Derivatives Use and the Value of Cash Holdings : Evidence from U.S. Oil and Gas Industry*

Sanghak Choi[a], Hyeonung Jang[a,*], Daejin Kim[b], Byoung Ki Seo[b]

[a] *Department of Management Engineering, Ulsan National Institute of Science and Technology, Ulsan 44919, Korea*

[b] *School of Business Administration, Ulsan National Institute of Science and Technology, Ulsan 44919, Korea*

Abstract

We examine the effect on the marginal value of cash holdings when oil and gas firms use derivatives for hedging risks. Analyzing 155 U.S. oil and gas producers from 1998 to 2017, we find that the use of derivatives for hedging risks, especially oil and gas-related risk, reduces the marginal value of corporate cash holdings. Furthermore, the effect of using derivatives is stronger for firms exposed to higher risk. Our findings imply that cash holdings and derivatives use act as substitutes in hedging risk in this industry.

Keywords: Derivatives use, Cash holdings, Marginal value of cash holdings

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*Corresponding author. Tel.: +82 10 3279 7678. Address: 114-708, 50 UNIST-gil, Ulju-gun, Ulsan, Korea, 44919

Email addresses: sanghak@unist.ac.kr (Sanghak Choi), hw7678@unist.ac.kr (Hyeonung Jang), daejin@unist.ac.kr (Daejin Kim), bkseo@unist.ac.kr (Byoung Ki Seo)

1. Introduction

Firms might increase their cash holdings if they foresee funding constraints, unexpected costs due to business uncertainty, or increases in product price volatility. Bates et al. (2018) argue that the recent increase in U.S. corporate cash holdings is due to the precautionary motive of preparing for investment opportunities and product market competition. While increasing cash reserves is one way of preparing for potential risks, using derivatives contracts enables firms to proactively control price volatility and reduce unexpected cash flows or avoid underinvestment problems (Froot et al., 1993; Haushalter et al., 2007). These facts suggest that firms are more likely to use derivatives when they are financially constrained or face growth opportunities (Géczy et al., 1997; Haushalter, 2000). Previous research also argues that the use of derivatives could either substitute or complement cash holdings (Opler et al., 1999; Haushalter et al., 2007; Bolton et al., 2011). Extending the literature, which has examined the relationship between cash holdings and derivatives use and investigates its impact on value, this study explores the implications of holding cash for value when firms using derivatives hold additional cash.

If a firm uses derivatives to reduce the uncertainty of cash demands, it can enhance its value by utilizing the cash to make more valuable investments or increase distributions to shareholders. Hedging helps firms reduce the expected costs of financial distress and increase debt capacity (Mayers & Smith Jr, 1990; Smith & Stulz, 1985; Leland, 1998). If a firm's motive of using derivatives is to manage potential risks, the shareholder value driven by additional cash holdings may increase since it is likely to distribute the cash among shareholders. For example, Allayannis & Weston (2001) suggest that the value of firms that use hedging is higher than that of firms that do not. Meanwhile, Guay & Kothari (2003) argue that the benefits of using derivatives are not significant; rather, the associated increase in market value is driven by the operational hedge, which is possibly correlated with derivatives use. Jin & Jorion (2006) further show that hedging reduces firms' stock price sensitivity to energy prices, but this effect does not seem to be related to their market value.

Previous research has investigated the relationship between hedging and firm value. To enhance understanding on this topic, we investigate the market evaluation of the additional cash that firms retain through derivatives to hedge risks. Corporate cash holdings with precautionary motives may increase investment efficiency because they enable firms to exploit valuable investment opportunities. Bates et al. (2018) assert that the marginal value of U.S. firms' cash holdings has increased with the rise in precautionary motives due to the investment set, cash flow volatility, and product market competition. According to Haushalter et al. (2007), the management of predation risk could explain the substitution relationship between corporate cash holdings and derivatives use; however, Opler et al. (1999) find a positive relationship between cash holdings and derivatives use, which indicates a complementary relationship. Investigating how shareholders evaluate firms' additional cash holdings acquired through derivatives may provide empirical evidence of this relationship. If a firm can lower the precautionary motive for holding cash using derivatives, shareholders may underestimate its marginal value of cash holdings as they presume that its purpose of holding cash could be altered through derivatives. Further, if the risk management from holding cash can be achieved by replacing it with derivatives, shareholders may consider additional cash more likely to be used to advance managers' private interests rather than shareholder interests.

Following Jin & Jorion (2006), we investigate the marginal value of cash holdings of oil and gas producers that use derivatives to hedge market risks. Focusing on this sector offers the following benefits. First, the cash flows of oil and gas firms are commonly affected by energy prices, and related derivatives are actively traded on exchanges.[1] Furthermore, compared to firms in other industries, where cash flows are influenced by various factors, energy companies' cash flows are largely dependent on oil and gas prices, facilitating easy investigation of the relationship between the marginal value of cash holdings and derivatives use. We also control the cross-sectional variation potentially caused by industry differences. Confining our study to the energy industry enables us to directly investigate the cash value depending on the use of derivatives by companies exposed to similar risks.

Our empirical results, derived from a sample of 155 U.S. oil and gas producers, show that their marginal value of cash holdings is positive, in line with Faulkender & Wang (2006). However, this value decreases significantly when firms use derivatives. It approaches zero as firms using derivatives hold additional cash. On average, the value of holding an additional dollar for firms using derivatives is $1.16 lower than for firms that do not use derivatives. These results imply that shareholders underestimate the value of additional cash holdings for firms hedging risk through derivatives compared to firms that do not. We interpret this as shareholders' devaluation of the cash value because derivatives use could reduce the risk of exposure, thereby reducing the need for cash holdings. Moreover, we find that only the oil and gas derivatives needed to manage the price risks of assets associated to related business activities are significant among the derivatives used by these firms. Since both cash holdings and derivatives use are endogenously decided by firms, we use propensity score matching (PSM) to address endogeneity issue and find that our results remain unchanged. This implies that cash holdings can be replaced by derivatives when a

[1] Jin & Jorion (2006) find that more than 90% of oil and gas extraction firms' profits come from the extraction business.

firm hedges risk using derivatives related to its main business.

According to Keynes (1936), firms tend to hold more cash when they foresee potential risks due to adverse cash flow shocks. In preparing for increases in cash flow uncertainty, firms can raise their proportion of liquid assets (Opler et al., 1999). The cash flows of oil and gas producers are sensitive to global energy prices and the supply and demand of oil and gas. When cash flow volatility increases due to shocks in oil and gas prices as well as their supply and demand, these firms may increase their precautionary demand for additional cash or use derivatives to eliminate the associated risks. If cash and derivatives have a substitution relationship in terms of cash flow shocks—in other words, if derivatives can take over the role of cash—retaining cash might be unnecessary to meet the firm's precautionary demand. Thus, the value of additional cash holdings might decrease when uncertainty in the crude oil market increases because the use of derivatives in turmoil markets might offer a more effective way of hedging the potential risks. We use the various exogenous shocks in oil markets to investigate the effect of derivatives use on the marginal value of cash holdings. Our empirical results show that the negative effect of derivatives use on this marginal value is more pronounced during an oil disruption. Thus, the marginal value of cash holdings may decrease during oil disruptions, because holding additional cash may be unnecessary once the price risks associated with the increased uncertainty have been eliminated by derivatives.

We show that the marginal value of cash holdings may decrease for firms using derivatives to hedge potential risks. Firms can either increase cash holdings or use derivatives to manage potential risks. Palazzo (2012) finds that firms with high risks, measured by the correlation between cash flow and risk exposures, have higher optimal savings. Thus, for these firms, the use of derivatives may be more effective as they might have a high precautionary demand. We check the robustness of our results by dividing the sample into high- and low-risk groups using various risk metrics such as market risk, oil price risk, firm-specific risk, and volatility risk. Our results show that the use of derivatives by firms exposed to high risk significantly reduces their marginal value of cash holdings. This suggests that firms' decision to use derivatives for reducing the marginal value of cash holdings may be based on its degree of risk exposure. In addition, we find a substitution relationship between derivatives and cash holdings in terms of precautionary demand, because both these tools can be used to manage risk.

This study investigates how shareholders evaluate derivatives use by estimating its impact on the marginal value of cash holdings. To our knowledge, it is the first to examine shareholder reaction to firms' additional cash holdings using derivatives. While empirical studies have focused on the relationship between the size of cash holdings and derivatives use, our study investigates how shareholders evaluate cash value when firms use derivatives to hedge the risks. That hedging the risk from derivatives may lower the precautionary demand for cash holdings and, thus, their marginal value provides the economic reason for the negative relationship between cash holdings and derivatives use. Simultaneously, our results confirm a substitution relationship between derivatives use and cash holdings through examining the market reaction of shareholders. In addition, our empirical study provides indirect evidence that holding additional cash when using derivatives may reduce corporate value, which indicates a trade-off relationship. Our results support previous findings that derivatives use may not increase firm value (Guay & Kothari, 2003; Jin & Jorion, 2006; Bartram et al., 2011).

The rest of our paper is organized as follows. Section 2 summarizes the related literature and develops our hypothesis. Section 3 describes the sample construction. Section 4 investigates the relationship between derivatives use and the marginal value of cash holdings. Finally, Section 5 concludes.

2. Literature review and hypotheses development

2.1. Literature review

Opler et al. (1999) argue that firms with high growth opportunities and volatile cash flows tend to hold more cash. This supports firms' precautionary motive to hold more cash, which might bring incentives when they are financially constrained. Moreover, financially constrained firms might increase precautionary cash holdings when cash flow volatility increases (Almeida et al., 2004; Han & Qiu, 2007). Bates et al. (2009) find that an increase in cash holdings might be associated with a decrease in inventories and capital expenditures and an increase in cash flow risk and R&D expenditures; they identify the precautionary motive as an important factor of firms' cash demand. Firms' precautionary demands are also associated with their risk exposure: the propensity to hold more cash is greater in firms with high cash flow risks and market risks (Riddick & Whited, 2009; Palazzo, 2012). According to Song & Lee (2012), the increase in cash holdings observed in East Asian firms after the Asian financial crisis of 1997-98 could be attributed to an increase in their sensitivity to cash flow volatility. Sun & Wang (2015) also indicate that a firm's propensity to increase corporate cash holdings is exacerbated during financial crises.

Furthermore, corporate cash holdings and derivatives could be used for similar purposes. Froot et al. (1993) argue that firms can use derivatives to reduce their liquidity risk and maintain investment levels even in the absence of cash holdings. Han & Qiu (2007) suggest that a hedging activity that controls future cash flow uncertainty reduces the precautionary motive for holding cash. Carter et al. (2006) empirically find that cash holdings are negatively related to the hedging amount.

Disatnik et al. (2014) also indicate that the cash flows of firms using derivatives is negatively related to their cash holdings. Haushalter et al. (2007) state that firms can use derivatives and hold cash to manage predation risks from underinvestment, which may lead to loss of investment opportunities and market share. Through an international study, Bartram et al. (2011) confirm that derivatives use is associated with lower firm risks. Thus, based on the similar roles of cash holdings and derivatives in risk management, the literature suggests a substitution relationship between them. In this study, we examine the effect of derivatives use on the value of additional cash holdings.

Faulkender & Wang (2006) find that the marginal value of corporate cash holdings is lower in firms with higher leverage, more cash holdings, or no financial constraints.[2] Several studies have identified corporate crises or opportunities as factors determining the marginal value of cash holdings. Denis & Sibilkov (2009) argue that an increase in investment opportunities could explain why the cash of financially constrained firms is more valuable than that of their counterparts. Their results also suggest that the impact of corporate cash holdings on investments increases with the need for hedging. Bates et al. (2018) find that the marginal value of cash holdings is positively associated with increases in investment opportunities, cash flow volatility, and market competition; furthermore, an increased precautionary motive for holding cash increases the value of excess cash holdings. In the same vein, Alimov (2014) finds that an increase in product market competition increases the marginal value of cash holdings. Examining the relationship between external financing cost and risk

[2]A strand of the marginal value of cash holdings literature focuses on the agency cost of corporate cash holdings. Good governance and monitoring increase this marginal value (Dittmar & Mahrt-Smith, 2007; Frésard & Salva, 2010; Ward et al., 2018). Compensation and CEO overconfidence also impact the marginal value (Liu & Mauer, 2011; Aktas et al., 2019).

management policies through a dynamic model, Bolton et al. (2011, 2013) argue that the marginal value of cash holdings for firms undertaking hedging activities is lower than that of their counterparts, but the result is reversed in extremely financially constrained firms.

2.2. Hypotheses Development

Our first hypothesis is derived from the argument that firms' purposes of using derivatives and of holding more cash are similar when it comes to risk management and elimination. The precautionary motive explains why firms increase cash holdings to prevent underinvestment problems due to a lack of cash. Underinvestment problems can be more pronounced in financially constrained firms that face high costs of external financing. Thus, firms have an incentive to increase cash holdings by hedging potential risks.

The use of derivatives can also reduce a firm's precautionary motive for holding cash. Firms' use of derivatives for hedging rather than speculation can lower the risk arising from price volatility. In turn, such lowered risks can reduce their precautionary demand for cash holdings. In this vein, Han & Qiu (2007) model cash holdings and precautionary motives and show that hedging activities that reduce cash flow uncertainty can lower the precautionary demand for cash holdings. The marginal value of cash holdings indicates how additional cash holdings are valued by shareholders. As discussed above, shareholders highly value additional cash holdings for firms with high precautionary motives such as high cash flow volatility, increased investment opportunity, and more product market competition. Such firms need to hold more cash to achieve steady growth, and shareholders may believe that they can spend their additional cash holdings on investment opportunities, enhancing shareholder value without causing overinvestment or agency problems. However, firms that hedge risks using derivatives have lower precautionary motives than firms that do not. Therefore, shareholders may presume that additional cash holdings are less beneficial to increasing shareholder value for the former. As a result, firms that hedge risks using derivatives may have lower precautionary demand than those that do not, which can in turn reduce the marginal value of cash holdings.

Hypothesis 1. Additional cash holdings are less valuable to shareholders of firms that use derivatives for hedging than to shareholders of firms that do not.

Considering the precautionary motive for holding cash for firms facing underinvestment problems induced by cash shortfalls, cash holdings are more valuable for firms exposed to higher cash flow risk—an argument supported by Riddick & Whited (2009). Similarly, derivatives use might be effective in reducing cash flow uncertainty for firms facing cash flow risk. For instance, after an industry shock that increases cash flow uncertainty, firms in that industry are more likely to hoard cash to manage cash flow risks, and thus, their precautionary motive increases; the degree of this increase might be lower for firms that use derivatives to hedge the price uncertainty of underlying assets. Therefore, the benefit that firms obtain from derivatives use is large when their cash flow uncertainty is high. In other words, the decreasing effect of derivatives use on firms' precautionary demand for cash could be greater when they are exposed to high cash flow risks. Consequently, when a shock increases cash flow uncertainty, firms' precautionary demand increases, and this increase is lower for firms that use derivatives than for firms that do not. Furthermore, the difference in this increase between firms using derivatives and those that do not results impacts the effect of derivatives use on the marginal value of cash. This is in line with our first hypothesis, which implies that firms' derivatives use may decrease the marginal value of their cash holdings as it reduces their precautionary demand for cash holdings.

Hypothesis 2. The decrease in the marginal value of cash holdings from firms' derivatives use is greater if the presence of cash flow risk.

3. Data and empirical methodology

3.1. Data sources and sample selection

Our study is based on a sample of 155 U.S. oil and gas firms from 1998 to 2017.[3] Following Jin & Jorion (2006), we select firms belonging to industries with Standard Industrial Classification (SIC) codes 1311(*Crude Petroleum and Natural Gas*), 1321(*Natural Gas Liquids*), 1381(*Drilling Oil and Gas Wells*), 1382(*Oil and Gas Field Exploration Services*), and 1389(*Oil and Gas Field Services*). We compile firms' 10-K filings manually to identify their use of derivatives for hedging. First, we take the market risk type from Item 7a of Financial Reporting Release No. 48 (FRR 48). The market risk for our sample firms could be associated with oil and gas, foreign currencies, credit, interest rates, or electricity. Next, we identify whether a firm uses derivatives to hedge risk. The derivatives used by firms could include swaps, options, forwards and futures, or some structured derivatives contracts such as collars; we include those used for hedging only.

Company information is extracted from the Center for Research in Security Prices (CRSP) and Compustat databases. We obtain the book-to-market and size factor returns from Kenneth R. French's web page to calculate the benchmark return. Our final sample consists of 1,364 firm-year observations from 1998 to 2017.

[3]Financial Reporting Release No. 48, which expands the disclosure requirements regarding firms' market risk, is effective for all firms after June 15, 1998.

3.2. Summary statistics

Table 1 shows a summary of firms' use of derivatives by risk type. About 89% of the 1,364 observations use derivative contracts to hedge at least one of the five risk types from Item 7a. Thus, most oil and gas companies use derivatives to hedge the risks associated with oil or gas. These firms may also use derivatives to hedge the risks associated with interest rates or credit. On the other hand, since most U.S. oil and gas companies deal with domestic demands, they might have less demand for foreign currency derivatives and seem to use electricity derivatives rarely. These results indicate that our sample firms actively use derivative contracts to manage oil and gas price risks.

INSERT Table 1 AROUND HERE

Figure 1 shows the firms' corporate cash holdings by type of market risk. It should be noted that firms that do not use derivatives tend to have relatively large cash holdings. This trend is more pronounced for firms that primarily use oil and gas derivatives. Thus, oil and gas companies using derivatives tend to hold less cash, suggesting that holding cash may be less valuable when using derivatives. These results are consistent with that of Haushalter et al. (2007) that cash holdings are negatively related to derivatives use. Figure 1 supports Hypothesis 1 and confirms that the use of derivatives could substitute for holding or increasing cash levels.

INSERT Figure 1 AROUND HERE

Table 2 presents the descriptive statistics for the study variables. First, the sample has an average excess return of 5.2%, and firms that do not use derivatives have 0.5% higher excess return than firms using derivatives. In addition, firms' cash holdings normalized by market value account for, on average, 7%. Firms not using derivatives, on average, have 8.5% more cash holdings than those using derivatives. These results are consistent with our assertion that cash holdings and derivatives use for hedging have a negative relationship.

INSERT Table 2 AROUND HERE

3.3. Methodology and variable description

The aim of this study is to investigate the effect of derivatives use on the marginal value of cash holdings. Following Faulkender & Wang (2006), we estimate the value of holding one additional dollar for firms. We include an indicator variable of derivatives use and its interaction with the change in cash holdings. Our primary regression model is as follows:

$$r_{i,t} - R_{i,t}^{ff} = \beta_0 + \beta_1 \frac{\Delta C_{i,t}}{M_{i,t-1}} + \beta_2 \cdot Hedging_{i,t} + \beta_3 \cdot Hedging_{i,t} \cdot \frac{\Delta C_{i,t}}{M_{i,t-1}} + \beta' \cdot X + \epsilon_{i,t} \quad (1)$$

where $r_{i,t}$ - $R_{i,t}^{ff}$ is an excess stock return for firm i during fiscal year t estimated as the difference between the actual stock return and benchmark portfolio return based on Fama & French (1993) three factors. Our main variable of interest is the interaction between $\frac{\Delta C_{i,t}}{M_{i,t-1}}$ and $Hedging_{i,t}$. $\Delta C_{i,t}$ denotes the change in cash holdings from year $t-1$ to year t; $\Delta C_{i,t}$ is the cash amount normalized by the previous year's market value of equity; the coefficient β_1 on $\Delta C_{i,t}$ indicates the dollar change in shareholder wealth for a one-dollar change in cash holdings; $Hedging_{i,t}$ is an indicator variable taking the value of one if a firm uses derivatives for hedging risk; β_2 measures the direct effect of the corporate derivatives uses on excess stock returns; and β_3 represents the effect of the corporate derivatives use on the additional value of cash holding. The negative (positive) coefficient of β_3 indicates that an additional one-dollar value of derivatives users is lower (higher) than that of firms that do not use derivatives.

We include various firm-specific variables. To control firm profitability, we include the change in earnings before interest and the extraordinary variable ($\Delta Earning_{i,t}$). We also include the change in in research and development expenses ($\Delta R\&D_{i,t}$) and net assets ($\Delta Non\text{-}Cash_{i,t}$), defined as total assets minus cash and cash equivalents. Moreover, we take into account variables representing financing activities such as changes in interest expenses ($\Delta Interest_{i,t}$), changes in common dividends ($\Delta Dividend_{i,t}$), and the firm's net financing ($Net\,Financing_{i,t}$). Faulkender & Wang (2006) find that the marginal value of cash holdings is sensitive to a firm's cash holdings and capital structure; thus, we add the previous year's cash holdings ($Cash_{i,t-1}$), market leverage ($Leverage_{i,t}$), and their individual interaction terms with the change in cash holdings. All control variables are deflated by the lagged market value of equity so that our results can be interpreted in terms of the dollar change in value from a one-dollar increase in the explanatory variables. All variables are transformed into real values in 2017 dollars using the U.S. consumer price index (CPI). Finally, we include firm- and year-fixed effects.

4. Empirical results

4.1. Derivatives use and cash holdings

We first examine the relationship between size of cash holdings and derivatives use. In line with Froot et al. (1993)'s findings, we expect a negative relationship because derivatives can substitute for cash holdings in hedging risk. Using a probit model, we estimate the association between corporate cash holdings and the indicator variable of derivatives use and find a negative relationship (Table 3). This result suggests that holding more cash is correlated with less use of derivatives. In other words, if firms hold less cash, they are more likely to use derivatives to hedge risks. This finding is also consistent with those of Haushalter et al. (2007), who demonstrate that derivatives use is negatively associated with industry-adjusted cash holdings.

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4.2. Derivatives use and cash value

Our hypotheses suggest that shareholders may devalue additional cash holdings of firms that hedge risks using derivatives. We estimate the marginal value of corporate cash holdings by determining how a firm's excess returns respond to its cash holdings. We run the regression model by including the derivatives use variable and its interaction with the change in cash holdings.

INSERT Table 4 AROUND HERE

Table 4 presents the results from the yearly panel data over 1998–2017. As expected, columns (1)–(3) show that derivatives use decreases the marginal value of cash holdings. The coefficients on the interaction term are negative and significant. This result implies that firms using derivatives face a smaller marginal value of cash holdings than those that do not. This result supports Han & Qiu (2007), who find that a firm's hedging activity reduces the precautionary motive to hold cash. In columns (4)–(6), we control the firm and year fixed effects and find consistent results.

4.3. Derivatives use and cash value by derivatives types

Next, we consider the type of derivatives. Oil and gas firms can use five types of derivatives depending on their underlying assets. The underlying assets of the derivatives used in the sample firm are oil and gas price, foreign exchange rate, credit risk, interest rate, and electricity price. We divide the derivatives use of these firms into five types and analyze the marginal value of corporate cash holdings. The five types of derivatives are derivatives that hedge oil and gas price risk ($Oil\,\&\,Gas_t$), foreign exchange risk ($Foreign\,Ex._t$), credit risk ($Credit_t$), interest rate risk ($Interest\,Rate_t$), and electricity cost risk ($Electricity_t$).

INSERT Table 5 AROUND HERE

Table 5 presents the estimated results. Following previous results that derivatives use has a negative impact on the marginal value of cash, column (1) shows that oil and gas derivatives may reduce the marginal value of corporate cash holdings; in contrast, the use of other types of derivatives has no significant relationship with firm's value of additional cash holdings. The result partially illustrates the degree of risk a firm can hedge using the different types of derivatives. In the oil and gas industry, firms' cash flows are heavily affected by the supply and demand of oil and gas products. For this reason, using this type could be more effective for firms in this industry than using other derivatives. In other words, using oil and gas derivatives can sufficiently lower their precautionary demand for cash holdings and lead to a significant decrease in the marginal value of cash observed empirically in the oil and gas industry.

4.4. Robustness tests

4.4.1. Oil disruption as exogenous shocks

We next conduct a quasi-experiment to check the robustness of our results. Above, we indicate that the value of cash holdings may decrease when firms use derivatives. When firms face sudden shocks, the incentive to hold more cash may increase. However, such an increase may be less for firms that use derivatives for hedging because their derivatives use could partially eliminate the risks from the sudden shock. Thus, firms' derivatives use could further decrease the marginal value of cash holdings when they are exposed to exogenous shocks. We extend our analysis by examining the relationship between firms' derivatives use and the marginal value of cash holdings when they face shocks that could threaten their earnings or cash flows. For oil and gas producers, the most serious threats are significant drops in oil and gas prices or increases in the uncertainty of demand and supply. When cash flow volatility increases due to such shocks in prices or supply and demand, oil and gas firms' precautionary motive for holding more cash could increase. We use the various exogenous shocks in oil markets to estimate whether hedging through the use of derivatives could lower the marginal value of firms' cash holdings during certain periods.[4] We construct a regression model incorporating an oil disruption dummy variable, which takes the value of one in the case of an oil market disruption.

INSERT Table 6 AROUND HERE

Table 6 reports the regression results, which show that the coefficient on the inter-

[4]We use the following oil market disruption incidents: OPEC production cuts (1999 and 2017), Venezuela oil strike (2002), surging distillate demand in China (2007), EU enforcement limiting over 10 ppm sulfur diesel (2008), and the collapse in Libya's oil production (2011 and 2014).

action term between the change in cash holdings and the oil disruption is significantly positive. This implies that firms' incentive to hold cash increases and additional cash holdings could become more valuable when they are exposed to shocks. This supports the finding of Riddick & Whited (2009) that firms' precautionary demand is greater with higher cash flow risk. Meanwhile, the coefficient on the triple-interaction term between the change in cash holdings, derivatives use, and oil disruption is negative and significant. This implies that the increased precautionary demand caused by unexpected shocks is less for firms using derivatives. Thus, the effect of firms' derivatives use on the marginal value of cash is more pronounced when they are exposed to exogenous shocks, suggesting that our results could be explained by the decrease in precautionary demand through derivatives use.

4.4.2. Propensity score matching

We now use the PSM matching method to address the endogenous problem that firms' risk management policies could be determined endogenously. The propensity score is calculated by a logit regression including various firm characteristics, such as the change in cash holdings, change in earnings, change in net assets, change in R&D expenditures, change in interest expenses, change in dividend, lagged cash holdings, leverage, and net financing. The PSM results in Table 7 are consistent with the previous results that the marginal value of cash holdings decreases when firms use derivatives. While the results in columns (1) and (2), which include all types of derivatives, are insignificant, those in columns (3) and (4), which include only oil and gas derivatives, show a significant decrease in the marginal value of cash holdings. Thus, our PSM results further support the previous results that the marginal value of cash holdings decreases when firms use derivatives to hedge oil and gas-related risks.

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5. Subsample analysis

We confirm that the use of derivatives for hedging may reduce the marginal value of cash holdings. The literature suggests that firms hold cash to defend against potential risks and that the level of cash holdings increases when they are financially constrained or face huge market risks (Opler et al., 1999; Almeida et al., 2004). If cash holdings and derivatives use have a substitution relationship in terms of precautionary demand, the destruction of cash value due to derivatives use may be prominent in high-risk firms. We analyze whether the substitution relationship between derivatives use and marginal value of cash is greater for high-risk firms. To measure risk exposure, we consider market beta, oil beta, idiosyncratic risk, and stock volatility. First, we divide the samples into high- and low-risk groups based on the median of each risk measure. Then, we rerun the test using the subsamples by including the interaction terms between the indicator variable of derivatives use and the change in cash holdings.

INSERT Table 8 AROUND HERE

Table 8 shows the results of the subsample analysis using market risk. The market beta is obtained from the CAPM model using daily returns for 252 days. Column (1) shows that the marginal value of cash holdings is significantly reduced for firms using derivatives. Column (2) also shows a negative coefficient on the interaction term, although it is not significant. Additionally, columns (3) and (4), which analyze the effect of using oil and gas derivatives, show negative relationships. This indicates that the effects of using derivatives is stronger for firms facing high market risk. This finding supports the argument that derivatives and corporate cash holdings act as substitutes in meeting precautionary demands driven by market risk. The results are also in line with Palazzo (2012)'s, who finds a positive relationship between a firm's risk exposure and its precautionary demand for cash holdings.

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We next examine the effects of derivatives use on the marginal value of cash holdings by using the oil beta. Following Jin & Jorion (2006), we use the oil beta calculated from daily returns of the NYMEX crude oil futures contracts. Table 9 presents the estimation results based on the subsamples divided by the median of oil betas. In columns (1) and (3), the coefficients on the interaction terms are negative and significant, while those in columns (2) and (4) are not. These results are similar to those of the previous analysis using market risks. These results imply that the effects of using derivatives are more pronounced in firms with high exposure to oil price risks. In other words, the value of additional cash holdings could decrease when firms are exposed to oil price risks and they hedge these risks using derivatives.

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In addition to using the systematic risk, we investigate the effects of derivatives use on cash value by dividing firms based on total and idiosyncratic risks. We use monthly stock returns to calculate annual volatility. Table 10 shows that the use of derivatives reduces the cash value in firms with high stock volatility, while the effect is not significant in those with low stock volatility. Similar results are observed in the analysis using oil and gas derivatives. Table 11 provides the results of an analysis using firm-specific risks. In this study, firm-specific risk is calculated as the fitted error terms after fitting market, size, and book-to-market factors annually. The results indicate similar trends to previous findings in the literature. Our results are also consistent to those of Bartram et al. (2011), who find that the use of financial derivatives could reduce both total and systematic risks.

In summary, our subsample analysis shows that derivatives use affects the decrease in cash value for firms with high risk exposure; for other firms, derivatives use might not affect the marginal value of cash holdings. Thus, cash holdings could be more valuable for high-risk firms because they can use the cash for a wide range of purposes. However, if some risks can be eliminated using derivatives, holding additional cash may be negatively evaluated by stakeholders because cash holdings can be substituted by derivatives.

6. Conclusion

This study investigates the market evaluation of additional cash held by firms to hedge risks using derivatives. To the best of our knowledge, it is the first to empirically examine the relationship between a firm's derivatives use and the marginal value of its cash holdings. The precautionary motive for holding cash is driven by hedging risk, as reserved cash can be used to maintain valuable investments or meet unexpected costs. In particular, we analyze the derivatives use and corporate cash holdings of 155 U.S. oil and gas producers from 1998 to 2017.

Using manually collected data, we find that a firm's use of derivatives for hedging could reduce the marginal value of its cash holdings, which indicates a negative relationship—consistent with previous studies. This finding is especially significant for oil and gas derivatives because our sample firms belong to the oil and gas industry. These results imply that the value of cash holdings may decrease if firms are already hedging their risks using derivatives related to their own business. These results are robust to the use of oil disruption as an exogenous shock and PSM analysis and indicate a substitution relationship between derivatives use and cash holdings.

Furthermore, we investigate how shareholders evaluate cash value when firms use derivatives to hedge risks. Our empirical results support a substitution relationship between cash holdings and derivatives use in the oil and gas industry. Because derivatives are effective tools for controlling price uncertainty, their use could reduce the demand for cash holdings to hedge potential risk. As Faulkender & Wang (2006) assert, additional cash may be valuable when firms have lower levels of cash or lower leverage. In other words, the marginal value of cash may decrease when firms already hold large cash amounts. We show that firms may substitute cash holdings with derivatives when the latter can be appropriately used for hedging risks. In turn, if firms use derivatives effectively, they could increase shareholder value by increasing dividends or investing in more valuable projects.

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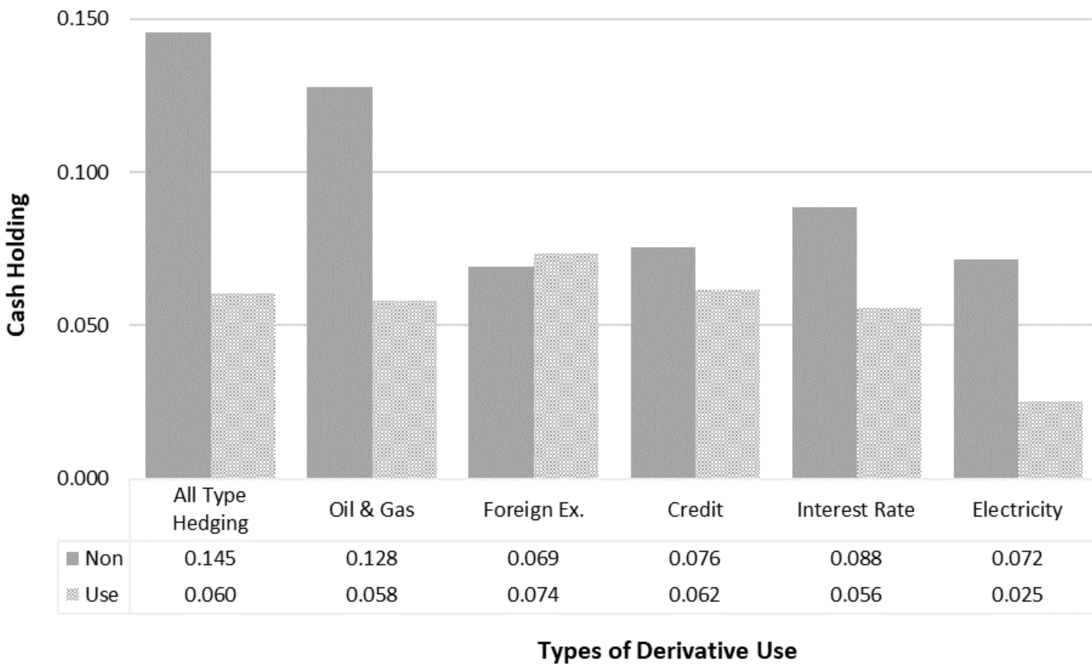
Figure 1: Cash Holdings by Derivative Uses



This figure shows the corporate cash holdings based on the derivatives use of the sample firms. Corporate cash holdings are measured as the sum of cash and cash equivalents divided by total assets.

Table 1: Sample Distribution by Risk Types

This table summarizes the types of risk the sample firms are exposed to and whether the firms use derivatives to hedge risks on a firm-year basis. Risk types include oil and gas price risk, foreign exchange rate risk, credit risk, interest rate risk, and electricity price risk. All Hedging Types indicates whether the firms use derivatives to hedge the above risks.

	Derivative Uses		
Risk Type	Non	Use	Total
Oil & Gas	259	1,105	1,364
Foreign Ex.	1,113	251	1,364
Credit	822	542	1,364
Interest Rate	603	761	1,364
Electricity	1,319	45	1,364
All Type Hedging	156	1,208	1,364

Table 2: Summary statistics

This table provides the summary statistics of the study variables. i and t indicate a firm and the end of a fiscal year, respectively. $r_{i,t} - R_{i,t}$ represents an excess stock return. ΔCash$_t$, ΔEarning$_t$, ΔNon-Cash$_t$, ΔR&D$_t$, ΔInterest$_t$, ΔDividend$_t$ indicate the changes in cash holdings, earnings, net assets, research and development expenses, interest expenses, and common dividends from year t-1 to t, respectively. Cash$_{t-1}$ denotes the cash holdings in the prior year. Leverage$_t$ and Net Financing$_t$ represent firms' market leverage and net financing, respectively. The t-statistics of the coefficient estimates are in parentheses. *, **, and *** denote significance at the 1%, 5%, and 10% levels, respectively.

	All Observations (N = 1,364)		Derivative Use = 0 (N = 156)		Derivative Use = 1 (N = 1,208)		Difference in means
	Mean	*Std.Dev.*	*Mean*	*Std.Dev.*	*Mean*	*Std.Dev.*	*t-stat.*
$r_{i,t} - R_{i,t}$	0.052	0.682	0.057	0.824	0.052	0.662	0.10
$Cash\,holdings_t$	0.070	0.133	0.145	0.182	0.060	0.096	9.15***
$\Delta Cash_t$	0.039	0.805	0.034	0.192	0.040	0.852	-0.10
$\Delta Earning_t$	0.100	0.947	0.029	0.332	0.109	0.999	-0.10
$\Delta Non\text{-}Cash_t$	0.026	0.396	0.012	0.075	0.027	0.42	-0.45
$\Delta R\&D_t$	-0.001	0.020	0.000	0.000	-0.001	0.021	-0.45
$\Delta Interest_t$	0.006	0.156	0.005	0.029	0.006	0.165	-0.05
$\Delta Dividend_t$	0.001	0.012	0.000	0.002	0.001	0.013	-0.80
$Leverage_t$	0.252	0.188	0.14	0.149	0.266	0.188	-8.05***
$Net\,Financing_t$	0.096	0.517	0.098	0.284	0.095	0.540	0.05

Table 3: Probit models examining the association between cash holdings and the decision to use derivatives

This table provides the results of the probit regression models. The dependent variable is a dummy variable indicating whether the firm has a derivatives contract during an observation year. Column (1) includes all kinds of derivatives use, and columns (2)–(6) show the results of each kind of derivative separately (Oil & Gas, Foreign Exchange, Credit Risk, Interest Rate, and Electricity). All control variables used in the previous tables are included with cash holdings. The pseudo R-squared is estimated by one minus the log likelihood of the model with all controls divided by the log likelihood of a model with a constant. The sample period is from 1998 to 2017. The z-statistics of the coefficient estimates are in parentheses. *, **, and *** denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable					
	(1) All Type Hedging	(2) Oil & Gas	(3) Foreign Exchange	(4) Credit Risk	(5) Interest Rate	(6) Electricity
$Cash\,holdings_t$	-2.295***	-1.905***	0.965**	-0.985**	-1.257***	-5.061**
	(-4.696)	(-4.588)	(1.967)	(-2.366)	(-3.314)	(-2.473)
$\Delta Cash_t$	0.380	0.120	-0.856*	-0.013	-0.001	0.199
	(0.934)	(0.529)	(-1.947)	(-0.132)	(-0.013)	(1.305)
$\Delta Earning_t$	0.054	0.147**	-0.048	-0.058	-0.062	-0.012
	(0.494)	(2.044)	(-0.811)	(-1.233)	(-1.410)	(-0.100)
$\Delta Non\text{-}Cash_t$	0.036	-0.294	0.018	0.081	-0.004	-0.262
	(0.088)	(-1.286)	(0.061)	(0.362)	(-0.017)	(-0.531)
$\Delta R\&D_t$	-6.447	-15.412	33.355	10.584	-15.004	4.824
	(-0.212)	(-0.424)	(0.366)	(0.498)	(-0.651)	(0.101)
$\Delta Interest_t$	-0.106	0.514	0.038	0.193	0.139	0.208
	(-0.238)	(0.746)	(0.095)	(0.632)	(0.411)	(0.335)
$\Delta Dividend_t$	9.028	1.783	-1.955	4.613	10.749**	6.289*
	(1.140)	(0.423)	(-0.507)	(1.602)	(2.239)	(1.810)
$Cash_{t-1}$	0.644	-0.594**	-0.895**	1.514***	-0.365	-0.449
	(1.488)	(-2.226)	(-2.120)	(4.682)	(-1.482)	(-0.470)
$Leverage_t$	1.806***	0.819***	0.054	0.874***	0.713***	-0.342
	(5.315)	(3.285)	(0.220)	(4.235)	(3.463)	(-0.784)
$Net\,Financing_{t-1}$	-0.106	-0.044	-0.204	-0.259**	0.040	-0.027
	(-1.040)	(-0.507)	(-1.392)	(-2.344)	(0.490)	(-0.145)
Observations	1,364	1,364	1,364	1,364	1,364	1,364
Pseudo R^2	0.109	0.0622	0.0107	0.0388	0.0322	0.0526

Table 4: Baseline regression

This table contains the results of the following regression model: $r_{i,t} - R^{ff}_{i,t} = \beta_0 + \beta_1 \frac{\Delta C_{i,t}}{M_{i,t-1}} + \beta_2 \cdot Hedge_{i,t} + \beta_3 \cdot Hedge_{i,t} \cdot \frac{\Delta C_{i,t}}{M_{i,t-1}} + \beta' \cdot X + \epsilon_{i,t}$, where $r_{i,t} - R^{ff}_{i,t}$ is an excess stock return for firm i during fiscal year t, $\Delta C_{i,t}$ is the change in cash holdings from year $t-1$ to year t, $M_{i,t-1}$ is the market value of equity at the end of year $t-1$, $Hedge_{i,t}$ is an indicator variable equal to 1 if the firm uses derivatives for hedging risk and 0 otherwise, and X contains the control variables from Faulkender & Wang (2006). $R^{ff}_{i,t}$ is estimated as the difference between the actual stock return and benchmark portfolio return based on the 25 Fama & French (1993)'s size and book-to-market portfolio. The sample period is from 1998 to 2017. The t-statistics of the coefficient estimates are in parentheses. *, **, and *** denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable = $r_{i,t} - R_{i,t}$					
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta Cash_t \times Hedge_t$	-1.184***	-1.145***	-1.158***	-1.256***	-1.201***	-1.161***
	(-4.145)	(-4.110)	(-4.142)	(-4.185)	(-4.039)	(-3.887)
$Hedge_t$	0.034	0.134**	0.130**	0.003	0.027	0.035
	(0.576)	(2.316)	(2.256)	(0.032)	(0.283)	(0.363)
$\Delta Cash_t$	1.203***	1.105***	1.141***	1.254***	1.158***	1.162***
	(4.228)	(4.000)	(4.137)	(4.189)	(3.922)	(3.941)
$\Delta Earning_t$		-0.028	-0.03		-0.018	-0.014
		(-1.314)	(-1.429)		(-0.852)	(-0.652)
$\Delta Non\text{-}Cash_t$		0.111	0.07		0.084	0.029
		(1.379)	(0.821)		(1.084)	(0.349)
$\Delta \text{R\&D}_t$		-1.186	-1.282		-1.500*	-1.574*
		(-1.295)	(-1.397)		(-1.676)	(-1.758)
$\Delta Interest_t$		-0.058	-0.052		-0.008	0.012
		(-0.444)	(-0.396)		(-0.050)	(0.076)
$\Delta Dividend_t$		3.185**	2.991**		1.16	1.095
		(2.189)	(2.057)		(0.728)	(0.688)
$Cash_{t-1}$		-0.247**	-0.443***		-0.203*	-0.488***
		(-2.515)	(-3.457)		(-1.909)	(-3.144)
$Leverage_t$		-0.835***	-0.827***		-0.830***	-0.845***
		(-8.424)	(-8.345)		(-5.930)	(-6.035)
$Net\,Financing_{t-1}$		0.098***	0.113***		0.097***	0.113***
		(2.662)	(3.026)		(2.588)	(2.966)
$\Delta Cash_t \times Cash_{t-1}$			0.022			-0.037
			(0.352)			(-0.618)
$\Delta Cash_t \times Leverage_t$			-0.676**			-0.518*
			(-2.471)			(-1.899)
Firm FE	No	No	No	Yes	Yes	Yes
Year FE	No	No	No	Yes	Yes	Yes
Observations	1,364	1,364	1,364	1,364	1,364	1,364
Adjusted R^2	0.011	0.080	0.084	0.203	0.234	0.237

Table 5: Types of Market Risks

This table provides the results of OLS regression models with dummy variables indicating whether firms use each kind of derivatives in the observation year. The dependent variable is an excess stock return estimated as the difference between the actual stock return and benchmark portfolio return based on the 25 Fama & French (1993)'s size and book-to-market portfolio. Derivatives are classified as Oil & Gas, Foreign Exchange, Credit Risk, Interest Rate, and Electricity. The sample contains 1,364 firm-year observations from 1998 to 2017. All the results are provided after controlling for firm-fixed and year-fixed effects. t-statistics of the coefficient estimates are in parentheses. *, **, and *** denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable = $r_{i,t} - R_{i,t}$				
	(1)	(2)	(3)	(4)	(5)
$\Delta Cash_t \times Oil\&Gas_t$	-0.802***				
	(-3.466)				
$Oil\&Gas_t$	-0.022				
	(-0.280)				
$\Delta Cash_t \times Foreign\,Ex._t$		-0.071			
		(-0.143)			
$Foreign\,Ex._t$		0.124			
		(1.457)			
$\Delta Cash_t \times Credit_t$			0.166		
			(0.790)		
$Credit_t$			0.059		
			(0.852)		
$\Delta Cash_t \times Interest\,Rate_t$				-0.104	
				(-1.357)	
$Interest\,Rate_t$				-0.021	
				(-0.372)	
$\Delta Cash_t \times Electricity_t$					-0.21
					(-0.333)
$Electricity_t$					-0.081
					(-0.492)
$\Delta Cash_t$	0.791***	0.037	0.033	0.073	0.033
	(3.529)	(0.765)	(0.693)	(1.286)	(0.689)
$\Delta Earning_t$	-0.023	-0.013	-0.014	-0.021	-0.014
	(-1.058)	(-0.608)	(-0.641)	(-0.945)	(-0.631)
$\Delta Non\text{-}Cash_t$	0.042	-0.018	-0.015	0.075	-0.015
	(0.502)	(-0.218)	(-0.182)	(0.712)	(-0.182)
$\Delta \mathrm{R\&D}_t$	-1.616*	-1.658*	-1.574*	-1.719*	-1.584*
	(-1.802)	(-1.839)	(-1.747)	(-1.899)	(-1.758)
$\Delta Interest_t$	-0.002	0.022	0.026	-0.036	0.025
	(-0.011)	(0.138)	(0.166)	(-0.222)	(0.159)
$\Delta Dividend_t$	0.970	1.023	0.906	1.052	1.069
	(0.609)	(0.640)	(0.565)	(0.658)	(0.666)
$Cash_{t-1}$	-0.445***	-0.538***	-0.525***	-0.566***	-0.517***
	(-2.836)	(-3.423)	(-3.348)	(-3.570)	(-3.293)
$Leverage_t$	-0.829***	-0.855***	-0.848***	-0.841***	-0.855***
	(-5.909)	(-6.070)	(-6.018)	(-5.972)	(-6.048)
$Net\,Financing_{t-1}$	0.109***	0.128***	0.131***	0.119***	0.127***
	-2.835	-3.364	-3.437	-3.071	-3.345
$\Delta Cash_t \times Cash_{t-1}$	-0.000	-0.067	-0.067	-0.134*	-0.067
	(-0.004)	(-1.094)	(-1.111)	(-1.679)	(-1.105)
$\Delta Cash_t \times Leverage_t$	-0.717**	-0.491*	-0.677*	-0.335	-0.453
	(-2.554)	(-1.787)	(-1.850)	(-1.132)	(-1.595)
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	1,364	1,364	1,364	1,364	1,364
Adjusted R^2	0.235	0.228	0.228	0.228	0.227

Table 6: Oil Disruptions

This table reports the coefficient estimates of the model with the oil disruption period dummy and its interactions. The oil disruption dummy is equal to 1 if there was an oil price shock in the observation year and 0 otherwise. OPEC production cut (1999 and 2017), Venezuela oil strike (2002), surging distillate demand in China (2007), EU enforcement limiting over 10 ppm sulfur diesel (2008), and the collapse in Libya's oil production (2011 and 2014) are taken as the oil disruption periods. The dependent variable is an excess stock return estimated as the difference between the actual stock return and benchmark portfolio return based on the 25 Fama & French (1993)'s size and book-to-market portfolio. t-statistics of the coefficient estimates are in parentheses. *, **, and *** denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable = $r_{i,t} - R_{i,t}$	
	(1)	(2)
$\Delta Cash_t \times Hedge_t \times Oil\,Dist._t$	-1.496***	
	(-2.724)	
$\Delta Cash_t \times Hedge_t$	-0.494	
	(-1.276)	
$Hedge_t$	0.04	
	-0.421	
$\Delta Cash_t \times Oil\&Gas_t \times Oil\,Dist._t$		-0.760*
		(-1.859)
$\Delta Cash_t \times Oil\&Gas_t$		-0.422
		(-1.374)
$Oil\&Gas_t$		-0.024
		(-0.302)
$\Delta Cash_t \times Oil\,Dist._t$	1.414***	0.691*
	-2.604	-1.73
$Oil\,Dist._t$	0.494***	0.549***
	-3.555	-3.908
$\Delta Cash_t$	0.526	0.440
	-1.373	-1.476
$\Delta Earning_t$	-0.02	-0.027
	(-0.891)	(-1.198)
$\Delta Non\text{-}Cash_t$	0.102	0.101
	-0.955	-0.941
$\Delta R\&D_t$	-1.663*	-1.706*
	(-1.851)	(-1.893)
$\Delta Interest_t$	-0.031	-0.032
	(-0.192)	(-0.201)
$\Delta Dividend_t$	1.13	1.021
	-0.712	-0.642
$Cash_{t-1}$	-0.516***	-0.488***
	(-3.224)	(-3.004)
$Leverage_t$	-0.822***	-0.820***
	(-5.876)	(-5.845)
$Net\,Financing_{t-1}$	0.102***	0.099**
	-2.633	-2.509
$\Delta Cash_t \times Cash_{t-1}$	-0.092	-0.048
	(-1.186)	(-0.591)
$\Delta Cash_t \times Leverage_t$	-0.384	-0.649**
	(-1.338)	(-2.201)
Firm FE	Yes	Yes
Year FE	Yes	Yes
Observations	1,364	1,364
Adjusted R^2	0.241	0.236

Table 7: PSM analysis

This table reports estimated coefficient estimates of the model using the sample based on propensity score matching. Columns (1) and (2) contain the hedge dummy variable indicating whether the firm uses any derivatives in the observation year, and columns (3) and (4) contain the Oil & Gas hedge dummy variable, which is equal to 1 if the firm uses oil or gas derivatives in the observation year and 0 otherwise. The dependent variable is an excess stock return estimated as the difference between the actual stock return and benchmark portfolio return based on the 25 Fama & French (1993)'s size and book-to-market portfolio. t-statistics of the coefficient estimates are in parentheses. *, **, and *** denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable = $r_{i,t} - R_{i,t}$			
	(1)	(2)	(3)	(4)
$\Delta Cash_t \times Hedge_t$	-1.312	-1.187		
	(-1.065)	(-0.904)		
$Hedge_t$	0.044	0.025		
	-0.212	-0.119		
$\Delta Cash_t \times Oil\&Gas_t$			-0.984***	-1.417***
			(-3.203)	(-3.514)
$Oil\&Gas_t$			-0.071	0.057
			(-0.451)	-0.369
$\Delta Cash_t$	1.366***	1.297	0.931***	1.457***
	(3.370)	(1.636)	(3.450)	(3.811)
$\Delta Earning_t$		-0.06		-0.095
		(-0.297)		(-1.198)
$\Delta Non\text{-}Cash_t$		0.265		0.094
		(0.867)		(0.483)
$\Delta R\&D_t$		102.024		242.839
		(0.167)		(0.200)
$\Delta Interest_t$		0.797		-0.311
		(0.238)		(-0.421)
$\Delta Dividend_t$		-0.110		-2.540
		(-0.009)		(-0.373)
$Cash_{t-1}$		-1.176**		-0.732***
		(-2.126)		(-2.834)
$Leverage_t$		-1.817**		-1.466***
		(-2.595)		(-4.361)
$Net\,Financing_{t-1}$		0.685*		0.271*
		(1.835)		(1.772)
$\Delta Cash_t \times Cash_{t-1}$		0.167		0.445**
		(0.075)		(2.311)
$\Delta Cash_t \times Leverage_t$		-6.352*		-4.051***
		(-1.857)		(-4.343)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	312	312	518	518
Adjusted R^2	0.104	0.14	0.127	0.2

Table 8: Subsample analysis 1: Market Beta

This table provides the results for the subsamples divided by market risk, estimated using the CAPM model. Columns (1) and (2) contain the hedge dummy variable indicating whether the firm uses any derivatives in the observation year, and columns (3) and (4) contain the Oil & Gas hedge dummy variable, which is equal to 1 if the firm uses oil or gas derivatives in the observation year and 0 otherwise. The dependent variable is an excess stock return estimated as the difference between the actual stock return and benchmark portfolio return based on the 25 Fama & French (1993)'s size and book-to-market portfolio. t-statistics of the coefficient estimates are in parentheses. *, **, and *** denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable = $r_{i,t} - R_{i,t}$			
	(1) High	(2) Low	(3) High	(4) Low
$\Delta Cash_t \times Hedge_t$	-0.939**	-0.418		
	(-2.072)	(-0.761)		
$Hedge_t$	0.248	0.005		
	(0.921)	(0.035)		
$\Delta Cash_t \times Oil\&Gas_t$			-1.102**	-0.531
			(-2.482)	(-1.222)
$Oil\&Gas_t$			-0.007	-0.057
			(-0.037)	(-0.456)
$\Delta Cash_t$	0.945**	0.31	1.099**	0.394
	(2.119)	(0.639)	(2.522)	(0.931)
$\Delta Earning_t$	0.003	-0.113**	0.003	-0.122**
	(0.091)	(-2.115)	(0.095)	(-2.273)
$\Delta Non\text{-}Cash_t$	0.085	0.002	0.106	-0.001
	(0.292)	(0.010)	(0.366)	(-0.004)
$\Delta R\&D_t$	-80.518	-13.436	-79.71	-17.001
	(-0.553)	(-0.409)	(-0.548)	(-0.537)
$\Delta Interest_t$	-0.118	-0.317	-0.133	-0.436
	(-0.468)	(-0.512)	(-0.525)	(-0.701)
$\Delta Dividend_t$	0.973	-10.471	0.920	-10.827
	(0.323)	(-1.380)	(0.306)	(-1.427)
$Cash_{t-1}$	-0.544	-0.599	-0.525	-0.507
	(-1.602)	(-1.545)	(-1.546)	(-1.279)
$Leverage_t$	-0.814***	-1.444***	-0.814***	-1.422***
	(-3.727)	(-4.664)	(-3.737)	(-4.608)
$Net\,Financing_{t-1}$	0.262***	0.103*	0.260***	0.098*
	(2.654)	(1.855)	(2.647)	(1.777)
$\Delta Cash_t \times Cash_{t-1}$	-0.069	0.146	-0.062	0.129
	(-0.660)	(0.326)	(-0.595)	(0.291)
$\Delta Cash_t \times Leverage_t$	-0.615	-0.358	-0.619	-0.376
	(-1.188)	(-0.375)	(-1.193)	(-0.404)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	567	532	567	532
Adjusted R^2	0.234	0.254	0.236	0.256

Table 9: Subsample analysis 2: Oil Beta

This table provides the results for the subsamples divided by the oil beta following Jin & Jorion (2006). Based on the CAPM model, daily prices of the NYMEX near-month oil futures contract is used to measure the oil beta. Columns (1) and (2) contain the hedge dummy variable indicating whether the firm uses any derivatives in the observation year, and columns (3) and (4) contain the Oil & Gas hedge dummy variable, which is equal to 1 if the firm uses oil or gas derivatives in the observation year and 0 otherwise. The dependent variable is an excess stock return estimated as the difference between the actual stock return and benchmark portfolio return based on the 25 Fama & French (1993)'s size and book-to-market portfolio. t-statistics of the coefficient estimates are in parentheses. *, **, and *** denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable = $r_{i,t} - R_{i,t}$			
	(1) High	(2) Low	(3) High	(4) Low
$\Delta Cash_t \times Hedge_t$	-1.632***	0.148		
	(-3.161)	(0.312)		
$Hedge_t$	0.323	0.042		
	(1.569)	(0.318)		
$\Delta Cash_t \times Oil\&Gas_t$			-1.206***	0.125
			(-2.906)	(0.275)
$Oil\&Gas_t$			0.158	-0.043
			(0.937)	(-0.377)
$\Delta Cash_t$	1.701***	0.212	1.240***	0.230
	(3.329)	(0.499)	(3.101)	(0.574)
$\Delta Earning_t$	-0.003	-0.104**	-0.015	-0.103**
	(-0.095)	(-2.143)	(-0.441)	(-2.113)
$\Delta Non\text{-}Cash_t$	-0.151	-0.061	-0.095	-0.063
	(-1.027)	(-0.370)	(-0.629)	(-0.383)
$\Delta R\&D_t$	-0.652	35.287	-0.712	35.382
	(-0.638)	(0.958)	(-0.696)	(0.961)
$\Delta Interest_t$	-0.390	0.637	-0.288	0.668
	(-0.526)	(1.199)	(-0.384)	(1.223)
$\Delta Dividend_t$	2.904	-9.304*	2.360	-9.388*
	(0.808)	(-1.960)	(0.655)	(-1.958)
$Cash_{t-1}$	-0.613*	-0.940**	-0.570	-0.942**
	(-1.748)	(-2.530)	(-1.602)	(-2.522)
$Leverage_t$	-0.639***	-1.286***	-0.583**	-1.294***
	(-2.767)	(-5.112)	(-2.518)	(-5.142)
$Net\,Financing_{t-1}$	0.201*	0.120**	0.209**	0.120**
	(1.954)	(2.471)	(2.021)	(2.472)
$\Delta Cash_t \times Cash_{t-1}$	-0.077	-0.350	-0.025	-0.342
	(-0.886)	(-0.938)	(-0.271)	(-0.914)
$\Delta Cash_t \times Leverage_t$	-0.570	-1.000	-0.813	-0.998
	(-1.025)	(-1.014)	(-1.445)	(-1.012)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	568	531	568	531
Adjusted R^2	0.307	0.218	0.303	0.218

Table 10: Subsample analysis 3: Stock Volatility

This table provides the results for the subsamples divided by stock price volatility. One-year stock return volatility is calculated using the monthly stock returns. Columns (1) and (2) contain the hedge dummy variable indicating whether the firm uses any derivatives in the observation year, and columns (3) and (4) contain the Oil & Gas hedge dummy variable, which is equal to 1 if the firm uses oil or gas derivatives in the observation year and 0 otherwise. The dependent variable is an excess stock return estimated as the difference between the actual stock return and benchmark portfolio return based on the 25 Fama & French (1993)'s size and book-to-market portfolio. t-statistics of the coefficient estimates are in parentheses. *, **, and *** denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable = $r_{i,t} - R_{i,t}$			
	(1) High	(2) Low	(3) High	(4) Low
$\Delta Cash_t \times Hedge_t$	-1.429***	0.974		
	(-3.361)	(1.281)		
$Hedge_t$	-0.065	0.121		
	(-0.472)	(0.758)		
$\Delta Cash_t \times Oil\&Gas_t$			-0.890***	0.636
			(-2.852)	(0.972)
$Oil\&Gas_t$			-0.099	-0.022
			(-0.829)	(-0.186)
$\Delta Cash_t$	1.457***	-0.628	0.906***	-0.576
	(3.458)	(-1.166)	(2.986)	(-1.076)
$\Delta Earning_t$	-0.012	0.076	-0.024	0.071
	(-0.453)	(0.647)	(-0.874)	(0.598)
$\Delta Non\text{-}Cash_t$	0.004	-0.013	0.016	0.005
	(0.036)	(-0.059)	(0.146)	(0.025)
$\Delta R\&D_t$	-2.358*	36.114	-2.404**	35.741
	(-1.932)	(1.143)	(-1.965)	(1.130)
$\Delta Interest_t$	0.004	1.884	-0.012	1.548
	(0.021)	(1.122)	(-0.064)	(0.901)
$\Delta Dividend_t$	1.091	-1.903	0.922	-1.717
	(0.554)	(-0.494)	(0.467)	(-0.445)
$Cash_{t-1}$	-0.395**	-0.512	-0.347*	-0.591
	(-1.974)	(-1.172)	(-1.719)	(-1.348)
$Leverage_t$	-0.865***	-0.961***	-0.837***	-0.923***
	(-4.284)	(-3.721)	(-4.137)	(-3.591)
$Net\,Financing_{t-1}$	0.068	0.189	0.064	0.183
	(1.386)	(1.323)	(1.285)	(1.279)
$\Delta Cash_t \times Cash_{t-1}$	-0.048	1.433	-0.005	1.700
	(-0.636)	(0.911)	(-0.066)	(0.986)
$\Delta Cash_t \times Leverage_t$	-0.357	-3.538**	-0.576*	-2.891*
	(-1.063)	(-2.168)	(-1.650)	(-1.890)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	762	602	762	602
Adjusted R^2	0.227	0.227	0.223	0.275

Table 11: Subsample analysis 4: Idiosyncratic Risk

This table provides results for the subsamples divided by the idiosyncratic risk. The idiosyncratic risk is calculated based on Fama and French's three-factor 5x5 model. Columns (1) and (2) contain the hedge dummy variable indicating whether the firm uses any derivatives in the observation year, and columns (3) and (4) contain the Oil & Gas hedge dummy variable, which is equal to 1 if the firm uses oil or gas derivatives in the observation year and 0 otherwise. The dependent variable is an excess stock return estimated as the difference between the actual stock return and benchmark portfolio return based on the 25 Fama & French (1993)'s size and book-to-market portfolio. t-statistics of the coefficient estimates are in parentheses. *, **, and *** denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable = $r_{i,t} - R_{i,t}$			
	(1) High	(2) Low	(3) High	(4) Low
$\Delta Cash_t \times Hedge_t$	-0.877**	3.228		
	(-2.022)	(1.383)		
$Hedge_t$	0.089	0.127		
	(0.522)	(0.928)		
$\Delta Cash_t \times Oil\&Gas_t$			-0.726*	2.471
			(-1.947)	(1.433)
$Oil\&Gas_t$			0.063	-0.090
			(0.428)	(-0.770)
$\Delta Cash_t$	0.968**	-3.676	0.807**	-2.912
	(2.272)	(-1.508)	(2.236)	(-1.591)
$\Delta Earning_t$	-0.015	-0.040	-0.022	-0.022
	(-0.445)	(-0.391)	(-0.657)	(-0.215)
$\Delta Non\text{-}Cash_t$	-0.140	0.000	-0.126	-0.002
	(-1.045)	(0.000)	(-0.930)	(-0.005)
$\Delta R\&D_t$	-1.550	24.050	-1.564	24.448
	(-1.235)	(1.049)	(-1.246)	(1.066)
$\Delta Interest_t$	0.123	-1.256	0.104	-1.249
	(0.582)	(-0.740)	(0.494)	(-0.736)
$\Delta Dividend_t$	2.432	-3.236	2.023	-3.248
	(0.495)	(-1.177)	(0.410)	(-1.181)
$Cash_{t-1}$	-0.673**	-0.844*	-0.623*	-0.900*
	(-2.036)	(-1.668)	(-1.869)	(-1.795)
$Leverage_t$	-0.890***	-0.675***	-0.872***	-0.687***
	(-3.431)	(-3.341)	(-3.361)	(-3.404)
$Net\,Financing_{t-1}$	0.099*	0.309**	0.099*	0.302**
	(1.755)	(2.314)	(1.749)	(2.264)
$\Delta Cash_t \times Cash_{t-1}$	-0.118	-10.328***	-0.093	-10.329***
	(-1.318)	(-3.421)	(-1.010)	(-3.481)
$\Delta Cash_t \times Leverage_t$	-0.505	2.912	-0.579	2.948
	(-1.028)	(1.154)	(-1.170)	(1.172)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	567	532	567	532
Adjusted R^2	0.197	0.324	0.196	0.324