Risk Reduction as a CEO's Motive for Corporate Cash Holdings

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ABSTRACT

We empirically test the risk-reduction hypothesis of the agency theory in the context of corporate cash holdings. Since corporate cash holdings can be viewed as risk-free investments, the risk-reduction hypothesis predicts that a risk-averse and self-interested CEO allocates more firm assets to corporate cash holdings to reduce firm risk at the expense of giving up some positive NPV but risky projects, which is not beneficial to shareholders. We use the sensitivity of the value of a CEO's stock options to stock return volatility (Executive Stock Options risk incentives) to study the relation between a CEO's risk incentives and corporate cash holdings. We find that firms with lower ESO risk incentives have more corporate cash holdings. We find that more corporate cash holdings reduce firm risk, and that corporate cash holdings have a negative marginal impact on firm value due to the risk-related agency problem. These findings are consistent with the risk-reduction hypothesis of the agency theory in the context of corporate cash holdings.

JEL Classification: G30; G32; G34
Keywords: Corporate cash holdings; Risk incentives; Risk reduction

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ABSTRACT

We empirically test the risk-reduction hypothesis of the agency theory in the context of corporate cash holdings. Since corporate cash holdings can be viewed as risk-free investments, the risk-reduction hypothesis predicts that a risk-averse and self-interested CEO allocates more firm assets to corporate cash holdings to reduce firm risk at the expense of giving up some positive NPV but risky projects, which is not beneficial to shareholders. We use the sensitivity of the value of a CEO's stock options to stock return volatility (Executive Stock Options risk incentives) to study the relation between a CEO's risk incentives and corporate cash holdings. We find that firms with lower ESO risk incentives have more corporate cash holdings. We find that more corporate cash holdings reduce firm risk, and that corporate cash holdings have a negative marginal impact on firm value due to the risk-related agency problem. These findings are consistent with the risk-reduction hypothesis of the agency theory in the context of corporate cash holdings.

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Opler, Pinkowitz, Stulz and Williamson (1999) argue that corporate cash holdings can be explained by the tradeoff theory, the financing hierarchy theory, and the agency theory. Among these, the agency theory has received much attention. The literature focuses on whether the agency theory can explain the level of corporate cash holdings (e.g., Opler et al., 1999; Dittmar, Marht-Smith and Servaes, 2003), and whether corporate cash holdings affect firm value through the agency problem (e.g., Harford, 1999; Mikkelson and Partch, 2003).

The agency theory includes two perspectives in the context of corporate cash holdings. First, since corporate cash holdings can be viewed as a source of financing available to the manager who serves his own interest instead of the shareholder's interest, corporate cash holdings are free cash flows (e.g., Jensen, 1986; Harford, 1999). This perspective can be called the "free cash flow hypothesis". Second, since corporate cash holdings can be viewed as risk-free investments, a risk-averse and self-interested CEO can allocate more firm assets to corporate cash holdings to reduce firm risk at the expense of giving up some positive NPV but risky projects, which is not beneficial to shareholders. This kind of risk reduction is a typical agency problem. For example, Amihud and Lev (1981) argue that a risk-averse manager may select lower NPV but less risky investment projects, which can reduce firm value. This perspective can be called the "risk-reduction hypothesis".

Previous papers in the literature have mainly focused on the free cash flow hypothesis, while leaving the risk-reduction hypothesis largely unexamined. To our knowledge, only Opler et al. (1999) attempt to study whether managerial risk incentives affect the level of corporate cash holdings, but they do not find supporting evidence.

The motivation of this paper is to empirically test the risk-reduction hypothesis of the agency theory in the context of corporate cash holdings. Compared with Opler et al. (1999), we include two improvements. First, we use a better measure for managerial risk incentives than the one used in Opler et al. (1999), which enables us to differentiate between the free cash flow hypothesis and the risk-reduction hypothesis. Second, we complement the study by investigating how corporate cash holdings affect firm value due to the risk-related agency

problem, which is an essential prediction in the risk-reduction hypothesis. This was not done in Opler et al. (1999).

In this study, we use a panel data of 2095 firms with 11018 firm-year observations. We focus on a CEO's risk incentives in this study.[1] Our measure for a CEO's risk incentives is derived from executive stock options (ESO). Following Guay (1999), we use the sensitivity of the value of a CEO's stock options to stock return volatility (ESO risk incentives) as the measure for a CEO's risk incentives.

We find that firms with lower ESO risk incentives have more corporate cash holdings. On average, we find that firms with lower ESO risk incentives have 1.4% more corporate cash holdings. We also find that more corporate cash holdings reduce firm risk. Moreover, we find that corporate cash holdings have a negative marginal impact on firm value due to the risk-related agency problem. On average, we find that a 1% increase in corporate cash holdings has the marginal impact of reducing firm value by 0.49%, due to the risk-related agency problem. These findings are consistent with the interpretation that a risk-averse and self-interested CEO allocates more firm assets to corporate cash holdings to reduce firm risk in a way that is not beneficial to shareholders.

We conduct robustness checks for these results. First, we calculate ESO risk incentives by using an alternative valuation method of executive stock options, as previous research (e.g., Huddart, 1994) has demonstrated that the valuation of executive stock options can be different from ordinary options. Second, we examine potential measurement errors in Tobin's Q as the measure for firm value, because it does not include the market value of debt. Third, we use size-adjusted ESO risk incentives to get relevant measures. We find similar results in these robustness checks.

Finally, we investigate two potential endogeneity issues in the analysis. First, according to the optimal contracting framework, the principal designs the compensation contracts of the agent so that ESO risk incentives can be endogenous. We use the Heckman two-stage estimation, and find similar results, in that firms with lower ESO risk incentives have more corporate cash holdings. Second, we use two-stage least square (2SLS) estimation due to the

endogenous corporate cash holdings, and find similar results, in that corporate cash holdings have a negative marginal impact on firm value due to the risk-related agency problem.

We conclude that these findings are consistent with the risk-reduction hypothesis of the agency theory in the context of corporate cash holdings.

The paper is organized as follows. Section I reviews the literature and develops the hypothesis. Section II describes the sample and variables. Section III describes the methodology. Section IV presents the results. Section V reports the robustness checks. Section VI examines the endogeneity issues. We conclude in Section VII.

I. Literature Review and Hypothesis Development

In this section, we first review the related literature on corporate cash holdings. Then we briefly review the related literature on ESO risk incentives. Finally we proceed to the hypothesis development.

A. Literature Review on Corporate Cash Holdings

We first review the literature on the agency theory in the context of corporate cash holdings. Opler, Pinkowitz, Stulz and Williamson (1999) argue that corporate cash holdings can be explained by the agency theory. They use managerial ownership as the combined measure for the free cash flow hypothesis and the risk-reduction hypothesis, but they do not find empirical evidence in support of the agency theory. Dittmar, Marhr-Smith and Servaes (2003) find that corporate cash holdings in different countries are affected by the degree of shareholder protection from law, and argue that it is consistent with the free cash flow hypothesis because firms with low shareholder protection cannot make managers disgorge cash. Harford (1999) finds that cash-rich firms are more likely to make value-decreasing acquisitions, and argues that it is consistent with the free cash flow hypothesis. Mikkelson and Partch (2003) find that firms with persistent high cash holdings do not have lower operating performances, and argue that it does not support the free cash flow hypothesis. In both Harford (1999) and Mikkelson et al. (2003), managerial ownership is used as the measure for

the agency problem. Dittmar and Mahrt-Smith (2006) find that corporate governance has a substantial impact on firm value through its impact on cash, which supports the free cash flow hypothesis. Pinkowitz, Stulz and Williamson (2006) examine the impact of investor protection across different countries on the value of corporate cash holdings and dividends.

Besides the agency theory, previous research has proposed other explanations for corporate cash holdings. Opler, Pinkowitz, Stulz and Williamson (1999) argue that corporate cash holdings can be explained by the tradeoff theory and the financing hierarchy theory.[2] Kim, Mauer and Sherman (1998) develop a tradeoff model and argue that the optimal amount of corporate cash holdings is determined by the tradeoff between lower returns and the benefits of minimizing the need for costly external financing. Almeida, Campello and Weisbach (2004) find that corporate cash holdings are affected by financial constraints. Pinkowitz and Williamson (2001) find that bank power can affect cash holdings in Japanese firms. Faulkender and Wang (2006) examine the variation in the marginal value of corporate cash holdings arising from differences in corporate financial policy. Foley, Hartzell, Titman and Twite (2006) propose a tax-based explanation on corporate cash holdings.

B. Literature Review on ESO Risk Incentives

Risk reduction is a typical agency problem between managers and shareholders. Amihud and Lev (1981) argue that risk-averse managers may select lower NPV but less risky projects, which reduces firm value. They apply this rationale to explain corporate diversification. Smith and Stulz (1985) make the similar argument that risk-averse managers may reject variance-increasing positive NPV projects.

Previous research has suggested using executive stock options to overcome this agency problem. Jensen and Meckling (1976) find that managers may behave in a risk-averse way which changes the operating characteristics of the firm and transfer wealth from stockholders to bondholders, and argue that one solution is to establish an incentive compensation system by giving the managers stock options. Moreover, previous research has pointed out that it is the convexity effect of option payoffs which gives managers risk-taking incentives. Lambert, Larcker and Verrecchia (1991) argue that since stock options can affect managerial risk

preference through both the convexity effect of option payoffs and the concavity of the managerial utility function, it is the convexity effect of option payoffs that makes managers less risk averse. Ross (2004) makes a similar argument by developing a general theory to prove that the convexity effect of option payoffs can always make managers less risk averse.

Recent literature has explicitly studied how the convexity effect of option payoffs affects managerial risk reduction. Guay (1999) develops an empirical measure for the convexity effect of option payoffs by using the sensitivity of the value of a CEO's stock options to stock return volatility (ESO risk incentives). Knopf, Nam and Thornton (2002) find that firm's use of derivatives is negatively related with ESO risk incentives. Rajgopal and Shevlin (2002) find that ESO risk incentives increase exploration risk taking in oil and gas firms. Coles, Daniel and Naveen (2006) find that ESO risk incentives implement riskier investments and financial policy choices, including relatively more investments in R&D, less investments in property, plant and equipment, more focus on fewer lines of business, and higher leverage.

C. Motivation and Hypothesis Development

C.1. Motivation

The motivation of this paper is to test the risk-reduction hypothesis of the agency theory in the context of corporate cash holdings. This paper has the following contributions compared with previous research.

First, we use the sensitivity of the value of a CEO's stock options to stock return volatility (Executive Stock Options risk incentives) as the measure for managerial risk incentives, instead of managerial ownership, which is used in Opler et al. (1999). ESO risk incentives provide a better measure for testing the risk-reduction hypothesis. As recognized by Opler et al. (1999), there are drawbacks in using managerial ownership as the measure, because it can be the proxy for both the risk-reduction hypothesis and the free cash flow hypothesis. For example, if we find a positive relation between managerial ownership and the level of corporate cash holdings, it can be interpreted in two different ways. On one hand, since managers are more risk averse due to higher ownership, they allocate more firm assets to corporate cash holdings to reduce firm risk. On the other hand, since managers are more

entrenched due to higher ownership (e.g., Stulz, 1988), they want to accumulate more cash holdings as free cash flows. In this case, it will not allow us to differentiate between the risk-reduction hypothesis and the free cash flow hypothesis if we use managerial ownership as the measure. Since ESO risk incentives only measure managerial risk incentives instead of the degree of entrenchment, this is a better measure for testing the risk-reduction hypothesis.

Second, we complement previous research by studying the marginal impact of corporate cash holdings on firm value due to the risk-related agency problem. The analysis on firm value has not been done in Opler et al. (1999). Since the risk-reduction hypothesis predicts that firm value will be reduced through this agency problem, it is necessary to investigate firm value for testing the risk-reduction hypothesis.

C.2. Hypothesis Development

C.2.1. The Risk-Related Agency Problem and Corporate Cash Holdings

The agency problem of risk reduction originates from different preferences towards risk between managers and shareholders. While the shareholder is risk neutral, the manager is risk averse.[3] Since the manager invests his human capital in a single firm, and since a substantial fraction of his wealth is tied to firm performance through a compensation scheme, he is unable to diversify firm-specific risk. As a consequence, while the risk-neutral shareholder wants to take all positive NPV projects regardless of risk, the risk-averse manager prefers to reduce firm risk by giving up some positive NPV but risky projects. This is not beneficial to the risk-neutral shareholder.

This rationale can be applied to the context of corporate cash holdings. Since corporate cash holdings are risk-free investments, a risk-averse and self-interested CEO can allocate more firm assets to corporate cash holdings to reduce firm risk at the expense of giving up some positive NPV but risky projects, which is not beneficial to shareholders. Therefore, corporate cash holdings have a negative marginal impact on firm value due to the risk-related agency problem.[4]

C.2.2. Executive Stock Options and Risk-taking Incentives

Executive stock options provide a way to mitigate the risk-related agency problem. Since the value of stock options increases with stock return volatility, this convexity effect in option payoffs provides the incentive for the manager to take risks. This can undermine the manager's risk aversion towards firm risk and thus reduce the magnitude of the risk-related agency problem. This risk-taking effect from the convexity feature in option payoff can be labeled as 'ESO risk incentives'. We quote the analysis in Guay (1999) and illustrate ESO risk incentives by the following equation.

Pratt (1964) shows that a risk-averse manager is indifferent between a risky payoff and its certainty equivalent, where the certainty equivalent is:

Certainty equivalent = E (wealth) – risk premium (1)

Guay (1999) differentiates this equation with respect to stock return volatility, where the stock return volatility is σ:

$$\frac{\partial\,(\text{Certainty equivalent})}{\partial\sigma} = \frac{\partial \text{E(wealth)}}{\partial\sigma} - \frac{\partial(\text{risk premium})}{\partial\sigma} \qquad (2)$$

ESO risk incentives correspond with the first part $\frac{\partial \text{E(wealth)}}{\partial\sigma}$ in equation (2). Since the derivative of the option value to stock return volatility is positive, it means that higher stock return volatility can increase the certainty equivalent by increasing the option value. This gives the risk-taking incentives to the CEO, which reduces the risk-related agency problem.[5]

In the context of corporate cash holdings, it implies that ESO risk incentives can encourage a manager to increase firm risk by reducing the level of corporate cash holdings. Since $\frac{\partial \text{E(wealth)}}{\partial\sigma}$ is positive due to ESO risk incentives, if the manager increases σ by reducing the level of corporate cash holdings, this can increase the certainty equivalent of the manager.

C.2.3. Hypotheses

We derive the following hypotheses for empirical tests.

First, since higher ESO risk incentives provide the manager with more incentives to take risks, we expect firms with lower ESO risk incentives to have more corporate cash holdings. Therefore, we have:

Hypothesis 1: Firms with lower ESO risk incentives have more corporate cash holdings.

Second, since corporate cash holdings can be viewed as risk-free investments, we expect that firm risk decreases with the level of corporate cash holdings. Therefore, we have:

Hypothesis 2: Firm risk decreases with the level of corporate cash holdings.

Third, a risk-averse and self-interested CEO can allocate more firm assets to corporate cash holdings to reduce firm risk at the expense of giving up some positive NPV but risky projects, which is not beneficial to shareholders. Therefore, we have:

Hypothesis 3: Corporate cash holdings have a negative marginal impact on firm value due to the risk-related agency problem.

III. Sample and Variables

A. Data and Sample

The data come from the following sources. We obtain the data on CEO stock option holdings from Execucomp, and stock return data from CRSP. We use Compustat as the source for the data on corporate cash holdings as well as other financial variables. We obtain the data on interest rates from the website of the Federal Reserve Bank.

We find firms that are in the Execucomp database from 1993 to 2000.[6] We exclude financial firms (SIC 6000-6999), because their cash holdings need to meet statutory capital requirements. Then we match Execucomp with Compustat and CRSP, and exclude the firms with incomplete data. After the screening process, we have a final sample of 2095 firms with 11018 firm-year observations.

B. Variables

In this section, we describe the variables used in the analysis.

B.1. Main Variables

Corporate Cash Holdings. We measure corporate cash holdings as the ratio of cash and marketable securities (#1) to total assets (#6).[7]

ESO Risk Incentives. We define ESO risk incentives as the number of shares outstanding in options held by a CEO times the Black-Scholes partial derivative of option value with respect to 0.01 change in the annualized standard deviation of stock return. Or it can be expressed as:

$$\text{ESO risk incentives} = (\#\text{ options held by CEO}) * \frac{\partial\,(\text{Black - Scholes option value})}{\partial(\text{Stock Return Volatility})} * 0.01 \qquad (3)$$

$$\text{With } \frac{\partial\,(\text{Black - Scholes option value})}{\partial(\text{Stock Return Volatility})} = e^{-dT}N'(Z)ST^{1/2}$$

$$Z = [\ \log(S/X) + T\left(r - d + \frac{\sigma^2}{2}\right)\ ] / \sigma T^{1/2}$$

Where N' = the normal density function
S = the price of the underlying stock
X = exercise price
σ = expected stock return volatility over life of option
r = risk-free interest rate
T = time to maturity of the option in years
d = expected dividend rate over life of option

This follows the definition in Guay (1999). We use the methodology in Core and Guay (1999) to calculate this measure. Their method has the advantage that only the data from one-year proxy statement are required. Core and Guay (2002) demonstrate that this methodology can capture more than 99% variation in the option portfolio value and sensitivities. We obtain the data on CEO option holdings, and divide them into newly granted options and previously granted options. We need six elements for the calculation: the exercise price of the option, time-to-maturity, the price of the underlying stock, expected dividend yield, expected stock return volatility, and risk-free interest rate. We can directly obtain the data for all these elements for the newly granted options. We obtain the data on the exercise price of the option, time-to-maturity, and the price of the underlying stock from Execucomp. We obtain the data on the dividend yield during the fiscal year from Execucomp as the proxy for the expected

dividend yield. For the expected stock return volatility, we use the annualized stock return volatility as the proxy, which is calculated as the standard deviation of the monthly stock return during the year multiplied by $\sqrt{12}$. We obtain the data on 10-year treasury constant maturity rate at the fiscal year end from the website of the Federal Reserve Bank to measure the risk-free interest rate. We need to obtain additional data for the previously granted options, as two elements are not available in the current year proxy statement: the exercise price and time-to-maturity. We use the current realizable value in Execucomp to calculate the average exercise price of exercisable and unexercisable options. The time-to-maturity of the unexercisable options is set equal to one year less than the time-to-maturity of the grant in the most recent year. The time-to-maturity of exercisable options is set equal to three years less than the time-to-maturity of the unexercisable options. [8]

Firm Value. We use Tobin's Q as the measure for firm value. We calculate Tobin's Q as the market value of equity (#199 multiplied by #25) minus the book value of equity (#60) plus the book value of assets (#6), divided by the book value of assets (#6).

Firm Risk. We use the standard deviation of daily stock returns during the year as the measure for firm risk.

B.2. Control Variables

We describe control variables in this section. These variables control for other determinants on the level of corporate cash holdings.

Size. Since firm size can affect corporate cash holdings due to the economy of scale in cash management (e.g., Miller and Orr, 1966), this is related with the transaction cost motive for cash holdings in the tradeoff theory (Opler et al., 1999). We expect that larger firms have less cash holdings. We use the natural logarithm of assets (#6) as the proxy for size. In some regressions, we use a dummy variable, which is one for the firm whose size is above the median of the observations in that year, and is zero otherwise.

Growth Opportunities. A higher growth opportunity means that, if faced with a cash shortage, the firm has to give up better projects. Therefore, due to the precautionary motive in

the tradeoff theory (Opler et al., 1999), we expect there to be more corporate cash holdings for the firms with higher growth opportunities. We use the growth rate of sales (#12) as the proxy for growth opportunities. In the corporate finance literature, it is common to use the market-to-book ratio as the proxy for growth opportunities. However, since the market-to-book ratio is highly correlated with Tobin's Q, it is improper to put Tobin's Q in the left hand side of the regression, and at the same time put the market-to-book ratio in the right hand side of regression. Therefore, we use sales growth rates as the alternative measure for growth opportunities.

Capital Expenditures. Opler et al. (1999) argue that capital expenditures can affect corporate cash holdings either from the tradeoff theory or from the financing hierarchy theory. The tradeoff theory predicts that firms with more capital expenditures have more cash holdings, because they have a higher precautionary motive to store cash for the situations where firms cannot get external funding for capital expenditures. However, the financing hierarchy theory predicts that firms that invest more have less cash holdings, because internal resources have been spent. Empirically, Opler et al. (1999) find corporate cash holdings increase with capital expenditures. We use the ratio of capital expenditures (#128) to assets (#6) as the proxy for a firm's capital expenditures.

Research and Development Expenses. R&D can affect corporate cash holdings in a similar way to capital expenditures, since they are also a firm's expenses. Moreover, R&D can additionally increase cash holdings through the precautionary motive, because more R&D increases asymmetric information which consequently makes external financing more costly. We use the ratio of research and development expenses (#46) to assets (#6) as the proxy for R&D.

Cash Flow. In the financing hierarchy theory (Opler et al., 1999), firms with high cash flow have more cash, as the internal source of funds is more plentiful. We use the ratio of income before extraordinary items (#18) to assets (#6) as the proxy for cash flow.

Leverage. Since higher leverage can increase the agency costs of debt (e.g., Jensen and Meckling, 1976), firms may want to keep high cash holdings to avoid the situations where the

agency costs of debt are so high that firms cannot raise funds to finance their valuable projects, according to the precautionary motive in the tradeoff theory. However, according to the financing hierarchy theory, firms with higher leverage have lower cash holdings, because firms raise debt when they do not have sufficient resources. Empirically, Opler et al. (1999) find that cash holdings are negatively related with leverage. We use the ratio of long-term debt (#9) to total assets (#6) as the proxy for leverage.

Dividends. Since the financing hierarchy theory predicts that firms have lower cash holdings if they spend more, we expect cash holdings to be lower for firms with higher dividends. We use the ratio of dividends (#21) to assets (#6) as the proxy for dividends.

Cash Flow Volatility. Cash flow uncertainty leads to the situation that sometimes firms have more outlays than expected. This can increase corporate cash holdings due to the transaction cost motive in the tradeoff theory. We expect firms with higher cash flow volatility to have more cash holdings. We use the standard deviation of the ratio of income before extraordinary items (#18) to assets (#6) in the prior three years as the proxy for cash flow volatility.

Net Working Capital. Since firms can hold other liquid assets besides cash, this can to some extent substitute corporate cash holdings. Net working capital is included to control for this. We use the ratio of net working capital, defined as working capital (#179) minus cash (#1), to assets (#6) as the proxy for net working capital.

Number of Years Being CEO. Although we have included ESO risk incentives in the regression, we still need to control for a CEO's risk aversion, as the risk-related agency problem originates from a CEO's risk aversion. However, it is difficult to construct an empirical measure for risk aversion, because a CEO's utility function is not observable to econometricians. Therefore, we use a crude measure for a CEO's risk aversion. We include a variable indicating the number of years that a CEO has been in this position in the regression. We obtain the data for this variable from Execucomp. Since this variable is related to career concern (e.g., Gibbons and Murphy, 1992), and since career concern can affect a manager's

decision on risk taking (e.g., Chevalier and Ellison, 1999), we use this variable to control for a CEO's risk aversion in the regression.

CEO Ownership. Following Opler et al. (1999), we use CEO ownership as the control variable for the free cash flow hypothesis of the agency theory in the context of corporate cash holdings. Since CEO ownership can be the measure for both the free cash flow hypothesis and the risk-reduction hypothesis, we only use it as a control variable, but do not use the estimates on CEO ownership to draw inferences about the hypotheses. We calculate CEO ownership as the sum of the proportion of shares outstanding held by a CEO plus the proportion of shares outstanding in options held by the CEO times Black-Scholes hedge ratio (the delta). Or it can be expressed as:

$$\text{CEO Ownership} = \frac{\#\,\text{Shares Held by CEO}}{\#\,\text{Shares Outstanding}} + \frac{\#\,\text{Options Held by CEO}}{\#\,\text{Shares Outstanding}} * \text{delta} \qquad (4)$$

The six elements needed for calculating delta are obtained by using the same method as the one for calculating ESO risk incentives. We use CEO ownership quantile in the regressions due to the skewness of CEO ownership.[9] We divide CEO ownership into four quantiles according to its ranking among the observations of that year.[10]

CEO Total Compensation. We include CEO total compensation as an additional control variable. Ross (2004) argues that stock options can affect a manager's risk preference through three aspects. First, stock options can bring the convexity effect of option payoffs. Second, stock options can bring a linear incentive due to option delta. Third, stock options can change the total compensation of the manager. Among these three effects, Ross (2004) argues that the convexity effect can always make the manager less risk averse. Since we have already included the variables for the first aspect and the second aspect in the regressions, CEO total compensation is added in the regressions to control for the third aspect. We obtain the data on a CEO's total compensation from Execucomp. CEO total compensation is defined as the total compensation of the CEO (salary, bonus, stock and stock option grants) divided by firm size. We standardize the total compensation by firm size to control for the size effect, because large firms can be associated with higher executive compensation (e.g., Murphy, 1985).

III. Methodology

In this section, we describe the methodology used for empirical tests.

A. ESO Risk Incentives and Corporate Cash Holdings

We construct a dummy variable, which is one for a firm whose ESO risk incentives are below the median of the observations in that year, and is zero otherwise. We define this dummy variable as "Low ESO Risk Incentives Dummy". We use the dummy variable in the analysis due to the skewness in the data of ESO risk incentives.[11] We use the following regressions to study how ESO risk incentives affect the level of corporate cash holdings.[12]

$$\begin{aligned}&\text{Corporate Cash Holdings}_{it}\\&= a + b_1(\text{Low ESO Risk Incentives Dummy}_{it}) + c_1(\text{Size Dummy}_{it}) + c_2\,(\text{Sales Growth}_{it})\\&\quad + c_3(\text{Capital Expenditures}_{it}) + c_4(\text{Earnings Volatility}_{it}) + c_5(\text{R\&D}_{it}) + c_6(\text{Cash Flow}_{it})\\&\quad + c_7(\text{Leverage}_{it}) + c_8(\text{Dividends}_{it}) + c_9(\text{Net Working Capital}_{it})\\&\quad + c_{10}(\text{Log }(1 + \text{Number of Years Being CEO}_{it})) + c_{11}(\text{CEO Ownership Quantile}_{it})\\&\quad + c_{12}(\text{CEO Total Compensation}_{it}) + \varepsilon_{it}\end{aligned} \tag{5}$$

According to Hypothesis 1, we expect $b_1 > 0$ in equation (5).

B. Corporate Cash Holdings and Firm Risk

We use firm fixed effect regressions to study whether more corporate cash holdings reduce firm risk. This is motivated by controlling for potential omitted variable problems (e.g., Greene, 1997). Moreover, we control for the lag of stock return volatility in the regressions, because Engle (1982) and Bollerslev (1986) argue that stock return volatility is autocorrelated. We also control for other corporate financial and investment policies which can affect firm risk in the regressions. Following Coles et al. (2006), we include capital expenditures, R&D and leverage in the regressions.

Therefore, we use the following regression:

$$\begin{aligned}&\text{Firm Risk}_{it}\\&= a_i + b_2(\text{Corporate Cash Holdings}_{it}) + c_1(\text{Capital Expenditures}_{it}) + c_2(\text{R\&D}_{it})\\&\quad + c_3(\text{Leverage}_{it}) + c_4(\text{Firm Risk}_{i,t-1}) + \varepsilon_{it}\end{aligned} \tag{6}$$

According to Hypothesis 2, we expect $b_2 < 0$ in equation (6).

C. Corporate Cash Holdings and Firm Value

We use firm fixed effect regressions to study how corporate cash holdings affect firm value due to the risk-related agency problem. As argued before, corporate cash holdings can affect firm value from different perspectives. We construct an interaction term, Corporate

Cash Holdings * Low ESO Risk Incentives Dummy. We use this interaction term to study the marginal impact of corporate cash holdings on firm value due to the risk-related agency problem. This interaction term captures the difference in the impact of corporate cash holdings on firm value between the firms with low ESO risk incentives and the firms with high ESO risk incentives. Given a certain level of corporate cash holdings, since the risk-related agency problem is more severe in the firms with low ESO risk incentives, it is more likely that these cash holdings are retained by the CEO at the expense of giving up some positive NPV but risky projects, which is not beneficial to shareholders. Therefore, we expect a negative estimate on this interaction term, reflecting a negative marginal impact of corporate cash holdings on firm value due to the risk-related agency problem. We use the following regression:

$$\begin{aligned}\text{Firm Value}_{it} &= a_i + b_3(\text{Corporate Cash Holdings}_{it}) \\ &\quad + b_4(\text{Corporate Cash Holdings*Low ESO Risk Incentives Dummy}_{it}) \\ &\quad + c_1(\text{Low ESO Risk Incentives Dummy}_{it}) + c_2(\text{Size}_{it}) + c_3(\text{Sales Growth}_{it}) \\ &\quad + c_4(\text{Capital Expenditures}_{it}) + c_5(\text{Cash Flow}_{it}) + c_6(\text{Leverage}_{it}) + c_7(\text{Dividends}_{it}) \\ &\quad + c_8(\text{CEO Ownership Quantile}_{it}) + c_9(\text{CEO Total Compensation}_{it}) + \varepsilon_{it} \end{aligned} \quad (7)$$

According to Hypothesis 3, we expect $b_4 < 0$ in equation (7).

D. Sub-sample with Positive Growth Opportunities

Since firms with positive growth opportunities are more likely to have positive NPV but risky projects, the risk-reduction hypothesis is more relevant to this sub-sample. Therefore, we get the sub-sample of the observations with positive sales growth, and separately make the analysis for this sub-sample in our empirical tests.

IV. Results

A. Univariate Statistics

Table I presents univariate statistics of the variables. Panel A shows that the mean of corporate cash holdings is 0.1123. The mean of ESO risk incentives is 83,584 dollars. It means that on average, a 1% increase in stock return volatility can increase a CEO's expected

wealth by 83,584 dollars. This magnitude is comparable to the findings in Coles, Daniel and Naveen (2006), which use a similar methodology and database. Panel A also shows that the mean of Tobin's Q is 2.1250. Panel B shows univariate statistics of other variables.

[Insert Table I - Univariate Statistics here]

B. ESO Risk Incentives and Corporate Cash Holdings

Table II presents the results on ESO risk incentives and corporate cash holdings by using OLS regressions. The dependent variable is corporate cash holdings. In the first column, we find that the estimate on Low ESO Risk Incentives Dummy is 0.014, and it is significant. It suggests that lower ESO risk incentives are associated with a higher level of corporate cash holdings. On average, firms with lower ESO risk incentives have 1.4% more corporate cash holdings.

The first column also shows the estimates on other control variables. The estimate on Size Dummy is -0.035. It suggests that larger firms have less cash holdings due to the economy of scale in cash management. The estimate on Cash Flow is 0.040. This suggests that firms with more plentiful internal resources have more cash holdings. For the other variables, Sales Growth, Earnings Volatility, R&D, Number of Years Being CEO, CEO Ownership, and CEO Total Compensation have a positive effect on the level of cash holdings, while Leverage, Dividends, and Net Working Capital have a negative effect.

In the second column of Table II, we report the regression for the sub-sample with positive sales growth. As described in the methodology section, since this sub-sample is more likely to have positive NPV but risky projects, it is more relevant for the risk-reduction hypothesis.[13] We find that the estimate on Low ESO Risk Incentives Dummy is 0.013, and it is significant. This suggests that lower ESO risk incentives are associated with a higher level of corporate cash holdings in the sub-sample with positive growth opportunities.

The findings in Table II are therefore consistent with the hypothesis that firms with lower ESO risk incentives have more corporate cash holdings.

[Insert Table II - ESO Risk Incentives and Corporate Cash Holdings here]

C. Corporate Cash Holdings and Firm Risk

Table III presents the results for corporate cash holdings and firm risk. The dependent variable in both columns of Table III is stock return volatility. In the first column, we find that the estimate on Corporate Cash Holdings is -0.004, and it is significant. In the second column for the sub-sample with positive sales growth, we find that the estimate on Corporate Cash Holdings is -0.003, and it is significant. For the other control variables, we find that firm risk increases with R&D and leverage, and decreases with capital expenditures.

Therefore, the results in Table III are consistent with the hypothesis that firm risk decreases with the level of corporate cash holdings.

[Insert Table III - Corporate Cash Holdings and Firm Risk here]

D. Corporate Cash Holdings and Firm Value

From previous results, we have found that a CEO's risk incentives can affect the level of corporate cash holdings, which in turn affects firm risk. Now we proceed to study how this can affect firm value.

Table IV shows the marginal impact of corporate cash holdings on firm value due to the risk-related agency problem. Both columns in the table show the results by using firm fixed effect regressions. The dependent variable is Tobin's Q. As discussed in the methodology section, the interaction term is used in the regressions for the empirical tests. In the first column, we find that the estimate on the interaction term Corporate Cash Holdings * Low ESO Risk Incentives Dummy is -0.491, and it is significant. This suggests that on average, a

1% increase in corporate cash holdings has the marginal impact of reducing firm value by 0.491% due to the risk-related agency problem. These findings are consistent with the interpretation that a risk-averse and self-interested CEO allocates more firm assets to corporate cash holdings to reduce firm risk at the expense of giving up some positive NPV but risky projects, which is not beneficial to shareholders.

In the second column, we study the sub-sample with positive sales growth. We find that the estimate on the interaction term Corporate Cash Holdings * Low ESO Risk Incentives Dummy is -0.670, and it is significant.

Therefore, the results in Table IV support the hypothesis that corporate cash holdings have a negative marginal impact on firm value due to the risk-related agency problem.

[Insert Table IV - Corporate Cash Holdings and Firm Value here]

V. Robustness Checks

In this section, we conduct robustness checks for the results.

A. Alternative Valuation Method of Executive Stock Options

Since executive stock options are not transferable, they are different from ordinary options. Moreover, the Securities Exchange Act prohibits insiders from selling short their firm's stock. These restrictions mean that CEOs can neither sell nor hedge their stock options. In addition, the executive option is an American-type option. After the grant of an executive option, there is a vesting period during which CEOs cannot exercise the options. After the vesting period, executive options can be exercised before maturity. As a consequence, executive options may be exercised earlier than ordinary options, due to a CEO's need for diversification, consumption or employment termination (e.g., Huddart, 1994; Kulatilaka and Marcus, 1994; Cuny and Jorion, 1995). The early exercise brings about potential drawbacks in using the Black-Scholes formula for valuing executive options.

We use an alternative valuation method of executive option as a robustness check for the results. Following Guay (1999), we use the method in the Statement of Financial Accounting Standard No. 123 by the Financial Accounting Standard Board (FASB, 1995). The FASB techniques recommend using the Black-Scholes model with the expiration date of the option set equal to its expected time to exercise. Therefore, following Guay (1999), we assume that the expected time to exercise for all options held is equal to 60% of the remaining time-to-maturity.[14]

We use the assumed expected time to exercise due to the difficulty in empirically estimating a CEO's early exercise decisions. Previous papers in the literature have used utility maximizing models to study early exercise of executive stock option (e.g., Huddart, 1994; Kulatilaka and Marcus, 1995), which include the parameters such as a CEO's outside wealth. However, these data are usually not available to econometricians. Therefore, we use the assumed expected time to exercise as proposed by Guay (1999).

Table V presents the results. Panel A of Table V reports the results on the determinants of corporate cash holdings. The first column shows the results on the robustness check for the alternative option valuation method. The estimate on Low ESO Risk Incentives Dummy is 0.012. Panel B of Table V reports the results for corporate cash holdings and firm value. The first column shows the results on the robustness check for the alternative option valuation method. The estimate on Corporate Cash Holdings * Low ESO Risk Incentives Dummy is -0.836. Therefore we find similar results in this robustness check.

B. Potential Measurement Error in Firm Value

When we calculate Tobin's Q as the proxy for firm value, it includes the market value of equity and the book value of debt. However, we have:

Firm value = Value of Equity + Value of Debt

Therefore, firm value should be measured by using both the market value of equity and the market value of debt. While the book value of debt is commonly used in calculating Tobin's Q in the corporate finance literature, it has potential drawbacks here. Since both equity and debt are option-like contingent claims,[15] if a CEO changes firm risk due to his consideration

on risk reduction, this can affect both the value of equity and the value of debt. However, since Tobin's Q uses the book value of debt, it does not include the impact of the change in the value of debt. Therefore, it is subject to potential measurement errors.

However, we do not have the data on the market value of debt. In this case, we use an alternative method to conduct the robustness check. We get the sub-sample of the observations whose leverage is below 10%.[16] Since these firms have lower leverage, the impact of measurement error from using the book value of debt is smaller for this sub-sample. Therefore, we use this sub-sample for the robustness check.

Table V presents the results. Panel A of Table V reports the results on the determinants of corporate cash holdings. The second column shows the results on the robustness check for the measurement error in firm value. The estimate on Low ESO Risk Incentives Dummy is 0.017. Panel B of Table V reports the results for corporate cash holdings and firm value. The second column shows the results on the robustness check for the measurement error in firm value. The estimate on Corporate Cash Holdings * Low ESO Risk Incentives Dummy is -0.973. Therefore we find similar results in this robustness check.

C. Size-Adjusted ESO Risk Incentives

When we calculate the ESO risk incentives, we use the number of stock options held by a CEO. However, since large firms can be associated with higher executive compensations (e.g., Murphy, 1985), it is likely that a CEO in a large firm receives more stock options. To control for this size effect, we calculate size-adjusted ESO risk incentives, which is defined as ESO risk incentives standardized by firm size. We modify the definition of Low ESO Risk Incentives Dummy, so that the dummy variable is one for the firm whose size-adjusted ESO risk incentives are below the median of the observations in that year, and is zero otherwise. We conduct the robustness check by using this modified dummy variable.

Table V presents the results. Panel A of Table V reports the results on the determinants of corporate cash holdings. The third column shows the results on the robustness check for size-adjusted ESO risk incentives. The estimate on Low ESO Risk Incentives Dummy is 0.006. Panel B of Table V reports the results for corporate cash holdings and firm value. The third

column shows the results on the robustness check for size-adjusted ESO risk incentives. The estimate on Corporate Cash Holdings * Low ESO Risk Incentives Dummy is -0.383. As a result, we find similar results in this robustness check.

[Insert Table V - Robustness Checks here]

D. OLS Regressions with More Control Variables and Firm Fixed Effect Regressions

We conduct the robustness check by using OLS regressions with dummy variables for year and industry. Industry dummy variables are constructed for each industry, which is defined by the two-digit SIC code. While the regressions in Table II include various firm-specific variables, the level of corporate cash holdings can also be affected by year and industry effects. The dummy variables for year and industry can control for these effects. We report the results in panel A of Appendix B. In the first column of panel A, we find that the estimate on Low ESO Risk Incentives Dummy is 0.020, which is significant. This implies that corporate cash holdings decrease with ESO risk incentives. We find similar results in the second column.

We also conduct the robustness check by using firm fixed effect regressions for the determinants of corporate cash holdings. Since we use OLS regressions for the determinants of corporate cash holdings in Table II, they can be subject to potential omitted variable problems. Firm fixed effect regression is a standard treatment for the omitted variable problem. We report the results of firm fixed effect regressions in panel B of Appendix B.

We use Log (1 + ESO Risk Incentives) in the firm fixed effect regressions,[17] instead of the Low ESO Risk Incentives Dummy. This is due to the consideration that Low ESO Risk Incentives Dummy can be time-invariant for some firms, while Zhou (2001) questions the use of fixed effect regressions when some regressors are time-invariant. In the first column of panel B, we find that the estimate on Log (1 + ESO Risk Incentives) is -0.0005, which is

significant. It implies that corporate cash holdings decrease with ESO risk incentives. We find similar results in the second column.[18]

Therefore, these robustness checks provide similar results as previous tables. They are consistent with the hypotheses that firms with lower ESO risk incentives have more corporate cash holdings, and that corporate cash holdings have a negative marginal impact on firm value due to the risk-related agency problem.

VI. About the Endogeneity Issues

In this section, we discuss two endogeneity issues.

A. Endogenous ESO Risk Incentives

In the previous analysis, we have taken ESO risk incentives as an exogenous variable. However, according to the optimal contracting framework, the principal designs the compensation contracts of the agent. This raises the endogeneity issue on ESO risk incentives. Since we used a dummy variable on ESO risk incentives in the previous analysis, it implies that the principal can choose to provide the CEO with the compensation contracts with either low or high ESO risk incentives. In this case, simple OLS regression is subject to an omitted variable problem with a non-randomly selected sample.[19] We use the Heckman two-stage estimation as the treatment for this endogeneity problem.[20]

A.1. First Stage

In the first stage, we assume that the principal's decision to provide the compensation contracts with low ESO risk incentives is determined by:

$$D_{it}^* = \gamma Z_{it} + u_{it} \quad (8)$$
$$D_{it} = 1, \text{ if } D_{it}^* > 0$$
$$D_{it} = 0, \text{ if } D_{it}^* < 0$$

where D_{it}^* is an unobservable latent variable, D_{it} is Low ESO Risk Incentives Dummy, Z_{it} is a set of firm characteristics that affect the principal's decision to provide the compensation contracts with low ESO risk incentives, and u_{it} is an error term.

We use the following probit regression for the first stage. In the probit regression, the dependent variable is Low ESO Risk Incentives Dummy. We include the variables on firm

characteristics as the measure for the underlying contracting parameters in the regression. For example, Guay (1999) argues that risk incentives in the executive compensation are positively related with a firm's investment opportunity. Therefore we include sales growth in the regression. We also include the variable indicating the number of years that a CEO has been in his position, because risk incentives can be related with a CEO's risk aversion. We also include other variables in the regression.

In the probit regression, we use Intangible, which is defined as the ratio of intangible assets to total assets, as the equation-specific variable for the identification.[21] Since intangible assets can contain growth options, we expect that high risk incentives are more likely to occur in the executive compensation contracts for firms with more intangible assets.

We use the following probit regression:

$$\begin{aligned}&\text{Low ESO Risk Incentives Dummy}_{it}\\&= a + c_1(\text{Size}_{it}) + c_2(\text{Size Square}_{it}) + c_3(\text{Sales Growth}_{it}) + c_4(\text{R\&D Dummy}_{it})\\&\quad + c_5(\text{Cash Flow}_{it}) + c_6(\text{Capital Expenditures}_{it}) + c_7(\text{Leverage}_{it})\\&\quad + c_8(\log(1 + \text{Number of Years Being CEO}_{it})) + c_9(\text{Intangible}_{it}) + \varepsilon_{it}\end{aligned} \tag{9}$$

From the probit regression, we obtain Lambda as the omitted variable.

$$\text{Lambda}_{it} = \frac{\phi(\gamma Z_{it})}{\Phi(\gamma Z_{it})} * D_{it} + \frac{-\phi(\gamma Z_{it})}{1-\Phi(\gamma Z_{it})} * (1 - D_{it}) \tag{10}$$

Where ϕ = the density function of the standard normal distribution
Φ = the cumulative distribution function of the standard normal distribution
D_{it} = Low ESO Risk Incentives Dummy

A.2. Second Stage

In the second stage, we run the regression with Lambda as an additional control variable. This provides the treatment for the endogeneity problem from the principal's decision on the risk incentives in the compensation contracts.

$$\begin{aligned}&\text{Corporate Cash Holdings}_{it}\\&= a + b_5(\text{Low ESO Risk Incentives Dummy}_{it}) + c_1(\text{Size Dummy}_{it}) + c_2(\text{Sales Growth}_{it})\\&\quad + c_3(\text{Capital Expenditures}_{it}) + c_4(\text{Earnings Volatility}_{it}) + c_5(\text{R\&D}_{it}) + c_6(\text{Cash Flow}_{it})\\&\quad + c_7(\text{Leverage}_{it}) + c_8(\text{Dividends}_{it}) + c_9(\text{Net Working Capital}_{it})\\&\quad + c_{10}(\log(1 + \text{Number of Years Being CEO}_{it})) + c_{11} * \text{Lambda}_{it} + \varepsilon_{it}\end{aligned} \tag{11}$$

According to Hypothesis 1, we expect $b_5 > 0$ in equation (11). In this regression, we do not include CEO ownership or CEO total compensation, because they are endogenous variables in the optimal contracting framework, which are determined by the underlying contracting

parameters (e.g., Himmelberg, Hubbard and Palia, 1999). Since we have included various firm characteristics and CEO characteristics in the equation (10) as the measure for the underlying contracting parameters, this can control for the impact of CEO ownership and CEO total compensation on the level of corporate cash holdings in the optimal contracting framework.[22]

B. Endogenous Corporate Cash Holdings

In the previous analysis, we have used the interaction term Corporate Cash Holdings * Low ESO Risk Incentives Dummy to study the marginal impact of corporate cash holdings on firm value due to the risk-related agency problem. However, since Low ESO Risk Incentives Dummy is a determinant of the level of corporate cash holdings, this interaction term can be subject to the endogeneity problem. We treat this endogeneity problem by using two-stage least square (2SLS) estimation.

We use Net Working Capital as the instrumental variable for corporate cash holdings. In the first stage, we get the predicted value on the level of corporate cash holdings by using the instrumental variable. Since Net Working Capital does not appear as an independent variable in either the regression of firm value or the probit regression of ESO risk incentives, this variable can be used as the instrumental variable. The predicted value is not endogenous with respect to either ESO risk incentives or firm value. In the second stage, we use the predicted value to study the marginal impact of corporate cash holdings on firm value due to the risk-related agency problem. Moreover, we include Lambda in the second-stage regression to control for the endogeneity issue on ESO risk incentives as discussed above. We do not include CEO ownership or CEO total compensation due to the similar reason as argued before.

C. Results

Table VI shows the results of the probit regression. We find that Sales Growth has a negative impact on the likelihood that low ESO risk incentives appear in a CEO's compensation contracts. This is consistent with the argument in Guay (1999). We also find that a CEO with a longer period in his position is less likely to have low risk incentives. For the equation-specific variable, we find that the estimate on Intangible is -0.622, which is

significant. This implies that firms with more intangible assets are less likely to be associated with low risk incentives in a CEO's compensation contracts.

[Insert Table VI - Heckman Two-Stage Estimation
First Stage: Probit Regression here]

Table VII shows the results on how ESO risk incentives affect the level of corporate cash holdings with controlling for the endogeneity issue. In the first column, we find that the estimate on Low ESO Risk Incentives Dummy is 0.026, which is significant. It implies that on average, firms with low ESO risk incentives have 2.6% more corporate cash holdings. Compared with the results in Table II, we find that ESO risk incentives have a larger impact on the level of corporate cash holdings with controlling for the potential endogeneity problem. We find that the estimate on Lambda is -0.023, which is significant. This implies that a firm's choice on the level of ESO risk incentives is correlated with the level of corporate cash holdings. We find similar results in the second column of Table VII. The findings in this table are consistent with the hypothesis that firms with lower ESO risk incentives have more corporate cash holdings.

[Insert Table VII - Heckman Two-Stage Estimation
Second Stage: ESO Risk Incentives and Corporate Cash Holdings here]

Table VIII shows the marginal impact of corporate cash holdings on firm value due to the risk-related agency problem by using two-stage least square estimation. We report the second-stage regression of firm value in the table, where we use the predicted value for corporate cash holdings from the first stage with the instrumental variable as discussed before. We find that the estimate on Corporate Cash Holdings * Low ESO Risk Incentives Dummy is -2.050, which is significant. We also include Lambda in the regression to control for the endogenous risk incentives. We find that the estimate on Lambda is negative and significant, implying that

a firm's choice on the level of ESO risk incentives is correlated with firm value. We find similar results in the second column of Table VIII. The findings in this table are consistent with the hypothesis that corporate cash holdings have a negative marginal impact on firm value due to the risk-related agency problem.

[Insert Table VIII - Corporate Cash Holdings and Firm Value
Two-Stage Least Square (2SLS) Estimation: The Second-Stage Regression here]

Therefore, after considering the endogeneity issues, we find similar results in this section which are consistent with the hypotheses.

VII. Conclusion

In this paper, we empirically test the risk-reduction hypothesis of the agency theory in the context of corporate cash holdings. We use the sensitivity of the value of a CEO's stock options to stock return volatility (Executive Stock Options risk incentives) to study the relation between a CEO's risk incentives and corporate cash holdings. We find that firms with lower ESO risk incentives have more corporate cash holdings. We also find that more corporate cash holdings reduce firm risk, and that corporate cash holdings have a negative marginal impact on firm value due to the risk-related agency problem. We conduct various robustness checks. We also use econometrics methods as the treatment for the potential endogeneity issues, and find similar results. These results support the interpretation that a risk-averse and self-interested CEO allocates more firm assets to corporate cash holdings to reduce firm risk at the expense of giving up some positive NPV but risky projects, which is not beneficial to shareholders.

We conclude that these findings are consistent with the risk-reduction hypothesis of the agency theory in the context of corporate cash holdings.

Appendix A: Definition of the Variables

Corporate Cash Holdings	Corporate Cash Holdings are defined as the ratio of cash and marketable securities (#1) to total assets (#6). We use # to denote Compustat item number.
ESO Risk Incentives	ESO Risk Incentives are defined as the number of shares outstanding in options held by a CEO times the Black-Scholes partial derivative of option value with respect to 0.01 change in the annualized standard deviation of stock return. Or it can be expressed as: $\text{ESO Risk Incentives} = (\#\text{ options held by CEO}) * \frac{\partial(\text{Black - Scholes option value})}{\partial(\text{Stock Return Volatility})} * 0.01$ With $\frac{\partial(\text{Black - Scholes option value})}{\partial(\text{Stock Return Volatility})} = e^{-dT} N'(Z) S T^{1/2}$ $Z = [\log(S/X) + T(r - d + \frac{\sigma^2}{2})] / \sigma T^{1/2}$ Where N' = the normal density function S = the price of the underlying stock X = exercise price σ = expected stock return volatility over the life of the option r = risk-free interest rate T = time to maturity of the option in years d = expected dividend rate over the life of the option See Section III for more details on the calculation of this measure.
Tobin's Q	Tobin's Q is defined as the market value of equity (#25 multiplied by #199) plus the book value of assets (#6) minus the book value of common equity (#60), divided by the book value of assets (#6).
Size	Size is defined as the natural logarithm of book value of assets (#6)
Sales Growth	Sales Growth is defined as the growth rate of sales (#12), calculated as the change in sales divided by the level of sales in the previous year.
Capital Expenditures	Capital Expenditures are defined as the ratio of capital expenditures (#128) to assets (#6).
R&D	R&D is defined as the ratio of research and development expenses (#46) to assets (#6). The missing value is set to zero.
Cash Flow	Cash Flow is defined as the ratio of income before extraordinary items (#18) to assets (#6).
Leverage	Leverage is defined as the ratio of long-term debt (#9) to total assets (#6).
Dividends	Dividends are defined as the ratio of dividends (#21) to assets (#6).
Earnings Volatility	Earnings Volatility is defined as the standard deviation of the ratio of income before extraordinary items (#18) to assets (#6) in the prior three years.
Net Working Capital	Net Working Capital is defined as the ratio of net working capital, defined as working capital (#179) minus cash (#1), to assets (#6).
Daily Stock Return Volatility	Daily Stock Return Volatility is defined as the standard deviation of the daily stock return during the year.
CEO Ownership	CEO Ownership is defined as the sum of the proportion of shares outstanding held by a CEO plus the proportion of shares outstanding in options held by the CEO times Black-Scholes hedge ratio (the delta)
CEO Ownership Quantile	CEO Ownership Quantile takes the value from 1 to 4 according to the ranking of CEO ownership among the observations for that year. For example, CEO ownership quantile is 1 if CEO ownership is below 25 percentile, and CEO ownership quantile is 4 if CEO ownership is above 75 percentile.
CEO Total Compensation	CEO Total Compensation is the total compensation (salary, bonus, stock and stock option grants) of the CEO divided by assets.
Number of Years Being CEO	Number of Years Being CEO is the number of years that a CEO has been in this position.

Appendix B
ESO Risk Incentives and Corporate Cash Holdings:
OLS Regressions with More Control Variables and Firm Fixed Effect Regressions

This table reports ESO risk incentives and corporate cash holdings by using OLS regressions with more control variables, and by using firm fixed effect regressions. Panel A reports the results of the OLS regressions with dummy variables for year and industry. Industry dummy variables are constructed for each industry, which is defined by the two-digit SIC code. The dummy variables for year and industry are not reported in the table. *Corporate Cash Holdings* are the ratio of cash and marketable securities to assets. *Low ESO Risk Incentives Dummy* is one if ESO risk incentives are below the median of the observations in that year, and is zero otherwise. *Size Dummy* is a dummy variable which is one if the size of the firm is above the median of the observations in that year, and is zero otherwise. *Sales Growth* is the growth rate of sales, calculated as the change in sales divided by the level of sales in previous year. *Capital Expenditures* are the ratio of capital expenditures to assets. *Earnings Volatility* is the standard deviation of the ratio of income before extraordinary items to assets in the prior three years. *R&D* is the ratio of research and development expenses to assets. *Cash Flow* is the ratio of income before extraordinary items to assets. *Leverage* is the ratio of long-term debt to assets. *Dividends* are the ratio of dividends to assets. *Net Working Capital* is the ratio of working capital minus cash, divided by assets. *Number of Years Being CEO* is the number of years that a CEO has been in this position. *CEO Ownership Quantile* takes the value from 1 to 4 according to the ranking of CEO ownership among the observations for that year. *CEO Total Compensation* is the ratio of the total compensation (salary, bonus, stock and stock option grants) of the CEO divided by assets. Panel B reports ESO risk incentives and corporate cash holdings by using firm fixed effect regressions. The intercepts are not reported in the table. *ESO Risk Incentives* are the number of shares outstanding in options held by a CEO times the derivative of Black-Scholes option value with respect to 0.01 change in annualized standard deviation of stock return. *Size* is the natural logarithm of the book value of assets. The p-value is noted in the brackets.

Panel A. OLS Regressions with Dummy Variables for Year and Industry

	Entire Sample	Sub-Sample: Sales Growth > 0
	Corporate Cash Holdings	Corporate Cash Holdings
Intercept	0.130	0.138
	(0.01)	(0.01)
Low ESO Risk Incentives Dummy	0.020	0.019
	(0.01)	(0.01)
Size Dummy	-0.035	-0.034
	(0.01)	(0.01)
Sales Growth	0.034	0.035
	(0.01)	(0.01)
Capital Expenditures	0.042	0.030
	(0.02)	(0.11)
Earnings Volatility	0.441	0.508
	(0.01)	(0.01)
R&D	0.166	0.156
	(0.01)	(0.01)
Cash Flow	0.073	0.078
	(0.01)	(0.01)
Leverage	-0.229	-0.245
	(0.01)	(0.01)
Dividends	-0.774	-1.007
	(0.01)	(0.01)
Net Working Capital	-0.260	-0.259
	(0.01)	(0.01)
log (1 + Number of Years Being CEO)	0.004	0.005
	(0.01)	(0.01)
CEO Ownership Quantile	0.010	0.007
	(0.01)	(0.01)
CEO Total Compensation	4.202	4.244
	(0.01)	(0.01)
Adjusted R-square	0.46	0.48

Panel B. Firm Fixed Effect Regressions

	Entire Sample	Sub-Sample: Sales Growth > 0
	Corporate Cash Holdings	Corporate Cash Holdings
Log (1 + ESO Risk Incentives)	-0.0005	-0.0006
	(0.09)	(0.07)
Size	-0.014	-0.015
	(0.01)	(0.01)
Sales Growth	-0.015	-0.014
	(0.01)	(0.01)
Capital Expenditures	-0.054	-0.042
	(0.01)	(0.02)
Earnings Volatility	-0.001	0.008
	(0.95)	(0.73)
R&D	-0.030	-0.039
	(0.01)	(0.01)
Cash Flow	0.228	0.237
	(0.01)	(0.01)
Leverage	-0.051	-0.048
	(0.01)	(0.01)
Dividends	0.045	0.143
	(0.74)	(0.34)
Net Working Capital	-0.230	-0.256
	(0.01)	(0.01)
log (1 + Number of Years Being CEO)	-0.003	-0.003
	(0.01)	(0.01)
CEO Ownership Quantile	0.004	0.005
	(0.01)	(0.01)
CEO Total Compensation	0.238	0.212
	(0.03)	(0.06)
Adjusted R-square	0.90	0.90

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Table I
Univariate Statistics

This table reports univariate statistics of the variables. The sample consists of 2095 firms in Execucomp in 1993-2000, with 11018 firm-year observation. Panel A reports univariate statistics on corporate cash holdings, ESO risk incentives and firm value. *Corporate Cash Holdings* are the ratio of cash and marketable securities to assets. *ESO Risk Incentives* are the number of shares outstanding in options held by a CEO times the derivative of Black-Scholes option value with respect to 0.01 change in annualized standard deviation of stock return. *Tobin's Q* is the market value of equity plus the book value of assets minus the book value of common equity, divided by the book value of assets. Panel B reports univariate statistics of other variables. *Size* is the natural logarithm of the book value of assets. *Sales Growth* is the growth rate of sales, calculated as the change in sales divided by the level of sales in the previous year. *Capital Expenditures* are the ratio of capital expenditures to assets. *R&D* is the ratio of research and development expenses to assets. *Cash Flow* is the ratio of income before extraordinary items to assets. *Leverage* is the ratio of long-term debt to assets. *Dividends* are the ratio of dividends to assets. *Earnings Volatility* is the standard deviation of the ratio of income before extraordinary items to assets in the prior three years. *Net Working Capital* is the ratio of working capital minus cash, divided by assets. *Daily Stock Return Volatility* is the standard deviation of the daily stock return during the year. *CEO Ownership* is the sum of the proportion of shares outstanding held by a CEO plus the proportion of shares outstanding in options held by the CEO times Black-Scholes hedge ratio (the delta). *CEO Total Compensation* is the total compensation (salary, bonus, stock and stock option grants) of the CEO divided by assets. *Number of Years Being CEO* is the number of years that a CEO has been in this position.

Panel A. Corporate Cash Holdings, ESO Risk Incentives and Tobin's Q

Variable	Mean	Median	Standard Deviation
Corporate Cash Holdings	0.1123	0.0397	0.1576
ESO Risk Incentives	83,584	26,865	247,269
Tobin's Q	2.1250	1.5752	1.5860

Panel B. Other Variables

Variable	Mean	Median	Standard Deviation
Size	20.8171	20.6780	1.5373
Sales Growth	0.1292	0.0951	0.2295
Capital Expenditures	0.0844	0.0551	0.0812
R&D	0.1282	0.0410	0.1721
Cash Flow	0.0459	0.0495	0.0863
Leverage	0.2023	0.1912	0.1635
Dividends	0.0119	0.0058	0.0150
Earnings Volatility	0.0369	0.0194	0.0522
Net Working Capital	0.0917	0.0662	0.1515
Daily Stock Return Volatility	0.0280	0.0244	0.0150
CEO Ownership	0.0389	0.0123	0.0675
CEO Total Compensation	0.0039	0.0016	0.0109
Number of Years Being CEO	6.9432	5.0000	7.2127

Table II
ESO Risk Incentives and Corporate Cash Holdings

This table reports ESO risk incentives and corporate cash holdings by using OLS regressions. *Corporate Cash Holdings* are the ratio of cash and marketable securities to assets. *Low ESO Risk Incentives Dummy* is one if ESO risk incentives are below the median of the observations in that year, and is zero otherwise. *Size Dummy* is a dummy variable which is one if the size of the firm is above the median of the observations in that year, and is zero otherwise. *Sales Growth* is the growth rate of sales, calculated as the change in sales divided by the level of sales in previous year. *Capital Expenditures* are the ratio of capital expenditures to assets. *Earnings Volatility* is the standard deviation of the ratio of income before extraordinary items to assets in the prior three years. *R&D* is the ratio of research and development expenses to assets. *Cash Flow* is the ratio of income before extraordinary items to assets. *Leverage* is the ratio of long-term debt to assets. *Dividends* are the ratio of dividends to assets. *Net Working Capital* is the ratio of working capital minus cash, divided by assets. *Number of Years Being CEO* is the number of years that a CEO has been in this position. *CEO Ownership Quantile* takes the value from 1 to 4 according to the ranking of CEO ownership among the observations for that year. *CEO Total Compensation* is the total compensation (salary, bonus, stock and stock option grants) of the CEO divided by assets. The p-value is noted in the brackets.

	Entire Sample	Sub-Sample: Sales Growth > 0
	Corporate Cash Holdings	Corporate Cash Holdings
Intercept	0.106	0.116
	(0.01)	(0.01)
Low ESO Risk Incentives Dummy	0.014	0.013
	(0.01)	(0.01)
Size Dummy	-0.035	-0.034
	(0.01)	(0.01)
Sales Growth	0.044	0.044
	(0.01)	(0.01)
Capital Expenditures	0.003	-0.016
	(0.83)	(0.31)
Earnings Volatility	0.505	0.589
	(0.01)	(0.01)
R&D	0.212	0.198
	(0.01)	(0.01)
Cash Flow	0.040	0.045
	(0.01)	(0.01)
Leverage	-0.258	-0.267
	(0.01)	(0.01)
Dividends	-0.851	-1.033
	(0.01)	(0.01)
Net Working Capital	-0.212	-0.216
	(0.01)	(0.01)
log (1 + Number of Years Being CEO)	0.004	0.006
	(0.01)	(0.01)
CEO Ownership Quantile	0.009	0.006
	(0.01)	(0.01)
CEO Total Compensation	4.620	4.657
	(0.01)	(0.01)
Adjusted R-square	0.42	0.43

Table III
Corporate Cash Holdings and Firm Risk

This table reports corporate cash holdings and firm risk by using firm fixed effect regressions. The intercepts are not reported in the table. *Daily Stock Return Volatility* is the standard deviation of daily stock return during the year. *Corporate Cash Holdings* are the ratio of cash and marketable securities to assets. *Capital Expenditures* are the ratio of capital expenditures to assets. *R&D* is the ratio of research and development expenses to assets. *Leverage* is the ratio of long-term debt to assets. The p-value is noted in the brackets.

	Entire Sample	Sub-Sample: Sales Growth > 0
	Daily Stock Return Volatility	Daily Stock Return Volatility
Corporate Cash Holdings	-0.004	-0.003
	(0.02)	(0.08)
Capital Expenditures	-0.011	-0.005
	(0.01)	(0.10)
R&D	0.007	0.009
	(0.01)	(0.01)
Leverage	0.004	0.008
	(0.01)	(0.01)
Daily Stock Return Volatility t-1	0.597	0.496
	(0.01)	(0.01)
Adjusted R-square	0.93	0.94

Table IV
Corporate Cash Holdings and Firm Value

This table reports corporate cash holdings and firm value by using firm fixed effect regressions. The intercepts are not reported in the table. *Tobin's Q* is the market value of equity plus the book value of assets minus the book value of common equity, divided by the book value of assets. *Corporate Cash Holdings* are the ratio of cash and marketable securities to assets. *Low ESO Risk Incentives Dummy* is one if ESO risk incentives are below the median of the observations in that year, and is zero otherwise. *Size* is the natural logarithm of book value of assets. *Sales Growth* is the growth rate of sales, calculated as the change in sales divided by the level of sales in the previous year. *Capital Expenditures* are the ratio of capital expenditures to assets. *Cash Flow* is the ratio of income before extraordinary items to assets. *Leverage* is the ratio of long-term debt to assets. *Dividends* are the ratio of dividends to assets. *CEO Ownership Quantile* takes the value from 1 to 4 according to the ranking of CEO ownership among the observations for that year. *CEO Total Compensation* is the total compensation (salary, bonus, stock and stock option grants) of the CEO divided by assets. The p-value is noted in the brackets.

	Entire Sample	Sub-Sample: Sales Growth > 0
	Tobin's Q	Tobin's Q
Corporate Cash Holdings	1.369	1.552
	(0.01)	(0.01)
Corporate Cash Holdings * Low ESO Risk Incentives Dummy	-0.491	-0.670
	(0.01)	(0.01)
Low ESO Risk Incentives Dummy	0.028	0.040
	(0.38)	(0.24)
Size	-0.084	-0.065
	(0.01)	(0.01)
Sales Growth	0.517	0.555
	(0.01)	(0.01)
Capital Expenditures	0.526	0.239
	(0.02)	(0.33)
Cash Flow	2.958	3.436
	(0.01)	(0.01)
Leverage	-0.448	-0.481
	(0.01)	(0.01)
Dividends	11.701	12.486
	(0.01)	(0.01)
CEO Ownership Quantile	-0.012	-0.003
	(0.40)	(0.86)
CEO Total Compensation	15.694	14.263
	(0.01)	(0.01)
Adjusted R-square	0.90	0.90

Table V
Robustness Checks

This table reports the results of robustness checks. Panel A reports ESO risk incentives and corporate cash holdings by using OLS regressions. *Corporate Cash Holdings* are the ratio of cash and marketable securities to assets. *Low ESO Risk Incentives Dummy* is one if ESO risk incentives are below the median of the observations in that year, and is zero otherwise. In the first column, ESO risk incentives are defined as the number of shares outstanding in options held by a CEO times the derivative of option value (FASB method) with respect to 0.01 change in annualized standard deviation of stock return. In the third column, Size-Adjusted ESO Risk Incentives are defined as ESO risk incentives standardized by firm size. Low ESO Risk Incentives Dummy is obtained based on the size-adjusted ESO risk incentives in that column. *Size Dummy* is a dummy variable, which is one if the size of the firm is above the median of the observations in that year, and is zero otherwise. *Sales Growth* is the growth rate of sales, calculated as the change in sales divided by the level of sales in the previous year. *Capital Expenditures* are the ratio of capital expenditures to assets. *Earnings Volatility* is the standard deviation of the ratio of income before extraordinary items to assets in the prior three years. *R&D* is the ratio of research and development expenses to assets. *Cash Flow* is the ratio of income before extraordinary items to assets. *Leverage* is the ratio of long-term debt to assets. *Dividends* are the ratio of dividends to assets. *Net Working Capital* is the ratio of working capital minus cash, divided by assets. *Number of Years Being CEO* is the number of years that a CEO has been in this position. *CEO Ownership Quantile* takes the value from 1 to 4 according to the ranking of CEO ownership among the observations for that year. *CEO Total Compensation* is the total compensation (salary, bonus, stock and stock option grants) of the CEO divided by assets. Panel B reports corporate cash holdings and firm value by using firm fixed effect regressions. The intercepts are not reported in the table. *Tobin's Q* is the market value of equity plus the book value of assets minus the book value of common equity, divided by the book value of assets. The p-value is noted in the brackets.

Panel A. Robustness Check for ESO Risk Incentives and Corporate Cash Holdings

	Sub-Sample: Sales Growth > 0		
	Alternative Executive Option Valuation Method	Sub-Sample: Leverage<10%	Size-Adjusted ESO Risk Incentives
	Corporate Cash Holdings	Corporate Cash Holdings	Corporate Cash Holdings
Intercept	0.113	0.187	0.119
	(0.01)	(0.01)	(0.01)
Low ESO Risk Incentives Dummy	0.012	0.017	0.006
	(0.01)	(0.01)	(0.03)
Size Dummy	-0.030	-0.059	-0.035
	(0.01)	(0.01)	(0.01)
Sales Growth	0.043	0.051	0.043
	(0.01)	(0.01)	(0.01)
Capital Expenditures	-0.018	0.036	-0.018
	(0.27)	(0.43)	(0.27)
Earnings Volatility	0.581	0.500	0.586
	(0.01)	(0.01)	(0.01)
R&D	0.172	0.168	0.169
	(0.01)	(0.01)	(0.01)
Cash Flow	0.047	0.178	0.045
	(0.01)	(0.01)	(0.01)
Leverage	-0.265	-0.472	-0.266
	(0.01)	(0.01)	(0.01)
Dividends	-0.977	-1.142	-0.982
	(0.01)	(0.01)	(0.01)
Net Working Capital	-0.212	-0.363	-0.211
	(0.01)	(0.01)	(0.01)
log (1 + Number of Years Being CEO)	0.006	0.007	0.006
	(0.01)	(0.04)	(0.01)
CEO Ownership Quantile	0.004	0.002	0.004
	(0.01)	(0.50)	(0.01)
CEO Total Compensation	6.273	3.635	6.171
	(0.01)	(0.01)	(0.01)
Adjusted R-square	0.44	0.36	0.44

Panel B. Robustness Check for Corporate Cash Holdings and Firm Value

	Sub-Sample: Sales Growth > 0		
	Alternative Executive Option Valuation Method	Sub-Sample: Leverage<10%	Size-Adjusted ESO Risk Incentives
	Tobin's Q	Tobin's Q	Tobin's Q
Corporate Cash Holdings	1.797	2.117	1.345
	(0.01)	(0.01)	(0.01)
Corporate Cash Holdings * Low ESO Risk Incentives Dummy	-0.836	-0.973	-0.383
	(0.01)	(0.01)	(0.02)
Low ESO Risk Incentives Dummy	0.044	0.089	-0.047
	(0.18)	(0.40)	(0.13)
Size	-0.069	-0.074	-0.077
	(0.01)	(0.21)	(0.01)
Sales Growth	0.560	1.087	0.556
	(0.01)	(0.01)	(0.01)
Capital Expenditures	0.263	0.155	0.282
	(0.28)	(0.81)	(0.25)
Cash Flow	3.411	4.226	3.421
	(0.01)	(0.01)	(0.01)
Leverage	-0.466	-0.737	-0.497
	(0.01)	(0.07)	(0.01)
Dividends	12.461	10.030	12.539
	(0.01)	(0.06)	(0.01)
CEO Ownership Quantile	-0.004	0.028	-0.005
	(0.81)	(0.48)	(0.74)
CEO Total Compensation	13.880	13.611	14.225
	(0.01)	(0.01)	(0.01)
Adjusted R-square	0.90	0.89	0.90

Table VI
Heckman Two-Stage Estimation
First Stage: Probit Regression

This table reports the probit regression as the first stage of the Heckman two-stage estimation. The dependent variable is Low ESO Risk Incentives Dummy. *Low ESO Risk Incentives Dummy* is one if ESO risk incentives are below the median of the observations in that year, and is zero otherwise. *Size* is the natural logarithm of book value of assets. *Sales Growth* is the growth rate of sales, calculated as the change in sales divided by the level of sales in previous year. *R&D Dummy* is one if a firm has positive R&D expenses, and is zero otherwise. *Cash Flow* is the ratio of income before extraordinary items to assets. *Capital Expenditures* are the ratio of capital expenditures to assets. *Leverage* is the ratio of long-term debt to assets. *Number of Years Being CEO* is the number of years that a CEO has been in this position. *Intangible* is defined the ratio of intangible assets to total assets. The p-value is noted in the brackets.

	Low ESO Risk Incentives Dummy
Intercept	15.526
	(0.01)
Size	-1.087
	(0.01)
Size Square	0.016
	(0.01)
Sales Growth	-0.150
	(0.01)
R&D Dummy	0.475
	(0.01)
Cash Flow	-0.674
	(0.01)
Capital Expenditures	-0.581
	(0.01)
Leverage	0.558
	(0.01)
log (1+Number of Years Being CEO)	-0.030
	(0.04)
Intangible	-0.622
	(0.01)
Cox and Snell R-square	0.20

Table VII
Heckman Two-Stage Estimation
Second Stage: ESO Risk Incentives and Corporate Cash Holdings

This table reports ESO risk incentives and corporate cash holdings as the second stage of the Heckman two-stage estimation. *Corporate Cash Holdings* are the ratio of cash and marketable securities to assets. *Low ESO Risk Incentives Dummy* is one if ESO risk incentives are below the median of the observations in that year, and is zero otherwise. *Size Dummy* is a dummy variable, which is one if the size of the firm is above the median of the observations in that year, and is zero otherwise. *Sales Growth* is the growth rate of sales, calculated as the change in sales divided by the level of sales in previous year. *Capital Expenditures* are the ratio of capital expenditures to assets. *Earnings Volatility* is the standard deviation of the ratio of income before extraordinary items to assets in the prior three years. *R&D* is the ratio of research and development expenses to assets. *Cash Flow* is the ratio of income before extraordinary items to assets. *Leverage* is the ratio of long-term debt to assets. *Dividends* are the ratio of dividends to assets. *Net Working Capital* is the ratio of working capital minus cash, divided by assets. *Number of Years Being CEO* is the number of years that a CEO has been in this position. *Lambda* is calculated based on the probit regression in Table VI, while Section VI provides the details of the calculation. The p-value is noted in the brackets.

	Entire Sample	Sub-Sample: Sales Growth > 0
	Corporate Cash Holdings	Corporate Cash Holdings
Intercept	0.618	0.593
	(0.01)	(0.01)
Low ESO Risk Incentives Dummy	0.026	0.025
	(0.05)	(0.07)
Size Dummy	-0.024	-0.022
	(0.01)	(0.01)
Sales Growth	0.060	0.060
	(0.01)	(0.01)
Capital Expenditures	-0.017	-0.038
	(0.25)	(0.02)
Earnings Volatility	0.527	0.623
	(0.01)	(0.01)
R&D	0.200	0.189
	(0.01)	(0.01)
Cash Flow	0.071	0.072
	(0.01)	(0.01)
Leverage	-0.264	-0.274
	(0.01)	(0.01)
Dividends	-1.002	-1.115
	(0.01)	(0.01)
Net Working Capital	-0.243	-0.249
	(0.01)	(0.01)
log (1 + Number of Years Being CEO)	0.006	0.007
	(0.01)	(0.01)
Lambda	-0.023	-0.022
	(0.01)	(0.01)
Adjusted R-square	0.41	0.43

Table VIII
Corporate Cash Holdings and Firm Value
Two-Stage Least Square (2SLS) Estimation: The Second-Stage Regression

This table reports corporate cash holdings and firm value by using two-stage least square (2SLS) estimation. Section VI provides the details of this method. The second-stage regression is reported in this table. We use firm fixed effect regressions. The intercepts are not reported in the table. *Tobin's Q* is the market value of equity plus the book value of assets minus the book value of common equity, divided by the book value of assets. *Corporate Cash Holdings* are the ratio of cash and marketable securities to assets. *Low ESO Risk Incentives Dummy* is one if ESO risk incentives are below the median of the observations in that year, and is zero otherwise. *Size* is the natural logarithm of book value of assets. *Sales Growth* is the growth rate of sales, calculated as the change in sales divided by the level of sales in the previous year. *Capital Expenditures* are the ratio of capital expenditures to assets. *Cash Flow* is the ratio of income before extraordinary items to assets. *Leverage* is the ratio of long-term debt to assets. *Dividends* are the ratio of dividends to assets. *Lambda* is calculated based on the probit regression in Table VI, while Section VI provides the details of the calculation. The p-value is noted in the brackets.

	Entire Sample	Sub-Sample: Sales Growth > 0
	Tobin's Q	Tobin's Q
Corporate Cash Holdings	4.306	4.332
	(0.01)	(0.01)
Corporate Cash Holdings * Low ESO Risk Incentives Dummy	-2.050	-2.184
	(0.06)	(0.05)
Low ESO Risk Incentives Dummy	-0.105	-0.030
	(0.77)	(0.94)
Size	-0.103	-0.080
	(0.03)	(0.10)
Sales Growth	0.493	0.538
	(0.01)	(0.01)
Capital Expenditures	0.520	0.247
	(0.04)	(0.36)
Cash Flow	2.780	3.313
	(0.01)	(0.01)
Leverage	0.189	0.189
	(0.18)	(0.21)
Dividends	17.359	18.519
	(0.01)	(0.01)
Lambda	-0.047	-0.032
	(0.02)	(0.14)
Adjusted R-square	0.88	0.88

Footnotes

[1] The Execucomp database provides the data for the five most highly compensated executives in the firms. We study a CEO's risk incentives due to data availability.

[2] The tradeoff theory argues that corporate cash holdings are determined by the tradeoff between the costs and the benefits of holding cash. The costs of holding cash include lower rate of returns and tax disadvantages. The benefits of holding cash include reducing transaction costs and retaining the ability to finance investment projects when external financing is too costly. The financing hierarchy theory argues that there is not an optimal level of cash holdings. Cash holdings are simply the outcome of investment and financing decisions which follow the pecking order theory suggested by Myers and Majuf (1984).

[3] A different assumption can be that both the shareholder and the manager are risk averse. However, while the shareholder only bears systematic risk, the manager bears both systematic risk and idiosyncratic risk. In this case, a risk-related agency problem still exists because the manager is more risk averse than the shareholder.

[4] From the investment perspective, corporate cash holdings are negative NPV projects because interest incomes from cash holdings are subject to double taxation (Opler et al., 1999). This can increase the impact of the risk-related agency problem on firm value.

[5] Guay (1999) argues that the second item $\frac{\partial(\text{risk premium})}{\partial\sigma}$ in equation (2) captures the impact of risk aversion on a manager's utility. It depends upon the degree of diversification in a manager's portfolio of wealth, the level of a manager's wealth, and manager-specific risk aversion parameters. We include various control variables for them in the regressions.

[6] We focus on the period up to the year 2000, because executives are more likely to hold underwater options due to market downturn starting from 2001, while Execucomp does not provide data on underwater options.

[7] We use # to denote Compustat item number.

[8] Core and Guay (1999, 2002) provide more details on this methodology.

[9] Table I shows that the mean of CEO ownership is 0.0389, and the median is 0.0123.

[10] The CEO ownership quantile takes the value from 1 to 4 according to the ranking of CEO ownership among the observations of that year. The CEO ownership quantile is 1 if CEO ownership is below the 25 percentile among the observations of that year, and the CEO ownership quantile is 4 if CEO ownership is above the 75 percentile among the observations of that year.

[11] In Table I, the mean of ESO risk incentives is 83,584 dollars, while the median is 26,865 dollars.

[12] In Section V, we conduct a robust check by using firm fixed effect regressions for the determinants of corporate cash holdings.

[13] The firms with positive sales growth represent 90.5% of the observations in the entire sample.

[14] There is a debate in the literature on whether the FASB method has limitations in valuing executive stock options (e.g., Hemmer, Matsunaga and Shevlin, 1994). However, Guay (1999) shows that the cross-sectional results are qualitatively unchanged by using both FASB and other alternative valuation methods.

[15] For example, Jensen and Meckling (1976) argue that stockholders can be viewed as holding a European call option on the total value of the firm with the exercise price equal to the face value of the debt, exercisable at the maturity date of the debt issue.

[16] The firms with leverage below 10 percent represent 30.6% of the observations in the entire sample.

[17] We use logarithm transformation due to the skewness in the data of ESO risk incentives. Since CEOs in some firms do not hold stock options, ESO risk incentives are zero for these firms. Therefore, we use log (1 + ESO Risk Incentives).

[18] For the other control variables, however, we find that some of them have different signs from the OLS regressions, while Dittmar and Mahrt-Smith (2006) report similar findings. For example, the estimate on R&D has a positive sign in the OLS regression, which is consistent with the prediction of the tradeoff theory. However, the estimate on R&D has a negative sign in the firm fixed effect regression, which is consistent with the prediction of the financing hierarchy theory. These two different situations raise the debate on whether the tradeoff theory or the financing hierarchy theory can better explain the level of corporate cash holdings. Nevertheless, we do not conduct further analysis on this issue, because it is beyond the scope of this paper, which focuses on the agency theory.

[19] See Heckman (1979) for more details.

[20] Campa and Kedia (2002) use a similar methodology to study the endogeneity problem in firm diversification.

[21] We use Intangible as the equation-specific variable for the identification. Opler, Pinkowitz, Stulz and Williamson (1999) do not include intangible assets as a determinant of the level of corporate cash holdings.

[22] An alternative method is to include both CEO ownership and CEO total compensation in the regression by using instrumental variables. However, since Himmelberg, Hubbard and Palia (1999) argue that it is difficult to obtain instrumental variables in the setting of optimal contracting framework, we do not use this method.