Managerial Performance Incentives and Firm Risk during Economic Expansions and Recessions

Elif Sisli Ciamarra, Economics Department, Brandeis University

Tanseli Savaser, Bilkent University

Working Paper Series

2015 | 93

Managerial Performance Incentives and Firm Risk during Economic Expansions and Recessions

Tanseli Savaser[a], Elif Sisli Ciamarra[b] *

[a]Bilkent University, Ankara 06800, Turkey. Email: tsavaser@bilkent.edu.tr

[b]Brandeis University, 415 South Street, MS 032, Waltham, MA 02478, U.S.A. Tel: +1 (781) 736-8544. E-mail: esisli@brandeis.edu

Abstract

We argue that the relationship between managerial pay-for-performance incentives and risk taking is procyclical. We study the relationship between incentives provided by stock-based compensation and firm risk for U.S. non-financial corporations over the two business cycles between 1992 and 2009. We show that a given level of pay-for-performance incentives results in significantly lower firm risk when the economy is in a downturn. The documented procyclical relationship between incentives and risk taking is consistent with state-dependent risk aversion. Our findings contribute to the literature on the depressive effects of performance incentives on firm risk by documenting the importance of the interaction between performance incentives and risk aversion.

JEL classification: G01, G3, M52

Keywords: executive compensation; risk taking; equity-based compensation; macroeconomy

*Corresponding author. We are indebted for useful comments and suggestions to Daniel Bergstresser, William Greene, Iftekhar Hassan, Abigail Hornstein, Jens Hilscher, Lubomir Litov, Catherine Mann, Debarshi Nandy, Carol Osler, Oguzhan Ozbas, Alon Raviv, David Yermack, Dan Zhang as well as seminar participants at Brandeis University, Williams College, Northeastern University, 2012 EFA Annual Meeting in Boston, the conference on Teaching Finance at Turbulent Times at Heilbronn University, 2014 Financial Management Association Meetings, 2014 Bilkent Turkish Finance Workshop, and the XXIII International Tor Vergata Conference on Money, Banking and Finance.

Managerial Performance Incentives and Firm Risk during Economic Expansions and Recessions

Abstract

We argue that the relationship between managerial pay-for-performance incentives and risk taking is procyclical. We study the relationship between incentives provided by stock-based compensation and firm risk for U.S. non-financial corporations over the two business cycles between 1992 and 2009. We show that a given level of pay-for-performance incentives results in significantly lower firm risk when the economy is in a downturn. The documented procyclical relationship between incentives and risk taking is consistent with state-dependent risk aversion. Our findings contribute to the literature on the depressive effects of performance incentives on firm risk by documenting the importance of the interaction between performance incentives and risk aversion.

JEL classification: G01, G3, M52

Keywords: executive compensation; risk taking; equity-based compensation; pay-for-performance incentives; macroeconomy

Managerial Performance Incentives and Firm Risk during Economic Expansions and Recessions

1 Introduction

A significant portion of pay packages of high level executives are in the form of equity-based compensation. Compensation tied to equity creates pay-for-performance sensitivity and is expected to incentivize managers to exert effort and take actions that increase stock values. However, the relationship between pay-for-performance incentives and firm risk is less clear. Pay-for-performance sensitivity could induce more risk taking because risky projects generally create more value and therefore increase the expected value of incentive compensation. However, it could also induce less risk-taking because of a desire to limit portfolio risk. This is mainly because managers are inherently more risk averse than diversified shareholders due to their organization-specific human capital and/or undiversified wealth portfolios (Smith and Stulz, 1985; Amihud and Lev, 1981; Tufano, 1996).

Despite the well-developed theoretical literature stressing the depressive effects of managerial performance incentives on risk taking, the number of empirical papers testing this argument remains limited. While existing studies have focused primarily on the variation in incentive compensation, it is a combination of incentive compensation and managerial risk aversion that should impact the relationship between performance incentives and firm risk. In this paper, we test the theory exploiting the variation in both incentive compensation and managerial risk aversion. We argue that risk aversion is higher during recessions. There is growing evidence illustrating that the individual risk aversion coefficients increase during recessions (Guiso et al., 2014; Cohn et al., 2014). In addition, managerial wealth is expected to decrease during recessions (Davis and von Wachter, 2011; Farber, 2011; Guvenen, 2014). Both the increase in risk aversion coefficients and the decrease in managerial wealth are expected to translate into lower risk appetite for a given level of performance incentives. Therefore, we propose and test a joint hypothesis that managerial risk aversion increases during recessions and that the increase in risk aversion leads to a weaker relationship between managerial performance incentives and risk taking.

In order to test this hypothesis, we assemble a panel dataset on executive compensation of the chief executive officers (CEOs) of the U.S. public firms between 1992 and 2009, a period that covers two macroeconomic recessions as determined by the National Bureau of Economic Research (NBER). We calculate the CEO performance incentives, which are provided by stock and stock option grants. These grants form a significant portion of the executive pay packages, amounting on average to 37 percent of a CEO's pay during our sample period.

We measure CEO performance incentives by delta – the change in the dollar value of a CEO's accumulated stock and stock options for a one percent change in the stock price (Core and Guay, 1999; Coles et al., 2006). Since the primary focus of our paper is the relationship between pay-for-performance incentives and firm risk, we emphasize the results regarding the effect of delta, but we also control for risk taking incentives provided to the managers through stock option compensation. Controlling for risk taking incentives is important because of the possibility that stock options that managers hold may slide out of the money during recessions, diminishing the risk taking incentives of managers. We measure risk taking incentives by vega – the change in the dollar value of a CEO's wealth for a 0.01 change in the annualized standard deviation of stock returns (Core and Guay, 1999; Coles et al., 2006).

In accordance with the extant literature, we use realized stock-return volatility as a measure of firm risk (e.g., Guay, 1999; Low, 2009; Hayes et al. 2012). Innovations to a firm's stock returns are reactions to news about the firm's future expected cash flows as a result of its investment and financing activities. Therefore, higher realized stock return volatility should reflect business decisions that have a larger impact on a firm's expected cash flow volatility into the future and provide an adequate measure of firm riskiness. In addition, realized stock return volatility would represent the net effect of all managerial risk-taking activities, including those that are unobservable, hence is an appropriate way of capturing firm risk (Low, 2009). Using stock-return volatility as a proxy for firm risk rests on the implicit assumption that the decisions during recessions have long-lived effects on cash flows. However, one may argue that changes in firm policies during recessions may be temporary and hence may not necessarily be detected in return volatility. Despite this possibility, the finance literature has argued that incomplete information environments (several explanations as to why such timely return (and volatility) reaction does not occur. First, incomplete information environments (e.g., Merton, 1987; Timmerman, 1993; Kurz, 1994; Morris, 1996; and Lewellen and Shanken, 2002) and/or investors with cognitive biases or limited attention (Hong and Stein, 1999, DellaVigna and Pollet, 2008) result in market reactions that tends to extend the effects of firm policies on stock returns beyond the relevant periods.

The NBER defines recession as "a period of falling economic activity spread across the economy, lasting more than a few months, normally visible in real GDP, real income, employment, industrial production, and wholesale-retail sales." The NBER identified two recessions that coincide with our sample period: March 2001 - November 2001 and December 2007 - June 2009.[1] Using these recession dates, we show that during economic expansions the relationship between pay-for-performance incentives and firm risk is positive. However, we observe no significant relationship between pay-for-performance incentives and firm risk during recessions. To state the impact of the recession periods in economic terms, we calculate the effect of increasing a CEO's delta from its 25th percentile value ($49,000) to its 75th percentile value ($403,000). Such an increase in CEO incentives is associated with a 16 percent increase in firm risk during the expansionary periods, while it has virtually no effect on firm risk during the recession periods.

The NBER recession dates may not precisely correspond to the declines in macroeconomic activity. According to the NBER, the "economic activity is typically below normal in the early stages of an expansion, and it sometimes remains so well into the expansion." With this concern, we repeat our analyses using additional measures that gauge the level of economy activity. The macroeconomic variables we use are the advance release values of real

[1] http://www.nber.org/cycles.html

gross domestic product (GDP) growth rate, the change in the non-farm payroll, the change in personal consumption expenditures, and the change in retail sales. Earlier literature shows that these macroeconomic indicators have a significant effect on the market sentiment (Andersen, Bollerselev, Diebold and Vega, 2007; Boyd, Jagannathan and Hu, 2005; Flannery and Protopapadakis, 2002; McQueen and Roley, 1993).

The findings using the alternative measures of macroeconomic activity are consistent with the NBER recession results. When the economy is at its highest state (GDP growth measure=4.8 percent), an increase in performance incentives from its 25th percentile (delta=\$49,000) to its 75th percentile (delta=\$403,000) would be associated with a 40 percent increase in firm risk. On the other hand, when the economy is at its lowest state (GDP growth measure =-6.1 percent), the same increase in performance incentives would result in a 30 percent decline in firm risk. We obtain similar results when we use the other macroeconomic measures.

To summarize, our results provide support for the joint hypothesis that managerial risk aversion increases during recessions and that the increase in risk aversion leads to a weaker performance incentive-firm risk relationship. In particular, we infer from our findings that the same manager with exactly the same level of equity-based compensation facing the same firm characteristics may target a lower (higher) risk level during economic recessions (expansions). The procyclical relationship between incentives and risk taking is consistent with state-dependent managerial risk aversion documented in the literature.

In order to ensure that the firm's operating environment does not influence the structure of the compensation contracts of its managers (Murphy, 2012), we explicitly account for the endogenous nature of the incentive contracts using estimation methods specifically designed to deal with endogeneity, namely instrumental variables and simultaneous equations. We also note that an additional endogeneity concern in this study is that the relation between volatility and pay-performance sensitivity might be correlated with some factor related to economic growth. By construction, the instrumental variables estimation treats the interaction of delta and the macroeconomic state as endogenous with respect to risk taking, alleviating this additional concern. Our main result is robust to these estimation techniques - as the macroeconomic state weakens (improves), so does the relationship between executive performance incentives and firm risk.

Another concern is that the macroeconomic conditions might have a mechanical impact on the value of performance incentives. As is standard in the literature (Core and Guay, 1999; Coles et al., 2006; Low, 2009), we are using the dollar-percentage measure of pay-for-performance sensitivity (i.e., dollar change in CEO wealth for a one percent change in the stock price). As such, the value of performance incentives would increase during macroeconomic expansions to the extent that the stock prices are higher. To ensure that our results are not influenced by this mechanical effect, we directly control for the economic state as a determinant of delta and vega when we conduct instrumental variables and simultaneous equations analyses. We also repeat our analyses using dollar-dollar measure of pay-for-performance sensitivity (i.e., dollar change in CEO wealth for a one dollar change in the stock price), which does not suffer from this mechanical effect. Our earlier results remain unchanged after controlling for the mechanical impact of the macroeconomic state on the value of performance incentives.

An additional concern is that our result may not be related to the underlying macroeconomic environment per se, but to the general declines in firm values that accompany the recessions. If the impact of macroeconomic state disappears once we control for firm value declines, then the results we present are merely an artefact of decreasing stock values during recessions and would undermine our hypothesis that delta-risk relationship is procyclical. To alleviate this concern, we show that the delta-risk relationship weakens even for firms that experience value increases during recessions. Furthermore, we show that our result applies to the firms that operate in recession-prone industries and not to the firms that operate in recession-proof industries. This finding supports our hypothesis because managers in recession-proof industries would not expect their wealth to change according to the underlying macro conditions, and therefore their risk aversion would be less sensitive to the economic environment.

The ability of the manager to adjust the firm's overall risk profile over a short period of time should vary across firms. Therefore, the paper's main prediction should be more applicable when the manager can alter the firm's risk profile more. Accordingly, we look into the instances when CEO's have more control over firm's resources. We focus on two variables that have been shown in the previous literature to be correlated with managerial control: CEO tenure (eg., Pan et al., 2014) and product market competition (eg., Giroud and Mueller, 2010). Using these measures of managerial control, we show that the relationship between firm risk and delta weakens more in recessions for firms that are managed by more powerful CEOs.

One may argue that during recessions, as stock values decline, there would be a mechanical increase in financial leverage. Due to its impact on stock beta, higher leverage would lead to an increase in stock return volatility. Even though the paper studies how the sensitivity of equity risk to pay-performance sensitivity varies with macroeconomic conditions, and not how equity risk varies with macroeconomic conditions, the effect of financial leverage on equity risk might vary with factors related to pay-for-performance sensitivity. To alleviate this concern, we confirm of our findings in a subsample of firms with very low levels of leverage.

We also show that our results remain unchanged if we use firm-specific risk. Showing that our results hold for firm-specific risk would partially alleviate the concern that the stock return volatility, our measure of firm risk, is correlated with the macroeconomic state. We use the residuals from the market model to calculate firm-specific risk (Low, 2009). In line with our total risk results, we find that the relationship between delta and firm-specific risk weakens as the macroeconomic environment deteriorates.

Our research contributes to the literature that studies the depressive effects of stock-based compensation on managerial risk taking. Our research also contributes to a small but growing literature on the impact of different economic states on risk taking behavior. Kempf et al. (2009) show that mutual fund managers decrease risk during years marked by negative stock market returns, when "employment risk" dominates "compensation incentives". Schoar and Zuo (2013) illustrate that managers who start their careers in recessions have more conservative management styles throughout their tenures as CEOs. Similarly, Malmandier and Nagel (2011) find that individuals who have experienced low stock market returns throughout their lives report lower willingness to take financial risks using data from the Survey of Consumer Finances from 1960 to 2007. Finally, DeYoung, Peng and Yan (2013) show that banks facing stronger (weaker) economic conditions choose more (less) risky business policies. However, none of these studies analyze the link between performance incentives and firm risk under different economic states. We add to this literature by incorporating the role of pay-for-performance incentives. To our knowledge, we provide the first evidence for the procyclicality of the relationship between managerial pay-for-performance incentives and firm risk. Regulators and compensation committees, who design compensation structures to provide appropriate performance and risk incentives, may find it useful to consider the procyclical nature of the relationship between performance incentives and firm risk.

2 Hypothesis Development

In this paper, we study the relationship between performance incentives and firm risk. In particular, we argue that a given level of performance incentive would implement a lower (higher) firm risk during economic recessions (expansions). Here, we motivate this hypothesis by augmenting the standard principal-agent model of executive compensation with a state-dependent managerial risk aversion coefficient (Guiso et al., 2014; Cohn et al., 2014), and state-dependent managerial wealth.

In the standard principal-agent models, the contracting problem involves the risk-neutral shareholders designing compensation schemes for risk-averse managers. Managers choose effort levels, which enable them to attain expected utility levels that are at least equal to their outside options, thus satisfying their participation constraints and incentive compatibility constraints.[2] In these models, stock-based compensation naturally emerges as a part of the optimal compensation contract because it incentivizes managers to exert effort and increase stock value by creating pay-for-performance sensitivity (delta). With regards to risk-taking, if higher net present value (NPV) projects are also inherently riskier, then higher performance incentives are expected to implement higher firm risk.[3]

However, it has long been recognized that the linear payoff structure of stock may induce a sufficiently risk averse manager to reject risky, positive NPV projects and therefore reduce the riskiness of the firm (Guay, 1999). This is because managers are inherently more risk averse than diversified shareholders due to their organization-specific human capital and/or undiversified wealth portfolios (Smith and Stulz, 1985; Amihud and Lev, 1981; Tufano, 1996). The relationship between performance incentives from stock-based compensation and firm risk is expected to weaken: (i) when managerial wealth declines, and/or (ii) when there is an increase in managerial risk aversion coefficient (Sung, 1995; Ou-Yang, 2003; Edmans

[2] Some recent papers add firm risk as a choice variable for the manager (Dittman and Yu, 2011; Edmans and Gabaix, 2011) and find that endogenizing risk does not change the nature of the relationship between risk aversion parameters, managerial wealth and firm risk.

[3] Consistent with this prediction, Coles et al. (2006), Armstrong and Vashishta (2012), and Milidonis and Stathopoulos (2014) find a positive relationship between performance incentives and firm risk.

and Gabaix, 2011; Ditmann and Yu, 2011).

To alleviate the effect of risk aversion, managers are provided with risk taking incentives (vega) through stock option grants. As the value of a stock option increases with stock price volatility, option compensation would provide a risk averse manager an incentive to take on risky investments (Jensen and Meckling, 1976; Myers, 1977; Smith and Stulz, 1985; Haugen and Senbet, 1981; Smith and Watts, 1992; Gaver and Gaver, 1993; Bizjak et. al., 1993; Guay, 1999; Core and Guay, 1999; Coles et al., 2006). Still, the convexity of the payoff function from option holdings may be more than offset by the concavity of the manager's utility function, and stock option holdings may not be enough to induce managerial risk taking (Guay, 1999; Ju et al., 2002). Consistent with this argument, Dittmann and Maug (2007) show that the proportion of CEOs whose risk aversion is neutralized by their option holdings is rather small. Similarly, Milidonis and Stathopoulos (2014) demonstrate that in circumstances when managerial risk aversion is more pronounced, the CEOs reduce firm risk even in the presence of strong risk taking incentives.

To summarize, the theory implies that while more pay-performance sensitivity could induce less risk-taking because of a desire to limit portfolio risk, it could also encourage more risk-taking because risky projects generally create more value and therefore increase the expected value of incentive compensation. Thus, the direction of the relationship between firm risk and pay-performance sensitivity can go either way. Two factors that characterize the manager's utility function are critical in determining the relationship: the risk aversion coefficient and the level of wealth.

In this paper, we argue that the relationship between firm risk and pay-performance sensitivity will be less positive (or more negative) during recessions regardless of which direction the unconditional relationship goes, because managerial risk aversion is expected to increase. More generally, we argue that the relationship between performance incentives and firm risk is pro-cyclical since managerial risk aversion increases during macroeconomic downturns and decreases during macroeconomic expansions.

The increase in managerial risk aversion during macroeconomic downturns may prevail due to two distinct reasons: First, the risk aversion coefficient that characterizes the managerial utility function is expected to increase during recessions. This increase can be thought of as a shift in the expected utility function of the manager for a given level of wealth. Second, we expect that the general decline in stock prices during recessions would lead to a decline in managerial wealth, thereby increasing the CEO's marginal utility of consumption. The wealth effect can be viewed as the manager moving to a more concave region of his/her utility function, making the executive more sensitive to risk. This is because the utility loss due to a given decline in wealth will be greater for lower levels of wealth. Hence, as with the increase in risk aversion coefficient during recessions, the decline in managerial wealth is also expected to generate a weakening of the relationship between delta and firm risk. This suggests that both the wealth effect and the risk aversion coefficient channel work in the same direction, implying the joint hypothesis that managerial risk aversion increases during recessions and that the increase in risk aversion leads to a weaker delta-risk relationship. In other words, the same manager with exactly the same level of performance incentives (delta) facing the same firm characteristics would target a lower (higher) risk level during economic recessions (expansions).

The empirical literature provides support for our assumptions about risk aversion coefficient and expected wealth. There is growing evidence indicating that individual risk aversion coefficient is state-dependent. Based on an investor survey and lab experiments, Guiso et al. (2014) show that individual risk aversion substantially increased after the 2008 financial crisis. They attribute the documented increase in risk aversion to the "fear of large losses," because even those survey responders who have not incurred financial losses still exhibited a decline in their risk aversion suggesting that actual wealth decline is not the only factor driving the changes in risk aversion. In another experiment, Cohn et al. (2014) prime financial professionals with boom and bust scenarios, and subsequently measure their risk taking. They show that subjects who were primed with a financial bust were substantially more risk averse than those who were primed with a financial boom. They, too, attribute the increase in risk aversion to subjects being more fearful during bust periods compared to boom periods.

There is also growing evidence that there is a decline in expected wealth during recessions. Recent labor economics literature shows that being displaced in recessions leads to more significant earnings losses compared to being displaced during non-recession periods. For example, Davis and von Wachter (2011) find that earnings losses of high-tenure employees from displacements that occur in recessions are twice as large for displacements that occur in expansions. Similarly, Farber (2011) shows that earnings losses and reemployment rates are substantially worse for those who lost their jobs in the Great Recession than those who were displaced in any earlier period in the last 30 years. The drop in earnings is even more significant for the top wage earners. Guvenen et al. (2014) show that the cyclicality of earnings risk is larger for the top one percent earners compared with the rest of the population.

Since neither the managerial risk aversion parameter nor the total managerial wealth is observable, we are not able to directly measure the magnitude of the two effects. However, we note that both channels work in the same direction and suggest a joint hypothesis that managerial risk aversion increases during recessions and that the increase in risk aversion leads to a weaker delta-risk relationship. Our empirical tests support this joint hypothesis. In addition, we show that even those firms whose value increase during recessions experience a weakening delta-firm risk relationship. This implies that the state-dependent link between delta and firm risk can also emerge independent of the wealth effect, as a consequence of the change in the manager's risk aversion coefficient.

3 Data and Variables

3.1 SAMPLE FORMATION

Our sample consists of the U.S. companies that are covered in the Standard and Poor's ExecuComp database between fiscal years 1992 and 2009. We exclude financial firms (SIC codes between 6000 and 6999) and utility firms (SIC codes between 4900 and 4999). For the majority of the firm-years, Execucomp identifies Chief Executive Officers (CEOs) with a flag. For firm-years when there is no CEO flag in the ExecuComp database, we identify the CEOs based on the dates when they assumed and quit office as provided by ExecuComp following Coles et al. (2006). We then merge the ExecuComp data with financial data from Compustat and with stock price data from Center for Research in Security Prices (CRSP). We require that firms have 3 years of consecutive financial data from Compustat, and that a firm's stock has been traded for at least 100 days in those fiscal years. These data requirements result in a sample size of 20,252 firm-year observations.

3.2 COMPENSATION VARIABLES

For each CEO, we get detailed compensation data including salary, bonus, stock option grants, restricted stock grants and total pay from ExecuComp.[4] The reporting of compensation variables has changed in ExecuComp following the implementation of FAS 123R for fiscal years ending after December 15, 2006. We follow Hayes et al. (2012) to perform the necessary modifications to ExecuComp variables during 2006-2009.

We follow Core and Guay (2002) to measure CEO incentives. We measure the sensitivity of a CEO's wealth from her employment to firm performance with delta - the change in

[4] If option grants (option_awards_blk_value) or stock holdings (shrown_excl_opts_pct) are missing in ExecuComp, we set their value to zero. Furthermore, there are some observations with negative bonus values, and we replace these figures with zero. Tenure is missing for some firm-years. We replace the missing tenure variables with zero and create indicator variables for missing tenure observations following (Coles and Li, 2011).

the dollar value of a CEO's wealth for a one percentage point change in the stock price. Similarly, we measure the sensitivity of a CEO's wealth from her employment to firm risk with vega – the change in the dollar value of a CEO's wealth for a 0.01 change in annualized standard deviation of stock returns. Following the prior literature, we winsorize delta, vega, bonus and salary at the 1st and 99th percentiles (Core and Guay, 2002; Coles et al., 2006). To account for the effect of inflation, we convert the compensation variables as well as firm financial variables in 1992 dollars using the GDP deflator.

In our analysis of the relationship between executive compensation and firm risk, we use the standard set of control variables, which includes firm size, market-to-book ratio, research and development expenditures scaled by total assets, capital expenditures scaled by assets and leverage ratio (Coles et al., 2006).

Table 1 presents summary statistics on the compensation variables and firm financial characteristics. Mean (median) total assets is $3,799 mn. ($735 mn.) in 1992 dollars. Mean (median) vega is $80,000 ($28,000), mean (median) delta is $531,000 ($140,000), and mean (median) cash compensation is $1,013,000 ($724,000). These figures are consistent with the prior literature and have the same order of magnitude as the descriptive statistics reported in Coles et al. (2006).

3.3 FIRM RISK

We measure firm risk using realized stock return volatility, which is one of the standard measures of risk in the compensation literature. Innovations to a firm's stock returns are reactions to news about the firm's future expected cash flows as a result its investment and financing activities. Therefore, higher realized stock return volatility should reflect business decisions that have a larger impact on a firm's expected cash flow volatility into the future and provide an adequate measure of firm riskiness. Alternatively, one can infer firm risk from financial and investment policies such as changes in capital expenditures, research and development expenditures, leverage or firm diversification, which will affect the volatility of the cash flows into the future. However, many aspects of uncertainty regarding these policies are unobservable. For instance, not all research and development projects are similarly uncertain. Realized stock return volatility represents the net effect of all managerial risk-taking activities, including those that are unobservable, hence is a more appropriate way of capturing firm risk (Low, 2009). Yet, one limitation of our firm risk measure is that it focuses on equity risk alone although total firm risk also includes the debt component. Since the data on private and public debt are not readily available, we are unable to estimate the risk of the firm's debt, but as standard in the literature, we do control for the impact of leverage on equity risk in all of our analyses.

One may conjecture that the cash flow effects of changes in firm policies during recessions may be temporary and hence may not necessarily be detected in return volatility beyond the current period. If, for example, firms can easily "add back" sources of risk that were temporarily removed during a recession after it ends, then the effects of the recession on the riskiness of the full stream of a firm's future cash flows would be limited. Despite this theoretical possibility, however, the finance literature has identified several explanations as to why such timely return (and volatility) reaction may not necessarily arise in financial markets. Rational explanations have generally focused on (rational) investor processing of incomplete information structures (e.g., Merton, 1987; Timmerman, 1993; Kurz, 1994; Morris, 1996; and Lewellen and Shanken, 2002). Behavioral explanations (Barberis and Thaler, 2004), on the other hand, argue that cognitive processing biases (e.g. representativeness and conservatism) lead to abnormally delayed return patterns. Overall, these studies suggest that investors operating in an incomplete information environment and/or investors with cognitive biases or limited attention (Hong and Stein, 1999, DellaVigna and Pollet, 2008) portray market reaction that tends to extend the effects of firm policies on stock returns beyond the relevant periods. A long-standing example in this regard is the investors' delayed response to earnings announcements (e.g. Abernell and Bernard, 1992). Compared to the publicly available earnings reports, specific information on firm policies regarding adjustments to firm risk in response to recessions may be less accessible and noisier, hence, may go undetected by investors for a relatively long period of time. This, in turn, would delay the stock return volatility reaction to changes in firm risk beyond the current period. In particular, Lewellen and Shanken (2002) show that in an environment where rational investors have imperfect information about expected cash flows, the (Bayesian) learning process necessary to update the investor's information set (and the parameter uncertainty associated with this process) is enough to generate increased return volatility even though prices react efficiently to cash-flow news. Even if information on firm policies regarding adjustments to firm risk in response to economic conditions were publicly available and easily accessible by the investor, under-reaction to information due to cognitive limits (Hong and Stein, 1999) may still delay the full market response. Hence, as these studies suggest, there is ample evidence suggesting that adjustments to risk during recessions are likely to affect cash flow and return volatility on a sustained basis beyond the current period.

We estimate stock return volatility with the annualized variance of daily stock returns over a fiscal year. We require a minimum of 100 daily returns during the fiscal year in order to estimate volatility. We also calculate firm-specific risk by estimating the market model, using CRSP value-weighted returns as our proxy for the returns of the market portfolio. Firm-specific risk is the annualized variance of the residuals.

3.4 MACROECONOMIC STATE VARIABLES

We use six variables to proxy the macroeconomic state. First, we create a recession indicator variable based on the business cycle dates determined by the National Bureau of Economic Research (NBER). If a firm's fiscal year coincides with an NBER recession period for at least 90 days, we assign the value one to the recession indicator variable. These are the fiscal years that coincide with macroeconomic recessions. The NBER recession indicator takes the value zero for 4,098 firm-years, corresponding to 18 percent of our full sample (Table 1)[5]. We also count the number of days in a firm's fiscal year that coincide with the NBER recession

[5] We believe this is a sufficient number of observations. To give a comparison, in Schoar and Zuo (2011), the recession dummy takes the value one for 21 percent of the 2,058 observations in the sample. In addition, we supplement the NBER recession indicator with four continuous measures of macroeconomic state, which have the advantage of capturing the variation in the macro state

dates. This count variable is our second measure of the macroeconomic state.

The NBER recession dates may not precisely correspond to the declines in macroeconomic activity. According to the NBER, the "economic activity is typically below normal in the early stages of an expansion, and it sometimes remains so well into the expansion." Also, the NBER recession-based proxies do not measure the degree of macroeconomic downturns or expansions. With these concerns, we repeat our analyses using alternative measures of macroeconomic conditions to test whether the change in managerial response to pay-for performance is generalizable beyond the NBER recession dates. These measures are based on the advance release values of GDP, non-farm payroll, personal expenditure and retail sales growth. We include these macro variables given the markets' strong reaction to their announcement (Andersen et al., 2007; Boyd et al., 2005; Flannery and Protopapadakis, 2002). We use the unrevised announcement values of the variables to capture the macroeconomic climate as perceived by the firms during a fiscal year[6].

The third measure of macroeconomic state is based on the seasonally-adjusted real GDP growth rates. In Figure 1, we plot the advance release values of GDP growth rates together with the official NBER recession dates. The GDP growth rates are announced quarterly

by utilizing the full sample.

[6] Revised values are released with a substantial lag and are not always within the information set of the management at the time of the decision making. The use of unrevised data has a number of advantages over the use of fully revised data for the purposes of real-time forecasting. For a detailed discussion of these advantages, see Swanson (1996). We get the unrevised values from Action Economics.

by the Bureau of Economic Analysis (BEA), therefore there are four announcements of this variable during a firm's fiscal year. We use the minimum of the four quarterly GDP growth rates during a firm's fiscal year. During our sample period, the minimum value for the GDP growth rate measure is -6.1 percent (2009), and the maximum value is 4.8 percent (1999).

Our fourth measure of macroeconomic state is the change in the non-farm payroll employment, which is compiled and published by the Bureau of Labor Statistics. Non-farm payroll is the total number of U.S. workers that receive a wage, excluding farm workers, private household employees, non-profit organization employees and government organization employees. The non-farm payroll statistics are announced monthly, are seasonally adjusted and represent changes in thousands of persons. We use the minimum of the twelve monthly releases during a firm's fiscal year to measure the state of the economy. During our sample period, the minimum value for the NFP measure is a decrease of 663,000 employees (2009), and the maximum value is an addition of 134,000 workers (1995).

Our fifth measure of macroeconomic state is the Personal Consumption Expenditure Growth, which is compiled and published by the Bureau of Economic Analysis. Personal consumption expenditures (PCE) is the primary measure of consumer spending on goods and services in the U.S. economy. It accounts for about two-thirds of domestic final spending, and thus it is the primary engine that drives future economic growth[7]. The PCE statistics are released monthly, and we use the minimum of the twelve monthly releases over a firm's

[7] For more detailed information on the PCE data, please see the website of the Bureau of Economic Analysis. http://www.bea.gov/national/pdf/NIPAhandbookch5.pdf

fiscal year. During our sample period, the minimum value for the PCE measure is -1.8 percent (2001), and the maximum value is 0.3 percent (1999).

Our sixth and final measure of macroeconomic state is the Retail Sales Growth. Retail Sales (RS) is a monthly index compiled and published by the U.S. Census Bureau. It measures the total receipts at stores that sell merchandise and related services to final consumers. The index is a broad measure of retail sales as it includes sales of both durables and non-durable goods. We use the minimum of the twelve monthly releases over a firm's fiscal year. During our sample period, the minimum value for the RS measure is -3.7 percent (2001), and the maximum value is 0.1 percent (1999).

4 Results

4.1 BASELINE MODEL: ESTIMATING THE RELATIONSHIP BETWEEN PERFORMANCE INCENTIVES AND FIRM RISK

We use the following empirical specification to test for the relationship between managerial performance incentives and firm risk:

$$\text{Firm risk}_{i,t} = \alpha + \beta_1 \text{Delta}_{i,t-1} + \beta_2 \text{Vega}_{i,t-1} + \sum_j \gamma_j X_{i,t} + \varepsilon_{i,t} \tag{1}$$

Analyses are conducted at the firm-year level. Our primary measure of firm risk is its stock return volatility, which we measure with the natural logarithm of the annualized volatility of daily stock returns during fiscal year, t. Our main variable of interest is delta – the change in the dollar value of CEO's employment-related wealth for a one percent change in stock price, which captures the managerial performance incentives. While pay-for-performance sensitivity is the primary focus of this paper, we also control pay-for-risk sensitivity (vega) that are provided to managers via stock options. Controlling for risk taking incentives is important because of the possibility that stock options that managers hold may slide out of money during recessions, diminishing the risk taking incentives of managers. We use lagged values of delta and vega (Coles et al., 2006). Both delta and vega enter the regressions in their natural logarithm forms.

Control variables, $X_{i,t}$, include CEO cash compensation (salary plus bonus), firm size, market-to-book ratio, research and development expenditures scaled by total assets, capital expenditures scaled by assets and leverage ratio. These are the standard controls employed in literature. Coles et al. (2006) and Armstrong and Vashishtha (2012) provide a detailed discussion of these control variables and their predicted signs in the firm risk equation.

We present the results in Table 2. In Column (1), the equation is estimated with industry fixed effects based on firms' 2-digit SIC codes. This approach controls for any time-invariant differences across industries that may contribute to the relationship between CEO incentives and firm risk. In Column (2), we estimate the equation using firm fixed effects, which control for time-invariant differences across firms. Firm fixed effects are used to mitigate the concern that unobservable characteristics might be affecting both the structure of executive compensation and firm risk choices. Finally, in Column (3), we estimate the equation using fixed effects for CEO employment spells. To apply this method, we construct a dummy variable for each unique combination of CEO and firm pairs using the firm-executive identifier (co_per_rol) available in Execucomp. This specification, as suggested by Graham et al. (2012) takes into account the possibility that a given CEO might be compensated differently in similar firms due to the heterogeneity in unobservable firm characteristics such as corporate culture. More importantly, this specification also alleviates the concern that career concerns and fear of large losses which affect risk aversion might vary for different managers due to the heterogeneity in their unobserved characteristics such as outside employment options. The fixed effects estimations would help alleviate the endogeneity concern that pay-performance sensitivity and return volatility might both be correlated with an unobserved firm or managerial characteristic. However, an additional endogeneity concern in the context of our study is that the relation between volatility and pay-performance sensitivity might be correlated with some factor related to economic growth. As such, in Section 5.2, we also estimate the instrumental variables regressions that directly deal with the possibility that the interaction of delta and the macroeconomic state may be endogenous with respect to risk taking. All regressions also include year fixed effects to capture systemic variations in firm risk over time. We cluster the standard errors at the firm-year level.

The results indicate a positive relationship between managerial performance incentives and firm risk. For example, the coefficient on delta using firm-manager fixed effects estimation is 0.021 and statistically significant at the one percent level – meaning that a one percent increase in delta translates into a 0.021 percent increase in firm risk after controlling for the other determinants of stock return volatility. According to this result, increasing managerial performance incentives from its 25th percentile ($49,000) to its 75th percentile ($403,000) is associated with a 15 percent increase in firm risk.

We would like to note that the results show a statistically significant negative relationship between managerial risk taking incentives (vega) and firm risk. Earlier studies (Coles et al., 2006; Low, 2009) find a positive correlation between vega and firm risk. Even though our emphasis in this paper is performance incentives (delta), we briefly investigate the reason for the difference in our findings with respect to vega. Since we have followed the specification in Coles et al. (2006), we attribute the differences in our results to the different sample periods. In columns (4) and (5), we estimate the equation for 1992-2002 in order to replicate the analyses in Coles et al. (2006) and we obtain a positive coefficient on vega. In a more recent study, Milidonis and Stathopoulos (2014) also report a significant negative relationship between vega and risk and attribute the finding to managerial career concerns. Savaser and Sisli-Ciamarra (2014) attribute this change in the relationship to announcement and implementation of an accounting rule (FAS 123R) that required the expensing of the employee stock options.

To summarize, the results from the baseline regressions exhibit a positive relationship between firm risk and lagged managerial performance incentives, which is in line with the extant literature (e.g., Coles et al., 2006; Armstrong and Vashishtha, 2012; Milidonis and Stathopoulos, 2014).

4.2 EFFECT OF THE MACROECONOMIC STATE ON THE RELATIONSHIP BETWEEN PERFORMANCE INCENTIVES AND FIRM RISK

In this section, we test our main hypothesis that the positive relationship between firm risk and managerial performance incentives is relatively lower (higher) during macroeconomic downturns (expansions). In order to test this hypothesis, we augment our baseline model (Equation 1) by adding various measures of macroeconomic state and interacting these measures with performance incentives:

$$\begin{aligned} \text{Firm risk}_{i,t} &= \alpha + \beta_1 \text{Delta}_{i,t-1} + \beta_2 \text{Vega}_{i,t-1} + \delta_1 \text{Macroeconomic state}_{i,t} \\ &+ \delta_2 \text{Macroeconomic state}_{i,t} * \text{Delta}_{i,t-1} \\ &+ \delta_3 \text{Macroeconomic state}_{i,t} * \text{Vega}_{i,t-1} \\ &+ \sum_j \gamma_j X_{i,t} + \varepsilon_{i,t} \end{aligned} \tag{2}$$

The main coefficient of interest belongs to the interaction of the Macroeconomic state with Delta (δ_2).

4.2.1 *Macroeconomic State Measure: The NBER Recessions*

The first two measures for macroeconomic downturns and expansions are based on the NBER business cycle dates. The NBER has identified two recessions that fall in our sample period: March 2001 to November 2001 and December 2007 to June 2009. First, we use a recession dummy, which takes the value one if a firm faced a recession for at least 90 days over a fiscal year and zero otherwise. Second, we count the number of days a firm faced recession over a fiscal year. We predict a statistically significant negative value for δ_2 when we use the macro measures based on the NBER recession dates, since we expect managerial risk aversion to increase during recessions.

The results using the NBER recession dates as a measure of macroeconomic state are presented in Table 3. In Columns (1), (2) and (3), we use the NBER recession dummy and estimate Equation 2 using industry, firm and firm-manager fixed effects respectively. In line with the predictions of our hypothesis, we obtain a negative and statistically significant coefficient on the interaction term for all specifications. For example, the interaction coefficient (δ_2) is -0.023 when we use firm-manager fixed effects, meaning that a one percent increase in delta is associated with a 0.023 percent decrease in firm risk if the firm faces a recession for at least 90 days over a fiscal year. To state the economic impact of recession on the relationship between performance incentives and firm risk, we calculate the impact of an increase in a CEO's delta from its 25th percentile ($49,000) to its 75th percentile ($403,000). Such an increase in performance incentives is associated with a 16 percent increase in firm risk during a non-recession period, but virtually no increase in risk during a recession period.

In Columns (4) – (6) of Table 3, we repeat the same analyses using the actual number of days that a firm was in recession over a fiscal year as a measure for the macroeconomic state. The results are similar: When the economy is in a recession, the relationship between delta and firm risk is lower. Each additional day of recession within a given fiscal year decreases the effect of delta on firm risk by 0.003 percent.

We also note that in all specifications, the coefficient on recession dummy is significant and positive, reflecting the elevated firm risk level during recessionary periods. In addition, the coefficient belonging to the interaction of the Macroeconomic state and Vega (δ_2) is insignificant for all specifications. According to these results, the relationship between managerial risk taking incentives and firm risk does not seem to vary over a business cycle.

4.2.2 *Macroeconomic State Measure: Growth in GDP, Employment, Consumption and Retail Sales*

We recognize that the NBER recession dates might not precisely correspond to the declines in macroeconomic activity. Therefore, we re-estimate Equation 2 using four alternative measures of macroeconomic state: advance release values of growth in seasonally-adjusted real GDP, non-farm payroll employment, personal expenditure and retail sales. Since an increase in these measures corresponds to a better macroeconomic state (thus lower managerial risk aversion), we predict a positive and significant coefficient for their interactions with Delta (δ_2).

Columns (1) – (3) of Table 4 present the results when we use GDP growth rate as a proxy for the macroeconomic state. Again, in line with the predictions of our hypothesis, we obtain a statistically significant positive coefficient on the interaction term for all specifications. For brevity, we focus on the specification using firm-manager fixed effects to discuss the economic magnitudes when discussing the results. The coefficient on the interaction term is 0.009 and statistically significant at the one percent level (column 3). This coefficient suggests that when the economy is at its highest state during our sample period (GDP growth measure=4.8 percent), an increase in managerial performance incentives from its 25th percentile (delta=$49,000) to its 75th percentile (delta=$403,000) would be associated with a 40 percent increase in firm risk. On the other hand, when the economy is at its lowest state (GDP growth measure =-6.1 percent), the same increase in performance incentives would result in a 30 percent decline in firm risk.

Next, we run our regressions using the non-farm payroll (NFP) measure. The results are presented in columns (4), (5) and (6). The coefficient on the interaction term when we use firm-manager fixed effects is 0.063 and is statistically significant at the one percent level. This coefficient suggests that when the economy is at its highest state (NFP measure=134,000) an increase in performance incentives from its 25th percentile (delta=$49,000) to its 75th percentile (delta=$403,000) would be associated with a 27 percent increase in firm risk. On the other hand, when the economy is at its lowest state (NFP measure=-663,000), the same increase in performance incentives would result in an 8 percent decline in firm risk.

Our next proxy for the macroeconomic state is the personal consumption expenditure (PCE) growth. The results are presented in columns (7), (8) and (9). Once again, the coefficient on the interaction term when we use the firm-manager fixed effects is 0.019 and is statistically significant at the one percent level. This coefficient suggests that when the economy is at its highest state (PCE measure=0.3 percent) an increase in performance incentives from its 25th percentile (delta=$49,000) to its 75th percentile (delta=$403,000) would be associated with a 23 percent increase in firm risk. On the other hand, when the economy is at its lowest state (PCE measure=-1.8 percent), the same increase in performance incentives would result in a 6 percent decline in firm risk.

Our final proxy for the macroeconomic state is the growth in retail sales (RS). The results are presented in columns (10), (11) and (12). The coefficient on the interaction term when we use the firm-manager fixed effects is 0.012 and is statistically significant at the one percent level. This coefficient suggests that when the economy is at its highest state (RS measure=0.1 percent) an increase in performance incentives from its 25th percentile (delta=$49,000) to its 75th percentile (delta=$403,000) would be associated with a 24.5 percent increase in firm risk. On the other hand, when the economy is at its lowest state (PCE measure=-3.7 percent), the same increase in performance incentives would result in an 8.15 percent decline in firm risk.

To summarize, the results based on the alternative measures of economic activity confirm our earlier analysis using the NBER recession measures. These findings illustrate that the relationship between equity-based compensation and risk taking depends on the state of the economy. In particular, we infer that the same manager with exactly the same level of performance incentives (delta) facing the same firm characteristics may target a lower (higher) risk level during economic recessions (expansions). The documented procyclical relationship between incentives and risk taking is consistent with state-dependent risk aversion (Cohn et. al. 2014; Guiso et al., 2013), and support our joint hypothesis that managerial risk aversion increases during recessions and that the increase in risk aversion leads to a weaker relationship between managerial performance incentives and risk taking.

5 Robustness

5.1 FIRM-SPECIFIC RISK

In our analyses, we have shown that the relationship between managerial performance incentives and firm risk weakens during economic downturns (and vice versa). In this section, we repeat our analyses using firm-specific risk as the dependent variable. Showing that our results hold for firm-specific risk would partially alleviate the concern that the stock return volatility, our measure of firm risk, is correlated with the macroeconomic state.

$$\begin{aligned}\text{Firm-specific risk}_{i,t} \;=\;& \alpha + \beta_1 \text{Delta}_{i,t-1} + \beta_2 \text{Vega}_{i,t-1} + \delta_1 \text{Macroeconomic state}_{i,t} \\ &+ \delta_2 \text{Macroeconomic state}_{i,t} * \text{Delta}_{i,t-1} \\ &+ \delta_3 \text{Macroeconomic state}_{i,t} * \text{Vega}_{i,t-1} \\ &+ \sum_j \gamma_j X_{i,t} + \varepsilon_{i,t}\end{aligned} \quad (3)$$

As in Low (2009), the idiosyncratic risk is the natural logarithm of annualized variance of the residuals from the market model. As before, the main coefficient of interest belongs to the interaction of the Macroeconomic state and Delta (δ_2), and we predict a negative (positive) δ_2 when we use NBER recessions (macro variables) as the measure of the macroeconomic state.

In Table 5, we summarize the results. All regressions include firm-manager fixed effects. Similar to the earlier results, we obtain a negative and statistically significant coefficient for the interaction terms when we measure macroeconomic state by the NBER recession dates (columns 1 and 2). For example, the coefficient on the interaction term for the NBER dummy is -0.041 and indicates that a one percent increase in delta is associated with a 0.041 percent reduction in firm-specific risk when the economy faces a recession during a firm's fiscal year. Accordingly, an increase in delta from its 25th percentile to its 75th percentile would be associated with a 10 percent increase in firm risk during expansion years, but with a 20 percent decrease in risk during recession years. We present the findings using the GDP growth rate, additions to non-farm payroll and personal consumption expenditure growth rate as a proxy for the macroeconomic state in columns 3, 4 and 5 respectively. We obtain a positive coefficient on the interactions terms across all specifications and all the estimates are significant at the one percent confidence level.

5.2 ENDOGENEITY

The existing empirical literature on executive compensation recognizes that firm risk and managerial compensation schemes might be jointly determined and also the causation between managerial incentives and firm risk may run in both directions. We have two additional endogeneity concerns specific to this study. First, the relationship between firm risk and pay-performance sensitivity might be correlated with a factor related to economic growth, and consequently the interaction of delta and the macroeconomic state may be endogenous with respect to risk taking. Second, the macroeconomic state may have a direct effect on the value of managerial incentives because during recessions lower stock prices would lead to a mechanical decrease in performance incentives (delta) for a fixed amount of stock and stock option holdings. Since, on average, firm risk increases in recessions, the weakening of the delta-risk relationship that we uncover may simply be a consequence of the increase in the value of our dependent variable accompanying the mechanical decline in the value of delta during recessions. Due to these concerns, we account for the endogenous nature of the incentive contracts using estimation methods specifically designed to deal with endogeneity - namely instrumental variables and simultaneous equations estimations.

5.2.1 *Instrumental Variables Regressions*

In this section, we treat CEO incentives (delta and vega) as endogenous and estimate the contract design and risk equations using two-stage least squares (2SLS). To implement the 2SLS, we need to identify valid instruments for delta and vega - the two compensation contract design features that we treat as endogenous. Our choices of instruments are based on the determinants identified by the previous literature, and include surplus cash (Core and Guay, 1999; Coles et al., 2006; Armstrong and Vashishtha, 2012), an indicator variable that is equal to one if a firm had a tax-loss carry forward in any of the past three years and zero otherwise (Armstrong and Vashishtha, 2012), and the accounting cost that public firms incurred by the implementation of FAS 123R (Hayes et al., 2012). We expect these variables only to have an indirect relationship with firm risk through their effect on equity incentives and the other control variables. We confirm the econometric validity of these instruments by conducting Hansen's tests of overidentifying restrictions. We present the 2SLS results in Table 6.

Surplus cash is a proxy for cash constraints of a firm, which can influence the CEO's equity incentives since cash-constrained firms tend to substitute cash compensation with restricted stock and stock options (Core and Guay, 1999). However, the presence (or lack) of cash constraints by itself does not necessarily imply systematically different levels of firm risk. Still, one may argue that cash surplus may not be a valid instrument if risky firms keep a larger cash cushion to avoid financial distress, and at the same time provide more equity incentives to their CEOs in order to deal with the agency problems associated with free cash flow. However, Armstrong and Vashishtha (2012) present evidence that the results of the 2SLS regressions are unchanged after removing the variation in cash balances due to precautionary motives by regressing firms' cash balance on an index of financial constraints.

The tax-loss carry forward indicator is a proxy for the firm's marginal tax rate. Firms with lower tax rates have more incentive to provide equity-based compensation. This is because Section 162(m) of the U.S. Internal Revenue Code limits the annual tax deduction to $1 million for compensation paid to each of a public company's chief executive officer and three highest compensated officers (other than the chief financial officer), but grants of options and restricted stock (i.e., sources of delta) are excluded. We do not expect tax-loss carry forward to have a direct effect on the firm risk.

With the implementation of FAS123R in 2006, public corporations were required to expense stock option grants at their fair market values.[8] Our last instrument is the accounting cost of implementing FAS123R (FAS cost), which is proxied with the ratio of the estimated market value of annual CEO option grants to reported net income. This ratio measures how much the reported net income of a firm would decline if stock option grants were expensed at their fair value. Prior to FAS123R, firms with high accounting costs granted more options, but following the rule change, these firms reduced stock option grants more because they would have had a larger accounting impact on their profitability measures (Hayes et al., 2012). This non-uniform response to the regulation implies a positive relationship between vega and accounting cost of FAS 123R. However, we do not expect FAS cost to affect firm risk. In fact, Hayes et al. (2012) show that the passage of FAS 123R has not been accompanied by a similar decline in firm risk.

As mentioned earlier, an additional concern in the context of our study is that the interaction of delta and the macroeconomic state may be endogenous with respect to risk taking. The 2SLS estimation is also helpful in alleviating this additional endogeneity concern because the interactions of endogenous variables with an exogenous variable are treated as

[8] Firms were required to shift to FAS 123R in the first accounting period after June 15, 2005. This date was later extended to 2007. Prior to the implementation of FAS123R, which required the expensing of employee stock options at their fair value, firms recorded stock option grants as an expenditure at their intrinsic values. As there were no cash outlay when the options were granted and no expense when they were exercised, firms presumed the "perceived cost" of options to be lower than their "economic cost". This in turn encouraged firms to compensate their executives with options (Hall and Murphy, 2003).

endogenous in the estimation. The interactions of instruments for the endogenous variables with the exogenous variable serve as valid instruments (Bun and Harrison, 2014; Wooldridge, p121-122, 2002). Therefore, aside from delta and vega, we also treat the interactions of delta and vega with the macroeconomic state measure as endogenous in our first stage regressions. Additionally, we include the interactions of the surplus cash, tax-loss carry forward indicator and the FAS cost with the macroeconomic state measure to our list of instruments.

The instrumental variable estimation involves the two-stage least squares method, where we first regress the equity incentives (delta and vega) on the list of instruments mentioned above and the exogenous controls suggested by the literature. Then, we regress the total firm risk on the predicted values of delta and vega (Table 6, columns 1 and 2). Both stages of regression include year and firm-manager fixed effects. Our first stage regression results are in line with the prior research (Armstrong and Vashishtha, 2012, Coles et al., 2006).[9] We test the validity of the instruments econometrically. We conduct the Hansen's test of overidentifying restrictions to see whether the exclusion restriction holds. We find that the J-statistics associated with the test are statistically insignificant at the ten percent level (J-statistics are .02 and 0.11 for total risk and firm-specific risk, respectively) confirming the validity of our instruments. An insignificant J-statistic implies that our maintained assumption that the instruments are exogenous is unlikely to be violated. In addition, the partial F-statistics suggest that, as a group, our instruments have a significant explanatory power in both the delta and vega regressions at the one percent level, and confirm that our

[9] Unreported for brevity. Available upon request.

results are not subject to the weak instrument bias.

In columns 1 and 2 of Table 6, we present the second stage results for interaction of the macroeconomic environment with managerial performance incentives. After controlling for endogeneity, we find a statistically significant positive coefficient on delta and its interaction term with GDP growth variable. The coefficients on the interaction terms are 0.099 and 0.094 in the total risk and idiosyncratic risk regressions respectively. These values are statistically significant at the one percent level. The 2SLS estimation results confirm the robustness of our main finding to the endogenous treatment of contract design, as well as the endogeneity of the interaction of delta and the macroeconomic state with respect to risk taking.

5.2.2 *Simultaneous Equations Regressions*

In this section, we estimate firm risk, delta and vega in a simultaneous regression framework in order to address the concern that the executive compensation contracts and firm risk might be jointly determined. As in Coles et al. (2006), we use contemporaneous rather than lagged values of vega and delta in order to conform to the underlying reasoning for simultaneous equations. We follow the same specification as in the instrumental variables estimation for delta and vega. Simultaneous equations require an additional variable in each equation that is unique to that equation for identification. For delta and vega equations, we use the median delta and vega values in the firm's industry since compensation structures vary across industries. For firm risk, we include the volatility of the S&P 500 index. All dependent variables in the system are explicitly taken to be endogenous and are treated as correlated with the disturbances in the system's equations. The system is estimated by the three-stage least squares method (3SLS), which is the most efficient estimation technique for the simultaneous systems (Schmidt, 1976). The method uses an instrumental variable approach to produce consistent estimates and generalized least squares to account for the assumed correlation structure in the disturbances across the equations. In the first stage, the method develops instrumented values for all endogenous variables by computing the predicted values from a regression of each endogenous variable on all exogenous variables in the system. In the second stage, the method obtains a consistent estimate for the covariance matrix of equation disturbances. In the final stage, a generalized least squares (GLS) estimation is performed using the covariance matrix estimated in the second stage, and the instrumented values from the first stage (see Greene, 2003, pp. 405-407).

In columns 3 and 4 of Table 6, we present the results for interaction of the macroeconomic state with managerial performance incentives for total risk and firm-specific risk equations respectively. Once again, in line with the predictions of our hypothesis, we obtain a statistically significant positive coefficient on the interaction terms. The coefficient on the interaction term is 0.021 for total risk (column 3) and is 0.053 for firm-specific risk (column 4). Both coefficients are statistically significant at the one percent level. These results confirm the main finding in the paper - the relationship between managerial performance incentives and firm risk depends on the underlying macroeconomic state and gets stronger (weaker) as the economy expands (contracts).

5.3 FIRM VALUE DECLINES OR MACROECONOMIC STATE?

The main result in this paper (delta-risk relationship weakens during recessions) may not be related to the underlying macroeconomic environment per se, but to the general declines in firm values that accompany the recessions. If the results we present are solely due to the general declines in firm values during recessions, then there is nothing special about the underlying macroeconomic environment when we think about how performance incentives affect firm risk. In other words, one would expect that the delta-risk relationship will become weaker whenever a firm's value declines regardless of the underlying macroeconomic state. Here, we address this concern with three additional tests.

5.3.1 *Changes in Firm Values*

We first investigate whether delta-risk relationship is weaker when firm valuations decrease without considering the impact of the underlying macroeconomic environment. This would shed light on the role of firm values on delta-risk relationship in general. To this end, we calculate the annual holding period returns for each firm, and divide the firms in two sub-samples: (i) Firms whose stock values decline over a fiscal year (negative returns), and (ii) firms whose stock values increase or stay the same over a fiscal year (positive returns). We create an indicator variable (Value Decline) that takes the value one for negative return firms and zero otherwise. We first perform a split-sample analysis by estimating the base-line regression (Equation 1) for the two groups separately and then augment the baseline regression equation by adding the "Value Decline" indicator and its interactions with delta and vega.

$$\begin{aligned}\text{Firm risk}_{i,t} &= \alpha + \beta_1 \text{Delta}_{i,t-1} + \beta_2 \text{Vega}_{i,t-1} + \delta_1 \text{Value Decline}_{i,t} \\ &+ \delta_2 \text{Value Decline}_{i,t} * \text{Delta}_{i,t-1} \\ &+ \delta_3 \text{Value Decline}_{i,t} * \text{Vega}_{i,t-1} \\ &+ \sum_j \gamma_j X_{i,t} + \varepsilon_{i,t}\end{aligned} \tag{4}$$

This specification enables us to formally test whether there is a significant difference in the relationship between pay-performance sensitivity and firm risk when the firm value declines. We present the results in Table 7, Panel A. The results indicate that the firms that experience value decreases over a fiscal year tend to increase firm risk whereas firms that experience value increases over a fiscal year tend to decrease firm risk. For firms with declining values, the coefficient on delta is significant and positive (column 1), while for firms with increasing values the coefficient on delta is significant and negative (column 2). The coefficient on the interaction term (Value Decline * Delta) is 0.031 and significant at the one percent level (column 3). This difference-in-difference analysis implies that a one percent increase in delta is associated with an additional 0.031 percent increase in firm risk for firms that experience declines in their stock valuations compared to firms whose values do not decrease.

This finding sounds counterintuitive because the theory predicts that a reduction in a firm's stock price would have a depressive effect on the manager's risk-taking incentives. A possible explanation might be related to how managers are evaluated for their performance. Brown et al. (1996) and Kempf et al. (2009) show that compensation incentives lead managers of funds with a poor interim performance to increase their fund's risk relative to managers of funds with a good interim performance. This is because the managers are assessed annually and respond to fund performance regardless of their incentives. Increasing risk increases their chance of catching up with the midyear winners. As the evidence from these findings imply, contrary to the theoretical prediction, managers of firms that experience stock price declines may choose to increase firm risk instead of reducing it.

This counterintuitive finding might also be related to the fact that the wealth effect is particularly difficult to capture due to the variations in CEOs' outside wealth, which we cannot directly measure in the U.S. setting because of lack of data. Neyland (2009) gets around this problem by using spousal divorce as a proxy for a negative shock to a CEO's outside wealth. He finds that firm risk decreases during the years of spousal divorce and attributes it to the increase in CEOs risk aversion. He attributes this result to the increase in managerial risk aversion as a response to the decline in the wealth of the executives following divorce.

Next, we look at firm value effects during recessions. We note that during recessions, 2,120 firms in our sample experienced value declines, and 1,978 firms experienced value increases. Therefore, we have variation in firm performance during fiscal years that coincide with NBER recession dates. If the main result we present in the paper (delta-risk relationship is weaker in recessions) is solely related to declines in firm values and not related to the macro environment, then the weakening of delta-risk relation should only be valid for firms that experience a decrease in value and not for firms whose value increase during recessions. In other words, if we find that the impact of macro state disappears once we control for firm value declines, then there would be nothing special about the macroeconomic state beyond its effect on firm values. To explore this possibility, in columns 4 and 5, we perform a split-sample analysis by estimating Equation 2 for the two groups separately, and in column 6, we augment our main regression equation (Equation 2) by adding the negative return dummy and its interactions with delta, vega and the recession indicator along with the triple interaction term (Delta*Value decline*Recession). This specification enables us to distinguish between firms whose values decrease in recessions and firms whose values increase during recessions.

The results show that the effect of delta on firm risk is negative during recessions for both types of firms (column 4 and 5). It is especially reassuring to see that the delta-risk relationship weakens even for firms that experience value increases during recessions (column 5). Hence the weakening delta-risk relationship we find during contractions is present regardless of whether a firm's value declines or not. Finally, in column 6, we see that, although both type of firms decrease firm risk during recessions, there is no statistically significant difference between the firms that experience a decline in firm value compared to the firms that do not experience a decline in firm value since the coefficient on the triple interaction term is insignificant at the ten percent level[10]. These results are robust to

[10] This finding is also in line with Guiso et al. (2014), who show that even the people who do not face any financial losses exhibit higher levels of risk aversion during recessions.

employing the continuous measures of macroeconomic state instead of the recession indicator, and also to employing firm-specific risk as the measure of firm riskiness.

In light of these results, we conclude that our main finding (the delta-risk relationship is weaker during macroeconomic downturns) is not simply related to the general declines in firm valuations during recessions.

5.3.2 *Non-macro Related Changes in Firm Values*

One would expect firm values to decrease during recessions in general. In this section, we test whether the relationship between risk-taking and pay-performance sensitivity changes with the declines in firm values that are orthogonal to macroeconomic conditions. The aim of this test is to further rule out the possibility that the sensitivity of delta-risk relationship to macroeconomic factors is simply an artefact of a general decline in firm values by focusing on non-macro related firm value changes.

To this end, we regress the monthly holding period returns for each firm on our monthly measure of macroeconomic activity, retail sales, and compound the monthly residuals from this regression over a fiscal year. The estimated annualized residuals capture the changes in firm value that are unrelated to the macroeconomic environment. Next, we create an indicator variable (Negative Residual) that takes the value one for firms with negative annualized residuals, and zero for firms with non-negative annualized residuals. Then, we divide the firms in two subsamples accordingly. We note that during recessions, we have 1,320 observations with positive residuals and 2,778 firms with negative residuals, therefore we have variation in firm performance during fiscal years that coincide with NBER recession dates.

Similar to the previous section, we first perform a split-sample analysis by estimating the baseline regression (Equation 1) for the two groups separately and then augment the baseline regression equation by adding the Negative Residual indicator and its interactions with delta and vega. We present the results in Table 7, Panel B. The results based on the estimated residuals echo the findings from the previous section that are based on absolute firm value changes. For negative residual firms, the coefficient on delta is significant and positive (column 1). For positive residual firms, the coefficient on delta is negative and significant (column 2). In column 3, the coefficient on negative residual-delta interaction is 0.035 and significant at the one percent level. This difference-in-difference analysis implies that a one percent increase in delta is associated with an additional 0.035 percent increase in firm risk for firms that experience a decline in its stock valuation due to factors unrelated to macro conditions compared to firms whose values do not decrease. As mentioned above, this result is consistent with the incentive compensation literature that focus on mutual fund managers (Brown et al., 1996 and Kempf et al., 2009).

Next, we look at firm value effects during recessions. If the main result we present in the paper (delta-risk relationship is weaker in recessions) is solely related to declines in firm value that are unrelated to the macro environment, then the weakening of delta-risk relationship should only be valid for firms that experience stock value declines orthogonal to macro fundamentals and not for firms that experience stock value increases during recessions. To explore this possibility, in columns 4 and 5, we perform a split-sample analysis by running Equation 2 for the two groups. Finally, in column 6, we augment it by adding the negative residual dummy, its interactions with delta, vega and the recession indicator along with the triple interaction term (Delta * Negative Residual * Recession). This specification enables us to distinguish between firms whose values decrease in recessions and firms whose values increase during recessions.

The results show that the delta-risk relationship is negative during recessions for both types of firms (column 4 and 5). The effect of delta on firm risk weakens in contractions not only for firms that experience value decreases orthogonal to macro conditions, but also for firms that experience value increases unrelated to macro conditions (column 5). Finally in column 6, we see that the coefficient on the triple interaction term is statistically indistinguishable from zero. This implies that there is no significant difference in the way delta affects firm risk in corporations that experience a decline in their stock valuations for reasons that are unrelated to macro conditions compared to firms whose values do not decrease during recessions. Once again, these findings are robust to employing the continuous measures of macroeconomic state instead of the recession indicator, and also to employing firm-specific risk as the measure of firm riskiness.

Overall, the results reinforce the finding that the macroeconomic environment does have a significant effect on risk taking decisions regardless of the direction of firm value changes during recessions. The depressive effects of performance incentives on firm risk is higher during recessions even for those firms whose values increase. In light of these results, we conclude that our main finding (the delta-risk relationship is weaker during macroeconomic downturns) is not simply related to the declines in firm valuations during recessions.

5.3.3 *Recession-proof versus Recession-prone Industries*

Finally, to further address the concern that the results we find may not be related to the macro environment per se, but to the general decline in firm values accompanied by macro contractions, we design a test that focuses on the differences between firms that are in recession-proof versus recession-prone industries. In recession-proof industries, the changes in firm values are less likely to be driven by macroeconomic conditions. Accordingly, managers in recession-proof industries would not expect recessions to decrease their wealth significantly, therefore their attitude towards risk-taking would be less sensitive to the underlying macroeconomic environment. If what drives our results are firm value declines that are truly orthogonal to macro conditions, then we should see no difference between recession-proof and recession-prone subsamples. If, instead, the result is driven by the changes in the underlying macro conditions, then the weakening of the delta-risk relationship should be more valid in recession-prone industries.

To test this conjecture, we create an indicator variable that takes the value one for firms operating in recession-proof industries and zero otherwise. Recession proof industries are oil and gas, food manufacturing, beverage, tobacco, mining, utilities and healthcare. These are the industries that are characterized with market betas that are lower than 1 (Hong and Kacperczyk, 2009). We present the results in Table 7, Panel C.

In columns 1 and 2, we perform a split-sample analysis by running the Equation 1 for the two groups separately. We find that there is no difference in the delta-risk relationship between firms that operate in recession proof and recession prone industries, as demonstrated by the statistically insignificant interaction term in column 3. In columns 4 and 5, we perform a split-sample analysis by running the Equation 2 for the two groups separately. In column 6, we augment the regression equation by adding the recession-proof dummy, its interactions with delta, vega and the recession indicator along with the triple interaction term (Delta * Recession * Recession-proof). This specification enables us to formally test whether the weakening of the delta - firm risk relationship in recession years is specific to firms that operate in recession-prone industries by utilizing the whole sample.

The results show that the delta-risk relationship is positive, but insignificant during recessions for firms that operate in recession-proof industries (column 4) while it is significantly negative during recessions for firms that operate in recession-prone industries (column 5). Finally, in column 6, we find that the effect of recessions on delta-risk relationship for recession-proof firms is statistically significant and positive, while the effect of recessions on delta-risk relationship for recession-prone firms is statistically significant and negative. These results suggest that the main finding in the paper (relationship between delta-risk weakens during recessions) comes specifically from those firms whose values are sensitive to the macro conditions (i.e., recession prone industries) and is not merely an artifact of a general decline in firm value that is unrelated to the macroeconomic environment.

5.4 CEO CONTROL

The main source of pro-cyclicality between delta and firm risk that we document in this paper is the agency problem caused by the differences in risk attitudes of managers and shareholders. Such an agency problem would be more pronounced when a manager has more control over the firm's resources. These managers will be able to influence firms' business decisions to a greater extent and therefore affect firm risk more. Hence in this section we focus on two variables that have been shown in the previous literature to be correlated with managerial control: CEO tenure (CEO power increases with tenure) and product market competition (CEO power decreases with product market competition).

We use tenure as a proxy for CEO control because boards' monitoring ability and control over a CEOs' actions are expected to decline as CEOs become more seasoned in the firm. Baker and Gompers (2003) show that the representation of independent outsiders on the board decreases with the tenure of the CEO. Perhaps more importantly, a CEO with a longer tenure is more likely to capture the board of directors, because directors who are appointed by a CEO exert less control over him/her (Mace, 1971; Lorsch and MacIver, 1989, Shivdasani and Yermack, 1999; Baker and Gompers, 2003; Morse et.al., 2011; Coles et al., 2014). These studies suggest that the board governance becomes less effective as CEO tenure gets longer. Most recent evidence for board capture by seasoned CEOs comes from Coles et al. (2014). They develop a measure of "board cooption" – the percentage of the board members that are appointed during a CEOs tenure. Using this measure, they show that board cooption increases with tenure, while the monitoring effectiveness of the board of directors decreases with co-option[11]. As boards' monitoring effectiveness decline, the CEOs would have a larger effect over company policies and therefore exert more control over firm risk. For instance, Baker and Mueller (2002) show that CEOs influence R&D spending to suit their own preferences as their tenure increase. A recent study by Pan et. al. (2014), too, shows that a CEO's power inside the firm varies systematically over his career. In particular, they find that CEOs who are more seasoned (with a tenure exceeding 3 years) tend to have more power over the board of directors and hence can influence firm decisions such as investments more compared to newly appointed CEOs. The authors further document that the CEO tenure effect exists regardless of the macroeconomic condition or the industry condition in which the CEO takes office. Similarly, CEO tenure has been widely used as a proxy for CEO control in the literature (e.g., in Fahlenbrach, 2009; Chava et al., 2010; Bebchuk et al., 2010, Ferreria et al., 2011; Agrawal and Nasser, 2009).

Product market competition acts as an important external governance device that limits the managers' ability to use firms' resources according to their own personal preferences. In fact, there is evidence that product market competition may be a substitute for internal governance mechanisms (Giroud and Mueller, 2010; Chhaochharia, 2012). The recent empirical literature indicates that product market competition reduces managerial indiscipline (Giroud and Mueller, 2010) and improves management practices (Bloom and Van Reenen, 2007, and Bloom et al., 2014). Masulis et al. (2007) illustrates that managers of firms that are facing greater product market competition undertake more valuable acquisitions. Giroud

[11] We also find that CEOs that are monitored by more co-opted boards are more able to decrease firm risk during recessions. We thank Lalitha Naveen for sharing the board cooption data with us.

and Mueller (2011) show that firms with weaker internal governance systems have higher capital expenditures and make more acquisitions than do good governance firms, however this result is not valid for firms operating in industries characterized by intense product market competition. Grullon and Michaely (2012) show that product market competition is a disciplinary force on managers, leading to higher corporate payouts. As these studies show, high product market competition seems to be a disciplining force on managers. Therefore, we expect these managers to be less able to adjust firms' operations to alter firm risk according to their own preferences. Similarly, Masulis et.al. (2007) emphasize that "managers of firms operating in more competitive industries are less likely to put valuable resources into inefficient uses, since the margin of error is thin in these industries and any misstep can be quickly exploited by competitors, seriously jeopardizing firms' prospects for survival and managers' prospect for keeping their jobs."

5.4.1 *CEO Tenure*

We divide the firms into two subsamples as suggested by Pan et al. (2014): (i) firms whose CEOs have a tenure exceeding 3 years, and (ii) firms whose CEOs have a tenure less than or equal to 3 years. We create a dummy variable that takes the value one for firms that are managed by long-tenured CEOs and zero otherwise. We test whether the delta-risk relationship is weaker during recessions for firms with seasoned CEOs compared to those firms whose CEOs have shorter tenure.

We perform the split-sample analysis by estimating Equation 2 for the two groups separately. We then augment the regression equation by adding the "Long Tenure" dummy, its interactions with delta, vega and the recession indicator along with the triple interaction term (Delta * Long Tenure * Recession). This specification enables us to test whether the delta-risk relationship is weaker during recessions for firms with seasoned CEOs compared to those firms whose CEOs have shorter tenure by utilizing the full sample.

We present the results in Table 8, columns 1-3. In line with our prediction, we find that the effect of delta on firm risk during recessions is significantly negative for those firms with seasoned CEOs (column 1). Although the coefficient is also negative for firms with short tenured CEOs, the effect is statistically insignificant at the ten percent level. In column 3, we see that the coefficient on the triple interaction term is negative (-0.045) and significant at the ten percent level implying that firms with seasoned CEOs tend to reduce firm risk during recessions more in response to a given level of delta compared to those firms that are run by short tenure CEOs.

5.4.2 *Product Market Competition*

To identify the instances of low product market competition, we use two different proxies from Hoberg and Phillips (2014), and Hoberg, Philipps, and Prabhala (2014)[12]. Our first measure of product market competition is the Herfindahl-Hirschman index (HHI) of industry concentration. Based on the text-based network industry classification (TNIC), HHI determines a group of competitor companies using pairwise similarity scores of product descriptions reported in annual 10-K reports. Due to the dynamic nature of the text-based

[12] The data are publicly available at http://scholar.rhsmith.umd.edu/ghoberg/home

approach, HHI captures the variation in firm characteristics across different industries better than static industry classification schemes such as the Standard Industrial Classification System (SIC) as explained in Hoberg and Phillips (2014). Our second proxy, the product market fluidity index, measures the emerging product market threats from other firms. The industrial organization literature highlights the notion that changes in rival threats can play a more important role in determining firm policies compared to changes in static measures of market share. Fluidity is an ex-ante measure of threats and has the advantage of dynamically capturing product market instabilities arising out of competitor actions as well as the firm's own-product instability (Hoberg, Phillips, and Prabhala, 2014).

Overall, high HHI scores and low product market fluidity index values indicate lower product market competition. Based on these studies, we expect the delta-risk relationship to be more sensitive to the changes in the macroeconomic environment in firms that experience lower product market competition. Since managers of such firms experience weaker external control over the their actions, they are more likely to have a larger impact over company policies compared to CEOs who face more competitive pressure and hence can influence firm risk more in response to the changes in economic state.

Herfindahl-Hirschman index (HHI) of industry concentration We divide the firms into two subsamples according to their HHIs: (i) firms whose HHI scores are above the sample median, and (ii) firms whose HHI scores are less than or equal to the median. We create an indicator variable that takes the value one for high HHI firms and zero otherwise. We test whether the delta-risk relationship is weaker during recessions for those firms with high HHI values compared to those with low HHI scores.

We perform a split-sample analysis by running Equation 2 for the two groups separately and report the results in Table 8,columns 4 and 5. In column 6, we augment the regression equation by adding the High HHI dummy, its interactions with delta, vega, the recession indicator along with the triple interaction term (Delta * High HHI * Recession). In line with our prediction, we find that the effect of delta on firm risk during recessions is significantly negative for those firms that face limited product market competition (column 4). Although the coefficient is also negative for firms that face significant product market competition, the effect is statistically insignificant at the ten percent level. In column 6, we see that the coefficient on the triple interaction term is negative (-0.041) and significant at the one percent level implying that firms that face less competition tend to reduce firm risk more during recessions in response to a given level of delta compared to those firms that operate in a more competitive environment.

Product market fluidity index Next, we repeat our analysis using an alternative product market competition proxy, namely the fluidity index, which measures the emerging product market threats from other firms. We divide the firms into two subsamples: (i) firms whose fluidity index is below the sample median, and (ii) firms whose fluidity scores are greater than or equal to the median. We create a dummy variable that takes the value one for low fluidity firms and zero otherwise. A lower fluidity index value represents limited competitive pressure on the firm. We test whether the delta-risk relationship is weaker during recessions for those firms with lower fluidity values compared to those with high fluidity index scores.

We perform the split-sample analysis by running Equation 2 for the two groups separately and report the results in Table 8, columns 7 and 8. In column 9, we augment the regression equation by adding the Low Fluidity dummy, its interactions with delta, vega and the recession indicator along with the triple interaction term (Delta * Low Fluidity * Recession). This specification enables us to test whether the delta-risk relationship is weaker during recessions for firms that face limited product market competition (Low Fluidity value) compared to firms that experience significant competitive pressure (High Fluidity value) by utilizing the full sample. We find that the effect of delta on firm risk during recessions is significantly negative at the one percent level for those firms that face limited product market competition (column 7), while the effect is positive and insignificant at the ten percent level for the firms experience strong competition (column 8). In column 9, we see that the coefficient on the triple interaction term is negative (-0.055) and significant at the one percent level implying that firms that face less competition tend to reduce firm risk more during recessions in response to a given level of delta compared to those firms that operate in a more competitive environment.

Overall, our analyses based on the CEO tenure and the two product market competition proxies suggest that the delta-risk relationship becomes more sensitive to the underlying macro economic environment when managers have more control over firm policies (either because they are more seasoned managers or because their firms face less product market competition). When there is less discipline imposed by internal and/or external governance sources, CEOs can have a strong influence over firm risk and hence can reduce firm risk during recessions more in response to a given level of delta compared to firms that are run by less powerful CEOs.

5.5 DOLLAR-DOLLAR MEASURE OF PAY-FOR-PERFORMANCE SENSITIVITY

As standard in the literature (Core, 1999; Coles et al., 2006; Low, 2009), we use the dollar-percentage measure of pay-for-performance sensitivity (i.e., dollar change in CEO wealth for a one percent change in the stock price). In this section, we recognize that the macroeconomic conditions may have a mechanical impact on the value of performance incentives. A one percent increase in stock price would automatically lead to a larger increase in the dollar value of performance incentives during expansions to the extent that stock prices are higher. To illustrate with an example, let's consider a CEO that holds 1,000 units of her firm's stock. If the price of the stock is $10, a 1 percent increase in stock price will increase the CEO's firm-related wealth by $100. If on the other hand, the stock value increases to $20 due to a positive macroeconomic environment, then a one percent increase in stock price will increase the CEO's wealth by $200. As this simple example illustrates, the dollar-percentage measure, which is the standard measure of pay-for-performance sensitivity is positively related to the macroeconomic conditions due to the higher stock prices during macroeconomic expansions.

To address this concern, we have included the macroeconomic state as an explanatory variable in both the delta and vega equations when we conducted instrumental variables and simultaneous equations estimations. Here, we provide an additional robustness check. We calculate the dollar-dollar measure of delta (i.e., the dollar increase in CEO wealth as a result of a dollar increase in stock price), and use it in our regressions instead of the dollar-percentage measure. The dollar-dollar measure of performance incentives is not sensitive to the level of the underlying stock price, and therefore is not impacted by the underlying macroeconomic conditions. We present the results using the dollar-dollar sensitivity in Table 9. Our results remain unchanged.

5.6 CLUSTERING OF STANDARD ERRORS

An additional concern is about the clustering of the standard errors. Throughout the paper, we cluster the standard errors either at the firm level or at the firm-manager level. Clustering at the firm level allows for the residuals of a given firm to be correlated across years. However, it does not allow for across-firm error correlations, where the residuals of a given year may be correlated across different firms due to common shocks. We acknowledge that, in the context of this study, the error terms are also possibly cross-sectionally correlated since macroeconomic recessions are likely to affect all firms, albeit differently. With only a few recessions, the number of truly independent observations may be small, resulting in under-estimation of the standard errors.

Ideally, we would cluster the standard errors both at the firm level and at the year level, using two-way clustering as suggested by Petersen (2009) and Thompson (2011). However, we do not have sufficient number of observations to cluster on both dimensions[13]. As an alternative, we have re-estimated Equation 3 by clustering standard errors at the industry-year level. This approach would partially alleviate the concern for cross-sectional correlation in the error terms, because the most obvious driver of clustering is the cross-sectional correlation in firm volatilities among firms in the same industry, since recessions are likely to affect firms in different industries differently[14]. Our results are robust to this alternative form of clustering.

5.7 FINANCIAL LEVERAGE

In our analyses, we have shown that the relationship between managerial performance incentives and firm risk weakens during economic downturns (and vice versa). However, one may argue that during recessions, as stock values decline, there will be a mechanical increase in financial leverage. Higher leverage would in turn lead to an automatic increase in firm risk (stock return volatility). In contrast, during macroeconomic expansions, effective financial leverage is expected to decrease mechanically due to the increase in stock valuations, thereby leading to a decrease in equity risk.

Even though the paper studies how the sensitivity of equity risk to pay-performance sen-

[13] In addition, due to the small number of years in our sample, two-way clustering would not be a valid procedure to address the cross-sectional correlation of errors. Thompson (2011) shows that the two-way clustering is valid only if the number of firms and number of years are both "large". Wooldridge (2011) suggests that with large number of firms and small number of years, as in our study, including time effects and clustering for serial correlation at the firm level is the only theoretically justified procedure. Similarly, Petersen (2009) notes that if the cross-sectional correlation of residuals is fixed, "the time dummies completely remove the correlation between observations in the same time period, and ... standard errors clustered by firm are unbiased."

[14] We thank the referee for this suggestion.

sitivity varies with macroeconomic conditions, and not how equity risk varies with macroeconomic conditions, the effect of financial leverage on equity risk might vary with factors related to pay-for-performance sensitivity. To address this concern, we estimate our main regressions (Equation 2) separately for firms that are in the lowest quartile of the leverage distribution in our sample[15]. These firms have very low financial leverage ratios: the mean leverage ratio for the firms in the lowest quartile is 0.003, and the median leverage ratio is zero. A confirmation of our findings for the sample of very low leverage firms would alleviate the concern that the results we present are merely related to the increases (decreases) in financial leverage during economic recessions (expansions). We present the results in Table 10. Our results remain unchanged for the sample of low-leverage firms. The coefficients on Delta-Macroeconomic State interaction terms are statistically significant in five of the six regression estimations.

6 Conclusion

In this paper, we show that the relationship between performance incentives and firm risk is sensitive to the underlying macroeconomic environment. Our results suggest that the same manager with exactly the same level of performance incentives facing the same firm characteristics may target a lower (higher) risk level during economic recessions (expansions). To our knowledge, we provide the first evidence of the procyclicality of this relationship, a result which is consistent with the state-dependent nature of individual risk aversion (Cohn

[15] We thank the referee for this suggestion.

et. al. 2014; Guiso et al., 2013).

Understanding how similar pay packages are associated with different risk levels under different economic conditions is crucial for designing compensation packages that yield a desired level of firm risk over the business cycle. A large set of corporate finance studies argues that excessive risk aversion on the part of CEOs and other senior executives is one of the most important and potentially most costly agency problems. In theory, shareholders and boards, who are well aware of the significance of this agency issue, can design contracts to mitigate executives' risk aversion. However, in practice, the contracts designed by the boards may not always sufficiently incentivize the executives to offset the effect of increasing risk aversion during recessions. Equally, not considering the effect of lower risk aversion levels during economic booms might result in managers taking excessive risks, as evidenced in the last financial crisis.

Our research highlights the importance of the interaction between managerial incentives and the macroeconomic environment. Boards and regulators, who design compensation structure to curb excessive risk taking, may find it useful to consider the procyclical nature of the relationship between performance incentives and risk taking. Our results indicate that counteracting the pro-cyclical relationship between pay-for-performance incentives and firm risk by providing less (more) risk taking incentives during economic expansions (recessions) can be beneficial.

References

Abarbanell, J. and Bernard V. (1992) Tests of analysts' overreaction/underreaction to earnings Information as an explanation for anomalous stock price behavior, Journal of Finance 47.3, 1181–207.

Agrawal, A. and Nasser, T. (2012) Blockholders on boards and CEO compensation, turnover and firm valuation, CELS 2009 4th Annual Conference on Empirical Legal Studies Paper.

Amihud, Y. and Lev, B. (1981). Risk reduction as a managerial motive for conglomerate mergers, Bell Journal of Economics, 12, 605–617.

Andersen, T., Bollerslev, T., Diebold, F. and Vega, C. (2007) Real-time price discovery in stock, bond and foreign exchange markets, Journal of International Economics 73, 251-277.

Armstrong, C. and Vashishtha, R. (2012) Executive stock options, differential risk-taking incentives, and firm value, Journal of Financial Economics 104, 70 - 88.

Baker, M. and Gompers, P. A. (2003) The determinants of board structure at the initial public offering, Journal of Law and Economics 46.2, 569-598.

Barberis, N. and R. Thaler (2004) A survey of behavioral finance, in G.Constantinides, M.Harris and R.Stultz (eds.) Handbook of the Economics of Finance, 1052–90.

Bebchuk, L. A., Grinstein, Y and Peyer, U. (2010) Lucky CEOs and lucky directors, The Journal of Finance 65.6, 2363-2401.

Berger, P. G. and Ofek, E. and Yermack, D. L. (1997) Managerial entrenchment and capital structure decisions, The Journal of Finance 52.4, 1411-1438.

Bettis, J.C., Bizjak J.M. and Lemmon M.L. (2001) Managerial ownership, incentive contracting, and the use of zero-cost collars and equity swaps by corporate insiders, Journal of Financial and Quantitative Analysis 36.3, 345-70.

Bettis, J.C., Bizjak, J.M. and Kalpathy S. (2010) Why do insiders hedge their ownership and options? An empirical examination, Working Paper, Arizina State University.

Boyd, J., Jagannathan, R. and Hu, J. (2005) The stock market's reaction to unemployment news: why bad news is usually good for stocks, Journal of Finance 60, 649–672.

Bizjak, J., Brickley, J. and Coles, J. (1993) Stock-based incentive compensation and investment behavior, Journal of Accounting and Economics 16, 349-372.

Black, F. and Scholes, M. (1973) The pricing of options and corporate liabilities, Journal of Political Economy 81, 637–654.

Bloom N. and Van Reenen J. (2007) Measuring and explaining management practices across firms and countries. Quarterly Journal of Economics 122, 1351–408.

Bloom, N., Propper, C., Seiler, S. and Van Reenen, J. (2015) The impact of competition on management quality: Evidence from public hospitals, Review of Economic Studies, forthcoming.

Brown, K.C., Harlow, W.V. and Starks, L.T. (1996) Of tournaments and temptations: an analysis of managerial incentives in the mutual fund industry, Journal of Finance, 51, 85–110.

Bun, M. and Harrison, T. (2014) OLS and IV estimation of regression models including endogenous interaction terms, working paper, LeBow College of Business, Drexel University.

Cameron, A. C., Gelbach, J.B. and Miller, D.L. (2011) Robust inference with multiway clustering, Journal of Business & Economic Statistics, 29.2.

Chhaochharia, V., Grinstein, Y., Grullon, G., & Michaely, R. (2012) Product market competition and internal governance: Evidence from the Sarbanes Oxley Act. Johnson School Research Paper Series, (18-2012).

Chava, S., Kumar, P. and Warga, A. (2010) Managerial agency and bond covenants, Review of Financial Studies 23.3, 1120-1148.

Cohn, A., Engelmann, J., Fehr, E. and Maréchal, M.A (2014) Evidence for countercyclical risk aversion: An experiment with financial professionals, American Economic Review, forthcoming.

Coles, J. and Li Z. (2011) Managerial attributes, incentives, and performance, mimeo, Arizona State University.

Coles, J., Naveen, D. and Naveen, L. (2006) Managerial incentives and risk-taking, Journal of Financial Economics 79, 431-468.

Coles, J. L., Naveen D. D and Naveen, L. (2104) Co-opted boards, Review of Financial Studies 27.6, 1751-1796.

Core, J. and Guay, W. (1999) The use of equity grants to manage optimal equity incentive levels, Journal of Accounting & Economics 28, 151-184.

Core, J. and Guay, W. (2002) Estimating the value of employee stock option portfolios and their sensitivities to price and volatility, Journal of Accounting Research 40, 613-630.

Davis, S.J. and von Wachter, T. (2011) Recessions and the costs of job loss. Brookings Papers on Economic Activity, Fall: 1–72.

Dellavigna S. and Pollet, J. M. (2009) Investor inattention and Friday earnings announcements, Journal of Finance 64, 709-749.

DeYoung, R., Peng E. M., and Yan, M. (2013) Executive compensation and business policy choices at U.S. commercial banks, Journal of Financial and Quantitative Analysis 48, 165-196.

Dittmann, I. and Maug, E. (2007) Lower salaries and no options? On the optimal structure of executive pay, Journal of Finance, 62, 303-343.

Dittmann, I. and Yu, K. (2011) How Important are Risk-Taking Incentives in Executive Compensation? Working paper, Tinbergen Institute.

Dittmar, A. and Mahrt-Smith, J. (2007) Corporate governance and the value of cash holdings, Journal of Financial Economics 83, 599-634.

Edmans, A. and Gabaix. X. (2011) The effect of risk on the CEO market, Review of Financial Studies 24, 2822–63.

Fahlenbrach, R. (2009) Shareholder rights, boards, and CEO compensation, Review of Finance 13, 81-113.

Fama, E. (1980) Agency problems and the theory of the firm, Journal of Political Economy 88, 288-307.

Farber, H. (2011) Job loss in the great recession: Historical perspective from the displaced workers survey, 1984-2010, working paper 17040, National Bureau of Economic Research.

Ferreira, D., Ferreira, M. A. and Raposo, C.C. (2011) Board structure and price informativeness, Journal of Financial Economics 99.3, 523-545.

Flannery, M. and Protopapadakis, A. (2002) Macroeconomic factors do influence aggregate stock returns, Review of Financial Studies 15, 751-782.

Gaver, J. and Gaver, K. (1993) Additional evidence on the association between the investment opportunity set and corporate financing, dividend, and compensation policies, Journal of Accounting and Economics 16, 125-160

Gilson, S. C. (1989) Management turnover and financial distress, Journal of Financial Economics 25, 241.262.

Giroud, X. and Mueller, H. (2010) Does corporate governance matter in competitive industries?, Journal of Financial Economics 95, 312-331.

Giroud, X., and Mueller, H. M. (2011) Corporate governance, product market competition, and equity prices, The Journal of Finance, 66.2, 563-600.

Gomes, J., Kogan, L. and Zhang, L. (2003) Equilibrium cross-section of returns, Journal of Political Economy 111, 693-732.

Graham, J., Harvey, C. and Puri, M. (2013) Managerial attitudes and corporate actions, Journal of Financial Economics 109, 103-121.

Greene, W. (2003) Econometric Analysis, Prentice Hall, Upper Saddle River, NJ, 5th edition.

Grullon, G., and Michaely, R. (2012). The Impact of Product Market Competition on Firms' Payout Policy.

Guay, W. (1999) The sensitivity of CEO wealth to equity risk: An analysis of the magnitude and determinants, Journal of Financial Economics 53, 43–71.

Guiso, L., Sapienza, P., and Zingales, L. (2014). Time Varying Risk Aversion, avilable at http://faculty.chicagobooth.edu/luigi.zingales/papers/research/time_varying_risk_aversion.pdf.

Guvenen F., Ozkan, S., and Song, J. (2014) The nature of countercyclical income risk, Journal of Political Economy 122, 621-660.

Hall B and Murphy, K.J. (2003) The trouble with stock options. Journal of Economic Perspectives 17, 49 -70.

Hansen, L. P. (1982) Large sample properties of generalized method of moments estimators, Econometrica 50, 1029.1054.

Haugen, R. and Senbet, L. (1981) Resolving the agency problem of external capital through options, Journal of Finance 36, 629 – 647.

Hayes, R., Lemmon, M. and Qiu, M. (2012) Stock options and managerial incentives for risk-taking: Evidence from FAS 123R, Journal of Financial Economics 105, 174 - 190.

Hoberg, G. and Phillips, G. (2014) Text-based network industries and endogenous product differentiation, working paper, University of Southern California.

Hoberg, G., Phillips, G. and Prabhala, N. (2014) Product market threats, payouts, and financial flexibility, Journal of Finance 69, 293-324.

Hong, H. and Kacperczyk, M. (2009) The price of sin: the effects of social norms on markets, Journal of Financial Economics 93, 15-36.

Hong, H. and Stein, J. (1999) A unified theory of underreaction, momentum trading, and overreaction in asset markets, Journal of Finance 54, 2143-2184.

Jensen, M. and Meckling, W. (1976) Rights and production functions: an application to labor-managed firms and codetermination, Journal of Business 52, 469–506.

Ju, N., Leland H. and Senbet L. (2002) Options, option repricing and severance packages in managerial compensation: Their effects on corporate risk, working paper, University of Maryland and University of California, Berkeley.

Kempf, A., Ruenzi, S. and Thiele, T. (2009) Employment risk, compensation incentives, and managerial risk taking: Evidence from the mutual fund industry, Journal of Financial Economics 92, 92–108.

Kurz, M. (1994) On the structure and diversity of rational beliefs, Economic Theory 4, 877–900.

Lewellen, J. and Shanken, J. (2002) Learning, asset-pricing tests, and market efficiency, Journal of Finance 57, 1113–45.

Li, M., Lu, Y., and Phillips, G. M. (2014) CEOs and the product market: when are powerful CEOs beneficial? Available at SSRN 2450893.

Low, A. (2009) Managerial risk-taking behavior and equity-based compensation, Journal of Financial Economics 92, 470-490.

Malmendier, U. and Nagel, S. (2011) Depression babies: Do macroeconomic experiences affect risk-taking? Quarterly Journal of Economics 126, 373–416.

Masulis, R. W., Wang, C. and Xie, F. (2007) Corporate governance and acquirer returns, The Journal of Finance 62, 1851-1889.

McQueen, G. and Roley V.V. (1993) Stock prices, news and business conditions, Review of Financial Studies 92, 307-328.

Merton, R.C. (1974) On the pricing of corporate debt: The risk structure of interest rates, Journal of Finance 29, 449-470.

Merton, R. (1987) A simple model of capital market equilibrium with incomplete information, Journal of Finance 42, 483–510.

Milidonis, A., and Stathopoulos, K. (2014) Managerial incentives, risk aversion and debt, Journal of Financial and Quantitative Analysis, 1-61.

Morris, S. (1996) Speculative investor behavior and learning, Quarterly Journal of Economics, 111, 1111–33.

Morse, A., Nanda, V. and Seru, A. (2011) Are incentive contracts rigged by powerful CEOs?, The Journal of Finance 66, 1779-1821.

Murphy, K. (2012) Executive Compensation: Where we are, and how we got there. G.Constantinides, M. Harris and R. Stulz, Eds. Handbook of the Economics of Finance, North Holland.

Myers, S. (1977) Determinants of corporate borrowing, Journal of Financial Economics 5, 147-175.

Ou-Yang, H. (2003) Optimal contracts in a continuous? Time delegated portfolio management problem. Review of Financial Studies 16, 173–208.

Neyland, J. (2012) "Wealth Shocks and Executive Compensation: Evidence from CEO Divorce." Available at SSRN 2140668.

Pan, Y., Wang, T. Y. and Weisbach, M. S. (2014) CEO Investment Cycles, working Paper; Fisher College of Business.

Savaser, T. and Sisli-Ciamarra, E. (2014) Managerial risk-taking incentives and firm Risk in the post-regulatory era, working paper, Brandeis University and Bilkent University.

Schoar, A., and Zuo, L. (2013) Shaped by booms and busts: How the economy impacts CEO careers and management styles, working paper 17590, National Bureau of Economic Research.

Schmidt, P. (1976) Econometrics. New York: Marcel Dekker, Inc.

Shivdasani, A. and Yermack, D. (1999) CEO involvement in the selection of new board members: An empirical analysis, Journal of Finance 54, 1829-1853.

Smith, C. and Stulz, R. (1985), The determinants of firms' hedging policies, Journal of Financial and Quantitative Analysis 20, 391–405.

Smith, C. and Watts, R. (1992) The investment opportunity set and corporate financing, dividend and compensation policy, Journal of Financial Economics 3, 263 -292.

Swanson, N. R. (1996) Forecasting using first-available versus fully revised economic time-series data, Studies in Nonlinear Dynamics & Econometrics 1, 1-20.

Timmerman, A. (1993) How learning in financial markets generates excess volatility and predictability in stock prices, Quarterly Journal of Economics 108, 1135–45.

Tufano, P. (1996) Who manages risk? An empirical examination of risk management practices in the gold mining industry, Journal of Finance 51, 1097-137.

Wooldridge, J. (2002) Econometric Analysis of Cross Section and Panel Data, The MIT Press, Cambridge, Massachusetts.

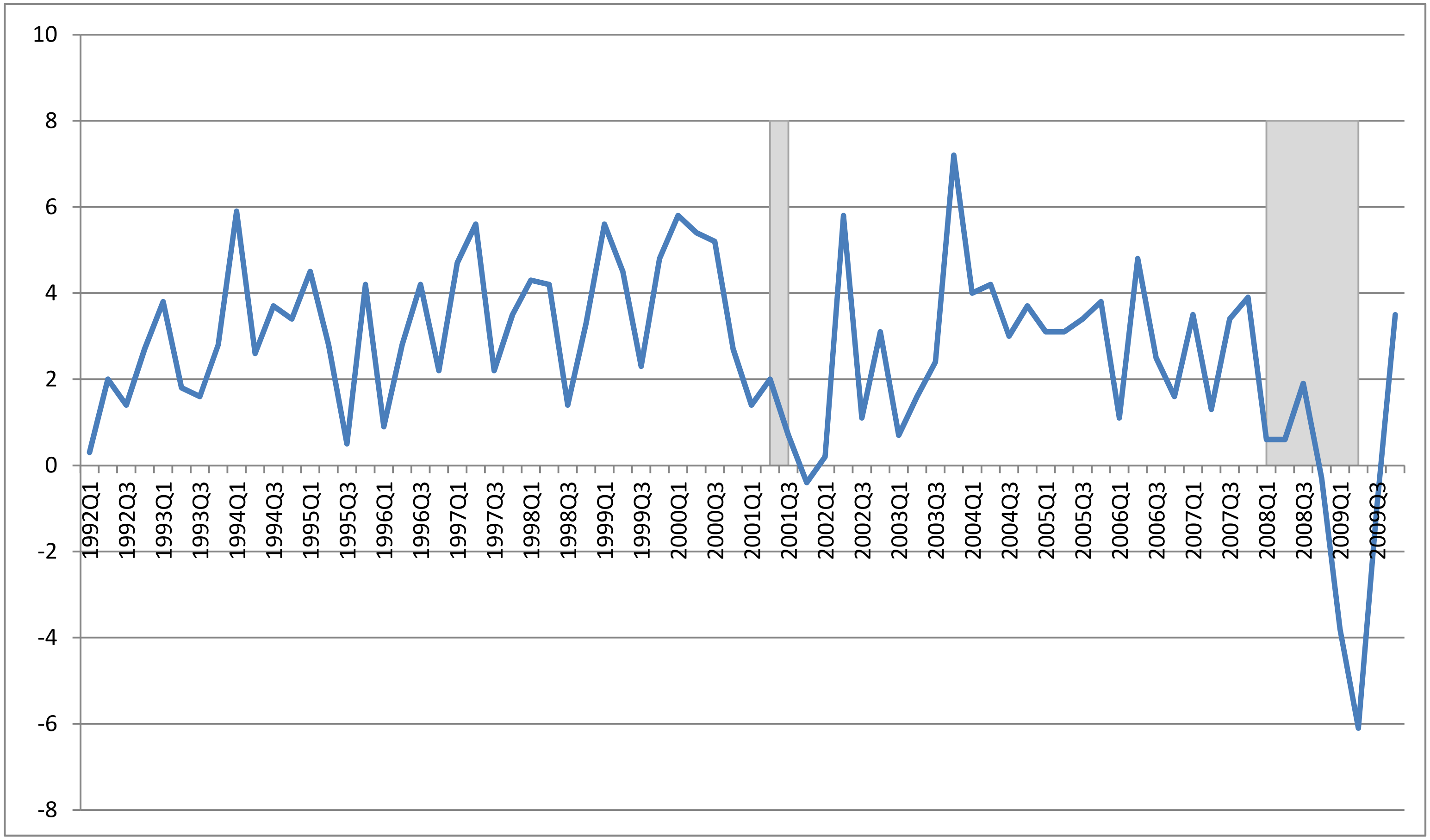
Appendix. Variable definitions and sources

Variable	Description	Source
A. CEO Incentive Measures		
Salary ($000s)	Base salary of the CEO	Execucomp
Bonus ($000s)	Bonus payments to the CEO. Calculated as "Bonus + Nonequity Incentives" after the fiscal year 2006.	Execucomp
Cash compensation ($000)	Salary plus bonus	Execucomp
Delta ($000s)	Dollar change in the CEO stock and option portfolio for a 1% change in stock price.	Authors' calculations
Vega ($000s)	Dollar change in the CEO stock and option portfolio for a 1% change in stock return volatility.	Authors' calculations
Tenure as CEO (years)	Number of years as CEO	Execucomp
Long tenure	An indicator variable that takes the value one if CEO tenure is greater than three years, and zero otherwise.	Execucomp
B. Risk Measures		
Total risk	Annualized variance of daily stock returns during a firm's fiscal year.	CRSP
Firm-specific risk	Annualized variance of residuals from the market model.	CRSP
C. Firm Financial Characteristics		
R&D Expenditures / Assets	Research and development expenditures scaled by total assets	Compustat
Capital Expenditures / Assets	Capital expenditures net of sales of plant, property and equipment scaled by total assets	Compustat
Leverage ratio	Ratio of long-term debt and debt in current liabilities to book value of assets.	Compustat
Size	Natural logarithm of net sales	Compustat
Market value	Sum of market value of common stock, liquidating value of preferred stock, and book value of total debt	Compustat, CRSP
Market-to-book ratio	Market value divided by book value of total assets	Compustat
Return on assets (ROA)	Earnings before interest, taxes, depreciation and amortization (EBITDA) scaled by total assets	Compustat
Stock return	Annual stock return over a firm's fiscal year	Compustat
FAS Cost	Ratio of Black-Scholes value of CEO stock option grants to net income. This variable serves as a proxy for accounting cost associated with the implementation of FAS 123R.	Compustat
Surplus Cash	Ratio of cash from assets-in-place (operating activities net cash flow minus depreciation plus R&D expenditures) to total assets	Compustat
Total Loss Carry Forward	An indicator variable that takes the value one if a firm has tax-loss-carry-forwards in any of the past three years and zero otherwise	Compustat
Industry Median Delta	The median value of delta in a firm's industry as identified by 2-digit SIC codes	Execucomp
Industry Median Vega	The median value of vega in a firm's industry as identified by 2-digit SIC codes	Execucomp
Value Decline	An indicator variable that takes the value one if a firm has a negative holding period return in a fiscal year, and zero otherwise	CRSP
Recession Proof	An indicator variable that takes the value one if a firm operates in a recession-proof industry, and zero otherwise	Compustat
HHI	Herfindahl-Hirschman index (HHI) of industry concentration	Hoberg and Phillips Data Library
Fluidity	Product market fluidity index	Hoberg and Phillips Data Library

D. Macroeconomic Risk Measures

Recession dummy	An indicator variable that takes the value one if a firm's fiscal year corresponds with 90 recession days as identified by the National Bureau of Economic Research (NBER) and zero otherwise	NBER
Recession days	The number of days a firm faced recession over a fiscal year	NBER
Gross Domestic Product (GDP) growth rate	Advance release values for real GDP growth rate (percentage changes from a year ago), seasonally adjusted. We calculate the minimum GDP growth rate over a fiscal year as the GDP measure	Bureau of Economic Analysis / Action Economics
Additions to Non-Farm Payroll Employment (NFP)	Advance release values for the change in the non-farm payroll, seasonally adjusted. We calculate the minimum of the changes in the non-farm payroll over a fiscal year as the NFP measure	Bureau of Labor Statistics / Action Economics
Personal Expenditure (PE) Growth Rate	Advance release values of the Personal Consumption Expenditure Growth, seasonally ajusted real values. We calculate the minimum of the personal expenditure growth rate over a fiscal year as the PCE measure	Bureau of Economic Analysis / Action Economics
Retail Sales (RS) Growth Rate	Advance release values of growth in the total receipts at stores that sell merchandise and related services to final consumers. We calculate the minimum of the personal expenditure growth rate over a fiscal year as the PCE measure	U.S. Cencus Bureau / Action Economics
S&P500 Volatility	Volatility of the S&P 500 Index during a firm's fiscal year	CRSP

GDP QUARTERLY RELEASE VALUES (%)



GREY SHADED AREAS REPRESENT THE RECESSION PERIODS AS IDENTIFIED BY THE NBER.

Table1. Summary Statistics

This table presents the summary statistics for the variables used in the analyses. The definition of the variables and the relevant data sources are provided in Appendix.

	N	Mean	Standard Deviation	p25	p50	p75
A. CEO Compensation Measures						
Salary ($000s)	22,906	484	246	304	440	624
Bonus ($000s)	22,906	524	750	59	281	660
Cash Compensation ($000)	22,906	1013	923	437	724	1259
Vega ($000s)	22,906	80	144	7	28	84
log(1+Vega)	22,906	3.15	1.80	2.05	3.38	4.44
Delta ($000s)	22,906	531	1368	49	140	403
log(1+Delta)	22,906	4.88	2	4	5	6
Tenure as CEO (years)	22,906	8	8	3	6	10
Long Tenure	22,906	0.71	0.45	0	1	1
Delta ($-$ sensitivity)	22,906	0.37	0.68	0.06	0.14	0.35
Vega ($-$ sensitivity)	22,906	0.06	0.08	0.01	0.03	0.07
B. Risk Measures						
Total Risk	22,906	0.276	0.366	0.092	0.171	0.331
log(Total Risk)	22,906	-1.726	0.914	-2.381	-1.764	-1.104918 -
Idiosyncratic Risk	22,906	0.231	0.307	0.075	0.141	0.276
log(Idiosyncratic Risk)	22,906	-1.924	0.934	-2.590	-1.961	-1.289
C. Firm Financial Characteristics						
Total Assets ($mn.)	22,902	3,799	16,003	281	735	2,235
Net Sales ($mn.)	22,897	3,372	10,771	284	768	2,291
Sales Growth	20,515	0.07	0.27	-0.03	0.06	0.16
Market-to-book Ratio	22,891	1.85	1.51	0.95	1.37	2.14
Leverage Ratio	22,902	0.21	0.20	0.04	0.20	0.33
R&D Expenditures / Assets	22,902	0.04	0.07	0.00	0.00	0.05
Capital Expenditures/ Assets	22,703	0.06	0.06	0.02	0.04	0.08
FAS Cost	22,897	0.07	2.84	0.00	0.00	0.02
Surplus Cash	22,635	0.08	0.11	0.03	0.08	0.13
Cash / Assets	22,897	0.20	0.23	0.03	0.10	0.29
Return on Assets (ROA)	20,536	0.06	0.21	0.02	0.07	0.13
Stock Return	20,536	0.10	1.09	-0.26	-0.01	0.26
Total Loss Carry Forward	22,906	0.37	0.48	0	0	1
Value Decline	22,472	0.40	0.49	0	0	1
Value Decline (orthogonal to macro)	22,472	0.78	0.42	1	1	1
Recession Proof	22,906	0.11	0.31	0	0	0
HHI	22,906	324.18	354.85	127	190	362
Fluidity	22,906	0.16	0.18	0.05	0.10	0.20
D. Macroeconomic State Measures						
Recession Dummy	22,906	0.18	0.38	0	0	0
Recession Days	22,906	46	105	0	0	0
GDP Growth Rate	22,906	0.96	2.06	0.50	1.30	2.30
Additions to Non-Farm Payroll	22,906	-140	201	-201	-57	-4
Personal Expenditure Growth Rate	22,906	-0.32	0.52	-0.50	-0.20	0.10
Retail Sales Growth Rate	22,906	-1.17	0.98	-1.40	-0.90	-0.40
S&P500 Volatility	22,906	0.01	0.01	0.01	0.01	0.01

Table 2. Performance Incentives and Risk

This table presents the results for the estimation of Equation 1 in the text. The dependent variable is firm risk, calculated as the logarithm of the annualized variance of the daily stock returns. The main variable of interest is the logarithm of the lagged value of delta, and represents the managerial performance incentives. The definitions of the rest of the variables are provided in the Appendix. All regressions control for year fixed effects. Robust standard errors are clustered at firm level in regressions that control for industry fixed effects and at manager level in regressions that control for firm-manager pair fixed effects. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

	Industry Fixed Effects	**Firm Fixed Effects**	**Firm-Manager Fixed Effects**	**Industry Fixed Effects**	**Industry Fixed Effects**
	1993-2009	**1993-2009**	**1993-2009**	**1993-2002**	**1993-2002**
Log(Delta $_{-1}$)	-0.000	0.014	0.021	0.042	0.015
	[0.963]	[0.005]***	[0.000]***	[0.000]***	[0.024]**
Log(Vega $_{-1}$)	-0.032	-0.051	-0.047	0.041	0.001
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.896]
Log(Cash Compensation$_{-1}$)	-0.087	-0.072	-0.057	-0.100	-0.102
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
CEO Tenure	-0.001	-0.003	0.014	-0.005	-0.002
	[0.435]	[0.050]*	[0.365]	[0.002]***	[0.211]
Log(Sales)	-0.173	-0.151	-0.113	-0.216	-0.188
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Market-to-book	-0.012	0.008	-0.004	0.016	0.005
	[0.067]*	[0.162]	[0.516]	[0.029]**	[0.433]
R&D Expenditures / Assets	1.861	0.234	0.269	1.749	2.030
	[0.000]***	[0.084]*	[0.073]*	[0.000]***	[0.000]***
Capital Expenditures / Assets	0.337	0.381	0.400	-0.908	0.092
	[0.034]**	[0.005]***	[0.009]***	[0.000]***	[0.637]
Leverage Ratio	0.247	0.301	0.402	0.344	0.189
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.008]***
Constant	-0.549	-0.674	-1.011	-0.245	-0.560
	[0.005]***	[0.000]***	[0.000]***	[0.077]*	[0.001]***
N	20352	20352	18184	20352	20352
Year Fixed Effects	Yes	Yes	Yes	No	Yes
R-sq	0.549	0.513	0.532	0.378	0.564
adj. R-sq	0.547	0.512	0.532	0.374	0.561

Table 3. Relationship between Managerial Performance Incentives and Firm Risk during Macroeconomic Recessions

This table presents the results for the estimation of Equation 2 in the text. The dependent variable is firm risk, calculated as the logarithm of the annualized variance of the daily stock returns. The main variable of interest is the interaction of logarithm of the lagged value of delta with the recession measure. The definitions of the variables are provided in the Appendix. All regressions control for year fixed effects. Robust standard errors are clustered at firm level in regressions that control for industry fixed effects and at firm-manager level in regressions that control for firm-manager pair fixed effects. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

Recession Measure:	**Recession Dummy**			**Number of Days in Recession**		
	Industry Fixed Effects	Firm Fixed Effects	Firm-Manager Fixed Effects	Industry Fixed Effects	Firm Fixed Effects	Firm-Manager Fixed Effects
Log(Delta $_{-1}$)	0.007	0.017	0.023	0.006	0.017	0.023
	[0.296]	[0.000]***	[0.000]***	[0.320]	[0.001]***	[0.000]***
Log(Vega $_{-1}$)	-0.031	-0.047	-0.046	-0.032	-0.047	-0.046
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
NBER Recession Measure	0.317	0.332	0.283	0.064	0.066	0.054
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Log(Delta $_{-1}$)* Recession Measure	-0.040	-0.027	-0.023	-0.007	-0.004	-0.003
	[0.000]***	[0.003]***	[0.023]**	[0.000]***	[0.006]***	[0.070]*
Log(Vega $_{-1}$) * Recession Measure	-0.002	-0.013	-0.003	-0.000	-0.002	-0.000
	[0.789]	[0.084]*	[0.754]	[0.972]	[0.118]	[0.817]
Log(Cash Compensation$_{-1}$)	-0.088	-0.072	-0.058	-0.088	-0.072	-0.058
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
CEO Tenure	-0.001	-0.002	0.014	-0.001	-0.002	0.014
	[0.502]	[0.063]*	[0.394]	[0.495]	[0.064]*	[0.393]
Log(Sales)	-0.172	-0.148	-0.111	-0.172	-0.148	-0.111
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Market-to-book	-0.012	0.008	-0.004	-0.012	0.009	-0.003
	[0.072]*	[0.144]	[0.540]	[0.080]*	[0.124]	[0.592]
R&D Expenditures / Assets	1.864	0.237	0.274	1.859	0.229	0.270
	[0.000]***	[0.076]*	[0.067]*	[0.000]***	[0.088]*	[0.073]*
Capital Expenditures / Assets	0.346	0.389	0.404	0.344	0.384	0.400
	[0.029]**	[0.004]***	[0.008]***	[0.030]**	[0.005]***	[0.009]***
Debt / Assets	0.244	0.296	0.397	0.246	0.299	0.399
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Constant	0.288	-0.722	-1.036	0.555	-0.723	-1.033
	[0.152]	[0.000]***	[0.000]***	[0.006]***	[0.000]***	[0.000]***
N	20352	20352	18184	20352	20352	18184
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-sq	0.550	0.515	0.534	0.550	0.515	0.534
adj. R-sq	0.548	0.514	0.533	0.548	0.515	0.533

Table 4. Relationship between Managerial Performance Incentives, Firm Risk and the Macroeconomic State

This table presents the results for the estimation of Equation 2 in the text. The dependent variable is firm risk, calculated as the logarithm of the annualized variance of the daily stock returns. The main variable of interest is the interaction of logarithm of the lagged value of delta with the macroeconomic state measure. The definitions of the variables are provided in the Appendix. All regressions control for year fixed effects. Robust standard errors are clustered at firm level in regressions that control for industry fixed effects and at firm-manager level in regressions that control for firm-manager pair fixed effects. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

Macroeconomic state measured by:	**GDP Growth**			**Non-Farm Payroll**		
	Industry Fixed Effects	Firm Fixed Effects	Firm-Manager Fixed Effects	Industry Fixed Effects	Firm Fixed Effects	Firm-Manager Fixed Effects
Log(Delta $_{-1}$)	-0.013	0.005	0.012	0.016	0.025	0.030
	[0.033]**	[0.365]	[0.063]*	[0.016]**	[0.000]***	[0.000]***
Log(Vega $_{-1}$)	-0.031	-0.051	-0.046	-0.032	-0.047	-0.049
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Macroeconomy	-0.123	-0.117	-0.111	-0.001	-0.001	-0.001
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Log(Delta $_{-1}$)* Macroeconomic State	0.014	0.009	0.009	0.112	0.075	0.063
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.002]***
Log(Vega $_{-1}$) * Macroeconomic State	-0.000	0.002	-0.000	-0.008	0.011	-0.013
	[0.813]	[0.313]	[0.880]	[0.614]	[0.467]	[0.439]
Log(Cash Compensation$_{-1}$)	-0.091	-0.075	-0.061	-0.090	-0.075	-0.061
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
CEO Tenure	-0.001	-0.002	0.012	-0.001	-0.002	0.012
	[0.516]	[0.067]*	[0.446]	[0.506]	[0.055]*	[0.432]
Log(Sales)	-0.171	-0.143	-0.106	-0.172	-0.145	-0.109
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Market-to-book	-0.013	0.008	-0.004	-0.012	0.009	-0.002
	[0.056]*	[0.150]	[0.543]	[0.071]*	[0.097]*	[0.702]
R&D Expenditures / Assets	1.861	0.233	0.277	1.853	0.217	0.261
	[0.000]***	[0.074]*	[0.063]*	[0.000]***	[0.096]*	[0.077]*
Capital Expenditures / Assets	0.348	0.381	0.388	0.327	0.351	0.360
	[0.028]**	[0.005]***	[0.012]**	[0.039]**	[0.010]***	[0.018]**
Leverage Ratio	0.243	0.298	0.396	0.242	0.300	0.399
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Constant	0.236	-0.556	-0.873	-0.573	-0.793	-1.089
	[0.241]	[0.000]***	[0.000]***	[0.004]***	[0.000]***	[0.000]***
N	20352	20352	18184	20352	20352	18184
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-sq	0.554	0.520	0.539	0.554	0.522	0.541
adj. R-sq	0.552	0.519	0.539	0.552	0.521	0.541

Table 4. Relationship between Managerial Performance Incentives, Firm Risk and the Macroeconomic State (cont'd)

Macroeconomic state measured by:	**Personal Expenditure Growth**			**Retail Sales Growth**		
	Industry Fixed Effects	Firm Fixed Effects	Firm-Manager Fixed Effects	Industry Fixed Effects	Firm Fixed Effects	Firm-Manager Fixed Effects
Log(Delta $_{-1}$)	0.011	0.020	0.026	0.025	0.030	0.033
	[0.085]*	[0.000]***	[0.000]***	[0.001]***	[0.000]***	[0.000]***
Log(Vega $_{-1}$)	-0.031	-0.049	-0.047	-0.027	-0.042	-0.044
	[0.000]***	[0.000]***	[0.000]***	[0.001]***	[0.000]***	[0.000]***
Macroeconomy	-0.276	-0.223	-0.184	-0.183	-0.154	-0.121
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Log(Delta $_{-1}$)* Macroeconomic State	0.036	0.023	0.019	0.022	0.015	0.012
	[0.000]***	[0.000]***	[0.001]***	[0.000]***	[0.000]***	[0.001]***
Log(Vega $_{-1}$) * Macroeconomic State	0.000	0.004	-0.000	0.003	0.006	0.002
	[1.000]	[0.379]	[0.923]	[0.349]	[0.040]**	[0.574]
Log(Cash Compensation$_{-1}$)	-0.089	-0.073	-0.058	-0.090	-0.072	-0.058
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
CEO Tenure	-0.001	-0.002	0.014	-0.001	-0.002	0.014
	[0.516]	[0.055]*	[0.377]	[0.559]	[0.061]*	[0.389]
Log(Sales)	-0.172	-0.148	-0.111	-0.172	-0.147	-0.111
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Market-to-book	-0.012	0.008	-0.004	-0.012	0.008	-0.004
	[0.071]*	[0.154]	[0.533]	[0.079]*	[0.161]	[0.521]
R&D Expenditures / Assets	1.865	0.235	0.274	1.868	0.238	0.278
	[0.000]***	[0.078]*	[0.066]*	[0.000]***	[0.071]*	[0.061]*
Capital Expenditures / Assets	0.338	0.371	0.386	0.342	0.372	0.389
	[0.034]**	[0.007]***	[0.012]**	[0.031]**	[0.006]***	[0.011]**
Leverage Ratio	0.244	0.298	0.399	0.242	0.296	0.399
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Constant	0.648	-0.742	-1.062	0.176	-0.867	-1.147
	[0.001]***	[0.000]***	[0.000]***	[0.369]	[0.000]***	[0.000]***
N	20352	20352	18184	20352	20352	18184
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-sq	0.551	0.516	0.535	0.552	0.517	0.535
adj. R-sq	0.549	0.515	0.534	0.550	0.516	0.535

Table 5. Relationship between Managerial Performance Incentives, Firm-Specific Risk and the Macroeconomic State

This table presents the results for the estimation of Equation 3 in the text. The dependent variable is firm-specific (idiosyncatic) risk, calculated as the logarithm of the annualized variance of residuals from the market model. The main variable of interest is the interaction of logarithm of the lagged value of delta with the macroeconomic state measure. The definitions of the variables are provided in the Appendix. All regressions control for year fixed effects. Robust standard errors are clustered at the firm-manager level. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

	Idiosyncratic Risk					
Macroeconomic state measured by:	***NBER Recession Dummy***	***NBER Recession Days***	***GDP Growth***	***Non-Farm Payroll***	***Personal Expenditure Growth***	***Retail Sales Growth***
Log(Delta $_{-1}$)	0.014	0.013	-0.004	0.023	0.016	0.027
	[0.016]**	[0.021]**	[0.544]	[0.000]***	[0.005]***	[0.000]***
Log(Vega $_{-1}$)	-0.044	-0.044	-0.045	-0.044	-0.044	-0.042
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Macroeconomy	0.369	0.069	-0.113	-0.001	-0.198	-0.131
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Log(Delta $_{-1}$)* Macroeconomic State	-0.041	-0.007	0.012	0.102	0.027	0.017
	[0.000]***	[0.001]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Log(Vega $_{-1}$) * Macroeconomic State	-0.004	-0.001	0.001	-0.002	0.001	0.002
	[0.616]	[0.563]	[0.723]	[0.913]	[0.827]	[0.520]
Log(Cash Compensation $_{-1}$)	-0.069	-0.069	-0.073	-0.073	-0.069	-0.069
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
CEO Tenure	0.016	0.016	0.015	0.015	0.017	0.016
	[0.285]	[0.283]	[0.327]	[0.312]	[0.259]	[0.273]
Log(Sales)	-0.125	-0.125	-0.121	-0.123	-0.126	-0.125
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Market-to-book	-0.016	-0.015	-0.017	-0.015	-0.016	-0.016
	[0.009]***	[0.011]**	[0.006]***	[0.011]**	[0.007]***	[0.007]***
R&D Expenditures / Assets	0.348	0.343	0.353	0.336	0.346	0.353
	[0.024]**	[0.027]**	[0.020]**	[0.026]**	[0.024]**	[0.020]**
Capital Expenditures / Assets	0.334	0.330	0.319	0.302	0.320	0.322
	[0.032]**	[0.034]**	[0.041]**	[0.051]*	[0.039]**	[0.038]**
Leverage Ratio	0.431	0.434	0.433	0.435	0.435	0.434
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Constant	-0.882	-0.880	-0.702	-0.938	-0.895	-0.990
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
N	18184	18184	18184	18184	18184	18184
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Manager Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-sq	0.495	0.495	0.500	0.500	0.495	0.496
adj. R-sq	0.494	0.494	0.499	0.499	0.494	0.495

Table 6. Endogeneity

This table presents the results for the estimation of Equation 2 and Equation 3 in the text by two-stage and three-stage least squares. In columns 1 and 3, the dependent variable is firm risk, calculated as the logarithm of the annualized variance of the daily stock returns. In columns 2 and 4, the dependent variable is firm-specific (idiosyncatic) risk, calculated as the logarithm of the annualized variance of residuals from the market model. The main variable of interest is the interaction of logarithm of the lagged value of delta with the macroeconomic state measure. Macroeconomic state is measured as the real GDP growth rate. The definitions of the variables are provided in the Appendix. All regressions control for year fixed effects. Robust standard errors are clustered at firm level. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

Estimation Method	***Two-stage Least Squares***		***Three-Stage Least Squares***	
	Total Risk	**Firm-Specific Risk**	**Total Risk**	**Firm-Specific Risk**
Log(Delta)	1.198	1.077	0.069	-0.102
	[0.113]	[0.123]	[0.087]*	[0.018]**
Log(Vega)	-1.266	-1.168	-0.214	-0.097
	[0.072]*	[0.072]*	[0.000]***	[0.000]***
Macroeconomy	-0.444	-0.425	-0.109	-0.229
	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Log(Delta)* Macroeconomic State	0.099	0.094	0.021	0.053
	[0.010]***	[0.008]***	[0.001]***	[0.000]***
Log(Vega) * Macroeconomic State	-0.042	-0.033	-0.003	-0.010
	[0.329]	[0.401]	[0.353]	[0.005]***
Log(Cash Compensation)	-0.326	-0.313	-0.013	-0.066
	[0.020]**	[0.017]**	[0.409]	[0.000]***
CEO Tenure	0.068	0.065	-0.010	0.001
	[0.313]	[0.293]	[0.000]***	[0.792]
Log(Sales)	-0.150	-0.157	-0.144	-0.157
	[0.190]	[0.162]	[0.000]***	[0.000]***
Market-to-book	-0.342	-0.321	-0.024	0.001
	[0.099]*	[0.094]*	[0.042]**	[0.951]
R&D Expenditures / Assets	1.191	1.186	2.326	2.042
	[0.089]*	[0.070]*	[0.000]***	[0.000]***
Capital Expenditures / Assets	0.042	-0.017	0.159	0.303
	[0.913]	[0.962]	[0.112]	[0.003]***
Leverage Ratio	0.832	0.815	0.256	0.245
	[0.023]**	[0.017]**	[0.000]***	[0.000]***
S&P 500 Volatility			0.433	0.240
			[0.000]***	[0.000]***
N	21832	21832	22426	22426
Year Fixed Effects	Yes	Yes	Yes	Yes
Hansen Statistics	0.073	0.246		
(p-value)	0.9641	0.8843		

Table 7. Effect of Macroeconomic Environment vs. Firm Values
Panel A. Comparison of Firms with Value Declines and Value Increases

This table presents the results for the estimation of Equation 1 and Equation 2 in the text for firms with declining and increasing valuations. The dependent variable is firm risk, calculated as the logarithm of the annualized variance of the daily stock returns. The main variables of interest is the interaction of logarithm of the lagged value of delta with the value decline indicator (column 3), and the interaction of logarithm of the lagged value of delta with the NBER recession dummy and value decline indicator (column 6). The definitions of the variables are provided in the Appendix. All regressions control for year fixed effects. Robust standard errors are clustered at firm level. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

				Interactions with the Recession Dummy		
	Subsample: Value Decline	Subsample: Value Increase	Full Sample	Subsample: Negative Return	Subsample: Positive Return	Full Sample
$Log(Delta_{-1})$	0.024	-0.028	-0.023	0.042	0.004	0.008
	[0.042]**	[0.000]***	[0.001]***	[0.000]***	[0.539]	[0.189]
$Log(Vega_{-1})$	-0.052	-0.040	-0.056	-0.046	-0.040	-0.050
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Negative Return			0.087			0.100
			[0.009]***			[0.003]***
$Log(Delta_{-1})$*Value Decline			0.031			0.019
			[0.000]***			[0.005]***
$Log(Vega_{-1})$ * Value Decline			0.027			0.024
			[0.000]***			[0.000]***
NBER Recession Dummy				1.080	1.131	1.078
				[0.000]***	[0.000]***	[0.000]***
$Log(Delta_{-1})$* Recession				-0.050	-0.082	-0.075
				[0.001]***	[0.000]***	[0.000]***
$Log(Vega_{-1})$ * Recession				-0.019	0.000	-0.001
				[0.182]	[0.971]	[0.906]
Value Decline * Recession						0.028
						[0.707]
$Log(Delta_{-1})$* Recession * Value Decline						0.024
						[0.110]
$Log(Vega_{-1})$* Recession * Value Decline						-0.016
						[0.197]
$Log(Cash Compensation_{-1})$	-0.011	-0.076	-0.050	-0.085	-0.122	-0.106
	[0.692]	[0.000]***	[0.003]***	[0.001]***	[0.000]***	[0.000]***
CEO Tenure	-0.005	-0.003	-0.004	-0.003	-0.003	-0.003
	[0.045]**	[0.095]*	[0.009]***	[0.189]	[0.115]	[0.047]**
Log(Sales)	-0.057	-0.080	-0.062	-0.127	-0.130	-0.125
	[0.065]*	[0.000]***	[0.002]***	[0.000]***	[0.000]***	[0.000]***
Market-to-book	-0.100	0.077	0.033	-0.041	0.114	0.070
	[0.000]***	[0.000]***	[0.000]***	[0.053]*	[0.000]***	[0.000]***
R&D Expenditures / Assets	0.520	0.477	0.415	0.234	0.100	0.181
	[0.032]**	[0.137]	[0.032]**	[0.249]	[0.750]	[0.288]
Capital Expenditures / Assets	-0.016	-1.185	-0.573	0.309	-0.628	-0.153
	[0.961]	[0.000]***	[0.006]***	[0.264]	[0.003]***	[0.395]
Debt / Assets	0.690	0.696	0.668	0.541	0.600	0.554
	[0.000]***	[0.000]***	[0.000]***	[0.001]***	[0.000]***	[0.000]***
Constant	-0.954	-0.838	-0.985	-0.375	-0.548	-0.550
	[0.000]***	[0.000]***	[0.000]***	[0.110]	[0.001]***	[0.000]***
N	8127	11687	19814	8127	11687	19814
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Manager Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-sq	0.033	0.065	0.088	0.230	0.252	0.271
adj. R-sq	0.031	0.065	0.087	0.228	0.251	0.270

Table 7. Effect of Macroeconomic Environment vs. Firm Values
Panel B. Residual Returns

This table presents the results for the estimation of Equation 1 and Equation 2 in the text for firms with declining and increasing valuations. The dependent variable is firm risk, calculated as the logarithm of the annualized variance of the daily stock returns. The main variables of interest is the interaction of logarithm of the lagged value of delta with the value decline indicator (column 3), and the interaction of logarithm of the lagged value of delta with the NBER recession dummy and value decline indicator (column 6). The definitions of the variables are provided in the Appendix. All regressions control for year fixed effects. Robust standard errors are clustered at firm level. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

				Interactions with the Recession Dummy		
	Subsample: Negative Residuals	Subsample: Positive Residuals	Full Sample	Subsample: Negative Residuals	Subsample: Positive Residuals	Full Sample
Log(Delta $_{-1}$)	0.050	-0.045	0.000	0.056	-0.010	0.024
	[0.000]***	[0.008]***	[0.970]	[0.000]***	[0.538]	[0.007]***
Log(Vega $_{-1}$)	-0.059	-0.022	-0.045	-0.056	-0.009	-0.035
	[0.000]***	[0.247]	[0.000]***	[0.000]***	[0.606]	[0.001]***
Negative Residual Dummy			-0.290			-0.120
			[0.000]***			[0.001]***
Log(Delta -1)* Negative Residual			0.035			0.022
			[0.000]***			[0.009]***
Log(Vega -1) * Negative Residual			-0.012			-0.018
			[0.188]			[0.051]*
NBER Recession Dummy				0.909	1.059	1.070
				[0.000]***	[0.000]***	[0.000]***
Log(Delta $_{-1}$)* Recession				-0.027	-0.054	-0.046
				[0.021]**	[0.040]**	[0.006]***
Log(Vega $_{-1}$) * Recession				-0.004	-0.013	-0.024
				[0.678]	[0.603]	[0.112]
Negative Residual * Recession						-0.130
						[0.137]
Log(Delta -1)* Recession * Negative Residual						0.014
						[0.446]
Log(Vega -1)* Recession * Negative Residual						0.021
						[0.184]
Log(Cash Compensation$_{-1}$)	-0.022	-0.073	-0.031	-0.082	-0.139	-0.091
	[0.281]	[0.057]*	[0.073]*	[0.000]***	[0.000]***	[0.000]***
CEO Tenure	-0.008	-0.002	-0.006	-0.006	-0.002	-0.005
	[0.000]***	[0.676]	[0.000]***	[0.001]***	[0.561]	[0.002]***
tenure_missing	-0.138	-0.276	-0.161	-0.018	-0.146	-0.028
	[0.064]*	[0.117]	[0.016]**	[0.790]	[0.345]	[0.641]
Log(Sales)	-0.097	0.051	-0.066	-0.144	-0.076	-0.131
	[0.000]***	[0.214]	[0.001]***	[0.000]***	[0.051]*	[0.000]***
Market-to-book	-0.094	0.036	-0.049	-0.037	0.089	0.009
	[0.000]***	[0.012]**	[0.000]***	[0.007]***	[0.000]***	[0.301]
R&D Expenditures / Assets	0.733	0.591	0.676	0.403	0.406	0.387
	[0.005]***	[0.015]**	[0.001]***	[0.082]*	[0.207]	[0.026]**
Capital Expenditures / Assets	0.392	-1.454	-0.027	0.576	-0.775	0.289
	[0.076]*	[0.010]**	[0.894]	[0.004]***	[0.105]	[0.100]*
Debt / Assets	0.822	0.577	0.790	0.675	0.536	0.655
	[0.000]***	[0.008]***	[0.000]***	[0.000]***	[0.019]**	[0.000]***
Constant	-1.065	-1.189	-0.880	-0.599	-0.474	-0.502
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.086]*	[0.001]***
N	15621	4193	19814	15621	4193	19814
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Manager Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-sq	0.045	0.047	0.044	0.22	0.269	0.232
adj. R-sq	0.044	0.045	0.043	0.22	0.267	0.231

Table 7. Effect of Macroeconomic Environment vs. Firm Values
Panel C. Recession-proof Industries

This table presents the results for the estimation of Equation 1 and Equation 2 in the text for firms in recession proof and recession prone indistries. The dependent variable is firm risk, calculated as the logarithm of the annualized variance of the daily stock returns. The main variables of interest is the interaction of logarithm of the lagged value of delta with the value decline indicator (column 3), and the interaction of logarithm of the lagged value of delta with the NBER recession dummy and recession proof industry indicator (column 6). The definitions of the variables are provided in the Appendix. All regressions control for year fixed effects. Robust standard errors are clustered at firm level. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

				Interactions with the Recession Dummy		
	Subsample: Recession Proof	Subsample: Not Recession Proof	Full Sample	Subsample: Recession Proof	Subsample: Not Recession Proof	Full Sample
Log(Delta $_{-1}$)	0.022	0.016	0.014	0.004	0.040	0.039
	[0.257]	[0.020]**	[0.045]**	[0.797]	[0.000]***	[0.000]***
Log(Vega $_{-1}$)	-0.095	-0.047	-0.051	-0.066	-0.045	-0.048
	[0.000]***	[0.000]***	[0.000]***	[0.001]***	[0.000]***	[0.000]***
Log(Delta -1)* Recession Proof			0.022			-0.025
			[0.296]			[0.199]
Log(Vega -1) * Recession Proof			-0.032			-0.008
			[0.163]			[0.716]
NBER Recession Dummy				0.766	1.021	1.018
				[0.000]***	[0.000]***	[0.000]***
Log(Delta $_{-1}$)* Recession				0.030	-0.046	-0.047
				[0.319]	[0.000]***	[0.000]***
Log(Vega $_{-1}$) * Recession				-0.043	-0.003	-0.003
				[0.096]*	[0.722]	[0.776]
Recession Proof * Recession						-0.197
						[0.153]
Log(Delta -1)* Recession * Recession Proof						0.081
						[0.017]**
Log(Vega -1)* Recession * Recession Proof						-0.045
						[0.128]
Log(Cash Compensation$_{-1}$)	0.023	-0.042	-0.036	-0.066	-0.097	-0.094
	[0.705]	[0.021]**	[0.039]**	[0.176]	[0.000]***	[0.000]***
CEO Tenure	-0.002	-0.006	-0.006	0.001	-0.005	-0.004
	[0.753]	[0.000]***	[0.000]***	[0.774]	[0.001]***	[0.003]***
tenure_missing	0.122	-0.168	-0.152	0.256	-0.041	-0.022
	[0.618]	[0.016]**	[0.025]**	[0.266]	[0.505]	[0.710]
Log(Sales)	0.059	-0.092	-0.062	-0.024	-0.155	-0.130
	[0.201]	[0.000]***	[0.003]***	[0.551]	[0.000]***	[0.000]***
Market-to-book	-0.090	-0.024	-0.027	-0.009	0.020	0.019
	[0.018]**	[0.010]***	[0.003]***	[0.798]	[0.020]**	[0.021]**
R&D Expenditures / Assets	-8.673	0.590	0.622	-6.929	0.325	0.359
	[0.282]	[0.004]***	[0.002]***	[0.239]	[0.059]*	[0.040]**
Capital Expenditures / Assets	0.224	-0.261	-0.135	0.040	0.313	0.245
	[0.545]	[0.269]	[0.503]	[0.899]	[0.122]	[0.161]
Debt / Assets	1.048	0.745	0.774	0.910	0.625	0.646
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Constant	-2.405	-0.809	-1.070	-1.506	-0.391	-0.572
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.016]**	[0.000]***
N	2191	17623	19814	2191	17623	19814
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Manager Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-sq	0.064	0.035	0.035	0.246	0.231	0.230
adj. R-sq	0.060	0.035	0.035	0.242	0.230	0.230

Table 8. Managerial Control

This table presents the results for the estimation ofEquation 2 in the text for firms with higher and lower levels of managerial control. The dependent variable is firm risk, calculated as the logarithm of the annualized variance of the daily stock returns. In columns 1-3, managerial control is proxied by CEO tenure, in clumns 4-6 by HHI and in columns 7-9 by product fluidity. The main variables of interest is the the interactions of logarithm of the lagged value of delta with the NBER recession dummy and managerial control measures (columns 3,6,9). The definitions of the variables are provided in the Appendix. All regressions control for year fixed effects. Robust standard errors are clustered at firm level. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

Managerial control measured by:	CEO Tenure			HHI			Product Fluidity		
	Long CEO Tenure	Short CEO Tenure	Full Sample	High HHI	Low HHI	Full Sample	Low Product Fluidity	High Product Fluidity	Full Sample
Log(Delta $_{-1}$)	0.022	0.038	0.037	0.018	0.029	0.027	0.016	0.026	0.021
	[0.000]***	[0.077]*	[0.000]***	[0.035]**	[0.000]***	[0.000]***	[0.011]**	[0.002]***	[0.001]***
Log(Vega $_{-1}$)	-0.047	-0.049	-0.055	-0.050	-0.044	-0.052	-0.041	-0.049	-0.049
	[0.000]***	[0.023]**	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
NBER Recession Dummy	0.269	0.238	0.198	0.296	0.204	0.162	0.373	0.218	0.179
	[0.000]***	[0.166]	[0.035]**	[0.000]***	[0.016]**	[0.019]**	[0.000]***	[0.006]***	[0.007]***
Log(Delta $_{-1}$)* Recession	-0.020	-0.023	0.019	-0.037	-0.003	-0.001	-0.060	0.003	0.002
	[0.037]**	[0.603]	[0.446]	[0.003]***	[0.804]	[0.957]	[0.000]***	[0.788]	[0.868]
Log(Vega $_{-1}$) * Recession	-0.004	-0.039	-0.055	0.011	-0.009	-0.004	0.015	-0.011	-0.012
	[0.638]	[0.382]	[0.013]**	[0.350]	[0.409]	[0.668]	[0.152]	[0.324]	[0.228]
Managerial Control			0.070			0.028			-0.085
			[0.037]**			[0.397]			[0.012]**
Managerial Control * Recession			0.099			0.214			0.216
			[0.304]			[0.008]***			[0.006]***
Log(Delta -1)* Recession * Managerial Control			-0.045			-0.010			-0.055
			[0.083]*			[0.127]			[0.001]***
Log(Delta -1)* Managerial Control			-0.017			-0.042			0.003
			[0.095]*			[0.011]**			[0.668]
Log(Vega -1)* Managerial Control			0.009			0.014			0.005
			[0.349]			[0.039]**			[0.472]
Log(Vega -1)* Recession *Managerial Control			0.057			0.004			0.022
			[0.014]**			[0.757]			[0.124]
Log(Cash Compensation$_{-1}$)	-0.055	-0.050	-0.060	-0.086	-0.033	-0.057	-0.059	-0.046	-0.057
	[0.000]***	[0.136]	[0.000]***	[0.000]***	[0.022]**	[0.000]***	[0.000]***	[0.011]**	[0.000]***
CEO Tenure	0.012	0.067	0.012	0.008	0.017	0.013	0.003	-0.005	0.014
	[0.189]	[0.001]***	[0.185]	[0.692]	[0.125]	[0.133]	[0.804]	[0.817]	[0.120]
Log(Sales)	-0.101	-0.187	-0.106	-0.131	-0.095	-0.109	-0.100	-0.088	-0.114
	[0.000]***	[0.011]**	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Market-to-book	-0.006	-0.055	-0.004	-0.025	-0.004	-0.004	-0.014	-0.009	-0.004
	[0.210]	[0.001]***	[0.394]	[0.003]***	[0.550]	[0.407]	[0.101]	[0.170]	[0.381]
R&D Expenditures / Assets	0.282	-0.110	0.284	0.088	0.321	0.272	0.799	0.241	0.274
	[0.021]**	[0.795]	[0.009]***	[0.521]	[0.021]**	[0.012]**	[0.008]***	[0.041]**	[0.012]**
Capital Expenditures / Assets	0.339	0.003	0.402	0.486	0.402	0.396	0.465	0.345	0.410
	[0.007]***	[0.994]	[0.000]***	[0.018]**	[0.005]***	[0.000]***	[0.007]***	[0.057]*	[0.000]***
Debt / Assets	0.409	0.287	0.396	0.368	0.401	0.397	0.492	0.358	0.389
	[0.000]***	[0.121]	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Constant	-1.111	-0.141	-1.089	-0.718	-1.264	-1.058	-1.233	-0.919	-0.945
	[0.000]***	[0.785]	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
N	14648	3536	18184	8054	10130	18184	10754	7430	18184
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-sq	0.526	0.415	0.535	0.533	0.557	0.535	0.513	0.592	0.535
adj. R-sq	0.525	0.410	0.534	0.531	0.556	0.534	0.512	0.591	0.534

Table 9. Dollar-Dollar Sensitivity as a Measure for Managerial Performance Incentives

This table presents the results for the estimation of Equation 2 in the text. The dependent variable is firm risk, calculated as the logarithm of the annualized variance of the daily stock returns. Delta in these regressions is measured as the dollar increase in CEO wealth as a result of a dollar increase in stock price. The main variable of interest is the interaction of logarithm of the lagged value of delta with the macroeconomic state measure. The definitions of the variables are provided in the Appendix. All regressions control for year fixed effects. Robust standard errors are clustered at firm level in regressions that control for industry fixed effects and at firm-manager level in regressions that control for firm-manager pair fixed effects. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

Macroeconomic State is Measured by:	**NBER Recession Dummy**			**GDP Growth**		
	Industry Fixed Effects	Firm Fixed Effects	Firm-Manager Fixed Effects	Industry Fixed Effects	Firm Fixed Effects	Firm-Manager Fixed Effects
Log(Delta $_{-1}$)	0.0024	0.0144	0.0201	-0.009	0.012	0.018
	[0.507]	[0.000]***	[0.000]***	[0.013]**	[0.003]***	[0.000]***
Log(Vega $_{-1}$)	-0.0320	-0.0480	-0.0440	-0.030	-0.051	-0.048
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Macroeconomy	0.1596	0.2075	0.2072	-0.077	-0.076	-0.079
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Log(Delta $_{-1}$) * Macroeconomic State	-0.1492	-0.1145	-0.1245	0.058	0.025	0.029
	[0.000]***	[0.003]***	[0.003]***	[0.000]***	[0.001]***	[0.000]***
Log(Vega $_{-1}$) * Macroeconomic State	-0.3078	-0.4927	-0.4636	0.056	0.057	0.038
	[0.088]*	[0.002]***	[0.007]***	[0.108]	[0.062]*	[0.216]
Log(Cash Compensation $_{-1}$)	-0.0892	-0.0741	-0.0594	-0.088	-0.073	-0.059
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
CEO Tenure	-0.0006	-0.0021	0.0130	-0.001	-0.002	0.013
	[0.331]	[0.009]***	[0.141]	[0.087]*	[0.002]***	[0.146]
Log(Sales)	-0.1762	-0.1555	-0.1183	-0.165	-0.145	-0.106
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Market-to-book	-0.0137	0.0073	-0.0041	-0.010	0.009	-0.003
	[0.000]***	[0.074]*	[0.374]	[0.011]**	[0.028]**	[0.526]
R&D Expenditures / Assets	1.8508	0.2409	0.2704	1.872	0.230	0.259
	[0.000]***	[0.017]**	[0.013]**	[0.000]***	[0.024]**	[0.018]**
Capital Expenditures / Assets	0.3308	0.3694	0.3900	0.346	0.375	0.386
	[0.001]***	[0.000]***	[0.001]***	[0.000]***	[0.000]***	[0.001]***
Leverage Ratio	0.2475	0.3017	0.3997	0.242	0.294	0.390
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Constant	-0.4754	-0.6430	-0.9722	0.161	-0.593	-0.923
	[0.000]***	[0.000]***	[0.000]***	[0.128]	[0.000]***	[0.000]***
N	20345	20345	18177	20345	20345	18177
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-sq	0.550	0.514	0.534	0.553	0.517	0.538
adj. R-sq	0.548	0.514	0.533	0.551	0.517	0.538

Table 10. Regressions for a Subsample of Low-Leverage Firms

This table presents the results for the estimation of Equation 2 in the text using a sub-sample of low-leverage firms, i.e. the firms that are in the lowest quartile of leverage distribution. The dependent variable is firm risk, calculated as the logarithm of the annualized variance of the daily stock returns. The main variable of interest is the interaction of logarithm of the lagged value of delta with the recession measure. The definitions of the variables are provided in the Appendix. All regressions control for year fixed effects. Robust standard errors are clustered at the firm level. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

Macroeconomic state measured by:	NBER Recessions			GDP Growth		
	Industry Fixed Effects	Firm Fixed Effects	Firm-Manager Fixed Effects	Industry Fixed Effects	Firm Fixed Effects	Firm-Manager Fixed Effects
Log(Delta $_{-1}$)	0.007	0.015	0.033	-0.012	0.002	0.023
	[0.417]	[0.082]*	[0.001]***	[0.160]	[0.870]	[0.052]*
Log(Vega $_{-1}$)	-0.007	-0.027	-0.043	-0.013	-0.030	-0.041
	[0.547]	[0.013]**	[0.001]***	[0.201]	[0.010]***	[0.005]***
Macroeconomy	0.268	0.263	0.233	-0.110	-0.116	-0.106
	[0.009]***	[0.006]***	[0.065]*	[0.000]***	[0.000]***	[0.000]***
Log(Delta $_{-1}$)* Macroeconomic State	-0.027	-0.024	-0.019	0.010	0.009	0.008
	[0.056]*	[0.075]*	[0.267]	[0.000]***	[0.000]***	[0.018]**
Log(Vega $_{-1}$) * Macroeconomic State	-0.028	-0.009	0.005	0.005	0.002	-0.002
	[0.037]**	[0.483]	[0.733]	[0.032]**	[0.572]	[0.524]
Log(Cash Compensation$_{-1}$)	-0.079	-0.047	-0.041	-0.090	-0.051	-0.043
	[0.000]***	[0.088]*	[0.173]	[0.000]***	[0.059]*	[0.151]
CEO Tenure	-0.009	-0.003	0.002	-0.008	-0.003	-0.001
	[0.000]***	[0.258]	[0.916]	[0.000]***	[0.303]	[0.967]
Log(Sales)	-0.177	-0.132	-0.085	-0.172	-0.124	-0.078
	[0.000]***	[0.000]***	[0.017]**	[0.000]***	[0.000]***	[0.026]**
Market-to-book	0.005	-0.011	-0.008	0.003	-0.010	-0.007
	[0.513]	[0.119]	[0.332]	[0.734]	[0.156]	[0.426]
R&D Expenditures / Assets	1.227	0.459	0.520	1.349	0.460	0.529
	[0.000]***	[0.005]***	[0.032]**	[0.000]***	[0.004]***	[0.025]**
Capital Expenditures / Assets	0.727	0.823	0.809	0.717	0.825	0.794
	[0.010]***	[0.002]***	[0.007]***	[0.012]**	[0.002]***	[0.008]***
Debt / Assets	-0.080	0.964	0.720	-0.286	0.882	0.683
	[0.881]	[0.092]*	[0.288]	[0.610]	[0.119]	[0.300]
Constant	-0.798	-0.587	-0.860	-0.536	-0.428	-0.725
	[0.004]***	[0.002]***	[0.000]***	[0.042]**	[0.028]**	[0.001]***
N	4930	4930	4443	4930	4930	4443
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-sq	0.577	0.540	0.524	0.582	0.547	0.532
adj. R-sq	0.570	0.537	0.521	0.575	0.545	0.529