 (0.636)	-0.191 (0.440)
WMT	$d\_Ln\_TCE_t$	-0.334 (0.150)	-0.066 (0.940)	-0.000 (0.529)	0.078 (0.391)	-0.001 (0.320)	-1.677 (0.128)	0.444 (0.451)
	$d\_Ln\_MVA_t$	0.022 (0.755)	0.108 (0.686)	0.000 (0.024)**	0.101 (0.000)***	-0.001 (0.001)***	-1.195 (0.000)***	0.109 (0.545)
XOM	$d\_Ln\_TCE_t$	-0.200 (0.255)	1.101 (0.013)**	0.001 (0.002)***	-0.524 (0.002)***	0.000 (0.191)	-1.243 (0.000)***	-0.152 (0.500)
	$d\_Ln\_MVA_t$	-0.085 (0.464)	0.092 (0.753)	-0.000 (0.272)	0.135 (0.230)	-0.000 (0.596)	0.089 (0.677)	-0.024 (0.872)

Note: p-values are in the parentheses.
0 < (p)*** < 0.01; 0.01< (p)** < 0.05; 0.05 < (p)* < 0.1
$d\_Ln\_TCE_t = \Delta^{1d} y_{1,t} = y_{1,t} - y_{1,t-1} = Ln\_TCE_t - Ln\_TCE_{t-1}$
$d\_Ln\_MVA_t = \Delta^{1d} y_{2,t} = y_{2,t} - y_{2,t-1} = Ln\_MVA_t - Ln\_MVA_{t-1}$
$d\_Ln\_TCE_{t-1} = \Delta^{1d} y_{1,t-1} = y_{1,t-1} - y_{1,t-2} = Ln\_TCE_{t-1} - Ln\_TCE_{t-2}$
$d\_Ln\_MVA_{t-1} = \Delta^{1d} y_{2,t-1} = y_{2,t-1} - y_{2,t-2} = Ln\_MVA_{t-1} - Ln\_MVA_{t-2}$

This indicates that firm performance is well aligned with CEO's own financial interests and that elder age helps firm performance, but longer tenure hinders firm performance. These results show that AXP CEO uses short tenure and elder age to increase both pay and performance.

In Boeing (BA), even though there is a negative and significant relationship between firm risk and current CEO pay (b=-0.932, p=0.008), no significant relationship is found between prior firm performance and current CEO pay (b=0.193, p=0.707). Thus, H1B is supported while H1A and H12 are not. These findings suggest that BA CEO may entrench oneself to get higher pay by making manager-specific investment that does not necessarily lead to high firm value.

For Caterpillar (CAT), we observe that the effect of prior firm performance on current CEO pay is positive and significant (b=0.771, p=0.000), which supports H1A not H1B. Current CEO pay increases as CEO ownership decreases (b=-0.002, p=0.034) and firm risk increases (b=0.339, p=0.015), which provides support for H12 but not H10. These results imply that CAT CEO is paid for performance and that the board needs to consider compensating CEO for high firm risk. Simultaneously, current firm performance increases as prior CEO pay decreases (b=-0.410, p=0.007), which supports H2B not H2A. There is a positive and significant relationship between firm risk and current firm performance (b=0.344, p=0.009), suggesting that CAT CEO is not risk-averse, which is different from Lee's (2009) finding. Hence, H7 is not supported. These results indicate that CAT CEO uses high firm risk to increase both pay and firm performance.

For Cisco (CSCO), no significant relationship is found between prior firm performance and current CEO pay (b=0.345, p=0.435), thus H1B is supported not H1A. The finding implies managerial entrenchment. We find that both small firm size (b=-1.219, p=0.045) and low risk (b=-2.045, p=0.039) result in high current CEO pay. Hence, neither H11 nor H12 is supported. Simultaneously, long tenure (b=0.001, p=0.017), young age (b=-0.197, p=0.004), small firm size (b=-0.985, p=0.001), and low risk (b=-0.967, p=0.043) lead to high current firm performance. Therefore, H3B, H4A, and H7 are supported while H3A, H4B, and H6 are not. These results show that CSCO CEO is risk-averse, utilizing small firm size and low firm risk to increase both pay and performance.

In Chevron (CVX), the relationship between prior firm performance and current CEO pay is negative and marginally significant (b=-0.464, p=0.062), implying possible managerial entrenchment. It supports H1B not H1A. The entrenchment is further confirmed by the positive and significant relationship between CEO ownership and current CEO pay (b=0.001, p=0.038), supporting H10. At the same time, the effect of CEO ownership on current firm performance is positive and significant (b=0.001, p=0.023), which confirms H5A not H5B. This result suggests that the board ties firm performance strongly with CEO's own financial interests. These findings shows that CVX CEO utilizes ownership to increase both pay and performance.

For DuPont (DD), we discover that there is no significant relationship between prior firm performance and current CEO pay (b=0.273, p=0.405). This finding supports H1B not H1A, implying managerial entrenchment. Simultaneously, current firm performance increases as CEO's tenure decreases (b=-0.000, p=0.001) and age increases (b=0.103, p=0.023). Hence, H3A and H4B are supported whereas H3B and H4A are not. The relationship between firm size and current firm performance is negative and marginally significant (b=-1.012, p=0.079). Thus, H6 is not supported.

In the case of Disney (DIS), there is no significant relationship between prior firm performance and current CEO pay (b=-0.228, p=0.856). Hence, H1B is supported not H1A. This result implies managerial entrenchment. We discover a negative and significant relationship between firm risk and current firm performance (b=-0.678, p=0.044), which supports H7.

For General Electric (GE), we find no significant relationship between prior firm performance and current CEO pay (b=0.973, p=0.128), which confirms H1B not H1A. This finding shows the presence of managerial entrenchment.

In terms of Home Depot (HD), we find that there is a positive and marginally significant relationship between prior firm performance and current CEO pay (b=1.063, p=0.080), which confirms H1B not H1A. This finding implies managerial entrenchment. In addition, current CEO pay increases as CEO's age decreases (b=-0.291, p=0.009), which supports H9B not H9A. The relationships between CEO's tenure and current CEO pay (b=0.000, p=0.055), between CEO ownership and current CEO pay (b=-0.000, p=0.075), and between firm risk and current firm performance (b=-0.506, p=0.076) are marginally significant. Therefore, H8A/B, H10, and H7 are not supported. Simultaneously, the effect of prior CEO pay on current firm performance is negative and significant (b=-0.150, p=0.023). Therefore, H2B is supported not H2A.

For International Business Machines (IBM), the relationship between prior firm performance and current CEO pay is positive and insignificant (b=0.719, p=0.244), which confirms H1B not H1A. This finding suggests managerial entrenchment. Moreover, current firm performance increases as CEO's age increases (b=0.095, p=0.041) and CEO ownership decreases (b=-0.001, p=0.029). Therefore, H4B and H5B are supported whereas H4A and H5A are not. The relationships between firm size and current firm performance (b=2.197, p=0.073) and between firm risk and current firm performance (b=0.435, p=0.078) are positive and marginally significant. Hence, H6 and H7 are not supported.

In the case of Intel (INTC), we find that there is no significant relationship between prior firm performance and current CEO pay (b=-0.287, p=0.126). Thus, H1B is confirmed not H1A. This result implies managerial entrenchment. Current CEO pay increases as CEO's age increases (b=0.106, p=0.048) and firm size decreases (b=-1.034, p=0.005). Therefore, H9A is supported however H9B and H11 are not. The effect of CEO ownership on current CEO pay is negative and marginally significant (b=-0.000, p=0.083). Hence, H10 is not supported.

For Johnson & Johnson (JNJ), we observe that the impact of prior firm performance on current CEO pay is negative and insignificant (b=-0.247, p=0.760). Thus, H1B is supported not H1A. This finding implies managerial entrenchment. Moreover, current CEO pay increases as CEO ownership decreases (b=-0.001, p=0.018). The relationships between CEO's age and current CEO pay (b=0.246, p=0.085) and between firm risk and current CEO pay (b=0.948, p=0.085) are marginally significant. Therefore, H10, H9A/B, and H12 are not supported. Simultaneously, current firm performance increases as CEO's tenure increases (b=0.000, p=0.003) and CEO's age decreases (b=-0.100, p=0.002). Hence, H3B and H4A are supported but H3A and H4B are not.

In JPMorgan Chase (JPM), the effect of prior firm performance on current CEO pay is positive and insignificant (b=0.322, p=0.616), which suggests managerial entrenchment. Therefore, H1B is supported whereas H1A is not. In addition, the effect of firm risk on current CEO pay is negative and marginally significant (b=-1.384, p=0.064). Thus, H12 is not supported.

For Coca-Cola (KO), the effect of prior firm performance on current CEO pay is positive and significant (b=2.636, p=0.017). Thus, H1A is supported while H1B is not. This suggests that KO CEO pay is closely tied to firm performance. High performance leads to high pay.

In McDonald's (MCD), we observe a positive and insignificant relationship between prior firm performance and current CEO pay (b=0.147, p=0.677). Thus, H1B is supported but H1A is not. Simultaneously, the effect of CEO's tenure on current firm performance is positive and significant (b=0.000, p=0.017), so is the effect of firm risk on current firm performance (b=0.455, p=0.049). Therefore, H3B is supported whereas H3A and H7 are not.

For 3M (MMM), there is no significant relationship between prior firm performance and current CEO pay (b=-0.451, p=0.318). Hence, H1B is supported not H1A, implying managerial entrenchment. Furthermore, current CEO pay increases as CEO ownership increases (b=0.003, p=0.046), which supports H10 and suggests managerial entrenchment.

In Merck (MRK), the effect of prior firm performance on current CEO pay is positive and significant (b=0.768, p=0.000). Thus, H1A is supported but H1B is not. Moreover, current CEO pay increases as CEO ownership decreases (b=-0.001, p=0.017) and firm risk increases (b=0.349, p=0.015). Therefore, H10 is not supported whereas H12 is.

As to Microsoft (MSFT), the relationship between prior firm performance and current CEO pay is negative and insignificant (b=-0.147, p=0.182). Therefore, H1B is supported not H1A. This result implies managerial entrenchment. Simultaneously, current firm performance increases as CEO's tenure increases (b=0.000, p=0.000). Thus, H3B is supported whereas H3A is not. The effect of CEO's age on current firm performance is negative and marginally significant (b=-0.071, p=0.050). Hence, H4A/B are not supported.

For Nike (NKE), the effect of prior firm performance on current CEO pay is positive and insignificant (b=0.231, p=0.401), which supports H1B not H1A and suggests managerial entrenchment. Moreover, current CEO pay increases as CEO's tenure decreases (b=-0.000, p=0.019), CEO's age increases (b=0.137, p=0.016), and firm size decreases (b=-1.578, p=0.002). Hence, H8B and H9A are supported whereas H8A, H9B, and H11 are not. Simultaneously, the effect of prior CEO pay on current firm performance is negative and marginally significant (b=-0.158, p=0.087). Therefore, H2A/B are not supported. Current firm performance increases as CEO ownership decreases (b=-0.000, p=0.008) and firm risk decreases (b=-0.625, p=0.041). Thus, H5B and H7 are supported while H5A is not.

In Pfizer (PFE), we find that there is a positive and significant relationship between prior firm performance and current CEO pay (b=0.319, p=0.015), which supports H1A not H1B. In addition, current CEO pay increases as CEO's tenure increases (b=0.000, p=0.001) and CEO's age decreases (b=-0.038, p=0.008). Thus, H8A and H9B are supported while H8B and H9A are not. The effect of CEO ownership on current CEO pay is negative and marginally significant (b=-0.000, p=0.097). Hence, H10 is not supported. Simultaneously, current firm performance increases as CEO's tenure increases (b=0.000, p=0.009) and CEO ownership decreases (b=-0.000, p=0.025). Therefore, H3B and H5B are supported while H3A and H5A are not. These results show that PFE CEO utilizes long tenure to increase both pay and performance.

In Proctor & Gamble (PG), we find a positive and significant relationship between prior firm performance and current CEO pay (b=0.951, p=0.018), which supports H1A not H1B. Moreover, current CEO pay increases as firm size decreases (b=-1.051, p=0.006). Thus, H11 is not supported. The effect of firm risk on current CEO pay is negative and marginally significant (b=-0.745, p=0.072). Hence, H12 is not supported. Simultaneously, the effect of prior CEO pay on current firm performance is negative and marginally significant (b=-0.167, p=0.053). Thus, H2A/B are not supported. Current firm performance increases as CEO ownership increases (b=0.001, p=0.037), which supports H5A not H5B.

For AT&T (T), the effect of prior firm performance on current CEO pay is negative and insignificant (b=-0.100, p=0.703). Hence, H1B is supported not H1A, suggesting managerial entrenchment. Current CEO pay increases as firm risk decreases (b=-1.311, p=0.000), which does not support H12. Simultaneously, current firm performance increases as CEO's tenure decreases (b=-0.002, p=0.044) and CEO's age increases (b=0.508, p=0.047). Thus, H3A and H4B are supported while H3B and H4A are not. The effect of CEO ownership on current firm performance is positive and marginally significant (b=0.000, p=0.078). Therefore, H5A/B are not supported.

In terms of UnitedHealth (UNH), the effect of prior firm performance on current CEO pay is negative and significant (b=-1.039, p=0.022), implying managerial entrenchment. Thus, H1A/B are not supported. Simultaneously, current firm performance increases as CEO's age increases (b=0.200, p=0.004), firm size decreases (b=-1.060, p=0.002), and firm risk decreases (b=-0.375, p=0.047). Hence, H4B and H7 are supported while H4A and H6 are not.

For United Technologies (UTX), the effect of prior firm performance on current CEO pay is positive and insignificant (b=0.353, p=0.355). Thus, H1B is supported not H1A. This result suggests managerial entrenchment. Current CEO pay increases as CEO ownership increases (b=0.001, p=0.007). Hence, H10 is supported. This finding implies that UTX CEO utilizes high ownership to exert power over the board and increase pay.

In Verizon (VZ), we find a negative and insignificant effect of prior firm performance on current CEO pay (b=-0.230, p=0.669), implying managerial entrenchment. Therefore, H1B is supported not H1A. Simultaneously, current firm performance increases as prior CEO pay increases (b=0.180, p=0.027). Hence, H2A is supported whereas H2B is not.

As to Walmart (WMT), the effect of prior firm performance on current CEO pay is negative and insignificant (b=-0.066, p=0.940), which suggests managerial entrenchment. Therefore, H1B is supported while H1A is not. Simultaneously, current firm performance increases as CEO's tenure increases (b=0.000, p=0.024), CEO's age increases (b=0.101, p=0.000), CEO ownership decreases (b=-0.001, p=0.001), and firm size decreases (b=-1.195, p=0.000). Hence, H3B, H4B, and H5B are supported whereas H3A, H4A, H5A, and H6 are not.

Last but certainly not least, for Exxon Mobil (XOM) case, we find that the effect of prior firm performance on current CEO pay is positive and significant (b=1.101, p=0.013). Thus, H1A is supported while H1B is not. Current CEO pay increases as CEO's tenure increases (b=0.001, p=0.002), CEO's age decreases (b=-0.524, p=0.002), and firm size decreases (b=-1.243, p=0.000). Hence, H8A and H9B are supported whereas H8B, H9A, and H11 are not.

THEORETICAL IMPLICATIONS

We apply the vector autoregression with exogenous variables (VARX) approach to integrate the optimal contracting theory (Tosi & Gomez-Mejia, 1989; Kaplan, 2008), the managerial entrenchment theory (Jensen & Meckling, 1976; Shleifer & Vishny, 1989; Miller, et al., 2002), the principal-agent theory (Tosi & Gomez-Mejia, 1994), the contextual criteria theory (Gomez-Mejia & Wiseman, 1997), and the upper echelon theory (Hambrick & Mason, 1984).

Table 5 shows that, under the contingencies of CEO's tenure, CEO's age, ownership, firm size, and firm risk, when the agency problem is not mitigated (i.e., CEO ownership is not positively and significantly tied to current firm performance), Group I CEOs are entrenched (i.e., prior firm performance is not positively and significantly tied to current CEO pay). This is consistent with the managerial entrenchment theory. In comparison, when the agency problem is mitigated (i.e., CEO ownership is positively and significantly tied to current firm performance), Group IV CEO is not entrenched (i.e., prior firm performance is positively and significantly tied to current CEO pay). This is in line with the optimal contracting theory.

Table 5. The Two-By-Two Matrix for Agency Problem and Managerial Entrenchment

	Agency Problem Not Mitigated	Agency Problem Mitigated
Entrenched	***Group I*** *BA, CSCO, DD, DIS, GE, HD, IBM, INTC, JNJ, JPM, MCD, MMM, MSFT, NKE, T, UNH, UTX, VZ, WMT*	***Group III*** *AXP, CVX*
Not Entrenched	***Group II*** *CAT, KO, MRK, PFE, XOM*	***Group IV*** *PG*

However, contrary to the conventional wisdom of managerial entrenchment, when the agency problem is not mitigated, Group II CEOs are not entrenched. We define such condition as one middle ground between the boundary of complete managerial entrenchment (i.e., agency problem not mitigated, CEO entrenched) and fully optimized contracting (agency problem mitigated, CEO not entrenched). In addition, contrary to the conventional wisdom of optimal contracting, when the agency problem is mitigated, Group III CEOs are still entrenched. We define such condition as the other middle ground between fully optimal contracted and fully entrenched.

Therefore, in this paper, we find two new settings where CEO non-entrenchment or entrenchment cannot be explained by the managerial entrenchment theory or optimal contracting theory alone. The VARX model (Figure 1; Eqs. 1–4) makes it possible to estimate the relationships between prior firm performance and current CEO pay and between CEO ownership and current firm performance simultaneously under the contingencies of contextual criteria and upper echelon. Such simultaneous estimation at the firm level allows us to study the boundary conditions of managerial entrenchment and optimal contracting jointly as a comprehensive system rather than separately as two diverging theories.

MANAGERIAL IMPLICATIONS

Merely mitigating the agency problem cannot prevent managerial entrenchment (Group III). However, not mitigating the agency problem at all leads to managerial entrenchment (Group I). Besides linking CEO ownership positively and tightly with firm performance, the board needs to pay attention to the contingency effects of contextual criteria and upper echelon (e.g., CEO's tenure, CEO's age, CEO ownership, firm size, firm risk) on both CEO pay and firm performance. The board can also look for other non-financial means to mitigate the agency problem and minimize managerial entrenchment. For example, the company provides corporate culture and value-based trainings to executives and employees, recognizes CEO for performance milestones and achievements on social media and other popular media outlets, builds goodwill and friendship (e.g., donation matching programs, "know your employee/boss day", birthday celebration, team building trips), increases pay transparency, smooths the information flow among stakeholders, ties management investments (e.g., Merger & Acquisition) to firm strategic values, and adds the oversight committee for CEO duality and pay manipulation concerns.

CONCLUSIONS

Based on the empirical results of a simultaneous two-equation vector autoregression with exogenous variables (VARX) model for CEO compensation and firm performance (Figure 1; Table 4), we find that when the agency problem is not mitigated, CEOs are entrenched; when the agency problem is mitigated, CEOs are not entrenched. New to the extant CEO compensation theories, we discover two middle ground conditions between the boundary of managerial entrenchment and optimal contracting. For example, CEOs in the five firms (CAT, KO, MRK, PFE, XOM) are not entrenched, when the agency problem is not mitigated. CEOs in the two firms (AXP, CVX) are entrenched, when the agency problem is mitigated (Table 5). These two middle ground conditions indicate that managerial entrenchment cannot be simply managed by dealing with the agency problem alone. But rather, managerial entrenchment is a complex problem that requires the boards to do more than linking CEO ownership tightly with firm performance. We recommend that the boards look at other non-financial means and social approaches to minimize the impact of managerial entrenchment on both firm performance and CEO compensation. We also recommend the boards take on the approaches unique to their own firms and their CEOs (i.e., contextual criteria, upper echelon, firm characteristics, CEO characteristics) to address managerial entrenchment. Another interesting finding revealed by the VARX model is that CEOs are entrenched in 19 of the 27 Dow-Jones firms (Group I, Table 5), where ownership is not positively and significantly tied to firm performance (Table 4).

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