

Cash holdings and CEO risk incentive compensation: Effect of CEO risk aversion

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Abstract

We examine the risk incentive effect (vega) on firm cash holdings and how this relationship is moderated by managerial risk aversion. We focus on zero or negative debt ratio firms in order to minimize the possibility that the risk incentive effect on cash is driven by bondholder-shareholder conflicts as suggested by Liu and Mauer (2011). We find that vega is positively related to cash holdings and that this relationship is enhanced for firms with greater managerial risk aversion. We conclude that managers appropriately respond to risk incentives by taking on riskier projects but increase cash holdings to reduce their undiversified risk to the firm as a consequence of greater risk incentive compensation.

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I. Introduction

Recently, Liu and Mauer (2011) examine CEO compensation risk-incentive effects (vega) on firm cash holdings and valuation. They document a positive correlation between cash holdings and vega, consistent with the costly contracting and costly external finance hypotheses they propose but inconsistent with the shareholder alignment hypothesis. The latter hypothesis, espoused by Jensen and Meckling (1976), suggests that firms use equity-based compensation to incent risk averse managers to take more risky and profitable projects to benefit shareholders. This would imply lower cash holdings. The costly contracting hypothesis stems from shareholder-bondholder conflict implications of risk incentive effects of compensation. To the extent that risk incentives lead to aggressive investments and decisions that favor shareholders (over bondholders), bondholders may insist on mitigating their position via contractual provisions such as enhanced liquidity. The costly external finance hypothesis is based on the assumption that risk incentives increase the cost of external finance when the need for such finance arises, leading managers to hedge future financing needs by holding extra cash. While both the costly contracting and costly external finance hypotheses are supported by the positive relation between cash holdings and vega documented in Liu and Mauer, the authors conduct further tests using cash valuation as the dependent variable, which favors costly contracting as the most likely explanation for the positive effect of vega on corporate liquidity.

We suggest and provide evidence for an alternate hypothesis to explain the positive vega-cash holdings relationship not considered by Liu and Mauer (2011). We propose that

managers for their own personal risk reasons may mitigate the risk incentive effects of their compensation by increasing firm cash holdings. That is, managers appropriately respond to the risk-incentive effects of their compensation by undertaking riskier investments but attempt to mitigate some of the personal risk by increasing liquidity. We expect such behavior to be especially evident for managers that are more likely to be risk averse and for firms with characteristics where this risk aversion will be particularly pertinent. We hypothesize that older CEOs and CEOs with higher stakes in the firm are likely to be more risk averse and prone to offset the risk incentive effects of option compensation by increasing firm liquidity. We also expect CEOs to offset the risk incentive effects of option compensation with greater liquidity for firms that are smaller, have greater R&D investments, and firms with greater earnings volatility. We test these relationships in a regression framework with cash holdings as the dependent variable and vega, interaction of vega with the risk-aversion proxies mentioned above, and a number of controls as the independent variables. We test the above using a sample of firms with zero or negative net debt to ensure that our results are not confounded by the costly contracting and costly external finance explanations detailed in Liu and Mauer (2011). Consistent with Liu and Mauer (2011) we reconfirm that vega and cash are positively related. However, since our sample is restricted to firms that have zero or negative net debt, it is unlikely that the positive cash-vega relationship is driven by shareholder-bondholder or external debt finance considerations. Consistent with our hypothesis, the interaction coefficients reveal that the positive vega-cash relationship is mitigated for firms with CEOs that are older and have greater ownership stakes in their firms, and for firms that are smaller, have greater R&D investments, and have higher volatility. The results are robust across a variety of estimation

methods including estimations that address potential endogeneity concerns. Finally, we find that our results are qualitatively similar for firms with positive debt, suggesting that managerial risk aversion can explain, at least partially, the positive vega-cash holdings relationship even for positive net debt leverage firms.

The rest of the paper is organized as follows. The next section provides a brief overview of related literature. Section III develops the hypothesis and details the empirical methodology and data. Section IV is devoted to a discussion of the results. Section V concludes the paper.

II. Related literature

A. Determinants of cash holdings

Cash now accounts for a very significant portion of firm assets, more than doubling since the early 1980s. The average cash ratio increased from 10.5% to 23.2% from 1980 to 2006 (Bates et al., 2006). These ratios are surprising in view of the developments in efficiency of information distribution speed and diversification of financial hedging tools enabling companies to undertake less risk exposure than ever before. The significant resource commitment to cash underscores the need to better understand what affects cash holdings.

Bates et al. (2006) identify four motivations for holding cash: the transactions motive, the precautionary motive, the tax motive and the agency motive. The transactions motive implies firms hold cash to save on transaction costs associated with raising funds such as liquidating assets to meet payments. The precautionary motive refers to the use of cash to fund investments and payments when other sources of funds are not available or too costly. Empirically these motives imply a systematic relationship between cash holdings and relevant firm characteristics such as size, volatility, investment opportunities, financial constraints, etc.

Opler et al. (1999) document that firm size, leverage, net working capital, firm cash flow, dividend payment, and industry volatility affect the company's cash holding level. Dittmar and Duchin (2013) conclude that holdings of excessive cash are associated with firms characterized by longer history, large size, stable cash flow volatility and lower potential growth opportunities. Han and Qiu (2007) show theoretically that cash flow volatility of a firm is positively correlated with the cash holding levels of the firm. Almedia et al. (2004) suggest that the cash holding for financially constrained firms is used to hedge cash flow shocks. They argue that financially constrained firms will hold higher cash as a ratio of cash flows.

The tax motive is relevant for multinational companies and other firms with subsidiaries abroad that generate significant revenues. Owing to the high US corporate tax rates, many firms with subsidiaries abroad are reluctant to bring back cash from their foreign operations as they will be subject to US taxes. Several popular press articles have highlighted this phenomenon in recent years. Foley et al. (2007) present empirical evidence in this regard.

The agency motive implies that cash holdings may be driven by principal-agent considerations between managers and owners and between bondholders and stockholders (e.g., Jensen(1986)). Liu and Mauer (2011) argue that managerial incentives will make CEOs to hold more cash. Their view is that the CEO will accede to the demands of debt holders to hold more cash as a hedge against potential bondholder-shareholder conflicts stemming from the risk incentive component of compensation. Dittmar and Duchin (2013) argue that managerial risk aversion may be an important determinant of cash holdings. They suggest that manager's stock option-exercising, CEO's personality and prior experiences determine the conservativeness of their finance and investment decisions. The financial and investment

decisions also directly affect the cash holding of firms. They hypothesize and find support for the view that CEOs who are older and faced financial difficulties in their prior career experience will tend to hold more cash and adopt a lower net debt ratio.

B. Risk incentive effects of compensation

The agency literature (e.g., Jensen and Meckling (1976)) advocates the use of equity compensation to align managerial and shareholder interests. Greater use of equity incentives leads to greater sensitivity of compensation to shareholder wealth. However, equity compensation also leads to greater risk for managers from undiversified holdings in the firm, which in turn may cause managers to adopt a more conservative stance in their operating and financing decisions (e.g., safer investments, lower leverage). This potential can be offset by including compensation elements that are sensitive to risk (e.g., stock options). Indeed, today stock options comprise a significant portion of executive compensation.

Thus, we can think of compensation as containing two components: one that is sensitive to wealth changes or the company's stock price (delta) and another that is sensitive to risk changes (vega). The delta links the profits of the CEO with the profits of the shareholders. As noted previously, higher delta will make the manager work harder to realize higher personal monetary benefit. On the other hand, she may also undertake more conservative managerial decisions given that she is undiversified. The effect of vega is to offset the tendency of conservative investment policy brought about by delta.

Several studies have explored the risk incentive effect of compensation on various operating and financing decisions of the firm. Coles, Daniel, and Naveen (2006) examine the risk incentive element of compensation on corporate and financing decisions of the firm

(investment policy, debt policy, and firm risk). They use the sensitivity of CEO wealth to stock volatility (vega) as an indicator of marginal incentive to CEO of taking on more risk. They find higher vega leads to more investment in R&D, less investment in PPE, more focus, and higher leverage—all suggestive of higher risk. However, they find causality runs in both directions. They show that firms with higher return volatility, and higher R&D investment will lead to higher vega in CEOs' compensation structures.

Taking a cue from the Coles, Daniel, and Naveen (2006) paper, Liu and Mauer (2011) investigate the risk-incentive effect of compensation on cash holdings. The shareholder alignment suggests an inverse relationship between cash holdings and vega, consistent with observed effects on operating investments and debt ratio. Liu and Mauer, however, document a positive relation between cash holdings and vega. They hypothesize that the positive relationship is consistent with the costly contracting and/or costly external finance explanations. The costly contracting hypothesis arises from shareholder-bondholder conflict implications of risk incentive effects of compensation. Assuming the latter leads to aggressive investments and decisions that favor shareholders (over bondholders), bondholders may insist on alleviating this risk by the firm maintaining a higher cash position. The costly external finance hypothesis on the other hand is motivated by the argument that risk incentives increase the cost of external finance when the need for such finance arises. This in turn leads managers to hedge future financing needs by holding extra cash. To differentiate between the two hypotheses, Liu and Mauer conduct additional tests examining the impact of vega on the marginal value of cash. They argue that costly contracting (costly external finance) has a positive (negative) impact on the marginal value of cash. Their overall conclusion is that vega

and cash holdings are positively related and attribute this to the costly contracting hypothesis. While Liu and Mauer consider three potential explanations for the relationship between cash holdings and vega, we propose another hypothesis which they do not explore and explain this in the next section.

III. Empirical design and data

A. Hypothesis development and methodology

Liu and Mauer's (2011) costly contracting and costly external finance hypotheses rely on the use of debt and presence of bondholder-shareholder conflicts as a motivation for the positive cash-vega relationship. These explanations are unlikely to hold for firms with zero debt or negative debt. Given that a substantial portion of firms have zero or negative debt ratios, it is conceivable that the results in Liu and Mauer are due not only to a debt motivated explanation as espoused in their paper but also to an alternative explanation that we explore. We propose an alternate explanation that supports a positive cash-vega relationship. Prior research (e.g., Coles, Daniel, and Naveen, 2006) has shown that managers appropriately respond to risk incentive compensation by adopting riskier operating decisions: more R&D investments, greater firm focus, and a higher debt ratio. In view of their undiversified exposure to the firm, we argue that managers will attempt to offset or hedge some of the risk incentive by holding larger cash balances. This effect obviously can coexist with the costly contracting and/or costly external finance explanations in the case of firms that use debt financing.

Our empirical assessment begins with establishing a positive relationship between cash and vega for a sample of firms where costly contracting and costly external finance are not likely considerations in affecting their cash holdings. These explanations presume reliance on

debt as significant sources of financing. A finding of a positive cash-vega relationship in a sample of firms where debt is not a factor would suggest there may be an alternate explanation for the positive relationship that does not rely on a debt motivation. This provides the initial backdrop for our argument that the positive cash-vega relationship is driven by manager's desire to offset their personal undiversified exposure to the firm associated with higher risk incentive embedded in their compensation. We realize that simply establishing a positive cash-vega relationship for a sample of firms with zero and negative debt ratios is not proof positive in favor of our personal risk mitigation hypothesis. We provide affirmative validation for our hypothesis by conducting a series of conditional tests using proxies that capture manager's relative risk aversion. These proxies include both manager and firm based characteristics: CEO age, CEO equity ownership, R&D expenditure, firm size, and earnings volatility.

Our basic model is patterned after the one used in Liu and Mauer (2011). The basic regression model we estimate is as follows:

$$\text{Cash}_{it} = \text{Vega}/\text{TC}_{it} + \text{Delta}/\text{TC}_{it} + \text{Controls}_{it} + e_{it} \quad (1)$$

The dependent variable, Cash, is the ratio of cash and marketable securities to the book value of net assets. The primary independent variable, Vega/TC, is the dollar value change for CEO option grants based on 0.01 change in the annualized stock return deviation, scaled by total compensation. Total compensation is the sum of bonus, restricted stock and option grants, long-term incentive payouts, and any other compensation. Delta/TC is the dollar value change in CEO equity-based compensation for a 1% change in the stock price, scaled by total compensation. We follow Core and Guay (2002), Coles et al.(2006), and Daniel et al., (2013) to calculate stock price sensitivity (delta) and stock return volatility sensitivity (vega). The

remaining variables are all control variables calculated as in Opler et al. (1999): Acquisition activity is defined as the ratio of expenditures on acquisitions relative to the book value of net assets. Capex is the ratio of capital expenditures to the book value of net assets. Cash flow is the ratio of EBITDA *minus* interest *minus* taxes *minus* common dividends to the book value of net assets. Dividend dummy is a dummy variable equal to one if the firm paid a common dividend in that year, and zero if it did not. Firm sigma is the standard deviation of cash flow over 5 years. Leverage is the ratio of total debt relative to the book value of net assets, where debt includes long-term debt plus debt in current liabilities. Log firm size is the natural logarithm of net assets. Market to book is measured as: (book value of total assets – book value of equity + market value of equity)/book value of net assets. NWC is the ratio of net working capital *minus* cash *plus* marketable securities to the book value of net assets. R&D is the ratio of research and development expense to sales. Finally, firm age is the difference between the sample year and the first year that the firm shows up on Compustat.

We estimate regression equation (1) in a variety of ways to ensure robustness of our results. Estimates are presented using contemporaneous values for compensation incentives, lagged incentive variables, 2-SLS with contemporaneous incentive variables, and 2-SLS with lagged incentive variables. For the 2-SLS models, we use CEO age and firm age as instruments for vega.

To test our hypothesis that the vega-cash relationship is moderated by managerial risk aversion, we modify equation (1) to include an interaction term between Vega/TC and a proxy for managerial risk aversion:

$$\text{Cash}_{it} = \text{Vega}/\text{TC}_{it} + \text{Vega}/\text{TC} * \text{RiskAversion}_{it} + \text{Delta}/\text{TC}_{it} + \text{Controls}_{it} + e_{it} \quad (2)$$

Proxies for managerial risk aversion include CEO age, CEO equity stake, R&D expenditure, firm size, and firm volatility. As CEOs near retirement, we expect CEOs to become more risk averse as they would not want to sustain any significant losses to their personal wealth in the firm or suffer any professional loss in reputation, which would be difficult to recover from in the remaining time to retirement. Similarly, we expect CEOs with large equity stakes to mitigate some of the risk incentive effects by maintaining larger firm liquidity positions. CEO equity stake is defined as value of the CEO's stock and option portfolio in the company she works for. Risk incentives associated with firms with higher R&D expenditures are expected to motivate managers to maintain higher cash balances as well as to offset some of the higher operating risk associated with these investments. Similarly, we expect managers to want to maintain higher liquidity for firms where risk incentives are associated with greater firm volatility and smaller firm size. To ease the interpretation of the interactions we use demeaned terms for the interactions as recommended by Williams (2013) and Ozer-Balli and Sorensen(2013).

B. Data and descriptive statistics

We use the ExecuComp database to build our sample. Our sample contains executive compensation and other data for firms in the S&P 500 (large cap), S&P 400 (midcap), and S&P 600 (small-cap) indices for the period 1992-2010. From this list we screen firms for zero or negative net debt ratio. We also filter out firms in regulated industries including financial services and utilities (SIC codes 6000-6999, 4900-4999). All non-compensation related data is taken from Compustat.

<Insert Table 1 Here>

Table 1 panel A presents sample descriptive statistics. The sample consists of 3,498 firm year observations. The median ratio of cash holdings to net assets is 39 percent. For the median firm, a one percent increase in volatility is associated with approximately \$64,000 increase in the CEO's wealth while a one percent increase in stock price is associated with approximately \$245,000 increase in CEO wealth. These increases in wealth translate to approximately 6.6 and 21.3 percent of total CEO compensation. The median CEO age is 55 years and has an equity stake of slightly over \$19 million. The median log firm size is 6.33. The median market to book ratio is 2.54 and the median return on asset is 5.4 percent. The median volatility of operating earnings is 13.4 percent and the median capital expenditure to net assets is 10.3 percent. Median R&D expenditure to sales is 6.6 percent and the median net working capital to net assets is 16.4 percent. The median firm reports zero acquisition activity and approximately a third of the firms report having paid dividends.

Table 1 panel B presents pair-wise correlations between the cash and risk incentive compensation and other variables. Vega is positively correlated with cash holdings. With the exception of firm size, all other pair-wise correlations between vega and delta and the independent variables are fairly low.

<Insert Table 2 Here>

Table 2 contains regression estimates of equation (1). Columns 1 and 2 contain estimates for equation (1) using OLS and 2-SLS methods with contemporaneous values for the compensation incentive variables (vega/TC and delta/TC). Columns 3 and 4 are similar to columns 1 and 2 but with only the risk incentive variable (vega/TC) and controls as the independent variables (delta/TC omitted). Columns 5-8 are analogous to columns 1-4 but with

lagged rather than contemporaneous values for the incentive variables. Industry and year dummies are included in all models. The results are fairly consistent across the various estimation methods. Consequently, our discussion is based on the OLS estimates (column 1). Our results basically replicate the findings of Liu and Mauer (2011) but restricted to a sample of firms with zero or negative debt ratios. Because Liu and Mauer's explanation for a positive cash-vega relationship relies on a debt financing motivation, the presence of a positive relationship for a sample of firms with zero or negative debt ratio would imply an alternate explanation that does not rely on debt motivated explanation. As revealed in Table 2, vega/TC is strongly positively related to cash holdings. Thus it is unlikely that the positive impact of risk incentive compensation on cash holdings can be solely attributed to the costly contracting or costly external finance hypotheses espoused by Liu and Mauer. With respect to delta/TC we observe a significant positive impact on cash holdings but less significant than vega/TC. Firm size, earnings volatility, and cash flow are significantly positively related to cash holdings, while net working capital and acquisition are negatively related to cash holdings. The other explanatory variables are generally not significant across the models. Qualitatively these findings are similar to those reported in Liu and Mauer.

<Insert Table 3 Here>

The strong positive cash-vega relationship for our sample indicates that managers have other motivations for holding higher cash balances than one based on creditor considerations. We next turn to additional tests that explore the validity of our managerial risk aversion hypothesis in explaining the positive effect. Table 3 presents equation (2) estimates. Recall that this equation adds interaction terms between vega/TC and proxies for managerial risk

aversion to those in equation (1). Table 3 regression estimates include the two CEO characteristics of managerial risk aversion—CEO age and CEO equity stake. Table 4 contains estimates based on firm characteristics suggestive of greater managerial risk aversion—R&D expenditure, firm size, and firm volatility. In addition, the final set of estimates includes all interactions considered simultaneously. Table 3 column 1 contains regression estimates with vega/TC interacted with CEO age while column 2 interacts vega/TC with CEO equity stake and the last column considers both interactions simultaneously. The vega/TC variable is significantly positive in all equations. CEO age is significantly positive indicating that older CEOs prefer to hold larger cash balances consistent with the view that older CEOs are more risk averse. The interaction term of CEO age with vega/TC is positive but not significant providing only qualitative evidence that older CEOs are more likely to offset the risk incentive effect of compensation by holding a larger cash balance. CEO equity stake is positively related to cash holdings suggesting that with higher undiversified exposure to the firm managers are likely to hold larger cash balances. Their desire to hold larger cash balances is enhanced when incented to take on more risky investments as revealed by the significantly positive CEO ownership-vega/TC interaction term.

<Insert Table 4 Here>

Table 4 columns 1-3 present interaction effects for the three firm based measures of managerial risk aversion. In all equations vega/TC is positively related to cash holdings. Column 1 reveals a significant negative interaction term between vega/TC and R&D expenditure. We interpret this to mean that when managers are incented to take on more risky investments (high vega/TC) they are likely to offset their personal risk through greater

liquidity for the more intense R&D firms. From column 2 we observe that smaller firms are associated with greater cash holdings, which is expected. The higher operating risk and difficulty of accessing financial markets necessitates that smaller firms maintain larger cash balances. The risk incentive effect is enhanced for smaller firms as revealed by the negative coefficient for the vega/TC-firm size interaction term. We interpret this to mean that manager's risk aversion is greater in smaller firms and respond to the risk incentive effect of compensation by enhancing liquidity to a greater degree than larger firms. Column 3 presents estimates with the interaction term between vega/TC and firm earnings volatility. We anticipate that managerial risk aversion will be greater for firms that have higher earnings volatility. Given that risk incentives encourage managers to undertake riskier investments it is expected that the higher managerial risk aversion in high firm volatility firms will encourage them to raise cash holdings to offset the firm risk promoted by the risk incentive inherent in their compensation. Column 4 includes all of the preceding three interaction terms simultaneously; the results are qualitatively unaffected when all the three interactions are considered simultaneously. Column 5 includes all five interactions variables with vega/TC—the two CEO level variables and the three firm level variables indicative of greater managerial risk aversion. The comprehensive regression in column 5 mirrors results observed when interactions are considered individually. Overall, our results support the view that for firms where net debt is zero or negative, managers with a higher propensity for risk aversion are likely to offset the risk incentive effect of compensation by increasing firm liquidity.

<Insert Table 5 Here>

The results presented above are for firms that have zero or negative net debt ratios. Our next step is to see if our results also hold for positive net debt ratio firms. Liu and Mauer (2011) argue that creditors of firms with strong risk incentive compensation insist on higher liquid balances to offset the greater propensity for risky investment decisions by these firms. If this is the primary determinant of the vega-cash holdings relationship, we should find that managerial risk aversion should not be a significant determinant of the vega-cash holdings relationship for positive net debt firms. In Table 5 we present results of equation (2). We present estimates using lagged incentive variables. Column 5 presents results for all five interaction terms considered at the same time. The interaction terms for CEO age, R&D, firm size, and firm volatility are significant in a manner consistent with the managerial risk aversion hypothesis. Interestingly, the lagged vega/TC variable is not significant in column 5 though it is significant in the reduced model without interaction terms (column 1) and the model with CEO interaction terms (column 2). The results for Table 5 inform us that managerial risk aversion is a contributing factor in explaining the positive impact of risk incentives on corporate cash holdings even for positive net debt ratio firms.

V. Conclusion

Recently Liu and Mauer (2011) document that risk incentive compensation (vega) is associated with higher cash holdings. They explain this by resorting to a bondholder-shareholder agency conflict explanation. Specifically, since risk incentives encourage managers to undertake riskier investments, creditors are likely to insist on higher liquid balances to reduce their risk exposure to the firm. We propose that managerial risk aversion may also provide an alternate explanation for the positive vega-cash holdings relationship documented

by Liu and Mauer. Specifically, owing to their undiversified risk in the firm which is exacerbated with greater risk incentive compensation, managers may mitigate the effects of higher risk investments they undertake by holding higher cash balances. So, in other words we assume that managers do respond appropriately to risk incentives by undertaking riskier projects (e.g., risky R&D) but mitigate this increased risk by holding larger cash balances. Using several proxies for propensity for managerial risk aversion including CEO age, CEO equity stake, firm size, R&D, and firm volatility we find that the vega-cash holding relationship becomes more positive as the propensity for risk aversion increases. To ensure that the relationship is not driven by creditors we restrict our sample to firms with zero or negative debt ratios. However, we find that our results hold qualitatively for a sample of firms with positive net debt.

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Table 1

Descriptive statistics and correlations of firm characteristics, CEO characteristics and CEO compensation incentives. The sample includes all continuous non-positive levered firm-years in the ExecuComp and Compustat databases during the period 1992 to 2010. The sample excludes financial and utility firms. Panel A reports descriptive statistics, and Panel B reports Pearson correlation coefficients. Vega and delta and all control variables are winsorized at the 1st and 99th percentiles. ***, **, and * in Panel B denote significance at the 1%, 5%, and 10% levels, respectively.

| Panel A | | | | | | |
|-----------------------------|------|-----------|------------|--------------|-----------|--------------|
| Description statistics | | | | | | |
| Variable | N | Mean | Std Dev | 1st Quartile | Median | 3rd Quartile |
| Cash | 3489 | 0.599 | 0.641 | 0.215 | 0.390 | 0.719 |
| CEO compensation incentives | | | | | | |
| Vega | 3489 | 131.116 | 170.688 | 25.129 | 64.389 | 165.439 |
| Delta | 3489 | 852.669 | 3159.000 | 82.350 | 245.064 | 693.772 |
| Vega/TC | 3489 | 0.101 | 0.108 | 0.028 | 0.066 | 0.133 |
| Delta/TC | 3489 | 0.659 | 2.209 | 0.092 | 0.213 | 0.526 |
| Instruments | | | | | | |
| CEO age | 3489 | 54.744 | 7.428 | 50.000 | 55.000 | 60.000 |
| Firm age | 3489 | 21.377 | 12.167 | 12.000 | 17.000 | 28.000 |
| Control variables | | | | | | |
| CEO equity stake | 3489 | 77008.000 | 312072.000 | 6418.150 | 19033.900 | 55955.400 |
| R&D/sales | 3489 | 0.218 | 3.202 | 0.000 | 0.058 | 0.158 |
| Log firm size | 3489 | 6.570 | 1.822 | 5.315 | 6.333 | 7.600 |
| Firm sigma | 3489 | 0.410 | 1.405 | 0.065 | 0.134 | 0.279 |
| Market to book | 3488 | 2.857 | 18.765 | 1.551 | 2.451 | 3.944 |
| Return on asset | 3488 | 0.023 | 0.199 | 0.007 | 0.054 | 0.104 |
| Capex/net assets | 3489 | 0.214 | 0.458 | 0.050 | 0.103 | 0.206 |
| Cash flow/net assets | 3489 | 0.156 | 2.459 | 0.077 | 0.296 | 0.560 |
| NWC/net assets | 3489 | -0.181 | 2.415 | -0.166 | 0.164 | 0.442 |
| Acquisition activity | 3489 | 0.100 | 0.375 | 0.000 | 0.000 | 0.047 |
| Dividend dummy | 3489 | 0.351 | 0.477 | 0.000 | 0.000 | 1.000 |

Panel B

Correlation between cash, CEO incentives, and firm characteristics

| Variable | Cash | Vega | Delta | Vega/TC | Delta/TC |
|----------------------|----------|----------|---------|----------|----------|
| Cash | 1.00 | | | | |
| Vega | -0.05*** | 1.00 | | | |
| Delta | -0.02 | 0.23*** | 1.00 | | |
| Vega/TC | 0.03* | 0.63*** | 0.12*** | 1.00 | |
| Delta/TC | -0.01 | 0.11*** | 0.69*** | 0.21*** | 1.00 |
| CEO age | -0.05*** | 0.03** | 0.11*** | -0.06*** | 0.09*** |
| Firm age | -0.20*** | 0.19*** | -0.01 | 0.03** | -0.05*** |
| CEO equity stake | -0.02 | 0.20*** | 0.99*** | 0.10*** | 0.70*** |
| R&D/sales | 0.09*** | -0.02 | -0.01 | -0.02 | -0.01 |
| Log firm size | -0.41*** | 0.55*** | 0.23*** | 0.29*** | 0.12*** |
| Firm sigma | 0.30*** | -0.08*** | -0.04** | -0.05** | -0.04** |
| Market to book | -0.05** | 0.04** | 0.04** | 0.01 | 0.03** |
| Return on asset | -0.15*** | 0.15*** | 0.07*** | 0.10*** | 0.06*** |
| Capex/net assets | 0.06*** | -0.03* | -0.02 | 0.02 | 0.01 |
| Cash flow/net assets | -0.19*** | 0.08*** | 0.03* | 0.07*** | 0.03* |
| NWC/net assets | -0.20*** | -0.01 | 0.01 | -0.00 | 0.02 |
| Acquisition activity | -0.02 | 0.04*** | 0.00 | 0.08*** | -0.01 |
| Dividend dummy | -0.24*** | 0.17*** | 0.10*** | -0.02 | 0.06*** |

Table 2

Regressions of cash holdings on CEO compensation incentives and control variables. The dependent variable is the ratio of cash plus marketable securities to net assets. All independent variables are as defined in the data and descriptive statistics section. Models 1–4 regress cash holdings in fiscal year t on CEO vega/tc and delta/tc incentives in year t. We use CEO age and firm age as instrument variables in the 2SLS (two stage least squares) estimations. Models 5–8 regress cash holdings in fiscal year t on CEO vega/tc and delta/tc incentives in year t-1. CEO vega/tc and delta/tc incentives in year t-1 help to predict the cash holding ratio in year t. Industry dummies are based on two-digit Standard Industrial Classification codes. t-statistics are in parentheses below parameter estimates. The t-statistics for models 1, 3, 5, 6, and 7 are based on heteroskedastic-consistent standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

| Independent variable | Contemporaneous incentives(1) | 2SLS(2) | Contemporaneous incentives (3) | 2SLS(4) | Lagged incentives (5) | Lagged 2SLS(6) | Lagged incentives (7) | Lagged 2SLS(8) |
|------------------------|-------------------------------|-----------------------|--------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Vega/TC | 0.740 (7.71)*** | 2.441 (2.36)** | 0.761 (7.99)*** | 2.108 (2.1)** | 0.736 (7.15)*** | 5.134 (2.91)*** | 0.744 (7.24)*** | 4.890 (2.84)*** |
| Delta/TC | 0.005 (2.16)** | 0.013 (2.76)*** | | | 0.007 (2.36)** | 0.010 (1.67)* | | |
| R&D/sales | 1.76E-05 (0.00) | 0.001 (0.20) | 1.41E-05 (0.00) | 0.001 (0.21) | -2E-04 (-0.04) | 4.1E-05 (0.01) | -1.8E-04 (-0.03) | 7.5E-05 (0.02) |
| Log firm size | -0.147 (-17.72)*** | -0.135 (-18.62)*** | -0.147 (-17.69)*** | -0.132 (-18.86)*** | -0.140 (-17.79)*** | -0.135 (-15.22)*** | -0.139 (-17.73)*** | -0.133 (-15.47)*** |
| Firm sigma | 0.082 (3.21)*** | 0.084 (7.31)*** | 0.081 (3.21)*** | 0.083 (7.48)*** | 0.078 (3.12)*** | 0.078 (5.67)*** | 0.078 (3.12)*** | 0.078 (5.8)*** |
| Market to book | -0.001 (-0.59) | -0.001 (-1.35) | -0.001 (-0.58) | -0.001 (-1.35) | -0.001 (-0.74) | -0.001 (-1.2) | -0.001 (-0.73) | -0.001 (-1.21) |
| Return on asset | 0.079 (1.15) | 0.103 (1.72)* | 0.080 (1.17) | 0.107 (1.83)* | 0.093 (1.36) | 0.100 (1.38) | 0.093 (1.36) | 0.099 (1.41) |
| Capex/net assets | -0.028 (-0.84) | -0.021 (-0.77) | -0.028 (-0.83) | -0.019 (-0.74) | -0.020 (-0.64) | -0.019 (-0.59) | -0.019 (-0.61) | -0.017 (-0.55) |
| Cash flow/net assets | 0.034 (2.66)*** | 0.038 (4.83)*** | 0.0341 (2.64)*** | 0.037 (4.89)*** | 0.029 (2.39)** | 0.032 (3.38)*** | 0.029 (2.39)** | 0.031 (3.44)*** |
| NWC/net assets | -0.038 (-1.83)* | -0.04 (-6.37)*** | -0.038 (-1.83)* | -0.04 (-6.48)*** | -0.034 (-1.73)* | -0.036 (-4.78)*** | -0.034 (-1.73)* | -0.036 (-4.87)*** |
| Acquisition activity | -0.104 (-4.62)*** | -0.093 (-3.53)*** | -0.104 (-4.64)*** | -0.094 (-3.67)*** | -0.100 (-4.36)*** | -0.090 (-2.76)*** | -0.100 (-4.4)*** | -0.091 (-2.86)*** |
| Dividend dummy | -0.029 (-1.46) | -0.045 (-1.84)* | -0.029 (-1.44) | -0.045 (-1.89)* | -0.030 (-1.51) | -0.040 (-1.38) | -0.031 (-1.53) | -0.041 (-1.42) |
| Industry dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of observations | 3488 | 3488 | 3488 | 3488 | 3409 | 3409 | 3409 | 3409 |
| Adj.R ² | 0.63 | 0.60 | 0.63 | 0.61 | 0.63 | 0.50 | 0.63 | 0.52 |

Table 3

Regressions of cash holdings on CEO compensation incentives, control variables and CEO characteristic interaction terms. The dependent variable is the ratio of cash plus marketable securities to net assets. All control variables are as defined in the data and descriptive statistics section. Interaction CEO age is the interaction term of vega/tc in time t-1 and CEO age in time t. Interaction CEO equity stake is the interaction term of vega/tc in time t-1 and CEO equity stake in time t. Models 1–3 regress cash holdings in fiscal year t on CEO vega/tc and delta/tc incentives in year t-1. Industry dummies are based on two-digit Standard Industrial Classification codes. t-statistics are in parentheses below parameter estimates. The t-statistics for models 1, 2, and 3 are based on heteroskedastic-consistent standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

| Independent variable | (1) | (2) | (3) |
|------------------------------|-----------------------|-----------------------|-----------------------|
| Lag Vega/TC | 0.736 (6.90)*** | 0.523 (4.22)*** | 0.520 (4.09)*** |
| Interaction CEO age | 0.267 (1.27) | | 0.159 (0.76) |
| CEO age | 0.002 (1.46) | | 0.001 (1.06) |
| Interaction CEO equity stake | | 0.503 (3.46)*** | 0.482 (3.30)*** |
| CEO equity stake | | 1.13E-07 (6.21)*** | 1.08E-07 (5.9)*** |
| R&D/sales | 6.87E-05 (0.01) | -2.98E-04 (-0.06) | -2.50E-04 (-0.05) |
| Log firm size | -0.150 (-19.31)*** | -0.159 (-19.76)*** | -0.158 (-19.67)*** |
| Firm sigma | 0.074 (2.98)*** | 0.073 (2.94)*** | 0.073 (2.94)*** |
| Market to book | -0.001 (-0.71) | -0.001 (-0.75) | -0.001 (-0.75) |
| Return on asset | 0.089 (1.31) | 0.085 (1.23) | 0.082 (1.2) |
| Capex/net assets | -0.021 (-0.66) | -0.024 (-0.73) | -0.022 (-0.68) |
| Cash flow/net assets | 0.030 (2.44)** | 0.029 (2.36)** | 0.029 (2.38)** |
| NWC/net assets | -0.036 (-1.81)* | -0.035 (-1.78)* | -0.036 (-1.79)* |
| Acquisition activity | -0.098 (-4.33)*** | -0.095 (-4.15)*** | -0.095 (-4.16)*** |
| Dividend dummy | -0.034 (-1.73)* | -0.029 (-1.46) | -0.033 (-1.66)* |
| Industry dummies | Yes | Yes | Yes |
| Year dummies | Yes | Yes | Yes |
| Number of observations | 3409 | 3409 | 3409 |
| Adj. R ² | 0.64 | 0.64 | 0.64 |

Table 4

Regressions of cash holdings on CEO compensation incentives, control variables and firm characteristic interaction terms. The dependent variable is the ratio of cash plus marketable securities to net assets. All control variables are as defined in the data and descriptive statistics section. Interaction R&D/sales is the interaction term of vega/tc in time t-1 and R&D/sales in time t. Interaction firm size is the interaction term of vega/tc in time t-1 and firm size in time t. Interaction firm sigma is the interaction term of vega/tc in time t-1 and firm sigma in time t. Models 1–3 regress cash holdings in fiscal year t on CEO vega/tc and delta/tc incentives in year t-1. Industry dummies are based on two-digit Standard Industrial Classification codes. t-statistics are in parentheses below parameter estimates. The t-statistics for Models 1, 2, 3, and 4 are based on heteroskedastic-consistent standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

| Independent variable | (1) | (2) | (3) | (4) | (5) |
|----------------------------|----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Lag Vega/TC | 0.886 (4.54)*** | 0.608 (6.32)*** | 1.195 (5.83)*** | 0.607 (6.21)*** | 0.630 (3.29)*** |
| Interaction CEO age | | | | | 0.253 (1.23) |
| CEO age | | | | | 0.002 (1.32) |
| Interact. CEO equity stake | | | | | 0.598 (3.95)*** |
| CEO equity stake | | | | | 1.04E-07 (5.82)*** |
| Interaction R&D/sales | 0.920 (2.46)** | 1.359 (3.59)*** | | | 0.978 (2.58)*** |
| R&D/sales | 0.002 (0.33) | 0.001 (0.23) | 1.61E-04 (0.03) | 0.001 (0.23) | 0.001 (0.29) |
| Interaction log firm size | -0.508 (-2.48)** | | -0.660 (-3.12)*** | | -0.599 (-2.86)*** |
| Log firm size | -0.137 (-15.3)*** | -0.149 (-19.32)*** | -0.137 (-15.19)*** | -0.148 (-19.18)*** | -0.143 (-15.71)*** |
| Interaction firm sigma | 1.006 (2.9)*** | | | 1.431 (4.19)*** | 1.065 (3.02)*** |
| Firm sigma | 0.064 (2.75)*** | 0.073 (3.03)*** | 0.074 (3.05)*** | 0.060 (2.59)*** | 0.062 (2.69)*** |
| Market to book | -0.001 (-0.79) | -0.001 (-0.76) | -0.001 (-0.75) | -0.001 (-0.76) | -0.001 (-0.82) |
| Return on asset | 0.144 (2.14)** | 0.134 (1.94)* | 0.090 (1.32) | 0.130 (1.98)** | 0.133 (1.97)** |
| Capex/net assets | -0.036 (-1.18) | -0.031 (-0.99) | -0.025 (-0.8) | -0.032 (-1.05) | -0.035 (-1.13) |
| Cash flow/net assets | 0.027 (2.35)** | 0.032 (2.69)*** | 0.029 (2.37)** | 0.025 (2.15)** | 0.027 (2.29)** |
| NWC/net assets | -0.036 (-1.93)* | -0.037 (-1.91)* | -0.036 (-1.78)* | -0.035 (-1.89)* | -0.036 (-1.92)* |
| Acquisition activity | -0.111 (-5.21)*** | -0.111 (-5.13)*** | -0.095 (-4.16)*** | -0.108 (-5.03)*** | -0.108 (-5.02)*** |
| Dividend dummy | -0.019 (-0.98) | -0.021 (-1.04) | -0.028 (-1.42) | -0.024 (-1.19) | -0.025 (-1.25) |
| Industry dummies | Yes | Yes | Yes | Yes | Yes |
| Year dummies | Yes | Yes | Yes | Yes | Yes |
| Number of observations | 3409 | 3409 | 3409 | 3409 | 3409 |
| Adj. R ² | 0.64 | 0.64 | 0.64 | 0.64 | 0.65 |

Table 5

Regressions of cash holdings on CEO compensation incentives, CEO characteristics and firm characteristics and their interactions, and control variables. The sample includes all positive levered firm-years in the ExecuComp and Compustat database during the period 1992 to 2010. The dependent variable is the ratio of cash plus marketable securities to net assets. All control variables are as defined in the data and descriptive statistics section. Interaction CEO age is the interaction term of vega/tc in time t-1 and CEO age in time t. Interaction CEO equity stake is the interaction term of vega/tc in time t-1 and CEO equity stake in time t. Interaction R&D/sales is the interaction term of vega/tc in time t-1 and R&D/sales in time t. Interaction firm size is the interaction term of vega/tc in time t-1 and firm size in time t. Interaction firm sigma is the interaction term of vega/tc in time t-1 and firm sigma in time t. Models 1-4 regress cash holdings in fiscal year t on CEO vega/tc and delta/tc incentives in year t-1. Industry dummies are based on two-digit Standard Industrial Classification codes. t-statistics are in parentheses below parameter estimates. The t-statistics for models 1, 2, 3, and 4 are based on heteroskedastic-consistent standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

| Independent variable | (1) | (2) | (3) | (4) |
|----------------------------|----------------------|----------------------|----------------------|----------------------|
| Lag Vega/TC | 0.155 (2.86)*** | 0.228 (2.83)*** | 0.103 (1.37) | 0.110 (1.2) |
| Interaction CEO age | | -0.098 (-0.95) | | -0.091 (-0.92) |
| CEO age | | 0.002 (2.46)** | | 0.002 (2.51)** |
| Interact. CEO equity stake | | -0.011 (-0.12) | | 0.015 (0.17) |
| CEO equity stake | | -5.28E-09 (-0.31) | | -5.78E-09 (-0.36) |
| Interaction R&D/sales | | | 0.686 (4.43)*** | 0.687 (4.42)*** |
| R&D/sales | 1.867 (5.01)*** | 1.871 (4.94)*** | 1.489 (3.78)*** | 1.495 (3.75)*** |
| Interaction log firm size | | | -0.330 (-3.46)*** | -0.318 (-3.21)*** |
| Log firm size | -0.019 (-5.87)*** | -0.032 (-6.19)*** | -0.024 (-4.14)*** | -0.025 (-4.24)*** |
| Interaction firm sigma | | | 0.682 (3.57)*** | 0.681 (3.52)*** |
| Firm sigma | 0.19 (3.37)*** | 0.173 (3.00)*** | 0.151 (2.58)*** | 0.151 (2.56)** |
| Market to book | 0.019 (5.08)*** | 0.019 (5.00)*** | 0.019 (5.05)*** | 0.019 (4.98)*** |
| Return on asset | -0.006 (-0.24) | -0.004 (-0.13) | -0.004 (-0.16) | -0.004 (-0.16) |
| Capex/net assets | -0.023 (-0.94) | -0.028 (-1.12) | -0.026 (-1.05) | -0.028 (-1.11) |
| Cash flow/net assets | -0.085 (-2.01)** | -0.089 (-2.07)** | -0.092 (-2.18)** | -0.091 (-2.14)** |
| NWC/net assets | -0.131 (-4.07)*** | -0.137 (-4.09)*** | -0.138 (-4.19)*** | -0.139 (-4.16)*** |
| Acquisition activity | -0.035 (-1.97)** | -0.034 (-1.84)* | -0.034 (-1.95)* | -0.032 (-1.79)* |
| Dividend dummy | -0.06 (-4.94)*** | -0.063 (-5.21)*** | -0.059 (-5.02)*** | -0.06 (-5.00)*** |
| Leverage | 0.071 (8.10)*** | 0.069 (7.99)*** | 0.067 (7.98)*** | 0.068 (7.92)*** |
| Industry dummies | Yes | Yes | Yes | Yes |
| Year dummies | Yes | Yes | Yes | Yes |
| Number of observations | 8894 | 8894 | 8894 | 8894 |
| Adj. R ² | 0.55 | 0.55 | 0.56 | 0.56 |