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CEO risk preferences, hedging intensity, and firm value

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ABSTRACT

We examine the effect of hedging with different derivative instruments on the market value of firms run by CEOs with different risk preferences – based on a noble dataset over five years. We focus on the interest rate, commodity, and foreign exchange derivatives and find striking similarities in the hedging intensities of risk-seeking and risk-averse CEOs. Our findings show that when the average firm experiences an extreme (three-standard-deviation) change in interest rates, commodity prices, or foreign exchange rates, its derivatives portfolio creates only modest gains, regardless of CEO risk preferences. These findings are consistent with the view that hedging is just an insurance policy, not a value-increasing strategy. Our results suggest that CEOs, irrespective of their different risk preferences, are unwilling to forgo wealth-creating projects to hedge corporate risks.

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1. Introduction

[Modigliani and Miller \(1958\)](#) argue that in the absence of market imperfections, hedging financial risk should not affect firm value. The traditional full-information, perfect capital market model of the firm says little about why firms hedge. This model also implies that hedging is irrelevant to shareholders because it can undo any risk-management activities implemented by the firm at the exact cost. [Smith and Stulz \(1985\)](#) and [Froot, Scharfstein, and Stein \(1993\)](#) claim that the goal of risk management is to minimize costly variances. Further, [Culp and Miller \(1995\)](#) argue that most value-maximizing firms do not hedge, implying that such firms do not perceive hedging to increase firm value. More recently, [Stulz \(2013\)](#) argues that hedging is unlikely to affect firms' value, suggesting that firms create value through other corporate decisions.

However, researchers have divergent views on the effects of hedging on firm value. The development of numerous hedging strategies using different derivative instruments (i.e., interest rates (*IRs*)), currencies (*FXs*), and commodities (*COMMs*)) have motivated several studies with conflicting results. For example, [Allayannis and Weston \(2001\)](#), [Allayannis et al. \(2001\)](#), [Pramborg \(2004\)](#), [Carter et al. \(2006\)](#), and [Chaudhry et al. \(2014\)](#) find a positive association between hedging and firm value. However, [Guay and Kothari \(2003\)](#), [Lookman \(2004\)](#), [Dan et al. \(2005\)](#), [Jin and Jorion \(2006\)](#), and [Bartram et al. \(2011\)](#) find no relationship. Interestingly, none of these studies examines the effect of total derivatives on the value of US firms over a multi-year setting. Therefore, whether hedging affects firm value remains debatable and warrants investigation since there

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is a lack of empirical consensus. Further, the previously mentioned studies rely on binary variables to account for derivatives hedging (Ahmed et al., 2010; Chaudhry et al., 2014). Contrary to these previous studies, we use continuous variables analogous to those of Campello et al. (2011) and Marami and Dubois (2013) to examine the impact of total hedging on firm value over the five years from 2008 to 2012. This sample period is appealing because, during unusual economic times, such as the Global Financial Crisis (GFC), one would expect to capture hedging intensity and its effectiveness better. Indeed, several papers examine these relationships using the GFC as a backdrop (e.g., Junttila et al., 2018). Precisely, we first determine whether hedging affects firm value, using total derivatives data reported by companies, that is, the sum of interest rate (*IR*), commodity (*COMM*), and foreign exchange (*FX*) derivatives. We also examine the effect of individual derivative hedging (*IR*, *FX*, and *COMM*) on firm value. Our results demonstrate that neither multi- nor single-derivatives hedging affects firm value.

To complement our initial findings, we then examine whether the personal risk preferences of CEOs play an important role in firm hedging decisions. In other words, we examine the impact of hedging on firm value conditional on CEO risk-aversion or risk-seeking sensitivity (risk preferences), inferred from the structure of CEO compensation contracts. Intuitively, we investigate whether CEO compensation packages, designed to induce risk-averse (risk-tolerant) managerial behavior, affect firm value. Even though CEOs decide corporate hedging policies, it is shareholders who develop CEOs' compensation contracts that determine CEOs' incentives to hedge less (risk-seeking) or more (risk-averse) (Stulz, 1984; Smith and Stulz, 1985). In other words, we examine whether low-powered CEO incentives (debt-like compensation) can invoke severe risk-aversion behavior, thereby increasing the tendency to hedge more. Contrarily, high-powered CEO incentives (convex compensation structure) are expected to invoke high risk-seeking behavior, thus increasing the propensity to hedge less. This investigation is vital because while corporate hedging techniques are designed and conducted by risk management experts with the board of directors aware of the hedging activities, the hedging policy is ultimately executed after the CEO's approval.¹ Thus, our study contributes substantially to the literature on the role of CEO risk preferences in hedging.

We use CEO compensation structures to capture CEO risk preferences since literature finds a strong effect of the CEO compensation structure on corporate hedging. For example, Rogers (2002) and Knopf et al. (2002) find delta to be positively related to hedging, while Cole et al. (2006) and Guay (1999) find CEO vega to be negatively associated with hedging. Further, Edmans and Liu (2011) and Belkhir and Boubaker (2013) find that CEO inside debt is positively related to hedging. Other scholars, such as Rogers (2002) and Stulz (1996) find that CEO stock ownership is positively associated with hedging. Knopf et al. (2002) also show that CEO cash compensation is positively associated with hedging. Therefore, following the literature, we identify risk-averse CEOs as those with higher total delta, high inside debt, high cash, and high stock compensation². Similarly, risk-seeking CEOs are those with higher vega (convex)ZX. We also determine the market value sensitivity of the total derivatives portfolio to extreme changes in underlying assets for firms run by risk-averse and risk-seeking CEOs.

Our paper contributes to the literature in several important ways. First, to the best of our knowledge, this is the first study to explore the effect of total derivatives hedging and each component of total derivatives hedging on firm value for US firms over several years. As already mentioned, the existing literature either focuses on only one type of derivatives hedging (*IR*, *FX*, or *COMM* derivatives hedging) on firm value or studies the impact of total derivatives hedging on firm value only for non-US firms. To this extent, this paper provides more convincing evidence that derivative hedging does not impact firm value.

Second, our study examines the impact of hedging on firm value conditional on CEO risk preference – an important factor in corporate hedging decisions that has been overlooked in the existing literature. Precisely, we examine whether the impact of hedging on firm value is higher for firms run by risk-averse CEOs than for firms run by risk-seeking CEOs. While several studies show that the nature of CEO compensation affects CEO risk preferences and their hedging decisions, the existing studies do not focus on the valuation effects of hedging (Stulz, 1996; Tufano, 1996; Knopf et al., 2002; Coles et al., 2006; Edmans and Liu, 2011; and Beber and Fabbri, 2012). We also analyze the market value sensitivities of the three types of derivatives hedging to movement in underlying assets. We perform these analyses separately for risk-seeking and risk-averse CEOs and compare how using derivatives hedging affects firm value for both groups. To the best of our knowledge, no other paper separately examines the magnitude of change in firm value due to derivatives hedging by risk-averse and risk-seeking CEOs. While Guay and Kothari (2003) look at the value creation of total derivatives hedging, these authors do not address the market value sensitivity of hedging for firms run by risk-averse and risk-seeking CEOs.

Finally, our sample period provides an ideal setting to study the effect of derivatives hedging. Covering the period between 2008–2009 in our analyses enables us to extract the actual impact of corporate hedging as corporations had limited support from their financial institutions. During this time, external liquidity declined substantially for reasons unrelated to firm performance. As a result, if derivative hedging has indeed been effective in increasing firm value, then our sample period provides the ideal time frame to filter out the effect of derivative hedging. Other studies, such as Júnior (2013) uses a relatively shorter sample period from 2007 to 2009 to identify the impact of derivatives hedging during different phases of the financial crisis. Also, given the difficulty of hand collecting data from 332 firms, we believe that our findings provide more convincing evidence compared to the existing literature in the same direction.

In this study, we use data from 332 Fortune 500 companies. Our sample consists of 1446 firm-year observations from 2008 to 2012. We find that the use of total derivatives hedging (i.e., *IR*, *COMM*, and *FX* derivatives) does not affect firm value

¹ See, <http://people.stern.nyu.edu/jgiddy/corphdg.htm>

² See, for example, Rogers (2002), Knopf et al. (2002), Cole et al. (2006), Guay (1999), and Caliskan and Doukas (2-15).

in an unconditional setting. This result contradicts [Allayannis et al. \(2001\)](#) and [Allayannis and Weston \(2001\)](#), who report a positive relation between firm value and derivatives. However, both of these studies use only *FX* derivatives, which represent less than half (41%) of firm total derivatives hedging used in our sample. To make a closer comparison to previous studies, we also examine the individual effects of the three different derivatives on firm value and find that none of the *FX*, *IR*, and *COMM* derivatives significantly impact firm value. These results hold even when we control for endogeneity. In sum, our findings show that firm value is not significantly affected by total derivatives or any of the individual derivatives (*FX*, *IR*, or *COMM*). Thus, our results are consistent with the valuation findings of [Jin and Jorion \(2006\)](#), [Brown et al. \(2006\)](#), and [Tufano \(1996\)](#) who use just one type of derivative. To contribute further to the literature, we also examine the valuation effects of corporate hedging conditional on CEO risk preferences. This is because the literature shows that the nature of CEO risk preferences, measured by the structure of compensation contracts, affects corporate hedging decisions ([Tufano 1996](#); [Guay 1999](#); [Knopf et al. 2002](#); [Rogers 2002](#); [Beber and Fabbri 2012](#); and [Cassel et al. 2012](#)). More recently, [Caliskan and Doukas \(2015\)](#) report that CEO risk preferences influence dividend policy. Conditioning our investigation on CEO risk preferences allows us to determine whether they result in different hedging intensities and subsequently impact firm value.

We address these issues by splitting our sample into risk-averse and risk-seeking CEOs based on the median value of five risk preference measures. Accordingly, CEOs with risk preference measures above their median values are identified as having a high value for that characteristic. Since risk-averse and risk-seeking CEOs are differentiated only through their compensation measures, they are more likely to accurately reflect how CEO risk preferences affect firm value through derivatives hedging. For each of the five CEO risk preference measures, we run pooled OLS regressions for risk-averse and risk-seeking CEO groups.

Our results show that derivatives hedging is not associated with the value of firms run by either risk-seeking or risk-averse CEOs, suggesting that the nature of CEO compensation contracts designed to induce different risk-seeking behavior does not impact derivatives hedging. We also find a similar pattern when we consider the individual influence of *IR*, *FX*, and *COMM* derivatives hedging on firm value and even when we control for endogeneity. In sum, our evidence shows that derivatives hedging, in both unconditional and conditional settings, does not matter for firm value. Since we consider the moderating effect of CEO risk preferences to analyze the effect of hedging on firm value over several years, our results provide more convincing evidence that hedging does not impact firm value.

Interestingly, the results indicate that the level of hedging intensity (measured through total derivatives scaled by assets) for firms run by risk-seeking and risk-averse CEOs is fairly similar (0.10–0.11), a finding not previously recorded in the literature. The similarity in the hedging intensities demonstrates that CEO compensation contracts do not alter CEO risk preferences. It suggests that in a world of asymmetric information, the hedging decisions of CEOs with convex (non-linear) compensation contracts are probably motivated by the idea of “locking in” performance and reputation rather than increasing firm value.³

We then examine the market value sensitivities of derivatives portfolios for all firms in our sample (unconditional setting) to extreme changes in underlying assets and find that the average firm's total derivative to market value sensitivity is \$3.7 billion. In other words, when the average firm in our sample experiences a three standard deviation change in *IRs*, *COMM* prices, and *FX* rates, the entire derivatives portfolio increases firm value by \$3.7 billion. This value is small compared to the average firm's total assets (\$29.6 billion) and sales (\$19.9 billion). Specifically, the sensitivity of the derivatives portfolio to changes in the price of the underlying asset is equal to 13% of total assets and 19% of total sales. This result provides a possible explanation as to why firms hesitate to hedge their entire *IR*, *FX*, and *COMM* risk using derivatives ([Bodnar et al., 1995](#)) in place of other strategies, such as operational hedging, exchange rate, and foreign currency debt ([Aretz and Bartram, 2010](#)).

Finally, to confirm our previous findings, we analyze whether the impact of hedging on firm value differs between risk-seeking and risk-averse CEOs, following the procedure of [Guay and Kothari \(2003\)](#) (see Appendix A for a detailed description). We find no significant differences in values for firms managed by either risk-seeking or risk-averse CEOs. Specifically, our evidence shows that risk-seeking CEOs (high vega) who hedge with *IR*, *FX*, and *COMM* derivatives increase firm value by approximately \$4.55 billion, just 12.8% of total assets and 21% of total sales. On the other hand, risk-averse CEOs increase firm value by \$5.21 billion, only 13.2% of total assets and 20.5% of total sales. It indicates that the market value sensitivities of derivatives (i.e., increases in firm value due to derivatives usage) in terms of total assets (13%) and total sales (21%) are modest and similar, regardless of CEO risk preference. Therefore, the results lend support to our conjecture that the hedging preference of both risk-seeking and risk-averse CEOs are similar. This is consistent with the argument put forward by [Guay and Kothari \(2003\)](#) that, on average, value creation using corporate derivatives is minimal compared to total risk exposure.

Overall, results suggest that CEO compensation contracts designed to alter risk preferences for value creation are ineffective regarding derivatives hedging. In other words, CEOs apparently use derivatives hedging as an insurance policy rather than a strategy to increase firm value per se. Therefore, our results provide evidence in support of the view that shareholder value-maximization objectives are better served through more efficient management of assets and operations ([Myers, 1977](#); [Peltzman, 1977](#); [Morck and Yeung, 1991](#); [Smith and Watts, 1992](#); [Froot et al., 1993](#); [Geczy et al., 1997](#)) than through derivatives hedging—a strategy that can only help protect firm value ([Stulz, 2013](#)). In addition, our results hold even when we control for endogeneity using the [Shen and Zhang \(2013\)](#) method for total derivatives and *IR*, *FX*, and *COMM* derivatives.

³ While this conjecture is not addressed in this study, it warrants future investigation.

This paper proceeds as follows. Section 2 briefly describes the literature, hypothesis development, and our underlying theoretical framework. Section 3 details our sample and methodology. Section 4 presents the results. Finally, Section 5 sets forth our conclusions.

2. Literature review and hypothesis development

2.1. Financial hedging and firm value

While the impact of hedging corporate risks on firm value has received increasing scholarly attention in recent years, there is no conclusive evidence regarding the effect of derivative hedging on firm value. In addition, most researchers have focused either on one type of derivative instrument or a specific industry. For example, [Jorion \(1990\)](#) focuses on FX derivatives and finds no impact on firm value. However, [Allayannis et al. \(2001\)](#) find that firms that use operational hedging along with FX derivatives improve firm value. Confirming this, [Allayannis and Weston \(2011\)](#) find that firms that hedge with FX derivatives have higher firm value compared to non-hedgers, with a value premium of 4.87%. This is consistent with [MacKay and Moeller \(2007\)](#), who find that FX hedging is associated with higher firm value. [Graham and Rogers \(2002\)](#) report that tax benefits from using derivatives (IR and currency) hedging increase a firm's market value by 1.1%. [Hagelin \(2003\)](#) finds a positive effect of FX hedging on firm value (Swedish firms). Other scholars also suggest that using derivatives hedging improves firm value. For example, [Gay et al. \(2011\)](#) state that using derivatives benefits shareholders by lowering IR spreads and argue that these firms are subject to less strict covenants in their loan agreements. In sharp contrast, [Clark et al. \(2006\)](#) do not find a relation between currency hedging and firm value (French firms). Taken together, the findings of these studies do not indicate a definitive impact of FX hedging on firm value.

Additionally, the existing literature examines the effect of hedging on firm value based primarily on a single industry. Unfortunately, the literature lacks consensus on the impact of hedging on firm value. For example, while [Tufano \(1996\)](#) examines corporate risk management activity in the North American gold mining industry and finds little empirical support for the notion that risk management maximizes shareholder value; [Carter et al. \(2006\)](#) show that the use of fuel hedging by US airline firms increases firm value by over 5% compared to non-hedging airline firms. Further, focusing on the oil and gas industry, [Jin and Jorion \(2006\)](#) find no relation between hedging and firm value, thus supporting [Tufano \(1996\)](#).

Other studies that examine the valuation effect of total derivatives (IR, FX, and COMM) across industries are based mainly on non-US data; however, their results nevertheless conflict. For example, [Bartram et al. \(2011\)](#), using international data from 47 countries, find only a weak relation between hedging and firm value. Similarly, [Ahmed et al. \(2010\)](#) use UK data for total derivatives and find mixed results. Contrarily, [Hagelin et al. \(2007\)](#), analyzing Swedish firms, find a positive relation between firm value and hedging. [Bartram et al. \(2009\)](#) use a sample of companies from 50 countries and report that IR hedging, but not FX hedging, is associated with firm value.

In sum, while previous studies examine the valuation effects of an individual component of derivatives, to the best of our knowledge, the existing literature largely ignores the effect of total derivatives on firm value based on the US data over a more extended period. Given the increasing use of derivatives by firms to manage risk, it is important to know the effect of total derivatives on firm value since the mechanism through which firm value may be affected is difficult to determine based on one type of derivative instrument or by focusing on one industry. Further, investigation based on a single year's data may yield misleading evidence. Therefore, we posit that considering data for multiple industries over several years has a much higher likelihood of producing more substantial evidence of the impact of the individual and total derivative hedging on firm value. Hence, we address the literature gap by first examining the effect of total derivatives and then by investigating the impact of individual derivatives on firm value in an *unconditional environment* for Fortune 500 US firms in a multi-year setting. In other words, based on the above arguments, we arrive at the following hypotheses.

H1: Total derivatives hedging is positively related to firm value.

H2: Individual derivatives (IR, FX, and COMM) hedging is positively related to firm value.

2.2. CEO compensation, hedging preferences, and firm value

We then examine the effect of derivatives on firm value conditional on CEO risk preferences, proxied by different components of CEO compensation contracts. The seminal [Jensen and Meckling \(1976\)](#) and [Jensen \(1986\)](#) discuss how stockholders design CEOs' compensation contracts to motivate risk-averse CEOs to take on more risk. [Smith and Stulz \(1985\)](#), [Tufano \(1996\)](#), and [Rajgopal and Shevlin \(2002\)](#) also show that by compensating CEOs through more option-like compensation contracts, shareholders incentivize CEOs to take on risky investment opportunities. Several researchers have recently established a strong relationship between CEO compensation structure and CEO risk-taking initiatives. For example, [Core and Guay \(1999\)](#) show that convex compensation or high vega (i.e., the sensitivity of equity compensation to stock return volatility) encourages CEOs to invest in value-increasing projects. [Coles et al. \(2006\)](#) show that high vega and low delta are positively associated with riskier policy choices. Complementing these studies, [Sundaram and Yermack \(2007\)](#) show that CEOs with more inside debt may decrease dividend payouts. [White \(2012\)](#) provides empirical support for this argument. Focusing on CEO inside debt holdings, [Cassell et al. \(2012\)](#) show that CEO inside debt exhibits negative risk-seeking behavior, proxied by the volatility of future stock returns, R&D expenditures, and financial leverage. On the other hand, inside debt encourages

CEOs to favor greater diversification in their asset liquidity decisions. [Caliskan and Doukas \(2015\)](#) complement these findings by showing that CEO inside debt holding is positively associated with the propensity to pay dividends.

2.2.1. Risk-averse behavior, CEO compensation, hedging probabilities

In this section, we formally obtain our theoretical framework of risk-averse behavior, CEO compensation, and hedging probabilities. Our theoretical framework shows that risk aversion makes CEOs more pessimistic than their actual subjective probabilities concerning firm value uncertainty. As a result, risk-averse CEOs are expected to hedge more than their risk-tolerant (i.e., seek-seeking) counterparts. Put differently, risk-averse CEOs exhibit less risk-seeking behavior for corporate decisions (i.e., more hedging) because of higher dispersion around their current managerial wealth. We predict that more risk-averse (risk-seeking) behavior is expected to be more (less) prevalent when the impact of uncertainty arising from foreign exchange, interest rate, and commodity hedging risks has a greater (lower) effect on CEOs' human capital value (wealth and reputation dispersion from current levels) in the executive labor market. This pattern occurs because firm exposure to foreign exchange, interest rate, and commodity hedging risks is perceived by risk-averse (risk-seeking) managers to have a higher (lower) adverse impact on their wealth and human capital reputation.

Let U represent the CEOs' utility function and W represents the manager's current state of wealth (reputation of human value). The likely corporate outcomes in good (G) and bad (B) states with a proportionate effect on manager wealth are W_g and W_b . The concave utility function $U(\cdot)$ of a risk-averse manager over related wealth levels is

$$U(pW_g + (1-p)W_b) > pU(W_g) + (1-p)U(W_b)$$

where $W_g > W > W_b$. E is the certainty equivalent of the CEOs' hedging decisions that satisfies

$$U(W + E)W_b > P_M U(W_g + (1-p)W_b)$$

Identifying the risk-neutral probabilities in our two-stage set up (W_g, W_b) implies that there is a probability z such that

$$W + E = z(W_g + E) + (1-z)(W_b + E)$$

$$W + E = z(W_g) + (1-z)W_b$$

with the solution as

$$z = [W + E - W_b] / (W_g + W_b) \quad (1)$$

Since the above satisfies the probability requirement $1 \geq z \geq 0$ and since for $z \geq 0$, the requirements are $(W - W_b)$, E and W_b be strictly positive, for $z \leq 1$, all that is required is E be not greater than $W_g - W$.

Risk aversion is factually equivalent to risk-neutral pessimism ([Backus, Chernov, & Martin \(2011\)](#), [Danthine and Donaldson \(2014\)](#), [Dumas and Luciano \(2017\)](#), [Heaton \(2018\)](#)). That is, the risk-neutral probability ($P_M > z$) is strictly less than the manager's subjective probability. Since E is the certainty equivalent of the expected utility of the outcome of the hedging,

$P_M U(W_g + (1 - P_M) U W_b)$, $U(P_M U(W_g + (1 - P_M) U W_b) > U(E)$ suggests that

$$E < P_M(W_g + (1 - P_M)U W_b)$$

$$P_M > [W + E - W_b] / (W_g + W_b) = z \quad (2)$$

That is, risk aversion makes a CEO act more pessimistically than his actual subjective-optimistic probabilities. Therefore, risk aversion can be a strong counterweight to induce a CEO to act as a well-calibrated but less risk-averse manager. It implies that as risk aversion declines or optimism increases, the risk-averse manager can act like a risk-seeking risk-neutral manager. This holds whenever

$$P_T < [W + E - W_b] / (W_g + W_b) < P_M$$

Prediction: This leads to the prediction that a risk-averse CEO may exhibit more risk-seeking behavior for hedging activity (i.e., engage in more hedging) with smaller dispersion around current CEO wealth than hedging with larger dispersion around current CEO wealth. This prediction implies that more risk-seeking (less hedging) occurs when foreign exchange, interest rate, and commodity risk have a lower impact on CEO wealth (i.e., CEO wealth is less sensitive to firm value). Similarly, more risk-averse behavior (more hedging) occurs when foreign exchange, interest rate, and commodity risk significantly impact CEO wealth (i.e., CEO wealth is more sensitive to firm value). Hence, the nature of CEO compensation contracts (incentive systems) can increase risk aversion (i.e., hedging activity) through high inside debt and delta (linear compensation packages), while they can increase risk-seeking behavior through convex (high vega) compensation contracts. These patterns occur because smaller-impact (larger-impact) uncertainty arising from foreign exchange, interest rate, and commodity risk have a low (high) impact on risk aversion, driving CEOs toward risk-seeking (risk-averse) behavior. That is, when foreign exchange, interest rate, and commodity risks cause low dispersion of current CEO wealth from future CEO wealth, the hedging intensity between risk-averse and risk-seeking CEOs is not expected to differ dramatically. On the other hand, when large foreign exchange, interest rate, and commodity risks cause high dispersion of current CEO wealth from future CEO wealth, CEO risk-seeking behavior declines (hedging increases). That is, hedging decisions have a direct cost

for firms and implicit costs for CEOs in the form of forced departures. It may also lead to an extremely low probability of a CEO finding a comparable position in another company. In sum, to the extent that firm value is not significantly affected by foreign exchange, interest rate, and commodity risks, risk-averse and risk-seeking CEOs are less likely to exhibit dramatically different hedging intensities.

Based on the above arguments, we first analyze how the total delta and total vega of CEO compensation affect the relationship between hedging and firm value. Guay (1999) and Rogers (2002) find that vega is negatively associated with hedging, while Knopf et al. (2002) and Coles et al. (2006) report that delta is positively associated with hedging. Second, we analyze the potential effects of CEO stock ownership on the relationship between hedging and firm value. If a stock portfolio has a linear payoff function, then the presence of stock equity in the CEO's total compensation portfolio increases the undiversifiable component of CEO wealth, and thus the CEO has an incentive to hedge more. In line with this argument, Rogers (2002) and Stulz (1996) find that firms run by CEOs with higher stock ownership engage in more hedging.

In sum, the findings of these studies suggest that CEO compensation contracts designed to encourage risk-taking (risk-averse) behavior directed towards value creation are less likely to be effective in the context of derivatives hedging. This leads to our third hypothesis:

H3: Market value sensitivities to derivatives hedging are unlikely to vary across CEOs with different compensation-inducing risk preferences.

Following the previous discussion, since high cash compensation increases the undiversified component of a CEO's total compensation portfolio, CEOs with high cash compensation are expected to hedge more. Therefore, we analyze the effect of CEO cash compensation on the relation between hedging and firm value. Finally, we examine whether CEO inside debt compensation influences the relationship between hedging and firm value. Inside debt is defined as the sum of CEO deferred compensation and pension benefits. Higher inside debts make the CEOs more risk-averse since it could jeopardize CEOs' post-retirement compensation. In line with this view, Sundaram and Yermack (2007), Edmans and Liu (2011), and Wei and Yermack (2011) show that high levels of CEO inside debt are associated with less risk-taking decisions and implementation of conservative firm-level policies. In the context of our study, CEOs with higher inside debt compensation are expected to hedge more. Taken together, we posit the following hypotheses:

H4: Firms run by risk-averse (risk-seeking) CEOs are expected to hedge more (less) with total derivatives, resulting in greater (lower) firm value.

H5: Firms run by risk-averse (risk-seeking) CEOs are expected to hedge more (less) with individual IR, FX, and COMM derivatives, resulting in greater (lower) firm value.

3. Sample selection and data

3.1. Data sources and description

Our sample consists of Fortune 500 companies. We selected the Fortune 500 list of companies for two reasons. First, most Fortune 500 companies are large and more likely to use derivatives compared to smaller firms since derivatives usage is costly (Nance et al., 1993; Bodnar et al., 1995; Hentschel and Kothari, 2001; Graham and Rogers, 2002). Second, the Fortune 500 list encompasses companies from a wide array of industries, thus negating any industry bias. Consistent with the literature, we use Tobin's Q as the main dependent variable to proxy for firm value (Allayannis et al., 2001; Allayannis et al., 2012). Tobin's Q is defined as the ratio of total assets minus book value of shareholder equity plus the market value of equity to book value of assets. Our main independent variable is the total notional derivative.

The initial sample consists of 500 companies, from which commercial banks, diversified financials, and securities and insurance companies are excluded since their purpose in using derivatives is entirely different (mainly speculation) from that of nonfinancial firms (mainly hedging risk). This reduces the sample size to 434 companies, for which we obtain Tobin's Q over a period of five years. Gross notional derivative information (our main independent variable) is obtained from the Mergent Online database, which provides 10-K data for all 434 companies from 2008 to 2012. The five-year sample period yields 2170 firm-year observations. To search for derivatives, we use the terms *hedge*, *notional*, *swaps*, *foreign currency*, and *forwards*. We use the notional value of derivatives from 10-K information as firm derivatives usage. Previous literature uses the fair value of derivatives as the dependent variable, but this approach is plagued by many problems.

First, the total notional quantity value of derivatives is the aggregate number a CEO has used for hedging and depicts the CEO's risk-taking preference. It also denotes the total price of the established hedge. Since the market value (fair value) of derivatives changes with the economy, this source is not reliable for evaluating a firm's total financial risk. Second, very few firms report fair value in their 10-K information; thus, using fair value would result in the loss of many observations. However, all firms reveal the total notional quantity value of derivatives in their 10-K data. Thus, firms that do not report the notional value of their derivatives in their 10-K (only fair values mentioned) are removed. In addition, private companies are excluded because they do not have public accounting data. Consistent with Geczy et al. (1997), firms involved in mergers and acquisitions during the five-year sample period are also removed from our sample. This reduces the sample to 350 firms with a total of 1630 firm-year observations.

We use the Thomson Reuters database and Google Finance as our main sources to obtain firm financial data. CEO managerial compensation information is obtained from the ExecuComp database and proxy statements. Ten of the 350 compa-

nies did not have appropriate exercised and non-exercised options data in the ExecuComp database, reducing the sample to 340 firms and a total of 1498 firm-year observations. Data for a CEO's past job qualifications/experience and education are obtained from proxy statements, 10-Ks, and the website www.nndb.com. We could not find appropriate experience information for eight CEOs, bringing the total sample to 332 firms, with 1446 firm-year observations. These 332 firms have used derivatives for COMM price fluctuations (COMM futures and swaps), IR risk (IR swaps and locks), and FX risk (FX forwards and futures). In 10-Ks, firms separately report derivatives used for hedging and those used for trading or speculation. We include only companies that use derivatives for hedging purposes.

Additionally, for some companies using COMM derivatives, the 10-K information includes the notional quantity of COMM hedging rather than a dollar amount. For example, firm A hedges 10 million BTU of natural gas and 45 million barrels of crude oil. In this case, to determine the number of derivatives, we multiply the total notional quantity hedged by the underlying price of the asset at that time. In addition, some companies mention the total number of contracts in their 10-Ks. In such cases, to obtain the notional quantity, we multiply the number of contracts by the total contract unit from the CME website⁴ and the underlying price at that time. In the case of foreign currency forwards and futures, all values are converted to dollar values using the exchange rate at the time of initiation of the contract.

3.2. Econometric methodology

We first perform a pooled OLS regression analysis without the effect of CEO compensation variables to examine whether using total derivative is associated with a higher firm value proxied by Tobin's Q. We then replicate the regression analysis with IR, FX, and COMM derivatives and determine how each derivative instrument affects firm value. Following previous studies (Junior and Laham, 2008; Ahmed et al., 2010; Allayannis et al., 2012; and Marami and Dubois, 2013), we control for time and industry fixed effects.

Since only firms with specific characteristics use derivatives, it may lead to self-selection bias. To resolve this problem, we deconstruct our primary independent variable into its predicted and excess components. This procedure was first applied by Shen and Zhang (2013) to address the endogeneity problem using a two-stage estimation procedure. Specifically, in the first stage, we regress derivatives on firm factors known to affect firm hedgings, such as R&D investment, leverage, and firm size, as in previous studies (Geczy et al., 1997; Graham and Rogers, 2002). In the second stage, the estimated excess derivative values from the first stage are used as independent variables to identify their effect on firm value. This approach mitigates the endogeneity problem.⁵ We also control for endogeneity using the two-stage least square (2SLS) regression by employing foreign currency debt and net operating loss carryforwards as instrumental variables for the derivatives variable (Hagelin et al., 2007).

After the unconditional test, we analyze the effect of derivatives on firm value in a conditional setting to find the impact of hedging on firm value subject to CEO risk preferences. Here we split the CEO compensation variables by their median values and define a CEO risk preference variable as high if it is above the median. Consistent with the literature, we define risk-seeking CEOs as having high vega and risk-averse CEOs as having high cash compensation, high equity compensation, high delta, and/or high inside debt compensation. We run five pooled OLS regressions, one for each risk preference variable: high CEO compensation total vega (risk-seeking), high CEO compensation total delta (risk-averse), high cash compensation (risk-averse), high CEO share ownership (risk-averse), and high CEO inside debt (risk-averse). We replicate this approach separately for total, IR, FX, and COMM derivatives.

3.3. Variable descriptions

Dependent variables

Our primary dependent variable is Tobin's Q, a proxy for firm market value. Consistent with Allayannis et al. (2012), we calculate Tobin's Q as the ratio of total assets minus book value of shareholder equity plus the market value of equity to book value of assets. In line with Allayannis and Weston (2001), we use the natural logarithm of Tobin's Q.

Independent variables -

We use the total notional quantity of derivatives used for hedging scaled by the total book value of assets (*Total Deriv/Assets*) as our primary independent variable. We also examine how individual derivatives, that is, IR derivatives (*IR/Assets*), FX derivatives (*FX/Assets*), and COMM derivatives (*COMM/Assets*) affect firm value. Total derivatives consist of COMM derivatives (forwards and futures), IR derivatives (futures, forwards, and swaps), and FX currency derivatives (futures, forwards, and swaps).

CEO risk preference variables (vega and delta of option and stock portfolios) -

We calculate the vega and delta of CEO stock option portfolios using the approach of Core and Guay (2002). They separately calculate the option grants for the current year and previous years. For current-year option grants, we collect data for CEOs' numbers of options from the ExecuComp database. The exercise price and time-to-maturity variables for current-year option grants are obtained from ExecuComp. Other variables required to estimate vega and delta, such as stock price, volatil-

⁴ www.cme.com

⁵ See, Caliskan and Doukas (2015) for using this procedure on a different corporate policy decision.

ity, interest rate, and dividend yield, are collected from proxy statements and 10-K reports. Consistent with the literature, the Black–Scholes (1973) option valuation formula is used to calculate the option price (Knopf et al., 2002; Rogers, 2002). ExecuComp provides exercisable and un-exercisable option values for previously granted options, but not the exercise price or time to maturity values. The Core and Guay (2002) approach is used to approximate time to maturity and exercise price. We calculate the vega and delta of the exercisable and un-exercisable options separately. A detailed explanation of the calculation of delta and vega is provided in Appendix B. Total vega of an options portfolio (vega) would be the sum of the vega of the current-year option portfolio and the vega of the previous year's exercisable and un-exercisable options. Total delta (delta) would be the sum of the delta of the current year options, the previous year's exercisable and un-exercisable options, and the sum of the delta of the stock portfolio. Finally, we multiply vega and delta by the total number of options to obtain the vega and delta of the entire CEO option portfolio. The previously described procedure is used to calculate the vega and delta for each year of the sample period.

After calculating CEO total delta and vega, we obtain the other three compensation variables—CEO stock compensation (*Shares*), CEO cash compensation (*Cash*), and CEO inside debt compensation (*Indebt*) variables – from the ExecuComp database. We then split our sample into risk-averse and risk-seeking CEOs. CEOs are defined as risk-seeking when their vega exceeds the median vega value and as risk-averse when their delta, share compensation, cash, and inside debt compensation are above the corresponding median values.

Control variables -

We follow previous scholarly works to add several control variables. The literature shows that firm size influences firm value (Peltzman, 1977; Mueller, 1987), but the results are ambiguous (Jin and Jorion, 2006). In line with previous studies, we use the logarithm of total assets (*Log Assets*) to control for firm size and expect a positive relation between firm size and firm value since larger firms hedge more with derivatives. We use the Quick Ratio (Quick ratio) to control for firm liquidity conditions and expect a positive relationship between this ratio and firm value (Rossi and Laham, 2008). To control for firm profitability, we use lagged free cash flow scaled by assets (*Lag FCF/Assets*). Firms with high free cash flow should be more profitable in the long run and have higher firm value (Jensen, 1986). We also use dividend yield (*Dividend Yield*) as a control variable and expect its sign to be either positive or negative. Previous studies on the valuation effect of dividend yields are contradictory. On the one hand, since a higher dividend yield is associated with better prospects, it should result in a higher valuation (Rossi and Laham, 2008). However, on the other hand, if the firm has a higher yield, it is less likely to be constrained and thus has a lower valuation (Allayannis and Weston, 2001).

The relationship between leverage and firm value is contradictory in the literature. Lang et al. (1996) and Servaes (1996) state that highly levered firms have higher Tobin's Q because they are most likely to undertake projects with a positive net present value, while Allayannis and Weston (2001) and Allayannis et al. (2012) find a negative relation between firm value and leverage. Therefore, we also expect the impact of the leverage variable on firm value to be either positive or negative. We use debt ratio (*Debt/Assets*) to proxy for firm leverage, following Bartram et al. (2011) and Ahmed et al. (2010). Following the literature (Allayannis and Weston, 2001; Rossi and Laham, 2008; Ahmed et al., 2010; Allayannis et al., 2012), we control for firm investment opportunities by using capital expenditures to assets (*Capex/Assets*) and R&D expenses to assets (*R&D/Assets*). We expect a positive relationship between these variables and firm value (Yermack, 1996). We also use foreign sales to total sales (*Foreign/Total Sales*) to control for geographic diversification. The relation between geographic diversification and firm value is conflicting. Doukas and Travlos (1988) show that geographic diversification through foreign mergers and acquisitions benefits firm value, especially for firms without prior foreign operations. Similarly, Morck and Yeung (1992) and Bodnar and Weintrop (1997) show that firms with high foreign sales have higher firm value. However, Dennis et al. (2002) find that geographic diversification reduces firm value. We use insider ownership (*Insider ownership*) to control for managerial entrenchment, which could cause a decrease in firm value since block-holders might work for themselves rather than for the shareholders (Faleye, 2007). We expect a negative relation between firm value and the insider ownership variable.

4. Results

4.1. Univariate results

Table 1 reports descriptive statistics of the variables used in the analysis. The average firm in our sample has a Tobin's Q of 2.87. This value is comparable to the average found in the literature. Bartram et al. (2011) report a Tobin's Q of 2.154, while Allayannis et al. (2012) and Allayannis and Weston (2001) report Tobin's Q values of 1.976 and 1.18, respectively. Examining our primary independent variable, we find that mean hedging amounts to only 10% of the total assets. This result is consistent with the evidence of Guay and Kothari (2003) that a firm's risk management program through derivatives hedging represents a small portion of the firm's total asset value. When we consider each derivatives component separately, we find that mean IR derivatives represent 5% of total assets, while mean FX and COMM derivatives represent 4% and 0.8%, respectively. As expected, the mean value of total assets is high (\$2.691 billion) since our sample firms are Fortune 500 companies. Examining R&D expenditure scaled by total assets and capital expenses scaled by asset value, we find both to be lower (1.44% and 7.25%, respectively), suggesting that firms in our sample invest only a minuscule amount in R&D and capital expenses.

Table 1
Summary statistics

Variable	Mean	Std Dev	Min	Max
Inside Debt (millions)	8.878	0.199	0	232.6
Idiosyncratic Risk	0.02	0.0122	0	0.114
Total Cash Compensation (millions)	1.494	0.022	0	0.31
Total Option comp value (Current, exercisable& un-exercisable options-in millions)	2.33	11.39	0	218
Delta of CEO Compensation (millions)	10.39	180.9	0	5275
Vega of CEO Compensation (millions)	4.768	123.3	0	4195
CEO Age (in years)	56.18	6.255	37	85
Tobin's Q	2.87	17.43	-	32.66
			4.43	
CEO Stock Compensation (millions)	543.99	0.7444	0	1179
Debt to Assets ratio	0.468	1.920	0	47.89
Total sales (billions)	2.01	3.089	0	26.50
Total assets (billions)	2.691	5.860	0	79.78
R&D Expense-scaled by Assets	0.0144	0.0361	0	0.399
Capital Expenditures- scaled by Assets	0.0725	0.245	0	4.588
Total Derivatives- scaled by AssetsInterest rate derivatives- scaled by AssetsFX derivatives- scaled by AssetsCommodity derivatives- scaled by Assets	0.1000.050.040.008	0.180.0010.080.05	0000	0.700.6360.670.56
Dividend Yield	0.0124	0.0182	0	0.146
Quick Ratio	0.946	0.819	0	7.568
Insider Ownership	0.0101	0.0627	0	1

This table reports the summary statistics of the variables used in the analysis based on firm-year data over the sample period 2008–2012. The sample excludes firm-year observations with missing values and firms that are utility and financial firms (SIC code between 4900–4999 and 6000–6999). Inside debt is the total pension and deferred compensation of CEO compensation. Total derivatives are the sum of total notional values of interest rate, commodity, and currency contracts. Idiosyncratic risk is the standard deviation of stock returns. Total observations are 1446. For a detailed description of variables see Appendices C and D.

Next, focusing on the CEO compensation variables, we observe that the mean CEO vega and delta of total CEO compensation are \$4.768 million and \$10.39 million, respectively, while the average CEO inside debt compensation is \$7.878 million. Average stock compensation is approximately \$533 million, suggesting that most of the CEO wealth in our sample is undiversified, with most CEOs' equity tied to the fortunes of their respective firms.

Table 2 shows the total mean notional quantity of derivatives by year. The total notional derivatives usage increased from 2008 to 2012, suggesting that firms have increased their hedging in recent years. Total IR derivatives represent 50.7% of total derivatives, while FX derivatives correspond to 41.25% of total derivatives. These findings further justify the inclusion of IR derivatives in our total derivatives sample rather than focusing only on FX or COMM derivatives, as is the case in most previous studies (Tufano, 1996; Allayannis et al., 2001; Beber and Fabbri, 2012).

4.2. Multivariate results

4.2.1. Unconditional setting

Previous studies on the effect of hedging on firm value find conflicting results on the impact of derivatives on firm value. For example, Carter et al. (2006) find a positive relationship between derivatives hedging and firm value for the airline industry. However, Jin and Jorion (2006) find no difference in firm value for hedgers and non-hedgers. More recently, based on a multi-year study of UK data, Ahmed, Azevedo, and Guney (2014) show substantial variation in the effect of using derivatives for hedging, which depends on the types of derivatives instruments used. Therefore, to resolve the previous conflicting findings, we examine the effect of using derivative instruments on firm value, proxied by Tobin's Q.

Table 3a reports the pooled OLS regression results for effect on firm value from total derivatives hedging and individual derivatives. The first column shows the regression results where the primary independent variable is total derivatives scaled by assets (*Total Deriv/Assets*). The second column displays the regression results where the independent variable is IR derivatives scaled by assets (*IR/Assets*). The third column reports the results where the primary independent variable is FX derivatives scaled by total assets (*FX/Assets*). The final column reports the regression results using COMM derivatives scaled by assets (*COMM/Assets*) as the primary independent variable. Analyzing the regression results in Model 1, we find that, consistent with previous evidence that uses non-US data (Ahmed et al., 2010; Bartram et al., 2011), *Total Deriv/Assets* does not have a statistically significant effect on firm value. To further analyze the validity of this result, we examine the association between each type of derivative (IR, FX, and COMM) and firm value. These results, reported in Models 2 through 4 of Table 3a, indicate that none of the individual derivatives are statistically significant in predicting firm value, suggesting that derivatives usage does not increase firm value. Specifically, this evidence is inconsistent with the results of previous studies using only currency (FX) derivatives (Allayannis and Weston, 2001; Allayannis et al., 2012), which report a positive relation between firm value and FX hedging. However, our results are comparable with the findings of Tufano (1996) and Jin and Jorion (2006), who, using only COMM derivatives, find no relation between derivatives usage and firm value.

Table 2
Notional of total derivatives broken down by year

Year	No. obs.	Interest rate (IR)	Commodity (COMM)	Foreign exchange (FX)	Total mean derivatives (In millions)	Derivatives/ Assets
2008	274	948.04 (58.68%)	104.62 (6.48%)	562.93 (34.84%)	1615.59	0.08
2009	293	1592.59(51.3%)	93.68 (2.85%)	1415.22 (45.8%)	3101.49	0.1
2010	294	1702.71(45.18)	183.75 (2.7%)	1614.23 (43.37%)	3500.7	0.11
2011	295	2186.68 (58.11%)	165.45 (9.39%)	1315.56 (32.5%)	3667.69	0.108
2012	290	1696.87(40.23%)	399.45 (10.1%)	2087.66 (49.76%)	4183.98	0.109

This table reports the total mean notional quantity of derivatives broken down by year (from 2008 to 2012). The three types of derivatives included here are the interest rate derivatives, commodity derivatives, and foreign exchange derivatives. All derivative values are in millions. In parentheses is the percentage of a specific derivative relative to total hedging.

Table 3a
Effect of Total Derivatives, and individual derivatives (IR, FX, and COMM) on firm value (unconditional setting)

VARIABLES	DV = Log (Tobin's Q)			
	(1)	(2)	(3)	(4)
Total Deriv/Assets	0.027 (0.036)			
IR/AssetsFX		0.021 (0.037)		
FX/Assets			-0.194 (0.182)	
COMM/Assets				-0.407 (0.453)
R&D/Assets	0.225 (0.762)	0.227 (0.762)	0.245 (0.762)	0.186 (0.763)
Capex/Assets	0.0235 (0.082)	0.0235 (0.082)	0.0241 (0.082)	0.0234 (0.082)
Debt/Assets	0.167*** (0.021)	0.167*** (0.021)	0.166*** (0.021)	0.166*** (0.021)
Log (Assets)	-0.0775*** (0.022)	-0.0775*** (0.022)	-0.0779*** (0.022)	-0.0779*** (0.022)
Div Yield	4.102*** (1.137)	4.110*** (1.137)	4.126*** (1.136)	4.123*** (1.137)
Foreign/Total Sales	0.337*** (0.082)	0.336*** (0.082)	0.330*** (0.082)	0.333*** (0.082)
Lag FCF/Asset	0.078 (0.084)	0.0764 (0.084)	0.0790 (0.084)	0.0757 (0.084)
Quick ratio	0.107*** (0.028)	0.108*** (0.028)	0.111*** (0.026)	0.109*** (0.028)
Insider ownership	-0.310 (0.266)	-0.309 (0.266)	-0.307 (0.266)	-0.301 (0.266)
Constant	1.459** (0.585)	1.461** (0.585)	1.498** (0.586)	1.473** (0.585)
Year FEIndustry FEObservations	YY1,439	YY1,439	YY1,439	YY1,439
R-squared	0.502	0.502	0.503	0.502

This table reports pooled OLS regression results of firm value (log (Tobin's q) on total derivatives hedging and individual derivatives (IR, FX, and COMM). Column (1) shows the regression where the main independent variable is Total Derivatives/assets (Total Deriv/Assets). Column (2) shows the regression where the independent variable is Interest rate derivatives scaled by assets (IR/Assets). Column (3) reports regression where our main independent variable is foreign exchange derivatives scaled by total assets (FX/Assets). Finally, Column (4) shows a regression where we use Commodity derivatives scaled by assets (COMM/Assets) as our main variable. The symbols ***, **, and * stand for statistical significance based on two-sided tests at the 1, 5, and 10% levels, respectively. The coefficients of the intercepts are suppressed. Standard errors are in parentheses. For a detailed description of the variables, see Appendices C and D.

To further establish the validity of our main findings, in Table 3b, we present the regression results with firm fixed effects to control for firm-level factors that do not vary over time. The results are consistent with our baseline model.

One may argue that the extent of hedging using derivatives and firm value are jointly determined. In that case, the parameter estimates from the OLS regression will be biased, as the regressors are endogenously determined along with the dependent variable. Therefore, we control for endogeneity using the Shen and Zhang (2013) method, where the main variable is decomposed into its predicted and excess components. In the first stage, we regress derivatives on firm factors known to affect hedging, such as R&D investments, leverage, and firm size (Geczy et al., 1997; Graham and Rogers, 2002), as shown in Table 4. In the second stage, we take the excess values from the first stage and use them as independent variables to estimate their effect on firm value. Consistent with our previous findings, the results presented in Table 5 demonstrate that total and individual hedging derivatives have no significant impact on firm value, even when we control for endogeneity.

Table 3b

Effect of Total Derivatives, and individual derivatives (IR, FX, and COMM) on firm value (unconditional setting) considering firm fixed effect

VARIABLES	<i>DV = Log (Tobin's Q)</i>			
	(1)	(2)	(3)	(4)
Total Deriv/Assets	0.011 (1.30)			
IR/Assets		-0.001 (-0.36)		
FX/Assets			0.172 (1.34)	
COMM/Assets				-0.228 (-1.56)
<i>R&D/Assets</i>	-1.804 (-1.44)	-1.816 (-1.45)	-1.844 (-1.47)	-1.785 (-1.43)
<i>Capex/Assets</i>	-0.019 (-0.19)	-0.021 (-0.21)	-0.020 (-0.20)	-0.017 (-0.18)
<i>Debt/Assets</i>	0.050** (2.29)	0.046** (2.02)	0.049** (2.24)	0.046** (2.10)
<i>Log (Assets)</i>	-0.082 (-1.57)	-0.091* (-1.74)	-0.090* (-1.73)	-0.089* (-1.71)
<i>Div Yield</i>	1.663 (1.63)	1.646 (1.61)	1.652 (1.62)	1.594 (1.56)
<i>Foreign/Total Sales</i>	-0.269** (-2.33)	-0.260** (-2.25)	-0.254** (-2.20)	-0.262** (-2.28)
<i>Lag FCF/Asset</i>	0.183* (1.78)	0.182* (1.77)	0.181* (1.75)	0.174* (1.69)
<i>Quick ratio</i>	0.007 (0.20)	0.009 (0.26)	0.007 (0.22)	0.009 (0.28)
<i>Insider ownership</i>	-0.164 (-0.88)	-0.166 (-0.90)	-0.168 (-0.90)	-0.166 (-0.89)
<i>Constant</i>	1.931 (-1.61)	2.104* (1.75)	2.078* (1.73)	2.059* (1.72)
Year FE	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y
Observations	1,439	1,439	1,439	1,439
R-squared	0.8428	0.8425	0.8428	0.8429

This table reports pooled OLS regression results of firm value (log (Tobin's q) on total derivatives hedging and individual derivatives (IR, FX, and COMM) after considering firm fixed effect. Column (1) shows the regression where the main independent variable is Total Derivatives/assets (Total Deriv/Assets). Column (2) shows the regression where the independent variable is Interest rate derivatives scaled by assets (IR/Assets). Column (3) reports regression where our main independent variable is foreign exchange derivatives scaled by total assets (FX/Assets). Finally, Column (4) shows a regression where we use Commodity derivatives scaled by assets (COMM/Assets) as our main variable. The symbols ***, **, and * stand for statistical significance based on two-sided tests at the 1, 5, and 10% levels, respectively. The coefficients of the intercepts are suppressed. Standard errors are in parentheses. For a detailed description of the variables, see Appendices C and D.

We also find that the debt ratio (*Debt/Assets*) has a positive sign and is statistically significant at the 1% level (Lang and Stulz, 1996; Servaes, 1996; Allayannis et al., 2012), suggesting that firms in financial distress are more likely to undertake riskier projects. The sign of the Quick Ratio (*Quick ratio*) is positive and statistically significant in line with the literature (Nance et al., 1993). Foreign sale (*Foreign Sales/Total Sales*) is positive and statistically significant at the 1% level, indicating that firms with high levels of international sales are associated with higher valuations (Morck and Yeung, 1992). To control for firm profitability, we use lagged free cash flow scaled by assets (*Lag FCF/Assets*). This profitability measure is not statistically significant, implying that free cash flow does not affect firm value. The total assets variable (*Log Assets*) is significant with a negative sign, implying that larger firms have a lower value compared to smaller firms. This evidence is consistent with the results of Warner (1977) and O'Brien and Bhushan (1990). The dividend yield (*Dividend Yield*) variable is positive and statistically significant at the 1% level, indicating that firms that pay more dividends have higher valuations.

In sum, the evidence shows that neither *H1* nor *H2* gains significant support in predicting a firm value in an unconditional setting for any individual or total derivatives hedging. Our results are robust to endogeneity tests using the Shen and Zhang (2013) and 2SLS methods.⁶

4.2.2. Conditional setting: CEO risk preferences

The literature on corporate hedging suggests that CEO risk preferences influence the extent to which CEOs hedge (Smith and Stulz, 1985; Tufano, 1996; Guay, 1999). Since risk-averse CEOs are more likely to hedge compared to their risk-seeking counterparts, and the value of firms that hedge using foreign currency derivatives is likely to be higher (Allayannis and Weston, 2001; Carter, Rogers, and Simkins, 2005), this strand of the literature suggests that hedging by risk-averse CEOs

⁶ Our 2SLS results are available upon request.

Table 4
Addressing for Endogeneity

VARIABLES	Total Deriv/Assets (1)	IR/Assets (2)	FX/Assets (3)	COMM/Assets (4)
R&D/Assets	-0.068 (0.602)	-0.253 (0.586)	0.146 (0.119)	-0.078 (0.048)
Debt/Assets	0.003 (0.016)	0.006 (0.016)	-0.002 (0.003)	-0.001 (0.001)
Capex/Assets	0.156*10 ⁻⁴ (0.064)	-0.003 (0.063)	0.004 (0.013)	0.174*10 ⁻⁴ (0.005)
Foreign/Total Sales	-0.023 (0.060)	-0.014 (0.059)	-0.010 (0.012)	-0.003 (0.005)
Log (Assets)	-0.005 (0.017)	-0.001 (0.017)	-0.003 (0.003)	-0.001 (0.001)
Div yield	1.070 (0.887)	0.882 (0.863)	-0.425*10 ⁻³ (0.175)	-0.007 (0.070)
NOLs/Assets	0.087 (0.313)	0.206 (0.304)	-0.086 (0.062)	-0.015 (0.025)
Constant	0.277 (0.458)	0.154 (0.446)	0.212** (0.091)	0.029 (0.036)
Year FEIndustry FEObservations	YY1,439	YY1,439	YY1,439	YY1,439
R-squared	0.216	0.213	0.353	0.409

This table reports regressions results based on the [Shen and Zhang \(2013\)](#) method to control for endogeneity and samples election bias. In Column (1), the dependent variable is Total Deriv/Assets. Similarly, in column (2), column (3), and column (4), the dependent variables are IR/assets, FX/assets, and COMM/Assets, respectively. The independent variables are taken from [Geczy et al. \(1997\)](#), [Nance et al. \(1993\)](#), and [Knopf et al. \(2002\)](#) which are known to affect hedging decisions. The symbols ***, **, and * stand for statistical significance based on two-sided tests at the 1, 5, and 10% levels, respectively. The coefficients of the intercepts are suppressed. Standard errors are in parentheses. For a detailed description of the variables, see Appendices C and D.

is likely to increase firm value. However, [Guay and Kothari \(2003\)](#) contradict this literature and argue that the benefits associated with derivatives are small compared to the resultant cash flows and changes in equity values. Therefore, to address this contradiction, we estimate the effect of derivatives on firm value conditional on CEO risk preferences. As before, we first examine the effect of total derivatives and then analyze the effects of IR, FX, and COMM derivatives separately on firm value.

In [Table 6](#), we report the effect of total derivatives hedging on firm value conditional on the five CEO risk preference measures. The results of Model 1 suggest that derivatives hedging by risk-seeking CEOs, measured by high vega compensation, does not affect firm value. Similarly, as shown in Models 2 through 5, firm value does not appear to be influenced by the hedging activities of risk-averse CEOs, as measured by high delta, high cash compensation, high share compensation, and high inside debt compensation, respectively. This evidence supports *H3*, which predicts that market value sensitivity to derivatives hedging for firms run by risk-averse or risk-seeking CEOs is unlikely to differ much. To ensure that our results are not endogenous, as before, we control for endogeneity following [Shen and Zhang \(2013\)](#) and report the results in [Table 7](#). The results remain unchanged after controlling for endogeneity. We also control for endogeneity using the 2SLS method, and our main results still hold.⁷ Collectively, the above results suggest that CEO compensation contracts designed to encourage risk-taking for the sake of value creation are ineffective in influencing CEO risk-taking behavior through derivatives hedging.

To complement the results in [Table 6](#) and [Table 7](#), we examine whether firm hedging intensity is influenced by CEO risk-taking behavior. Previous literature finds that hedging is positively associated with the level of CEO entrenchment ([Kumar and Rabinovitch, 2013](#)) and a corresponding decline in firm value ([Chang and Zhang, 2015](#)). Therefore, it is imperative to investigate the impact of a CEO compensation structure that induces risk-seeking on firm hedging intensity. [Table 8](#) shows that hedging intensity, measured through total derivatives scaled by firm assets, is similar for risk-seeking and risk-averse CEOs. Specifically, the results indicate that risk-seeking CEOs have a hedging intensity of 0.136. In contrast, on average, the four risk-averse CEO compensation measures show that risk-averse CEOs have a hedging intensity of 0.130. [Guay and Kothari \(2003\)](#), using 1998 hedging data for a sample of 234 large nonfinancial firms, find similar evidence without investigating the differences in hedging intensity between risk-averse and risk-seeking CEOs. This pattern in our findings provides new evidence in support of the view that the nature of compensation contracts and alternative measures used to capture CEO attitudes toward risk do not have a bearing on firm value, as has been argued in previous studies. The proximity of hedging intensity between risk-averse and risk-seeking CEOs suggests that CEOs view hedging more as an insurance policy than a value-increasing decision. In sum, our findings contradict the previously held notion that hedging affects firm value and varies with CEO risk preferences.

4.2.3. Market value sensitivity of firm derivatives portfolios

Recent research on the relationship between hedging and firm value provides mixed support for the value-maximization proposition. For example, [Graham and Rogers \(2002\)](#) find that derivative-induced debt-capacity is positively associated with firm value. On a similar note, [Nance et al. \(1993\)](#) and [Geczy et al. \(1997\)](#) show that hedging firms have more growth oppor-

⁷ Results available upon request.

Table 5
Effect of total Derivatives & IR, FX and COMM derivatives on firm value (Unconditional setting): Addressing for Endogeneity

VARIABLES	<i>DV = Log (Tobin's Q)</i>			
	(1)	(2)	(3)	(4)
Excess_Deriv	0.0278 (0.036)			
IR_Excess		0.0227 (0.0369)		
FX_Excess			-0.210 (0.182)	
COMM_Excess				-0.424 (0.453)
R&D/Assets	0.224 (0.762)	0.222 (0.762)	0.221 (0.762)	0.220 (0.762)
Capex/Assets	0.023 (0.082)	0.023 (0.082)	0.023 (0.082)	0.023 (0.082)
Debt/Assets	0.167*** (0.021)	0.167*** (0.021)	0.167*** (0.021)	0.167*** (0.021)
Log (Assets)	-0.078*** (0.022)	-0.078*** (0.022)	-0.0773*** (0.022)	-0.077*** (0.022)
Div yield	4.131*** (1.137)	4.128*** (1.137)	4.126*** (1.136)	4.126*** (1.136)
Foreign/Total Sales	0.337*** (0.082)	0.336*** (0.082)	0.332*** (0.082)	0.334*** (0.082)
Lag FCF/Asset	0.078 (0.084)	0.076 (0.084)	0.0790 (0.084)	0.076 (0.084)
Quick Ratio	0.107*** (0.028)	0.107*** (0.028)	0.111*** (0.029)	0.109*** (0.028)
Insider own	-0.310 (0.266)	-0.309 (0.266)	-0.307 (0.266)	-0.301 (0.266)
Constant	1.467** (0.585)	1.465** (0.585)	1.459** (0.585)	1.461** (0.585)
Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Observations	1,439	1,439	1,439	1,439
R-squared	0.502	0.502	0.503	0.502

This table reports pooled OLS regression results of firm value (\log (Tobin's q) on total derivatives hedging and individual derivatives (IR, FX, and COMM) after controlling for endogeneity using the Shen and Zhang (2013) method. Column (1) shows the regression where the main independent variable is Total Derivatives/assets (Total Deriv/Assets). Column (2) shows the regression where the independent variable is Interest rate derivatives scaled by assets (IR/Assets). Column (3) shows regression where the main independent variable is foreign exchange derivatives scaled by total assets (FX/Assets). Finally, column (4) reports a regression where we use Commodity derivatives scaled by assets (COMM/Assets) as our main variable. The symbols ***, **, and * stand for statistical significance based on two-sided tests at the 1, 5, and 10% levels, respectively. The coefficients of the intercepts are suppressed. Standard errors are in parentheses. For a detailed description of the variables, see Appendices C and D.

tunities than non-hedging firms. However, Jin and Jorion (2006) show that in the context of the oil and gas industry, hedging does not affect firm market value. Therefore, to resolve this apparent contradiction between the two strands of research, we examine the sensitivity of firm market value to using derivatives for hedging. To do this, we examine the market value sensitivity of derivatives portfolios by estimating the total sensitivity for an average firm's value in our sample based to extreme (three standard deviations) changes in the prices of the underlying assets—that is, FX rates (US dollar index), IRs (T-bills), and COMMs (Producer Price Index, or PPI, for fuel)—following Guay and Kothari (2003). Appendix A provides a detailed description of the methodology. Panel A of Table 9 shows that a three standard deviation change in the exchange rate increases an average firm's market value by \$302 million. Similarly, by examining IR exposure, we find that a three standard deviation change in T-bills increases the IR derivatives portfolio by \$3.3 billion. Finally, we find that the average firm's market-based sensitivity to a three standard deviation change in COMM prices is \$148 million. The sum of these values in response to a three standard deviation (extreme) change in the total derivatives portfolio value suggests that an average firm's market value increases by \$3.7 billion. This value is modest compared to the average value of total assets (13%) and total sales (19%) of the average firm in our sample. Overall, these results are consistent with the findings by Guay and Kothari (2003).

To complement these previous findings, we then examine changes in the sensitivity of the market value of derivatives for firms run by risk-averse and risk-seeking CEOs, separately. Panel B of Table 9 shows that an average firm's market-based exposure to a three standard deviation change in FX rates (US dollar index), IRs (T-bills), and COMMs (PPI for fuel) for firms run by risk-seeking CEOs increases the value of the derivatives portfolio by \$357 million, \$4.01 billion, and \$179 million, respectively. Combining the three derivatives portfolios, we observe that for a three standard deviation change in the value of underlying assets, the total derivatives portfolio of firms run by risk-seeking CEOs increases average firm value by \$4.57 billion. This number is modest relative to the total assets (12.8%) and total sales (21%) of the average firm in our sample.

Table 6
Effect of total derivatives on firm value conditional on CEO risk preferences

VARIABLES	DV = Log (Tobin's Q)				
	Risk-seeking (High vega) (1)	Risk-averse (High delta) (2)	Risk-averse (High Cash) (3)	Risk-averse (High Shares) (4)	Risk-averse (High InDebt) (5)
Deriv/Assets	0.030 (0.046)	0.039 (0.038)	0.027 (0.031)	0.043 (0.039)	0.021 (0.040)
R&D/Assets	-2.482** (1.260)	-2.831** (1.183)	-1.989** (0.994)	-3.543*** (1.198)	1.077 (1.185)
Capex/Assets	0.432** (0.187)	-0.152 (0.096)	-0.137 (0.090)	-0.140 (0.096)	-0.045 (0.096)
Debt/Assets	0.124*** (0.032)	0.202*** (0.025)	0.142*** (0.022)	0.184*** (0.025)	0.470*** (0.047)
Log (Assets)	-0.120*** (0.036)	-0.120*** (0.036)	-0.130*** (0.025)	-0.124*** (0.033)	0.034 (0.032)
Div yield	4.182** (1.891)	4.948*** (1.800)	4.347*** (1.332)	4.246** (1.767)	3.546** (1.676)
Foreign Sales	0.116 (0.123)	0.084 (0.124)	0.298*** (0.100)	0.018 (0.126)	-0.016 (0.129)
Lag FCF	0.833** (0.367)	1.317*** (0.344)	0.259 (0.189)	1.051*** (0.273)	-0.003 (0.101)
Quick ratio	0.202*** (0.042)	0.251*** (0.039)	0.072** (0.036)	0.219*** (0.042)	0.093** (0.047)
Insider own	-0.240 (0.324)	-0.207 (0.289)	1.301** (0.589)	0.255 (0.371)	0.243 (0.402)
Constant	3.289*** (0.923)	3.088*** (0.882)	2.906*** (0.629)	3.115*** (0.826)	-0.515 (0.774)
Year FEIndustry FEObservations	YY718	YY718	YY715	YY718	YY806
R-squared	0.553	0.542	0.658	0.542	0.530

This table reports pooled OLS regression results where the dependent variable is log (Tobin's q) and the main independent variable is Total derivatives/Assets. Each of the regression below is split up by the median value of each of the five CEO compensation variables (Total CEO vega, Total delta, Total Cash compensation, CEO Share Compensation, and CEO Inside Debt). All variables greater than the median value are termed "high". The risk preference variables are then divided into risk-seeking CEOs proxied by high vega (Column (1)), and risk-averse CEOs proxied by high delta (Column (2)), high cash compensation (Column (3)), high share compensation (Column (4)) and high inside debt (Column (5)). The symbols ***, **, and * stand for statistical significance based on two-sided tests at the 1, 5, and 10% levels, respectively. The coefficients of the intercepts are suppressed. Standard errors are in parentheses. For a detailed description of the variables, see Appendices C and D.

4.2.4. Derivatives' market value sensitivity for firms run by risk-averse CEOs

To complement our findings related to the market value sensitivity of derivatives portfolios, we investigate the market value sensitivity of the total derivatives portfolios of firms managed by risk-averse CEOs, proxied by high delta, high cash, high stock awards and high inside debt compensation. We report these results alongside those for risk-seeking CEOs in Panel B of Table 9. When we average the values for the four risk-aversion measures, a three standard deviation change in T-bills increases the IR derivatives portfolio by an average of \$4.664 billion. A three-standard deviation change in the dollar index increases firm value by \$393.754 million for the FX derivatives, and a three-standard deviation in the PPI of fuel (COMM index) increases the COMM derivatives portfolio by \$157.5 million. Finally, the total derivatives usage by risk-averse CEOs increases firm value by \$5.216 billion, or 13.2% in total assets, and by 20.5% in total sales. In sum, the total derivatives portfolios of firms run by risk-seeking and risk-averse CEOs increase firm value by only \$4.57 billion and \$5.216 billion, respectively, representing modest amounts relative to total assets and sales.

These results suggest that the risk management policies of risk-averse and risk-seeking CEOs are very similar and have only a small impact on firm value. The main implication of these findings, in combination with the similar hedging intensities of risk-averse and risk-seeking CEOs (0.12 and 0.11, respectively), is that hedging is not a value-maximizing strategy. Our findings also suggest that hedging policies do not vary significantly with CEO risk preferences and compensation packages designed to motivate risk-seeking behavior (i.e., engage in less hedging). In other words, our results suggest that compensation packages do not alter the inherent risk-averse attitude of CEOs concerning firm hedging. Overall, our multi-year evidence is inconsistent with the conventional belief, as well as with H4 and H5, that firms run by risk-averse (risk-seeking) CEOs are expected to hedge more (less) with total (individual) derivatives, resulting in greater (lower) firm value.

Thus far, we have investigated how the use of total derivatives affects firm value on an aggregate level in an unconditional setting as well as conditional on CEO risk preferences. We have also examined the effect of three different types of derivative instruments on firm value in an unconditional setting. We find no statistically significant effect of derivatives on firm value. To provide conclusive evidence for our findings, here we examine whether individual derivative instruments affect firm value in the presence of differential CEO risk preference.

Table 7

Effect of total derivatives on firm value conditional on CEO risk preferences after controlling for endogeneity.

VARIABLES	DV = Log (Tobin's Q)				
	Risk-seeking (High vega) (1)	Risk-averse (High delta) (2)	Risk-averse (High Cash) (3)	Risk-averse (High Shares) (4)	Risk-averse (High InDebt) (5)
Excess_Deriv	0.030 (0.046)	0.039 (0.038)	0.027 (0.031)	0.043 (0.039)	0.0214 (0.040)
R&D/Assets	-2.484** (1.260)	-2.834** (1.183)	-1.991** (0.994)	-3.546*** (1.198)	1.076 (1.185)
Capex/Assets	0.432** (0.187)	-0.152 (0.096)	-0.137 (0.090)	-0.140 (0.096)	-0.0450 (0.096)
Debt/Assets	0.124*** (0.032)	0.203*** (0.025)	0.142*** (0.022)	0.185*** (0.025)	0.470*** (0.047)
Log (Assets)	-0.130*** (0.036)	-0.130*** (0.036)	-0.140*** (0.025)	-0.124*** (0.033)	0.034 (0.0321)
Div yield	4.213** (1.890)	4.990*** (1.799)	4.375*** (1.331)	4.292** (1.766)	3.567** (1.674)
Foreign Sales	0.115 (0.123)	0.083 (0.124)	0.298*** (0.100)	0.017 (0.126)	-0.016 (0.129)
Lag FCF	0.833** (0.367)	1.317*** (0.344)	0.259 (0.189)	1.051*** (0.273)	-0.0028 (0.101)
Quick ratio	0.202*** (0.042)	0.251*** (0.039)	0.072** (0.036)	0.219*** (0.042)	0.093** (0.047)
Insider own	-0.240 (0.324)	-0.207 (0.289)	1.301** (0.589)	0.255 (0.371)	0.243 (0.402)
Constant	3.297*** (0.923)	3.097*** (0.881)	2.914*** (0.629)	3.125*** (0.826)	-0.507 (0.774)
Year FEIndustry FEObservations	YY718	YY718	YY715	YY718	YY806
R-squared	0.553	0.542	0.658	0.542	0.530

This table reports pooled OLS regression results where the dependent variable is log (Tobin's Q) and the main independent variable is Excess Derivatives/Assets variable. Each of the regression below is split up by the median value of each of the five CEO compensation variables (Total CEO vega, Total delta, Total Cash compensation, CEO Share Compensation, and CEO Inside Debt). All variables greater than the median value are termed "high". The risk preference variables are then divided into risk-seeking CEOs proxied by high vega (Column (1)), and risk-averse CEOs proxied by high delta (Column (2)), high cash compensation (Column (3)), high share compensation (Column (4)) and high inside debt (Column (5)). The symbols ***, **, and * stand for statistical significance based on two-sided tests at the 1, 5, and 10% levels, respectively. The coefficients of the intercepts are suppressed. Standard errors are in parentheses. For a detailed description of the variables, see Appendices C, and D.

Table 8

Hedging intensity of firms managed by risk-seeking and risk-averse CEOs.

	High vega CEOs (Risk-seeking) (1)	High delta CEOs (Risk-averse) (2)	High Cash CEOs (Risk-averse) (3)	High Shares CEOs (Risk-averse) (4)	High Inside Debt CEOs (Risk-averse) (5)
CEO Hedging intensity	0.136	0.133	0.130	0.125	0.115

This table reports the Hedging Intensity of firms managed by risk-averse and risk-seeking firms. Hedging intensity is measured based on the Total Derivatives/Assets ratio. The risk preference variables are then divided into risk-seeking CEOs proxied by high vega (Column (1)), and risk-averse CEOs proxied by high delta (Column (2)), high cash compensation (Column (3)), high share compensation (Column (4)) and high inside debt (Column (5)).

Recently, firms' involvement in interest rate hedging has received significant scholarly attention. However, there is no consensus on the reasons behind such hedging activity. While some scholars argue that interest rate risk management is driven primarily by speculation (Faulkender, 2005), others argue that such risk may be managed via both hedging and speculative motivations (Chernenko and Faulkender, 2011). Further, Ahmed, Azevedo and Guney (2014) show that interest rate risk hedging is negatively associated with firm financial performance but positively associated with hedging with a forward contract. The findings of these studies indicate that the effect of interest rate risk management on firm value may be conditional on the circumstances in which such hedging is used. Therefore, to complement these findings, we examine the valuation effects of individual derivatives hedging, conditional on CEO risk preferences, and report the results in Table 10. Consistent with the previously reported results, Model 1 shows that hedging through IR derivatives by risk-seeking CEOs does not affect firm value. In models 2 through 5, we observe a similar pattern for risk-averse CEOs. Therefore, these results confirm our previous findings that hedging by risk-averse CEOs does not affect firm value. As before, these results remain

Table 9

Market value sensitivities of firms' derivatives portfolios at the end of 2008

Panel A: Reports market value (MV) sensitivities for firms' total derivatives portfolios at end of the year 2008. Market value sensitivity is defined as the change in the annual market value resulting from each derivative security in the portfolio for a three-standard deviation annual change in the price of the underlying asset (i.e., change in exchange rates, interest rates, or commodity prices) and in aggregate. For a detailed explanation of the procedure first used by Guay and Kothari (2003) , see Appendix A.)						
Sensitivity of Derivatives (by type)	Change in firm value					
FX derivatives	\$302 million					
IR derivatives	\$3.3 billion					
COMM derivatives	\$148 million					
Total derivatives	\$3.7 billion					
Firm total assets (average)	\$29.7 billion					
Firm total sales (average)	\$19.9 billion					
Sensitivity of derivatives MV to total assets	13%					
Sensitivity of derivatives MV to total sales	19%					
Panel B: Reports market value (MV) sensitivities for firms' derivatives portfolio at the end of the year 2008. Market value sensitivity is defined as the change in the annual market value resulting from each derivative security in the portfolio for a three-standard deviation annual change in the price of the underlying asset (i.e., change in exchange rates, interest rates, or commodity prices) and in aggregate. For a detailed explanation of the procedure used by Guay and Kothari (2003) , see Appendix A.)						
Sensitivity Variables (in millions \$)	Risk -seeking (High vega)	Risk-averse (High delta)	Risk-averse (High Cash)	Risk-averse (High Shares)	Risk-averse (High InDebt)	Risk Averse (Average sensitivity)
	(1)	(2)	(3)	(4)	(5)	(6)
FX Derivatives	357	336	441	378	420	393.75
IR derivatives	4011	4400	5157	4600	4500	4664.25
COMM derivatives	179	201	140	200	89	157.50
Total Derivatives	4547	4937	5738	5178	5009	5215.5
Total Assets (average)	35600	37600	41500	3900	39600	
Total Sales (average)	21900	23400	26000	23800	27700	
Sensitivity of derivatives MV to total assets	12.80%	13.10%	13.80%	13.30%	12.60%	
Sensitivity of derivatives MV to total sales	21%	21%	23%	22%	19%	

unchanged when we control for endogeneity using the procedure of [Shen and Zhang \(2013\)](#) and the 2SLS instrumental variable approach.⁸

Collectively, the results obtained using IR derivatives are similar to those documented for total derivatives, i.e., IR hedging carried out by both risk-seeking and risk-averse CEOs does not affect firm value. Combining this result with the hedging intensity result reported in [Table 8](#), we can infer that derivatives hedging does not matter to firm value. Thus, it can be safely argued that CEO compensation contracts intended to motivate greater risk tolerance (less hedging) to increase firm value through derivatives hedging do not work.

Prior research on the effect of foreign currency derivatives on firm value indicates that currency derivatives do not generate consistent results. For example, [Allayannis and Weston \(2001\)](#) find a positive relationship between currency derivatives and firm value. However, [Pramborg \(2004\)](#) finds no valuation effect from currency derivatives in the context of Swedish firms. In sharp contrast, [Nguyen and Faff \(2004\)](#) show that using foreign currency derivatives for hedging reduces firm value for Australian firms. One may argue that a major concern related to these studies is that they do not consider CEO risk preferences. Therefore, to address this gap in the literature, we replicate the previous analysis by focusing on the valuation effect of FX derivatives conditional on CEO risk preferences. The results in [Table 11](#) demonstrate a similar pattern to that obtained for both total and IR derivatives hedging. As before, these results are robust to endogeneity tests using the method of [Shen and Zhang \(2013\)](#) and 2SLS.⁹

In the context of commodity hedging, the finance literature does not find a unanimous effect of commodity hedging on firm value. For example, while [Jin and Jorion \(2006\)](#) do not find a statistically significant relation between hedging and firm value for the oil and gas industry, [MacKay and Moeller \(2007\)](#) show that hedging can increase firm value in the case of oil refiners. In line with [MacKay and Moeller \(2007\)](#), [Carter et al. \(2006\)](#) also show a positive relationship between fuel hedging and firm value in the context of the airline industry. Their findings suggest an industry-specific effect of commodity hedging on firm value. Therefore, to extend the literature on the relationship between commodity hedging and firm value, we examine the valuation effect of COMM derivatives conditional on the CEO risk preference measures. We report the results in [Table 12](#). Consistent with previous findings, we document that COMM derivatives hedging does not affect firm value, regardless of the risk preference measures used to capture CEO risk-averse or risk-seeking behavior.

⁸ Results available upon request.

⁹ Results available upon request.

Table 10
The Effect of Interest rate derivatives (IR) on firm value conditional on CEO risk preferences

	DV = Log (Tobin's Q)				
	Risk-seeking (High vega)	Risk-averse (High delta)	Risk-averse (High Cash)	Risk-averse (High Shares)	Risk-averse (High InDebt)
VARIABLES	(1)	(2)	(3)	(4)	(5)
IR/Assets	0.015 (0.047)	0.034 (0.039)	0.026 (0.031)	0.041 (0.039)	0.015 (0.041)
R&D/Assets	-2.478** (1.260)	-2.833** (1.183)	-1.988** (0.994)	-3.540*** (1.199)	1.079 (1.185)
Capex/Assets	0.432** (0.187)	-0.152 (0.096)	-0.137 (0.090)	-0.140 (0.096)	-0.045 (0.096)
Debt/Assets	0.124*** (0.032)	0.202*** (0.025)	0.141*** (0.022)	0.184*** (0.025)	0.470*** (0.047)
Log (Assets)	-0.130*** (0.036)	-0.130*** (0.036)	-0.140*** (0.025)	-0.120*** (0.033)	0.034 (0.032)
Div yield	4.213** (1.892)	4.958*** (1.800)	4.354*** (1.332)	4.253** (1.767)	3.561** (1.675)
Foreign Sales	0.115 (0.123)	0.083 (0.124)	0.298*** (0.100)	0.016 (0.126)	-0.018 (0.129)
Lag FCF	0.833** (0.367)	1.319*** (0.344)	0.260 (0.189)	1.051*** (0.273)	-0.004 (0.101)
Quick ratio	0.202*** (0.042)	0.252*** (0.039)	0.072** (0.036)	0.220*** (0.042)	0.094** (0.047)
Insiders own	-0.238 (0.324)	-0.206 (0.289)	1.300** (0.589)	0.258 (0.371)	0.245 (0.402)
Constant	3.289*** (0.923)	3.093*** (0.882)	2.905*** (0.629)	3.116*** (0.826)	-0.511 (0.774)
Year FE	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y
Observations	718	718	715	718	806
R-squared	0.552	0.542	0.658	0.542	0.530

This table reports pooled OLS regression results where the dependent variable is log (Tobin's q) and the main independent variable is Interest rate derivatives/assets (**IR/Assets**). Each of the regression below is split up by the median value of each of the five CEO compensation variables (Total CEO vega, Total delta, Total Cash compensation, CEO Share Compensation, and CEO Inside Debt). All variables greater than the median value is termed "high" The risk preference variables are then divided into risk-seeking CEOs proxied by high vega (Column (1)), and risk-averse CEOs proxied by high delta (Column (2)), high cash compensation (Column (3)), high share compensation (Column (4)) and high inside debt (Column (5)). The symbols ***, **, and * stand for statistical significance based on two-sided tests at the 1, 5, and 10% levels, respectively. The coefficients of the intercepts are suppressed. Standard errors are in parentheses. For a detailed description of the variables, see Appendices C and D.

4.2.5. Alternative proxy for CEO risk preference

To further establish that our findings are robust to an alternative measure of CEO risk preference, we follow Serfling (2014) and use CEO age as an alternative proxy for CEO risk-taking behavior. Serfling (2014) finds that older CEOs invest less in R&D, diversify their firms, and lower the operating leverage of their firms. Older CEOs are also associated with lower stock return volatility of their firms. To re-establish that CEO hedging behavior is not conditional on CEO risk preference, we split our sample based on the median value of CEO age and re-run the regressions for total derivative and each component of derivative hedging. The results are presented in Table 13. Consistent with our findings based on CEO compensation as a proxy for CEO risk attitude, we find that hedging intensities are similar for risk-seeking and risk-averse CEOs. In sum, we provide multiple pieces of evidence that CEOs' risk preference does not impact derivatives hedging intensity.

4.2.6. Heterogeneity test

Finally, to strengthen our argument that derivative hedging does not impact firm value and to eliminate the concern that our findings are outcomes may be specific to the period of recession, we re-run our analyses by dividing the sample into 2008–2010 and 2011–2012. The results are presented in Table 14. The results indicate that both during and after the great recession, firm value is not affected either by total derivative (*Total Deriv/Assets*) or by each component of total derivative (i.e., *IR/Assets*, *FX/Assets*, and *COMM/Assets*, respectively). Therefore, we provide conclusive evidence that hedging does not impact firm value.

In sum, our results point out that neither unconditional derivatives hedging (total derivative hedging and individual derivative hedging instruments) nor derivatives hedging conditional on CEO risk preferences affect firm value. Thus, the evidence does not support the predictions of *H4* and *H5*. Our evidence suggests that hedging acts as insurance rather than a value-increasing strategy, regardless of CEO risk preferences. Interestingly, our evidence also points out that CEO compensation packages, structured to tilt managers' risk preferences in favor of risk-seeking behavior, fail to motivate less hedging. Put differently, compensation packages designed to motivate risk-seeking (less hedging) behavior do not seem to change the inherent risk-averse attitude of CEOs, as demonstrated by the similarity in the hedging intensities of risk-averse and risk-seeking CEOs.

Table 11

The Effect of Foreign Exchange derivatives (FX) on firm value conditional on CEO risk preferences.

	<i>DV = Log (Tobin's Q)</i>				
	Risk seeking (High vega)	Risk-averse (High delta)	Risk-averse (High Cash)	Risk-averse (High Shares)	Risk-averse (High InDebt)
VARIABLES	(1)	(2)	(3)	(4)	(5)
FX/Assets	-0.018	-0.239	0.024	-0.521*	-0.290
	(0.281)	(0.264)	(0.294)	(0.288)	(0.286)
<i>R&D/Assets</i>	-2.472*	-2.802**	-2.002**	-3.450***	1.120
	(1.261)	(1.184)	(0.995)	(1.197)	(1.185)
<i>Capex/Assets</i>	0.433**	-0.153	-0.138	-0.142	-0.043
	(0.187)	(0.096)	(0.090)	(0.096)	(0.096)
<i>Debt/Assets</i>	0.124***	0.202***	0.142***	0.184***	0.469***
	(0.032)	(0.025)	(0.022)	(0.025)	(0.047)
<i>Log (Assets)</i>	-0.130***	-0.130***	-0.14***	-0.12***	0.034
	(0.037)	(0.036)	(0.025)	(0.033)	(0.032)
<i>Div yield</i>	4.248**	5.055***	4.407***	4.390**	3.671**
	(1.889)	(1.799)	(1.332)	(1.763)	(1.675)
<i>Foreign Sales</i>	0.114	0.075	0.296***	-0.001	-0.036
	(0.124)	(0.124)	(0.10)	(0.126)	(0.130)
<i>Lag FCF</i>	0.834**	1.338***	0.259	1.067***	-0.003
	(0.368)	(0.345)	(0.190)	(0.272)	(0.101)
<i>Quick ratio</i>	0.203***	0.257***	0.073**	0.231***	0.099**
	(0.042)	(0.040)	(0.036)	(0.043)	(0.047)
<i>Insider own</i>	-0.238	-0.201	1.304**	0.308	0.270
	(0.324)	(0.289)	(0.589)	(0.371)	(0.403)
<i>Constant</i>	3.289***	3.095***	2.912***	3.087***	-0.460
	(0.925)	(0.882)	(0.630)	(0.825)	(0.775)
IndustryYearObservations	YY718	YY718	YY715	YY718	YY806
R-squared	0.552	0.542	0.658	0.544	0.531

This table reports pooled OLS regression results where the dependent variable is log (Tobin's Q) and the main independent variable is Foreign Exchange derivatives/Assets (**FX/Assets**). Each of the regression below is split up by the median value of each of the five CEO compensation variables (Total CEO vega, Total delta, Total Cash compensation, CEO Share Compensation, and CEO Inside Debt). All variables greater than the median value are termed "high." The risk preference variables are then divided into risk-seeking CEOs proxied by high-vega (Column (1)), and risk-averse CEOs proxied by high delta (Column (2)), high cash compensation (Column (3)), high share compensation (Column (4)) and high inside debt (Column (5)). The symbols ***, **, and * stand for statistical significance based on two-sided tests at the 1, 5, and 10% levels, respectively. The coefficients of the intercepts are suppressed. Standard errors are in parentheses. For a detailed description of the variables, see Appendices C and D.

5. Conclusion

We examine the impact of hedging on firm value and the hedging intensity of firms run by CEOs with different risk preferences. Using hedging data from a hand-collected sample of derivatives for Fortune 500 firms over five years, we first examine the impact of derivatives hedging on firm value and find that neither total derivatives hedging nor individual (*IR*, *FX*, and *COMM*) derivatives hedging affects firm value. Unlike previous studies, we find that the total derivative portfolio increases firm value modestly compared to a firm's overall risk exposure. We also find striking similarities in the hedging intensities of risk-seeking and risk-averse CEOs.

Specifically, we find that the total derivatives portfolio increases firm value by only \$3.7 billion on average. This is a modest increase compared to the total assets (13%) and total sales (19%) of the average firm in our multi-year sample. This result is inconsistent with the previous literature, which mostly uses only *FX* or *COMM* derivatives data. Further, in contrast to the previous literature, when we re-examine the relationship between hedging and firm value conditional on CEO risk preferences, we find that derivatives hedging does not have a significant impact on firm value run by either risk-seeking or risk-averse CEOs. Specifically, the evidence suggests that the value gains from using derivatives are minimal for both types of CEO (approximately 13% relative to total assets and 21% relative to total sales for the average Fortune 500 firm). This result shows that value creation by derivatives hedging is minimal compared to overall firm risk exposure. We also find that when the average firm experiences an extreme (three standard deviation) change in interest rates, commodity prices, or foreign exchange rates, its derivatives portfolio creates only modest gains, regardless of CEO risk preferences.

Finally, our investigation also shows that risk-seeking and risk-averse CEOs exhibit the same magnitude of hedging intensity (0.10–0.11), as measured through total derivatives scaled by assets, a finding not recorded in the previous literature. Contrary to earlier studies, these results demonstrate that CEO risk preferences fail to alter inherent CEO risk aversion. It also suggests that CEO compensation contracts designed to motivate risk-taking (hedge less) do not seem to work as expected. The similarities in hedging intensity- between risk-seeking and risk-averse CEOs, in conjunction with the value irrelevance of hedging, indicate that corporate managers view derivatives usage as an insurance policy rather than a value-maximizing decision.

Table 12

The Effect of Commodity derivatives (COMM) on firm value conditional on CEO risk preferences

	DV = Log (Tobin's Q)				
	Risk seeking (High vega)	Risk-averse (High delta)	Risk-averse (High Cash)	Risk-averse (High Shares)	Risk-averse (High InDebt)
VARIABLES	(1)	(2)	(3)	(4)	(5)
COMM/Assets	-0.696 (0.648)	-0.634 (0.641)	0.147 (0.723)	-0.232 (0.673)	-2.212* (1.277)
R&D/Assets	-2.472* (1.261)	-2.945** (1.188)	-1.984** (0.997)	-3.58*** (1.202)	1.084 (1.182)
Capex/Assets	0.433** (0.187)	-0.156 (0.096)	-0.138 (0.090)	-0.141 (0.096)	-0.047 (0.096)
Debt/Assets	0.124*** (0.032)	0.202*** (0.025)	0.142*** (0.022)	0.184*** (0.025)	0.469*** (0.047)
Log (Assets)	-0.130*** (0.037)	-0.130*** (0.036)	-0.140*** (0.025)	-0.130*** (0.033)	0.033 (0.032)
Div yield	4.248** (1.889)	4.950*** (1.800)	4.410*** (1.331)	4.302** (1.768)	3.505** (1.671)
Foreign Sales	0.114 (0.124)	0.085 (0.124)	0.297*** (0.100)	0.013 (0.126)	-0.021 (0.129)
Lag FCF	0.834** (0.368)	1.297*** (0.344)	0.260 (0.189)	1.045*** (0.273)	-0.003 (0.101)
Quick ratio	0.203*** (0.042)	0.254*** (0.039)	0.073** (0.036)	0.222*** (0.042)	0.095** (0.047)
Insider own	-0.238 (0.324)	-0.193 (0.289)	1.304** (0.589)	0.260 (0.372)	0.239 (0.402)
Constant	3.289*** (0.925)	3.208*** (0.888)	2.910*** (0.630)	3.155*** (0.832)	-0.475 (0.772)
IndustryYearObservationsR-squared	YY7180.552	YY7180.542	YY7150.658	YY7180.541	YY8060.532

This table reports pooled OLS regression results where the dependent variable is log (Tobin's Q) and the main independent variable is Commodity derivatives/Assets (**COMM/Assets**). Each of the regression below is split up by the median value of each of the five CEO compensation variables (Total CEO vega, Total delta, Total Cash compensation, CEO Share Compensation, and CEO Inside Debt). All variables greater than the median value are termed "high." The risk preference variables are then divided into risk-seeking CEOs proxied by high vega (Column (1)), and risk-averse CEOs proxied by high delta (Column (2)), high cash compensation (Column (3)), high share compensation (Column (4)) and high inside debt (Column (5)). The symbols ***, **, and * stand for statistical significance based on two-sided tests at the 1, 5, and 10% levels, respectively. The coefficients of the intercepts are suppressed. Standard errors are in parentheses. For a detailed description of the variables, see Appendices C and D.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A: Calculation of the market value sensitivities of the total derivatives portfolio for extreme (three-standard-deviation) changes in the underlying asset, as noted by Guay and Kothari (2003)

FX derivatives. For FX derivatives, an extreme change is defined as a 21.33% change in the currency exchange rate. A 21.33% change equals three times the average historical standard deviation of annualized percentage changes in the US dollar exchange rate for the 10 most heavily weighted currencies in the Federal Reserve's Nominal Major Currencies Dollar Index. The annualized standard deviations are computed using monthly observations over the 10-year period from 1998 through 2008.

IR derivatives. We measure the market value (cash flow) sensitivity of IR derivatives to IR movements as the estimated change in IR derivatives' value (annual cash flow) for a 191-percentage point change in the six-month yield on T-bills. The choice of 191 percentage points reflects a three-standard deviation change in the annualized percentage point change in the six-month T-bill yield, using monthly observations over the 10-year period from 1998 through 2007.

COMM derivatives. The cash flow sensitivity of COMM derivatives to COMM price movements is measured as the estimated change in COMM derivatives' annual cash flows for a 37% change in the underlying COMM price. The choice of 78% reflects a three-standard deviation change in the annualized percentage return on the quarterly Producer Price Index (PPI) for fuel over the 10-year period from January 1988 through December 1997.

Appendix B: Calculating delta and vega using the Black-Scholes option pricing model

In this appendix, we first present how CEO stock option values, deltas, and vegas are derived

Table 13

Effect of Total Derivatives, and individual derivatives (IR, FX, and COMM) on firm value, conditional on alternative measure of CEO risk preference (CEO age)

VARIABLES	<i>DV = Log (Tobin's Q)</i>							
	Older CEO	Younger CEO	Older CEO	Younger CEO	Older CEO	Younger CEO	Older CEO	Younger CEO
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Total Deriv/Assets	-0.154	-0.066						
	(-0.99)	(-0.49)						
IR/Assets			-0.184	0.116*10⁻³				
			(-0.74)	(0.03)				
FX/Assets					-0.006	-0.148		
					(-0.03)	(-0.60)		
COMM/Assets							-0.192	-0.148
							(-0.73)	(-0.60)
<i>R&D/Assets</i>	2.187**	-0.236	2.075*	-0.201	2.202**	-0.229	2.182**	-0.229
	(2.03)	(-0.29)	(1.90)	(-0.25)	(2.01)	(-0.28)	(2.03)	(-0.28)
<i>Capex/Assets</i>	-0.115	0.174*	-0.114	0.175*	-0.110	0.173*	-0.111	0.173*
	(-0.66)	(1.71)	(-0.65)	(1.73)	(-0.63)	(1.71)	(-0.64)	(1.71)
<i>Debt/Assets</i>	0.277***	0.136***	0.277***	0.135***	0.278***	0.135***	0.278***	0.135***
	(9.83)	(5.07)	(9.85)	(4.88)	(9.86)	(5.05)	(9.87)	(5.05)
<i>Log (Assets)</i>	-0.051**	-0.022	-0.051**	-0.022	-0.050**	-0.022	-0.050**	-0.022
	(-2.17)	(-0.77)	(-2.14)	(-0.76)	(-2.10)	(-0.76)	(-2.12)	(-0.76)
<i>Div Yield</i>	2.968**	2.153	2.978**	2.147	2.921**	2.147	2.894**	2.147
	(2.38)	(1.11)	(2.38)	(1.10)	(2.34)	(1.10)	(2.32)	(1.10)
<i>Foreign/Total Sales</i>	0.459***	0.071	0.460***	0.073	0.463***	0.068	0.462***	0.068
	(4.93)	(0.66)	(4.95)	(0.67)	(4.98)	(0.63)	(4.97)	(0.63)
<i>Lag FCF/Asset</i>	-0.010	0.245**	-0.010	0.245**	-0.017	0.248**	-0.017	0.248**
	(-0.17)	(2.32)	(-0.17)	(2.31)	(-0.28)	(2.34)	(-0.29)	(2.34)
<i>Quick ratio</i>	0.013	0.047	0.011	0.045	0.010	0.047	0.011	0.047
	(0.40)	(1.22)	(0.36)	(1.19)	(0.30)	(1.23)	(0.34)	(1.23)
<i>Insider ownership</i>	-0.462	0.851*	-0.466	0.848*	-0.468	0.861**	-0.461	0.861*
	(-1.33)	(1.76)	(-1.34)	(1.75)	(-1.35)	(1.77)	(-1.32)	(1.77)
<i>Constant</i>	1.372**	0.634	1.345**	0.617	1.314**	0.620	1.326**	0.620
	(2.43)	(0.93)	(2.39)	(0.90)	(2.33)	(0.91)	(2.36)	(0.91)
<i>Year FE</i>	Y	Y	Y	Y	Y	Y	Y	Y
<i>Industry FE</i>	Y	Y	Y	Y	Y	Y	Y	Y
<i>Observations</i>	700	739	700	739	700	739	700	739
<i>R-squared</i>	0.3046	0.1912	0.3041	0.1909	0.3036	0.1913	0.3041	0.1913

This table reports pooled OLS regression results of firm value (log (Tobin's q) on total derivatives hedging and individual derivatives (IR, FX, and COMM) conditional on older and younger CEOs. We divide the sample based on the median age of CEOs. Columns (1) and (2) show the regression where the main independent variable is Total Derivatives/assets (Total Deriv/Assets). Columns (3) and (4) show the regression where the independent variable is Interest rate derivatives scaled by assets (IR/Assets). Columns (5) and (6) report regression where our main independent variable is foreign exchange derivatives scaled by total assets (FX/Assets). Finally, Columns (7) and (8) show regressions where we use Commodity derivatives scaled by assets (COMM/Assets) as our main variable. The symbols ***, **, and * stand for statistical significance based on two-sided tests at the 1, 5, and 10% levels, respectively. The coefficients of the intercepts are suppressed. Standard errors are in parentheses. For a detailed description of the variables, see Appendices C and D.

The Black–Scholes (1973) model for valuing European call options modified for dividend payments, as Merton (1973), is as follows:

$$\text{Value} = S \exp(-d * T) * N(d_1) - X \exp(-r * T) * N(d_2) \quad (\text{B1})$$

where

$$d_1 = (\ln(\frac{S}{X}) + T(r - d + \frac{\sigma^2}{2})) / \sigma \sqrt{T}$$

$$d_2 = d_1 - \sigma \sqrt{T}$$

$N(\cdot)$ = cumulative probability function for the normal distribution

S = share price of stock at the fiscal year-end

d = dividend yield as of the fiscal year-end

X = exercise price of the option

r = risk-free rate of US T-bond yields corresponding to the option's time to maturity

σ = annualized standard deviation of daily stock returns measured over the 120 days prior to the fiscal year-end

T = remaining years to maturity of the option

As [Core and Guay \(2002\)](#), the delta and vega measures are the option values' sensitivity with respect to a 1% change in stock price and a 0.01 change in the standard deviation, respectively, and are expressed as follows:

$$\frac{\partial \text{value}}{\partial S} * \frac{S}{100} = \exp\{-dT\} N(d_1) * \frac{S}{100} \quad (\text{B2})$$

Table 14

Effect of Total Derivatives, and individual derivatives (IR, FX, and COMM) on firm value (unconditional setting) conditional on sample period

VARIABLES	DV = Log (Tobin's Q) Period =2008 - 2010				DV = Log (Tobin's Q) Period =2011- 2012			
	Total Deriv/Assets	IR/Assets	FX/Assets	COMM/ Assets	Total Deriv/Assets	IR/Assets	FX/Assets	COMM/ Assets
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Total Deriv/Assets	0.009 (0.59)				0.019 (0.94)			
IR/Assets		0.001 (0.32)				0.276 (1.09)		
FX/Assets			-0.182 (-0.72)				-0.255 (-0.94)	
COMM/Assets				-0.015 (-0.04)				-0.175 (-0.64)
R&D/Assets	0.646 (0.76)	0.659 (0.78)	0.676 (0.80)	0.659 (0.78)	0.190 (0.21)	0.131 (0.14)	0.207 (0.22)	0.192 (0.21)
Capex/Assets	0.088 (0.68)	0.096 (0.74)	0.093 (0.72)	0.094 (0.73)	-0.045 (-0.43)	-0.037 (-0.35)	-0.036 (-0.34)	-0.038 (-0.36)
Debt/Assets	0.183*** (7.25)	0.184*** (7.14)	0.182*** (7.22)	0.182*** (7.23)	0.210*** (6.19)	0.213*** (6.28)	0.212*** (6.26)	0.212*** (6.25)
Log (Assets)	-0.003 (-0.12)	-0.006 (-0.23)	-0.006 (-0.25)	-0.005 (-0.22)	-0.070** (-2.47)	-0.071** (-2.51)	-0.072** (-2.54)	-0.071** (-2.52)
Div Yield	1.302 (0.78)	1.352 (0.81)	1.427 (0.85)	1.377 (0.83)	3.556** (2.46)	3.639** (2.52)	3.605** (2.50)	3.634** (2.51)
Foreign/Total Sales	0.324*** (3.33)	0.324*** (3.32)	0.320*** (3.27)	0.324*** (3.32)	0.278*** (2.64)	0.272*** (2.59)	0.274*** (2.61)	0.269** (2.56)
Lag FCF/Asset	0.010 (0.08)	0.012 (0.09)	0.015 (0.12)	0.012 (0.09)	0.138** (2.15)	0.142** (2.22)	0.137** (2.14)	0.138** (2.15)
Quick ratio	0.053 (1.60)	0.052 (1.58)	0.055 (1.64)	0.052 (1.58)	0.016 (0.42)	0.018 (0.46)	0.015 (0.40)	0.016 (0.42)
Insider ownership	0.060 (0.12)	0.054 (0.11)	0.053 (0.11)	0.055 (0.11)	0.266 (0.74)	0.261 (0.73)	0.261 (0.73)	0.272 (0.76)
Constant	0.278 (0.47)	0.323 (0.55)	0.340 (0.58)	0.321 (0.55)	1.760*** (2.63)	1.777*** (2.66)	1.762*** (2.64)	1.766*** (2.64)
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y	Y	Y
Observations	856	856	856	856	583	583	583	583
R-squared	0.2023	0.2021	0.2025	0.202	0.2164	0.2021	0.2164	0.2157

This table reports pooled OLS regression results of firm value (log (Tobin's q) on total derivatives hedging and individual derivatives (IR, FX, and COMM) using two different sample period. Columns 1 - 4 show the regressions results for the sample period 2008 to 2010 and Columns 5 - 8 show the regressions results for the sample period 2011 to 2012. The main independent variable are Total Derivatives/assets (Total Deriv/Assets) in columns (1) and (5), Interest rate derivatives scaled by assets (IR/Assets) in columns (2) and (6), foreign exchange derivatives scaled by total assets (FX/Assets) in columns (3) and (7), and Commodity derivatives scaled by assets (COMM/Assets) in columns (4) and (8). The symbols ***, **, and * stand for statistical significance based on two-sided tests at the 1, 5, and 10% levels, respectively. The coefficients of the intercepts are suppressed. Standard errors are in parentheses. For a detailed description of the variables, see Appendices C and D.

$$\frac{\partial value}{\partial S} * 0.01 = 0.01 * [\exp \{-d * T\} N'(d2) S \sqrt{T}] \quad (B3)$$

where $N'(\cdot)$ is the normal probability density function.

The exact values of the exercise price and time to maturity are obtained from proxy statements for current-year option grants. For options granted in prior years, the CoreGuay (2002) algorithm is used. We estimate average exercise prices by subtracting the ratio of the realizable value of options to the number of options (for both exercisable and unexercisable options) from the fiscal year-end stock prices. The time to maturity is set at one year less the time to maturity of the current year's grant (or nine years if no new grant is made) for unexercisable options. The time to maturity is set at three years less the time to maturity of exercisable options (or six years if no new grant is made). The delta and vega values for shares of stock held are assumed to be equal to one and zero, respectively.

Appendix C: Firm variables

This appendix presents the company variables.

- Debt/Assets: Total debt to total book value of assets
- Deriv/Assets: Total derivatives value (FX, IR, and COMM) divided by total assets
- IR/Assets: Total notional value of interest rate (IR) derivatives scaled by total assets
- FX/Assets: Total notional value of foreign exchange (FX) derivatives scaled by total assets

- **COMM/Assets:** Total notional value of commodity (*COMM*) derivatives scaled by total assets
- **Excess_Deriv Residual** derivatives after controlling for endogeneity (using the method of Shen and Zhang, 2013) divided by total assets
- **Foreign sales:** International sales revenue divided by total sales revenue
- **Capex/Assets:** Logarithm of the total capital expenditure of the firm divided by the total book value of assets
- **Quick ratio:** (Current assets - inventories)/current liabilities
- **R&D/Assets:** Total R&D expenses of the firm divided by assets
- **Insider own:** CEO's insider stock ownership (%) of company shares
- **Div Yield:** Total dividend yield of the company, calculated by dividing dividends by the current stock price
- **Lag FCF:** Lagged free cash flow of the firm divided by assets
- **Assets:** Total book value of assets
- **NOLs/Assets:** Net operating loss carryforwards scaled by total assets

Appendix D: CEO risk preference variables

- **Delta:** Total delta of the CEO compensation portfolio (sum of the delta values of the CEO's current options, exercisable options, and un-exercisable options and the CEO's stock options)
- **Vega:** Total vega of the CEO compensation portfolio (sum of the vega of the CEO's current options, exercisable options, and un-exercisable options)
- **InDebt:** The inside debt is the sum of the CEO's deferred compensation and pension benefits
- **Cash:** The sum of total salary and bonuses of the CEO's compensation portfolio
- **Shares:** CEO's total stock equity compensation
- **High vega:** A continuous variable that equals all vega values greater than the median CEO total vega
- **High delta:** A continuous variable that equals all delta values greater than the median CEO total delta.
- **High Shares:** A continuous variable that uses all shares values greater than the median CEO total share compensation.
- **High InDebt:** A continuous variable that uses all inside debt values greater than the median CEO total inside debt compensation.
- **High Cash:** A continuous variable that uses all cash compensation values greater than the median CEO total cash compensation.

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