THE TIME VARYING PROPERTY OF FINANCIAL DERIVATIVES IN ENHANCING FIRM VALUE

Bach Dinh and Hoa Nguyen*

School of Accounting, Economics and Finance
Faculty of Business and Law
Deakin University
221 Burwood Highway
Burwood VIC 3125
Australia

Corresponding author Email: hoa.nguyen@deakin.edu.au;

Phone: 03 92446190 Fax: 03 92446283

THE TIME VARYING PROPERTY OF DERIVATIVES IN ENHANCING FIRM VALUE

Abstract

In this paper, we investigate the role of derivatives in enhancing firm value using a sample of 94 U.S oil and gas exploration and production companies between 2005 and 2008. More importantly, we aim to examine whether the ability of financial derivatives to enhance firm value through hedging exercises is time varying as a function of commodity price volatility. Our results show that although hedging is associated with a firm value discount as measured by Tobin's Q for the entire sampling period, the hedging discount is only present in the period characterised by increasing oil and gas prices. During the period of falling oil and gas prices, hedging is found to enhance firm value. This result is consistent with the notion that a hedging program is most valuable to a resources firm when commodity prices decline.

Key words: financial derivatives, firm value, hedging, resources firms

JEL Classification: G21, G32

1. Introduction

Can corporate risk management via the use of financial derivatives enhance firm value? That is the question that a stream of corporate finance literature has been trying to address. Studies that looked at incentives for corporate hedging appear to suggest that hedging can be a value enhancing exercise since corporations hedge to minimize expected taxes, underinvestment costs and financial distress costs (Nance, Smith and Smithson 1993). Nevertheless, studies that investigate the direct relationship between hedging and firm value have met with conflicting results. Allayannis and Weston (2001) examine the relationship between foreign currency hedging and Tobin's Q and conclude that hedging activities enhance firm value. The notion of a hedging premium is further supported by Carter, Rogers, and Simkins (2006) in a sample of US airlines. On the other hand, Jin and Jorion (2006) find that hedging does not seem to affect firm value in oil and gas producers or even influences firm value negatively in gold mining companies (Jin and Jorion 2007). While numerous factors could potentially explain the discrepancy in these empirical findings, it appears that the success of a hedge in monetary terms is largely dependent on treasury forecasts and once the hedging decision has been made, the behaviour of the underlying source of risk. For example, in the context of a resource firm that have revenue-based commodity price exposures, hedging is most financially beneficial, at least in the short run, when commodity price falls and vice versa when commodity price increases. Accordingly, in this paper, we aim to reinvestigate the relationship between hedging, commodity price exposure and firm value in a sample of US oil and gas companies that have been documented in Jin and Jorion (2006) in an updated period of 2005 – 2008. In doing so, we pay particular attention to the behaviour of oil and gas price and how such fluctuations in commodity price affect the dynamic of the relationship between hedging and firm value. Our examination of the time varying property of derivatives in affecting firm value constitutes a major contribution of this paper.

Oil and gas is chosen as the industry of interest for a number of reasons. First, the movement in oil and gas prices has a direct and immediate effect on the cash flow of oil and gas companies. Second, the homogeneity of the oil and gas industry can provide a unique prospective from which to analyse the value of firms' hedging activities. The identification of the impact of corporate derivative use would be easier with a homogenous industry compared to multi-sector industry where other significant factors may come into play. Comparison of Q ratios in a multi-sector industry sample may be contaminated by the effect of other variables not included in the analysis (Geczy et al. 1997). Finally, hedging in the oil and gas industry may potentially influence firm value because the oil and gas reserves make up a significant portion of the total value of companies in this industry.

The sampling period of 2005 – 2008 provides another interesting motivation for this study. During this period, the price of oil and gas experienced unusually high volatility, partly due to the turmoils in the financial markets caused by the global financial crisis. Hedging, by definition, adds value by reducing the volatility of the firm's expected cash flows. As the result, the value of hedging activities is expected to be maximized during this volatile sampling period. We also choose a sample of US firms as a significant advantage in using a sample U.S companies is data availability. From the 1990s, US companies are required to disclose information regarding market risk and usage of derivatives instruments in the balance sheet. These improved reporting requirements provide a richer set of hedging data available in financial reports for our study.

Our results show that although significant exposure to oil (gas) prices are evident in approximately one third (sixth) of the firms, the extent of hedging as measured by the proportion of production and reserves hedged does not appear to be associated with a lower level of exposure. In addition, the incidence of hedging seems to link to a lower Tobin's Q as a proxy of firm value while the actual hedging deltas are not documented to bear any relationship with firm value. However, a closer examination reveals that the hedging discount was only present in periods of increasing oil and gas prices. For periods characterised by falling oil and gas prices, hedging actually leads to an increase in firm value. Our finding offers an alternative viewpoint about the motives behind corporate hedging. Hedging discounts previously documented have been linked to a managerial aversion motive where hedging is the product of managers aiming to maximize their own utility. In our study, the hedging discount is more likely to be the result of consistent hedging policy over prolonged period of increasing oil and gas price during the 2005 – 2007 period. As a result, the negative impact on firm value from hedging is a manifestation of incorrect expectations of firms in relation to future movements of oil and gas price rather than managerial risk aversion. From this perspective, the hedging discount is not necessarily the result of managerial risk aversion. Our finding that hedging activities only result in a discount in an inflationary environment has an important implication for studies that investigate the relationship between firm value and hedging. The dynamic of this relationship is time varying and largely depends on the behaviour of commodity price during the sampling period.

The remainder of this paper proceeds as follows. The next section offers a brief literature review. Data and methodology are documented in Section 3. We discuss our results in Section 4 and Section 5 concludes.

2. Literature Review

As was previously mentioned, existing studies examining the relationship between hedging and firm value did not provide a conclusive result and empirical evidence is mixed. Jorion (1990) examines foreign currency hedging activities in a sample of U.S multinational companies and finds that these firms' foreign currency beta is close to zero which implies that currency hedging would not affect firm value. On the other hand, Gagnon, Lypny and McCurdy (1998) document that dynamic hedging strategies lead to risk reduction and utility gain by constructing currency portfolios.

Rajgopal (1999) examines 38 U.S oil and gas companies and reports that oil and gas reserves as a proportion of total asset has a positive impact on the sensitivities of stock return to oil and gas price's change. Similarly, Jin and Jorion (2006) provide supporting results in a sample of 119 U.S oil and gas firms that there was no relationship between hedging and firm value, but hedging plays an important role in reducing stock return sensitivity to changes in oil and gas prices.[1] In contrast, the magnitude of oil and gas reserves increases stock return sensitivity to changes in oil and gas futures prices. In another study that looks at the gold mining industry, Jin and Jorion (2007) find that firms with hedging activities are associated with a discount to their firm value. Recently, Chen, Jin and Wen (2008) examine the impact of hedging and executive compensation on firm value in a sample of U.S oil and gas producers. They report that executive compensation motivates hedging decisions and consequently a negative relationship between hedging activities and firm value is found.

In one of the pioneer papers that directly address the relationship between hedging and firm value, Allayannis and Weston (2001) report a positive relationship between foreign currency hedging and firm value as measured by Tobin Q ratio in a sample of 720 U.S non-financial firms. Hedged firms are associated with a 5% on average hedging premium compared to non hedged firms. However, Guay and Kothari (2003) examine a sample of 234

[1] Geczy et al (1997) argue that examining the impact of hedging activities on multinational companies would be difficult because other factors such as foreign sales, foreign denominated debts and foreign tax also significantly affect firm value. Therefore, Jin and Jorion (2006) focuses on a homogeneous industry such as oil and gas or gold mining to provide more accurate results on the relationship between hedging and firm value.

large non-financial corporations and demonstrated that the proportion of hedging activities is economically small in relation to their entity-level risk exposures and have no significant effect on firm values. They also argue that the result from Allayannis and Weston (2001) could be spurious as the increase in firm value is affected by other risk management activities such as operational hedging which is correlated to derivative hedging. Carter, Rogers, and Simkins (2006) examine jet fuel price hedging in a sample of 28 American airline companies and report a similar result to that of Allayannis and Weston (2001). Fuel hedging in this industry increases the firm value by a significant 12-16% for hedged firms. Similarly, Bartram et al. (2003) find a positive impact of hedging activities on firm value by investigating interest rate hedging in a large sample of multi industry companies.[2]

Dan et al (2005) investigate the impact of hedging on stock return and firm value in a sample of Canadian oil and gas companies. The methodology in this research is different from previous studies by using nonlinear regression in investigating the payoff from hedging activities. They show that the relationship between stock returns and the change in oil and gas prices is nonlinear and the stock returns do not decrease as oil and gas prices decrease. In addition, gas hedging plays a more important role than oil hedging in reducing the sensitivity of stock returns. The proportion of oil and gas reserve also has a greater influence on stock return than hedging activities. Similarly, Dan et al (2005) examine the impact of hedging on firm value by using both linear and non linear models and highlight that hedging, profitability, leverage and reserves have significant effects on firm value. Furthermore, gas production hedging activities have a marginally negative impact on firm value while gas reserve hedging activities have a positive impact on firm value.

Most recently, Kapitsinas (2008) reports that hedged firms are associated with about 4.6% hedging premium on average in a sample of 81 non-financial Greek companies from 2004-2006. In addition, there is no evidence supporting the hypothesis that manager using hedging activities for their own personal interest. Rossi and Laham (2008) provide a similar result in a sample of non-financial Brazilian companies from 1996 to 2005. Similarly, Magee (2008) finds that foreign currency hedging is positively related to past Tobin's Q ratio in a sample of 408 large non-financial U.S companies. However, foreign currency hedging has no effect on firm value after controlling for the dependency of foreign currency hedging on past amount of Tobin's Q ratio.

---

[2] Bartram et al (2003), however, reported a statistically insignificant relationship between currency hedging and firm value

3. Data and Methodology

3.1 Data Set

Our initial sample is chosen by extracting from Compustat the list of firms with Global Industry Classification Standard code of 1010 for Energy industry group. This industry group includes five sub-classes: Integrated Oil and Gas, Oil and Gas Exploration and Production, Oil and Gas Refining and Marketing, Oil and Gas Storage and Transportation Coal and Consumable Fuels. However, only companies belonging to the Oil and Gas Exploration and Production sub-classes were chosen into the sample as these companies are more likely to have direct exposures to fluctuations in oil and gas prices, Furthermore, the value of these firms are more dependent on oil and gas prices than companies in other sub-classes.

Consistent with Jin and Jorion (2006), only firms that meet the following selection criteria are retained in the sample: the book value of total assets is greater than $20 millions,[3] 10-K reports are available from Edgar,[4] proved oil and gas reserves are reported in 10-K reports, sufficient information in 10-K reports for calculating hedging position. The application of these restrictions produce a final sample of 94 firms from 2005 to 2008, or 322 firm year observations.

3.2 Variables Description

3.2.1 Hedging

Hedging information for each firm year observation is manually collected from the 10-K annually from 2005-2008. The oil and gas industry in the US discloses more information compared to other countries because of the strict requirement on information disclosure. The U.S Security and Exchange Commission issued Financial Reporting Release No. 48 in January 2007 which required the disclosure of market risk information for all firms for fiscal year ending after June 1998. Under this rule, firms are required to report the quantitative information about the market risk in one of three formats: tabular, sensitivity analysis or value at risk; and oil and gas companies usually choose the tabular format.

---

3 Jin and Jorion (2006) states that firms with total assets of less than $20 million, called "small business issuers", are required to disclose less information. Therefore, it is hard to indentify whether firms do not hedge or do not disclose hedging information.

4 All companies, foreign and domestic, are required to file registration statements, periodic reports, and other forms electronically through EDGAR.

Under the tabular disclosure method, financial instruments are classified by four characteristics: fixed or variable rate assets or liabilities, long or short forwards or futures; written or purchased put or call options; receive fixed or variable swaps (Jin and Jorion 2006). In addition, SFAS 105, released by the Financial Accounting Standards Board in June 1990, requires firms to disclose information about financial instruments with off balance sheet risk for fiscal year ending after 1990. In general, SFAS 105 and FRR 48 require firms to report contract amounts and the weighted average price at which these contracts were entered into.

Following Jin and Jorion (2006), we measure hedging as the sum of delta equivalents of each position reported at fiscal year-end.[5] It is assumed that Δ = -1 for short position and Δ=1 for long position in all linear hedging instruments of crude oil and gas such as short futures and forwards, swaps and fixed price contracts. For nonlinear contracts such as options and collars, hedging deltas are calculated by using the Black's option pricing model as follows: [6]

$$\Delta\,(\text{call}) = e^{-rT} * N(d_1) \quad (1)$$

$$\Delta\,(\text{put}) = -e^{-rT} * N(-d_1) \quad (2)$$

$$d_1 = \frac{\text{Ln}\left(\frac{S}{X}\right)+\left(r+\frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}} \quad (3)$$

After determining the delta for each contract, the deltas are aggregated to obtain the total delta for crude oil and gas. We develop two measures of deltas as follows:

Relative delta oil (gas) production = - Total delta oil (gas)/ Next year oil(gas) production (4)
Relative delta oil (gas) reserve = - Total delta oil (gas)/Same-year proved oil (gas) reserve (5)

The first ratio demonstrates the degree of next year oil/gas production that is effectively hedged and the second ratio shows the proportion of the current reserve that is hedged.

Panel A of Table I provides a snapshot of the number of observations that have exposure to oil and gas prices while Panel B shows the number of observations that engage in hedging. A firm is said to have oil/gas exposure when the firm explores and produces oil/gas and thus is exposed to oil/gas price in that year. Out of 322 firm-year observations, 305 have exposure to both oil and gas prices 17 have exposure to only oil prices. All firms, however, have exposure to gas prices. Panel B breaks down the sample into observations of oil hedgers

---

5 This procedure provides a more precise measure of the extent of hedging than notional amounts or hedging dummy. This method also follows Tufano (1996).

6 In order to calculate the delta for nonlinear contracts in each firm year observation, an Excel program based on the Black's option price model was written.

and non-oil hedgers, gas hedger and non-gas hedgers. The hedging policies are similar in that most firms either hedge both oil and gas exposures (153 firm-years) or hedge neither of them (94 firm-years).

3.2.2 Firm Value

Consistent with the literature, in this study firm value is measured by Tobin's Q ratio. Traditionally, the Tobin's Q ratio is calculated by dividing the market value of a company by the replacement value of total assets. Consistent with Jin and Jorion (2006), three measures of Q ratios are employed as proxies for firm value:

$$Q_1 = \frac{\text{BV total assets} - \text{BV common equity} + \text{MV common equity}}{\text{BV total assets} - \text{BV oil (gas) proved reserves} + \text{NPV oil (gas) proved reserves}} \tag{6}$$

$$Q_2 = \frac{\text{BV total assets} - \text{BV common equity} + \text{MV common equity}}{\text{BV total assets} - \text{BV oil (gas) proved reserves} + \text{MV oil (gas) proved reserves}} \tag{7}$$

$$Q_3 = \frac{\text{BV total assets} - \text{BV common equity} + \text{MV common equity}}{\text{BV total assets}} \tag{8}$$

The numerators of Equations (6), (7) and (8) are identical and approximate the market value of the firm. The numerators are calculated by taking book value of total assets minus the book value of common equity and plus the market value of common equity. On the other hand, the denominators in these equations take different forms but they all approximate the replacement cost of total assets. For the Q_1 ratio, the denominator is calculated by taking book value of total assets minus the book value of oil/gas proved reserves and plus a "standardized measure of oil/gas proved reserves" which is determined in accordance with the rules and regulations of the SEC. The Net Present Value (NPV) of oil and gas proved reserves is measured as the present value of estimated future net revenues to be generated from the production of proved reserves less expenses such as general and administrative, debt service, future income tax, depreciation, depletion and amortization and discounted using an annual discount rate of 10%.[7] For Q_2, the NPV is replaced by the market value of oil/gas proved reserves without any adjustment. Q_3 is a simple Q ratio that uses the book value of

---

[7] The information needed for the calculation of NPV is obtained from the 10-K annual report. The market value of the reserve is calculated by multiplying the quantity of the reserve to market oil/gas price as at 31 Dec of a particular year.

total assets as a proxy for replacement costs. The measures using NPV or market value of proved reserves, however, are expected to better capture the replacement cost of total assets.

The descriptive statistics of the sample firms are presented in Table II. Panel A describes the whole sample. The sub-sample of oil hedging activities and gas hedging activities are reported in Panel B and C respectively. Panel D reports descriptive statistics for companies without hedging activities.

Total assets are measured at book value. The value of oil and gas reserve is the standardized measure of proved oil and gas reserves which are reported in annual 10-K reports. Oil (gas) production hedged (delta production) is the amount of production hedged divided by the actual oil (gas) production next year. Effectively, this measure gives an indication of the proportion of next year production that is hedged using financial derivatives. The oil (gas) reserve hedged (delta reserves) is the amount of reserves hedged divided by the oil (gas) reserve for the same year. As is indicated in Panel A of Table II, the average total asset for the entire of sample is around $3.5 billion. In addition, 10 percent of the companies have assets equal to or less than $69 million and similarly 10 percent of firms have total assets of more than $8.8 billion. The median total asset is significantly less than the mean which implies a skewed distribution caused by a number of extreme observations.

Panels B, C and D further show that the average total asset for oil hedging firms is around $4.9 billion, $5.1 billion for gas hedging firms and $0.44 billion for non-hedging firms. The mean total assets of non-hedging firms is significantly less than that of firms that hedge. This result is consistent with previous studies that larger firms are more likely to hedge than smaller firm. The MVE variable demonstrates similar patterns. The average MVE for the entire sample is $2.8 billion, for oil-hedged firms is $3.7 billion and $4.2 billion for gas-hedged firms. The non-hedged firms have an average MVE of $ 0.5 billion, which is 7.4 and 8.4 times smaller than oil hedgers and gas hedgers respectively. The mean of proved reserve value for the sample is around $3 billion which is more than 85% of total asset. For oil and hedging firm, the proved oil and gas reserves are 82.5% and 79% of their total assets on average respectively.

The values of Q_1 and Q_3 ratios are quite similar in all settings and they are much higher than the value of Q_2 ratio. The reason is that the denominator of Q_2 includes the market value of oil and gas reserves. This variable is calculated by multiplying the quantity of proved oil and gas reserves by the market price, and these values are substantially greater than the book value of oil and gas reserves which leads to a higher denominator for Q_2 .For the whole sample, the average values of Q_1, Q_2, and Q_3 are 1.72, 0.56 and 1.82 respectively while the median are 1.59, 0.43 and 1.46. Q ratios which are greater than one indicate that the market assess the firm to generate profits in excess to the cost of replacing its assets. A comparison of the mean and median Q values also shows a skewed distribution. More importantly, it is observed that Q ratios for oil and gas hedging firms are lightly lower than that of non hedging firms. This observation holds for all three measures of Q ratios.

As mentioned in the preceding section, out of 305 firm year observations with oil exposure from 2005 to 2008, 170 observations reported oil hedging activities. Of the firms that hedge, the mean (median) production delta is 41.35% (36.3%) of next year oil production which is approximately 4.7% (3.06%) of the proved oil reserve. Similarly, 211 observations, out of 322 with gas exposure, are engaged in gas hedging activities. The mean (median) gas delta is approximately 39% (34.32%) of next year gas production which amounts to roughly 4% (3.26%) of proved gas reserve. Compared to Jin and Jorion (2006), it can be seen that during the 2005-2008, companies hedge oil prices more intensively while the delta for gas hedging shows sign of declining compared to the 1998 – 2001 sampling period used in Jin and Jorion (2006). In particular, Jin and Jorion (2006) show that U.S oil producers hedged 33% of their next year oil production while gas producer hedged 41% of their next year gas production. There was not any firm with negative delta ratio in the entire sample which indicates that all firms truly hedge or have a net short total delta with oil and gas exposure.

3.2.3 Control Variables

In order to accurately estimate the effect of hedging activities on firm value, it is necessary to control other explanatory variable that potentially affect firm values. Following previous studies, the following control variables are included in the regressions: Firm size (natural logarithm of total assets), profitability (return on assets), investment growth (capital expenditures to total assets), access to financial markets (a dummy variable equalling to unity if the firm makes any payout to shareholders in a particular fiscal year and zero otherwise), leverage (book value of debt to market value of equity) and production costs (the cost of extracting oil and natural gas which includes both the lifting cost and production taxes). The information regarding production cost is collected manually from firm's 10-K annual reports either on the basis of per Boe (Barrel of oil equivalent) or per Mcfe (thousand cubic feet equivalent). The choice of our control variables is largely based on the literature.

3.3 Methodology

As the first step, we measure the sensitivity of individual firm monthly stock return to changes in oil/gas prices. Subsequently, the oil/gas beta is allowed to interact with the hedging variables to determine whether hedging has any impact on such sensitivity. The impact of hedging on firm value, on the other hand, is tested by comparing the Tobin's Q ratio in hedged and non hedged firms by univariate and multivariate analyses.

3.3.1 Hedging and Firm Stock Sensitivity

Following the method from Jin and Jorion (2006), the sensitivity of monthly firm stock return to changes of oil and gas prices are estimated by using a two or three factor model specified as below:

$$R_{i,t} = \alpha_i + \beta_{m,i} \times R_{mkt,t} + \beta_{oil,i} \times R_{oil,t} + \varepsilon_{i,t} \tag{9}$$

$$R_{i,t} = \alpha_i + \beta_{m,i} \times R_{mkt,t} + \beta_{gas,i} \times R_{gas,t} + \varepsilon_{i,t} \tag{10}$$

$$R_{i,t} = \alpha_i + \beta_{m,i} \times R_{mkt,i} + \beta_{oil,i} \times R_{oil,t} + \beta_{gas,i} \times R_{gas,t} + \varepsilon_{i,t} \tag{11}$$

where $R_{i,t}$ is the total stock return for firm i in month t., $R_{mkt,t}$ is the monthly rate of change in the stock market index, $R_{oil,t}$ is the monthly rate of change in the price of crude oil, $R_{gas,t}$ is the monthly rate of change in the price of natural gas and $\varepsilon_{i,t}$ is the error term.

The effect of hedging on and β_{oil} and β_{gas} are examined by estimating the following equations:

$$R_{i,t} = \alpha_1 + \beta_m \times R_{mkt,t} + \left(\gamma_1 + \gamma_2 \times \Delta_{oil,i} + \gamma_3 \times \frac{oil\ reserve_i}{MVE_i}\right) \times R_{oil,t} + \beta_{gas} \times R_{gas,t} + \varepsilon_{i,t} \tag{12}$$

$$R_{i,t} = \alpha_1 + \beta_m \times R_{mkt,t} + \beta_{oil} \times R_{oil,t} + \left(\gamma_1 + \gamma_2 \times \Delta_{oil,i} + \gamma_3 \times \frac{gas\ reserve_i}{MVE_i}\right) \times R_{gas,t} + \varepsilon_{i,t} \tag{13}$$

$$R_{i,t} = \alpha_1 + \beta_m \times R_{mkt,t} + \left(\gamma_1 + \gamma_2 \times \Delta_{oil,i} + \gamma_3 \times \frac{oil\ reserve_i}{MVE_i}\right) \times R_{oil,t} + (\gamma_4 + \gamma_5 \times \Delta_{gas,i} + \gamma_6 \times \frac{gas\ reserve_i}{MVE_i}) \times R_{gas,t} + \varepsilon_{i,t} \tag{14}$$

where Δ_{oil} is the relative production delta and oil reserve/MVE is the dollar value of reserves divided by the total market value of equity. Definitions of other variables remain the same as before.

Following the method of Jin and Jorion (2006), the betas of oil and gas in Equations (9) to (11) are replaced by a function of hedging delta and oil/gas reserves proportional to total assets. Hedging activities are expected to reduce the stock prices sensitivities to oil and gas prices therefore γ_2 *and* γ_5 are predicted to have a negative sign. On the other hand, the higher proportion of the assets in the form of oil and gas reserves is expected to increase the sensitivities of the stock return with the changes in oil and gas prices. This implies a positive sign for γ_3 *and* γ_6.

3.3.2 Hedging and Firm Value

To test for the relationship between hedging and firm value, the following regressions are estimated:

$$Ln\ Q\ ratios = \alpha + \beta \times Hedging\ dummy + \sum_j \gamma_j \times Control\ variable_j + \varepsilon \qquad (15)$$

$$Ln\ Q\ ratios = \alpha + \beta \times Delta\ Production + \sum_j \gamma_j \times Control\ variable_j + \varepsilon \qquad (16)$$

$$Ln\ Q\ ratios = \alpha + \beta \times Delta\ Reserve + \sum_j \gamma_j \times Control\ variable_j + \varepsilon \qquad (17)$$

where Q ratios are proxy for firm value. The natural logarithmic of Q ratios are used to control the skewness of the variables which has been discussed previously. This exercise is also essential to transform the distribution of the variable to a normal distribution. [8] In the above regressions, hedging variables include hedging dummy, delta production and delta reserves. The hedging dummy is equal 1 if the firm implements hedging activities in that year. Delta production is the ratio between total hedging positions and next year oil/gas production. Delta reserves is the ratio of total hedges to the proved oil/gas reserves at same year. Equations (15) to (17) are run for both oil and gas.

One of our important aims in this paper is to examine how commodity price volatility impacts the dynamic of the relationship between hedging and firm value. In particular, derivative usage is expected to provide benefits for the firm when oil and gas price falls as derivative contracts allow them to lock in a selling price that is likely to be higher than the market price at the time of delivery and vice versa. The sample from 2005-2008, when oil

---

[8] This method is also implemented in Jin and Jorion (2006), Lang and Stulz (1994) and Allayannis and Weston (2001) and in most other related studies

and gas prices experience high volatility, provides a perfect setting for this analysis to take place. In particular, as is evident from Figure I that plots the monthly prices of world crude oil and natural gas over the period of 2005-2009, oil and gas price demonstrate both an increasing and declining pattern in this period. To test for the impact of commodity price volatility on hedging firm value relationship, we develop two dummy variables D_A and D_B. D_A equals 1 if the observation is in year 2008 and 0 otherwise. D_B equals 1 if the observation is between 2005-2007 and equal 0 otherwise. The cut-off date is arbitrarily chosen based on the observation that the first period 2005-2007 corresponds to price increases while the fiscal year 2008 corresponds to price decreases. The sub-sample has an annual cut off due to the fact that hedging variables such as delta production and delta reserves can only be collected on an annual basis. The dummy variables are allowed to interact with the hedging variables as specified below:

$$Q\ ratio = \alpha + \beta_1 \times Hedging\ dummy\ \times D_B + \beta_2 \times Hedging\ dummy\ \times D_A\ + \sum_j \gamma_j \times Control\ variable_j + \varepsilon \quad (18)$$

$$Q\ ratio = \alpha + \beta_1 \times Delta\ Production \times D_B + \beta_2 \times Delta\ Production \times D_A + \sum_j \gamma_j \times Control\ variable_j + \varepsilon \quad (19)$$

$$Q\ ratio = \alpha + \beta_1 \times Delta\ Reserve \times D_B + \beta_2 \times Delta\ Reserve \times D_A + \sum_j \gamma_j \times Control\ variable_j + \varepsilon \quad (20)$$

4. Results

4.1 Stock Return Sensitivity and Hedging

Table III presents the statistical properties of the exposure coefficients from the two-factor and three-factor models. Two models are estimated for 94 firms by using monthly data over the period from 2006 to 2009, which are the years following the sample period over which hedging data are collected. Panel A presents the result for two-factor model for both oil and gas, while the result for three-factor model is reported in Panel B. In general, the table shows that the exposures to oil and gas prices are mostly positive and significant. This result is consistent with expectation as the most significant market risk of oil and gas companies is the volatility of commodity prices. A decrease in oil and gas price would lead to a significant decrease in revenue and cash flows, as well as firm value as the major assets of these firms are in the form of oil/gas reserves. Out of 94 regressions in the two-factor model, around 85% and 80% of coefficients are positive and significant for oil and gas models respectively. In terms of economic significance, the changes in oil price have more effect on the firm stock returns than the changes in gas price. For the median firms, a 1% increase in oil prices leads to an increase of 0.28% in the stock returns. The magnitude of this oil beta is largely consistent with previous studies (see Rajgopal 1999, Jin and Jorion 2006 and Dan et al 2005). However, a 1% increase in gas prices leads to an increase of 0.14% in the stock returns which is slightly higher than what is reported in Dan et al (2005) (0.1%) and much lower that the result found by Rajgopal (1999) (0.41%) and Jin and Jorion (2006) (0.29%).

Interestingly, none of the betas are significantly negative in both oil and gas models. 24.47% (10.64%) of oil (gas) betas are positive and significant at 5% level; and 36.17% (17.02%) of oil (gas) betas are positive and significant at 10% level.[9] As expected, market betas are statistically and economically significant. Specifically, a 1% change in market return leads to a 1.26% change in stock return on average. Around 98% percent of the market coefficients are positive; 76% and 80% of them are significant at 5% level and 10% level respectively. Similar to the oil and gas beta, market betas are largely positive.

Similar results are obtained from the three-factor model. However, compared to the two-factor model, oil and gas betas have less economic significance. The mean oil beta reduces from 0.317 to 0.294 and the gas beta from 0.143 to 0.083. The number of firms that have significant exposures to oil and gas price changes also declines. The three-factor model records 26.6% of firms with significant oil exposure and 13.83% of firms with significant gas exposure compared to 36.17% and 17.02% in the two factor model.

4.1.2 Effect of hedging on stock price sensitivity to oil and gas prices

Table IV summarises pooled cross-sectional time-series regressions of stock returns on the market and oil (gas) price changes, with coefficients adjusted for the effect of hedging and reserves, over the years 2006 to 2009. Panel A estimates separately the sample of oil and gas hedging firms and Panel B combines them. The signs of γ_2 *and* γ_5 are expected to be negative because hedging activities aim at reducing the exposure to oil and gas prices. However, the higher quantity of oil and gas reserves is expected to increase the sensitivities of the stock return with the changes in oil and gas prices. The implied expected sign for γ_3 *and* γ_6 is therefore positive. Table IV suggests that hedging activities and the proportion of oil and gas

[9] Jin and Jorion (2006) and Rajgopal (1999) used one-sided tests for statistical significance. However, the proportion of significant of oil and gas beta is not significantly higher than the result from our study, which made use of two-sided tests.

reserves to total assets do not have any impact on the stock prices sensitivities to oil and gas price exposures, as is evident by the lack of statistical significance of $\gamma_2, \gamma_3, \gamma_5, \gamma_6$.

The change in oil prices and market returns remains positive and significant parameters in estimating the firm stock returns. The effect of oil prices exposure to firm stock return is stronger in this model than in models without hedging and reserves variables. A 1% increase in oil return leads to an increase by 0.53%, 0.31% and 0.44% to firm stock return in separate oil model, gas model and in joint model respectively. The market return coefficients are consistent with previous estimations whereby a 1% increase in market return can lead to an increase in the region of 1.25-1.27% in firm stock return. However, gas return does not significantly affect stock return in either oil and gas separate models or joint model.

4.2 Firm Value and Hedging

4.2.1 Univariate Analysis

Results of univariate tests that investigate the difference in the mean Q ratio of hedgers and non-hedgers as a group are reported in Table V. As is evident from Table V, the Q ratios of firms with hedging activities are consistently lower than Q ratios of firms that do not hedge across different measures of Q. This result is similar to that of Jin and Jorion (2007) and Chen et al (2008). Both of these studies find that hedgers are associated with discount to their firm values. Chen et al (2008) further report that hedging activities are motivated by managerial risk aversion.

Panels A and B display the results in relation to oil hedging. Panel A compares Q ratios, total asset and market value of equity between oil hedging firms and non-oil hedging firms. The Q ratios of hedged firms are significantly lower than non-hedged firms in both panels. In Panel A, the average Q_1 value for hedgers is 1.58 and for non-hedger is 1.87, resulting a 0.29 difference which is approximately 18.3% and 15.5% of oil hedgers' and non-oil hedgers' firm value respectively. A comparison between median Q values of hedgers and non-hedgers yield similar result that firms that hedge have lower firm value than firms that do not hedge in relation to Q_3. Hedgers and non-hedgers, however, are not statistically different in relation to Q_1 and Q_2. In addition, the difference in median Q values is not as substantial compared to the mean difference. Panel B compares oil hedging firms with firms that do not engage in any type of hedging. The results in this Panel continue to suggest that oil hedgers have lower firm values than non-hedgers. The magnitude of the difference is even more significant compared to Panel A. The difference in mean Q_1, Q_2 and Q_3 is 0.38, 0.33 and 0.76 respectively in favour of non-hedgers.

Similar results are found for firms with gas exposure. Comparisons between gas hedging firms with respect to non-gas hedging firms and non-hedging firms are reported in Panel C and D respectively. In Panel C, the value discount of hedging amounts to 0.25, 0.33 and 0.52 for Q_1, Q_2 and Q_3 respectively. These differences in firm value increase to 0.32, 0.35 and 0.59 in Panel D.

Table V also presents the result for the mean equality test in relation to firm size. On average, oil hedging firms have 2.5 times more assets than non-oil hedging firm and 11 times more assets than non-hedging firms. Similarly, the total assets of gas hedging firms are 10.7 times greater than those of non-gas hedging firms and 11.7 times of non-hedging firms. The essence of the results does not change when the median values are used in the test. Overall, the univariate analysis shows uniformly the presence of a significant hedging discount for both oil and gas hedging activities. Furthermore, consistent with expectations, hedgers are found to be significantly larger than non-hedgers.

4.2.2 Multivariate Analysis

The results of multivariate analysis are reported in Table VI, where Panel A shows the outcome of pooled cross-sectional time-series least squares regression with the firm value measured by $Ln(Q_1)$, while in Panels B and C the same regression is re-estimated but the dependent variables are $Ln(Q_2)$and $Ln(Q_3)$.

In order to make the analysis comparable to other studies, initially we focus on analysing result from panel C with Q_3 measure of which the denominator is the book value of total assets in Panel C. One of the main variables used to test the relationship is the hedging dummy that equal 1 if a firm uses oil or/and gas hedging activities and 0 otherwise. The coefficients of the hedging dummy are negative and significant, at 1 % level for oil regression and 10% level for gas regression, which suggests that the existence of hedging activities significantly reduces the firm value. As the hedging dummy coefficient is interpreted as a change of x% in firm value due to full hedging ceteris paribus, firms with oil hedging activities are associated with a lower market value of the magnitude of 15.3 % and gas hedging activities associate with lower firm value by 12.3%. The result is similar in Panel A where firm value is measured by Q_1 ratio. Firms with oil hedging activities have a 14% lower market value, significant at 5% level. The most striking result in relation to the hedging dummy is the fact that hedging is associated with a firm value discount, in a range of 12.3 to 15.5% depending on the nature of the hedge (oil or gas).

Another important hedging variable is delta production. Panel C reports negative coefficients of production hedging for both oil and gas regressions, once again indicating that hedging associates with lower firm value. In particular, the coefficient of delta production for oil (gas) companies is – 0.146 (-0.233) which imply that firms that hedge 100% of their oil (gas) production next year would have a lower firm value of 14.6% (23.3%). However, gas producers, on average, hedge around 39% of their next year gas production therefore the effect from hedging activities to their firm values is only 9.1% discount. The production hedging are not significant to firm values neither for Q_1 and Q_2 measures, but the signs of their coefficients are the same and suggest that production hedging has a negative relationship with firm value.

The results are mixed in relation to the delta reserves variable, measured as the ratio of total hedge position over proved oil/gas reserves of the same fiscal year. The coefficients for delta reserves are not significant across the Panels except in gas regression in Q_2 measure. The gas producing firms that hedge 100% of their proved gas reserve would obtain a premium of 126.9% in their firm values. However, those firms hedge about 4% of their reserve therefore the hedging activities actually enhance their values by 5.1%. The coefficient of delta reserves in gas model with Q_3 measure has a negative value but it is insignificant. Those coefficients are not economically as well as statically significant in oil model in Panel A and C.

Table VI shows that most control variables have expected signs across all panels. The coefficients of log total assets are negative and significant at 1% level in Panels B and C, but it is not significant with Q_1 measure. Negative coefficient of log total asset suggests that smaller firms appear to have higher Q ratios. This result is consistent with the studies of Lang and Stulz (1994) and Allayannis and Weston (2001). The return on asset variable has a positive sign, as expected, which is consistent with result of Allayannis and Weston (2001). The result indicates that highly profitable firms appear to have higher Q ratios. This positive relationship is significant at 1% level in both oil and gas regression in Panel C, but it is insignificant in Q_1 and Q_2 models. The coefficients of growth opportunity, measured as the ratio of capital expenditure over total assets, show a statistically positive significant relationship with respect to firm value. The market seems to highly value firms with high capital expenditure and investment opportunities, which supports the evidence from Allayannis and Weston (2001). Firms with any form of payout (dividend or share repurchase) during the fiscal year have significantly higher Q ratio as payout can indicate positive signals from management about future profitability. Firms with higher leverage level are associated with a lower Q ratio, which is consistent with Kapitsinas (2008) who examine the impact of derivative use in Greek companies. The results are strongly significant at 1% level in Panels B and C for both oil and gas models and at 10% level in gas model in Panel A. Production costs, on the other hand, do not appear to have any impact on firm value.

4.2.3 The value of hedging and commodity price volatility

The results of our investigation on the impact of commodity price volatility on the dynamic of the relationship between hedging and firm value are reported in Table VII.[10] The introduction of dummy variables that proxy for periods of increasing/decreasing oil and gas prices produces major qualitative and quantitative changes to the results. Firms with hedging activities before fiscal year 2008 are associated with a significant discount to firm values compared to firms without derivative hedging. The coefficients for the hedging dummy D_B which depicts the effect of derivative usage on firm value in the increasing price period are negative across the panels in both oil and gas models and are strongly significant at 1% level using Q_2 and Q_3. In comparison with the results in the entire sample as presented in Table VI, the magnitudes of the hedging dummy during this period are extremely negative with the values of -0.350 and -0.376 in oil model; -0.484 and -0.406 in gas model using Q_2 and Q_3 respectively. The coefficients provide a manifestation that firms with oil hedging are associated with a discount of 35%-37.6% to their firm values; while firms with gas hedging activities have lower firm value by approximately 40.6% to 48.4%.

On the other hand, the coefficients of the hedging dummy (D_A) for the second period, characterised by falling commodity prices, have positive signs, as expected, which can be interpreted as hedged firms were observing hedging premiums. A premium in a range of 15.6% - 17.3%, is present in firms with exposure to crude oil price through the use of derivatives. The premium of derivatives usage is consistent with the previous research of Allayannis and Weston (2001) and in line with Carter et al (2006) and Lookman (2003), who report that hedging created premium of 3.6% - 14% and in some excessive cases, the premium can reach 16% -26%.

The result from other hedging variable, delta production, also supports the hypotheses that hedging activities in 2005-2007 is associated with a lower firm value while firm value is

---

[10] The coefficients relating to the control variables are not reported in Table VII to conserve space and are available from authors upon request.

actually enhanced via hedging activities in 2008. The oil model reports significant negative coefficients of delta production for firm year observations before 2008 with the value -0.438 and -0.317 using Q_2 and Q_3 measures. The result can be interpreted as firms with oil derivatives in years 2005-2007 who hedge 100% of next year oil production, have lower firm value by a magnitude of 31.7% to 43.8 %. However, the oil production companies hedge 41.35% of their next year production on average, therefore the impacts of hedging actually are 13.1% or 18.1% lower Q ratio which are in line with the result for the entire sample reported in Table VI.

Derivative usage to hedge gas price exposure provides a similar result. For a firm in 2005-2007 that hedges 100% of their next year gas production, a discount of 59% to 73.5% to is documented. However, since firms do not hedge 100% of production, the actual impacts of gas hedging are a discount of 23% to 28.65%. These results are strongly statically significant at 1% level using Q_2 and Q_3 measures. The positive coefficients for delta production in fiscal year 2008 provide the evidence that oil hedging activities are highly rewarded by the market in times of declining oil and gas price. For the firms with oil hedging, the firm value would increase by 29.6% if a full hedge is observed. Given that a full hedge is not undertaken by firms in 2008, firms that engage in hedging are associated with higher firm values of approximately 12.2% on average. The impact of gas hedging activities is not significant in this case.

The final hedging variable, delta reserves, provides a similar result and supports the hypotheses. The signs of coefficients in oil model fluctuate and in general are not significant across the panels. However the results in the gas model are strongly significant at 1% level using Q_2 and Q_3 measures and are in accordance with the expectations. Firms with hedging activities in years 2005-2007 have lower value by a range of 592.2% to 635.8% if they hedge 100% of their proved reserve gas. On average, their total hedge position is about 4% of the quantity of reserve. Therefore the actual reduction is from 23.7% to 25.4%. On the other hand, firms that hedge during the decreasing period of gas price (2008) are rewarded by investors with higher valuation. The positive coefficient with the magnitude of 1.593 is found in Panel B using Q2 measure indicating that the users of gas derivatives have higher firm value than nonuser by 159.3% if they hedge 100% of their reserve. On average firms hedge 4% of their reserves, therefore the hedging impact in the sample is a 6.4% discount.

4.3 Robustness Checks

We conduct a number of robustness checks to ensure the reliability of the results reported earlier. In particular, this section will provide empirical test for potential non-linearity between hedging and firm value. In addition, to eliminate the concern that the results might have been impacted upon by the existence of outliers, the regressions are re-estimated on an adjusted sample after outliers are removed. The final robustness check that is conducted replaces the OLS model by the fixed effect model in estimating the coefficients. These robustness tests are detailed below.

4.3.1 Testing for Non Linearity

Dan et al (2005) find that hedging activities affect firm value and firm monthly stock return in a non-linear manner in a sample of Canadian oil and gas firms by employing nonlinear semi-parametric additive models. To test for non-linearity, the square of delta production and delta reserves variables are introduced in Equations (14) to (16), specifically, the following equations are estimated:

$$Ln\ Q\ ratio = \alpha + \beta \times Delta\ Production + \delta \times Delta\ Production^2 + \sum_j \gamma_j \times Control\ variable_j + \varepsilon \quad (21)$$

$$Ln\ Q\ ratio = \alpha + \beta \times Delta\ Reserve + \delta \times Delta\ Reserve^2 + \sum_j \gamma_j \times Control\ variable_j + \varepsilon \quad (22)$$

The coefficient of interest here is δ as a statistically significant δ indicates a non-linear relationship between firm value and the extent of hedging. Nevertheless, out of 12 variants of the above regressions, δ is statistically significant in one variant where firm value is proxied by Q2 and hedging is measured as delta reserves. This lack of statistical significance confirms the non-existence of non-linearity in the current sample and results reported in preceding sections are not affected by potential non-linearity. Panel A of Table VIII presents these results.

4.3.2 Outlier Removal

The main purpose of this exercise is to minimise the noise in the data and to improve the accuracy and the fit of regressions which depict the relationship between hedging and firm value more reliably. In conducting this exercise, observations with production hedging ratio (delta) in excess of 1 are removed from the sample. A delta greater than 1 suggests that the firm hedges more than 100% of its next year production. As a result, derivative usage in these firms may be driven by factors other than a demand to hedge oil and gas exposures. By removing outliers for delta production, outliers for delta reserves are automatically removed as these two variables are highly correlated. 15 firm year observations are removed in total, for both oil and gas models. The removal of outliers, however, does not produce any significant difference in the reported data. The essence of our reported data remains largely unchanged and most notably, hedging continues to be associated with lower firm value. These results are reported in Panel B of Table VIII

4.3.3 Fixed Effect

As a final robustness check, the fixed effect model is used to estimate the coefficients instead of the pooled OLS model. The main reason for the use of a balanced panel data model is to control for the unobservable heterogeneity which can affect the level of Q ratios. There are characteristics that are difficult to be observed or measured and they vary among across firms but remain constant overtime or vary among period but remain constant to firms. By using the simplest and most common method of balanced panel data pooled OLS, the estimator can be biased because this method does not take into account the effect of heterogeneity.

Two variations of the fixed effect models are employed. The first model assumes that the coefficients are the same for every company but different between years. The estimates are equivalent to estimating OLS model and adding a dummy variable for each year in the sample. The second model assumes that individual companies have different coefficients but they are constant in different years. The estimates are equivalent to estimating OLS model and adding a dummy variable for each individual company in the sample. The results derived from the fixed effect models however do not largely differ from what is reported earlier. Only one exception exists in relation to the fixed effect model with fixed cross-section. In this setting, hedging no longer appears to have an impact on firm value as the coefficients on hedging variables are no longer statistically significant. Fixed effects results are reported in Panel C of Table VIII.

- The impacts of oil and gas price exposures on firm stock returns are positive and significant. However, there is lack of relationship between hedging and exposure.

- Firms that hedge have lower firm value compared to those that do not. Oil hedging is associated with a hedging discount in the region of 14% – 15% while gas hedging produces a hedging discount to the magnitude of 9.1% – 12.3%.

- The hedging discount is only present in periods of increasing oil and gas prices. On the contrary, in periods of declining prices, hedging is found to have a positive impact on firm value. The hedging discount can be as substantial as 48.6% while hedging policies in periods characterized by falling oil and gas prices produce a hedging premium between 6.4% – 17.3%.

5. Conclusion

In this paper, we detail an empirical study of the impact of hedging on firm risk and firm value in a sample of 94 U.S oil and gas companies from 2005 to 2008. Our main findings are as follows. First, approximately 17%-36% of firms have significant exposures to oil and gas prices. However, we do not find any evidence to support the hypothesis that hedging reduces the sensitivity of stock return to commodity's price exposure. Second, the empirical findings are strongly suggestive of a negative and significant relationship between hedging and firm value. The magnitude of the impact differs between oil hedging and gas hedging. Firms with oil hedging policies experience a decrease in values of 14%-15% while gas hedging is associated with a 9.1% -12.3% hedging discount. Finally and most interestingly, we find that the negative impact of hedging on firm value is only evident in periods of increasing oil and gas prices. In an inflationary environment where oil and gas price increases, hedging plays an important role in enhancing firm value. This finding is a major contribution of this paper and has the potential to explain the discrepancies in results previously documented regarding the relationship between hedging and firm value.

Table I: Description of Sample by Exposure and Hedging Decisions

Panel A splits the total sample of 322 firm-years into observations with and without oil exposure, and with and without gas exposure. The observation is said to have oil/gas exposure when the firm explore and produce oil/gas and thus are exposed to oil/gas price in that year. Panel B breaks down the sample into observations with or without hedging activities as oil hedgers and non oil hedgers, gas hedger and non gas hedgers.

Panel A: Distribution of Exposures Across Firm-Years

	Oil exposure	Non-oil exposure	Total
Gas exposure	305	17	322
Non-gas exposure	0	0	0
Total	305	17	322

Panel B : Distribution of Hedging Decisions for Firm-Years with Exposure to Both Factors

	Oil Hedgers	Non-oil Hedgers	Total
Gas hedgers	153	58	211
Non-gas hedgers	17	94	111
Total	170	152	322

Table II: Summary Statistic for Firm Characteristics

Panel A describes the sample of 94 U.S oil and gas companies from 2005 to 2008, with a total of 322 firm-year observations. Subsamples of firm-years with oil hedging activities are reported in Panel B and with gas hedging activities are reported in Panel C. Panel D describes firm-years without any hedging activities. Total assets represent BV of assets. The value of reserves is the standardized measure of oil and gas reserves, as reported in 10-Kannual reports. Oil/gas production hedged is the total amount of hedging divided by the actual production next year. Oil/gas reserve hedged is the amount of hedging divided by the oil/gas reserves reported for the same year. The three Q ratios share the same numerator and differ only in the denominator. Numerator = BV total assets − BV common equity + MV common equity. The denominators for Q_1, Q_2, Q_3, respectively, are BV total assets − BV oil/gas proved reserves + NPV proved reserves; BV total assets − BV oil/gas proved reserves + MV proved reserves; and BV of assets.

	Observation	Mean	SD	Median	10th per	90th per	Maximum
Panel A: All Firm-Years							
Total Asset ($m)	322	3,553	8,136	668	69	8,852	58,844
MVE ($m)	322	2,807	6,400	547	39	7,079	39,495
Reserve ($m)	322	2,995	6,186	619	70	8,374	48,739
Q_1	322	1.72	1.32	1.59	0.86	2.91	5.01
Q_2	322	0.56	0.64	0.43	0.21	0.91	1.64
Q_3	322	1.82	1.15	1.46	0.91	3.12	10.54
Panel B : Firm-Years with Oil Hedging Activities							
Total Asset ($m)	170	4,898	9,388	1,330	244	12,089	58,844
MVE ($m)	170	3,715	6,429	1,252	129	11,746	35,803
Reserve ($m)	170	4,040	7,709	1,081	162	10,329	48,739
Oil Delta Prod (%)	170	41.35	33.99	36.3	4.45	83.68	182.34
Oil Delta Res (%)	170	4.70	9.56	3.06	0.30	9.43	115.58
Q_1	170	1.58	0.99	1.51	1.00	2.34	5.01
Q_2	170	0.47	0.26	0.43	0.21	0.74	1.71
Q_3	170	1.49	0.58	1.33	0.91	2.24	4.35
Panel C : Firm-Years with Gas Hedging Activities							
Total Asset ($m)	211	5,145	9,641	1,330	175	15,815	58,844
MVE ($m)	211	4,256	7,295	1,219	128	15,143	39,495
Reserve ($m)	211	4,056	7,572	1,104	130	10,419	48,739
Gas Delta Pro (%)	211	38.98	26.92	34.32	5.21	75.34	137.52
Gas Delta Res (%)	211	4.05	7.28	3.26	0.51	7.44	100.95
Q_1	211	1.63	1.26	1.60	0.96	2.52	5.01
Q_2	211	0.45	0.21	0.43	0.21	0.68	1.64
Q_3	211	1.63	1.05	1.37	0.91	2.48	10.54

Panel D : Firm-Years without Hedging Activities							
Total Asset ($m)	94	440	740	132	38	1,495	38,254
MVE ($m)	94	498	799	217	37	1,092	20,440
Reserve ($m)	94	369	915	67	13	1,157	31,281
Q_1	94	1.98	1.55	1.62	0.57	3.91	8.06
Q_2	94	0.82	1.11	0.44	0.21	1.27	6.78
Q_3	94	2.23	1.33	1.92	0.87	4.12	5.93

Table III: Statistical Properties of Stock Price Exposure

This table presents the statistical properties of the exposure coefficients from the two-factor model, specified as follows:

$$R_{i,t} = \alpha_i + \beta_{m,i} \times R_{mkt,t} + \beta_{oil,i} \times R_{oil,t} + \varepsilon_{i,t} \quad (9)$$

$$R_{i,t} = \alpha_i + \beta_{m,i} \times R_{mkt,t} + \beta_{gas,i} \times R_{gas,t} + \varepsilon_{i,t} \quad (10)$$

where $R_{mkt,t}$, $R_{oil,t}$, and $R_{gas,t}$ are the S&P return, the change in the crude oil price, and the change in the natural gas price, respectively. The cross-sectional distribution of the slope coefficients is reported in Panel A. Panel B reports the result of the three-factor model, specified as follows:

$$R_{i,t} = \alpha_i + \beta_{m,i} \times R_{mkt,i} + \beta_{oil,i} \times R_{oil,t} + \beta_{gas,i} \times R_{gas,t} + \varepsilon_{i,t} \quad (11)$$

The sample consists of 94 firms' monthly stock returns from January 2006 to December 2009.

Panel A : Two-Factor Model

	Oil Model		Gas Model	
	Beta_market	Beta_oil	Beta_market	Beta_gas
Mean	1.264	0.317	1.474	0.143
Median	1.222	0.284	1.436	0.140
SD	1.066	0.567	0.863	0.185
Minimum	-5.474	-2.306	-2.302	-0.416
Maximum	5.020	4.039	3.610	0.706
Percent >0	96.81%	85.11%	97.87%	80.85%
Percent > 0;significant at p=5%	75.53%	24.47%	81.91%	10.64%
Percent > 0;significant at p= 10%	79.79%	36.17%	86.17%	17.02%
Percent < 0;significant at p=5%	0.00%	0.00%	0.00%	0.00%

Panel B : Three-Factor Model

	Beta_market	Beta_oil	Beta_gas
Mean	1.255	0.294	0.083
Median	1.217	0.247	0.088
SD	1.062	0.602	0.224
Minimum	-5.412	-2.323	-0.921
Maximum	5.017	4.314	0.766
Percent >0	96.81%	84.04%	71.28%
Percent > 0; significant at p= 5%	76.60%	19.15%	6.38%
Percent > 0; significant at p=10%	80.85%	26.60%	13.83%
Percent < 0; significant at p=5%	0.00%	0.00%	0.00%

Table IV: Effect of Hedging on Oil and Gas Betas

This table summarises pooled cross-sectional time-series regressions of stock returns on the market and oil (gas) price changes, with coefficients adjusted for the effect of hedging and reserves, over the years 2006 to 2009. Panel A models the oil and gas betas separately.

$$R_{i,t} = \alpha_1 + \beta_m \times R_{mkt,t} + \left(\gamma_1 + \gamma_2 \times \Delta_{oil,i} + \gamma_3 \times \frac{oil\ reserve_i}{MVE_i}\right) \times R_{oil,t} + \beta_{gas} \times R_{gas,t} + \varepsilon_{i,t} \quad (12)$$

where Δ_{oil} is the relative production delta and oil reserve/MVE is the dollar value of reserves divided by the total market value of equity. Panel B jointly models the oil and gas beta

$$R_{i,t} = \alpha_1 + \beta_m \times R_{mkt,t} + \left(\gamma_1 + \gamma_2 \times \Delta_{oil,i} + \gamma_3 \times \frac{oil\ reserve_i}{MVE_i}\right) \times R_{oil,t} + (\gamma_4 + \gamma_5 \times \Delta_{gas,i} + \gamma_6 \times \frac{gas\ reserve_i}{MVE_i}) \times R_{gas,t} + \varepsilon_{i,t} \quad (14)$$

In Panel A, regressions include oil (gas) hedging firms only. In the Panel B, regressions include all firms with both oil and gas exposures and some hedging activities. White-adjusted *t*-statistics are reported between parentheses. ***, **,* denote significance at the 1%, 5% and 10% levels, respectively.

Panel A: Separate Oil and Gas Beta Model

Independent Variables	Oil Regression	Gas regression
R_mrt	1.275	1.247
	(4.73)***	(5.63)***
R_oil	0.531	0.310
	(2.49)**	(2.83)***
R_gas	0.048	0.124
	(0.42)	(0.77)
Delta_(oil/gas) x R_(oil/gas)	-0.343	-0.192
	(-0.95)	(-0.58)
[Reserve_(oil/gas)/MVE] x R_(oil/gas)	-0.001	0.005
	(-0.06)	(0.30)
Adjusted R-squared	2.20%	2.40%
Number of Observations	2,059	2,506

Panel B: Joint Oil and Gas Beta Model

Independent Variable	Coefficients	t-Statistics
R_mrt	1.29	(4.28)***
R_oil	0.44	(1.83)*
Delta_oil x R_Oil	-0.23	(-0.58)
[Reserve_oil/MVE] x R_oil	0.00	(-0.11)
R_gas	0.15	(0.68)
Delta_gas x R_gas	-0.22	(-0.48)
[Reserve_gas/MVE] x R_gas	0.00	(0.05)
Adjusted R-squared	1.69%	
Number of Observations	1,843	

Table V : Comparison of Hedgers and Non-hedgers

This table compares the mean and median of three measures of *Q* ratios, total assets, and market value of equity for hedgers and non-hedgers. Panel A compares firms with oil hedging activities and firms without oil hedging activities. Panel B compares firms with oil hedging activities to firms with neither oil nor gas hedging activities. Similarly, Panel C compares the firms with and without gas hedging activities, and Panel D compares firms with gas hedging activities to firms with neither oil nor gas hedging activities. Comparison of means is constructed using a *t*-test; comparison of medians is constructed using Wilcoxon rank-sum *Z*-test. Two-sided *p*-values are reported.

Panel A: Oil Hedging versus Nonoil Hedging Firm-Years

Variable	Hedgers (n=170)	Non-hedgers (n=152)	Difference	Z-Score	p-value
Q_1 (mean)	1.58	1.87	-0.29	1.99	0.05
Q_1(median)	1.51	1.64	-0.13	1.41	0.16
Q_2 (mean)	0.47	0.66	-0.19	2.68	0.01
Q_2 (median)	0.43	0.43	0	0.98	0.33
Q_3 (mean)	1.49	2.18	-0.69	5.59	0.00
Q_3 (median)	1.33	1.72	-0.38	4.1	0.00
TA ($m,mean)	4,898	2,030	2,868	-3.2	0.00
TA ($m,median)	1,330	240	1,090	7.78	0.00
MVE ($m,mean)	3,715	2,181	1,534	-2.23	0.03
MVE ($m,median)	1,252	343	909	5.47	0.00

Panel B: Oil Hedging versus Non Hedging Firm-Years

Variable	Hedgers (n=170)	Non-hedgers (n=93)	Difference	Z-Score	p-value
Q_1 (mean)	1.58	1.96	-0.38	2.42	0.02
Q_1(median)	1.51	1.62	-0.11	0.43	0.67
Q_2 (mean)	0.47	0.8	-0.33	3.78	0.00
Q_2 (median)	0.43	0.43	0	1.57	0.12
Q_3 (mean)	1.49	2.25	-0.76	6.42	0.00
Q_3 (median)	1.33	1.96	-0.63	4.43	0.00
TA ($m,mean)	4,898	441	4,457	-4.59	0.00
TA ($m,median)	1,330	147	1,183	9.69	0.00
MVE ($m,mean)	3,715	511	3,204	-4.81	0.00
MVE ($m,median)	1,252	224	1,028	7.25	0.00

Table V: Comparison of Hedgers and Non-hedgers (cont)

Panel C: Gas Hedging versus Non-gas Hedging Firm-Years

Variable	Hedgers n=211	Non-hedgers n=111	Difference	Z-Score	p-value
Q_1 (mean)	1.63	1.88	-0.25	1.61	0.11
Q_1(median)	1.6	1.49	0.11	0.59	0.55
Q_2 (mean)	0.44	0.77	-0.33	4.45	0.00
Q_2 (median)	0.43	0.43	0	2.03	0.04
Q_3 (mean)	1.64	2.16	-0.52	3.93	0.00
Q_3 (median)	1.37	1.92	-0.55	3.8	0.00
TA ($m,mean)	5,169	480	4,690	-5.1	0.00
TA ($m,median)	1,330	178	1,152	9.81	0.00
MVE ($m,mean)	4,276	562	3,714	-5.33	0.00
MVE ($m,median)	1,237	253	983	7.22	0.00

Panel D: Gas Hedging versus Non Hedging Firm-Years

Variable	Hedgers n=211	Non-hedgers n=95	Difference	Z-Score	p-value
Q_1 (mean)	1.63	1.96	-0.32	1.95	0.05
Q_1(median)	1.6	1.62	-0.02	0.09	0.93
Q_2 (mean)	0.44	0.79	-0.35	4.47	0.00
Q_2 (median)	0.43	0.43	0	1.85	0.06
Q_3 (mean)	1.64	2.23	-0.59	4.2	0.00
Q_3 (median)	1.37	1.96	-0.59	3.93	0.00
TA ($m,mean)	5,169	439	4,731	-4.76	0.00
TA ($m,median)	1,330	147	1,184	9.75	0.00
MVE ($m,mean)	4,276	512	3,764	-5	0.00
MVE ($m,median)	1,237	224	1,013	7.31	0.00

Table VI: Hedging and Firm Value

This table presents the pooled cross-sectional time-series least squares regressions of the impact of hedging on firm value. The models are

$$Ln\ Q\ ratios = \alpha + \beta \times Hedging\ dummy + \sum_j \gamma_j \times Control\ variable_j + \varepsilon \quad (15)$$

$$Ln\ Q\ ratios = \alpha + \beta \times Delta\ Production + \sum_j \gamma_j \times Control\ variable_j + \varepsilon \quad (16)$$

$$Ln\ Q\ ratios = \alpha + \beta \times Delta\ Reserve + \sum_j \gamma_j \times Control\ variable_j + \varepsilon \quad (17)$$

The dependent variables are measured by the natural log of Q_1, Q_2, and Q_3. The sample includes 94 firms from 2005 to 2008, or a total of 322 firm-years observation. The variable Hedging dummy is a dummy variable equal to one if the company hedges; delta production is the ratio of total hedges to production; and delta reserves is the ratio of total hedges to reserves. The control variables are as follows: log (asset) is the log of BV of total assets; *ROA* is defined as the ratio of net income to total assets; Investment_growth is measured as the ratio of capital expenditure over total assets; Leverage is defined as the BV of long-term debt over MV of common equity; Payout dummy equals one if the firm has some form of payout including both dividend and share repurchase on its common equity in the current year and Production cost is dollar cost per barrel of oil equivalent. *t*-statistics are reported in the parentheses. *, **, *** denote significance at the 10%, 5% and 1% levels, respectively

	Oil			Gas		
	1	2	3	1	2	3
Panel A: Dependent Variable is LnQ1						
Hedging dummy	-0.140			-0.030		
	(-2.33)**			(-0.43)		
Delta_production		-0.057			-0.013	
		(-0.59)			(-0.12)	
Delta_reserve			0.002			0.118
			(0.08)			(0.26)
Log(asset)	0.077	0.042	0.015	0.052	0.043	0.041
	(1.91)*	(1.12)	(0.40)	(1.19)	(1.12)	(1.12)
ROA	0.060	0.082	0.065	0.093	0.093	0.092
	(0.44)	(0.59)	(0.47)	(0.68)	(0.67)	(0.66)
Invest_growth	0.421	0.405	0.340	0.420	0.413	0.407
	(2.27)**	(2.16)**	(1.77)*	(2.22)**	(2.15)**	(2.18)**
Payout dummy	0.118	0.120	0.117	0.113	0.112	0.112
	(2.08)**	(2.09)**	(2.03)**	(1.97)**	(1.96)**	(1.96)**
Leverage	-0.036	-0.038	-0.033	-0.045	-0.046	-0.047
	(-1.47)	(-1.48)	(-1.31)	(-1.79)*	(-1.77)*	(-1.89)*
Production cost	-0.002	-0.002	-0.003	0.008	0.008	0.008
	(-0.60)	(-0.69)	(-1.13)	(0.43)	(0.44)	(0.42)
Observation	316	316	316	316	316	316
R-squared	0.062	0.047	0.038	0.045	0.044	0.044

Table VI: Hedging and Firm Value (cont)

	Oil			Gas		
	1	2	3	1	2	3
Panel B: Dependent Variable is LnQ2						
Hedging dummy	0.05			-0.056		
	-0.66			(-0.66)		
Delta_production		-0.009			-0.166	
		(-0.07)			(-1.27)	
Delta_reserve			0.019			1.269
			-0.88			(2.38)**
Log(asset)	-0.228	-0.214	-0.257	-0.196	-0.198	-0.217
	(-4.68)***	(-4.70)***	(-5.63)***	(-3.76)***	(-4.31)***	(-4.93)***
ROA	0.147	0.141	0.134	0.146	0.151	0.133
	-0.88	-0.84	-0.81	-0.87	-0.9	-0.8
Invest_growth	0.114	0.123	-0.021	0.147	0.188	0.127
	-0.5	-0.54	(-0.08)	-0.65	-0.82	-0.57
Payout dummy	0.2	0.2	0.191	0.201	0.202	0.205
	(2.93)***	(2.92)***	(2.76)***	(2.92)***	(2.94)***	(3.00)***
Leverage	-0.097	-0.094	-0.078	-0.093	-0.085	-0.104
	(-3.22)***	(-3.04)***	(-2.61)***	(-3.06)***	(-2.73)***	(-3.46)***
Production cost	-0.002	-0.002	-0.005	-0.006	-0.004	-0.008
	(-0.58)	(-0.49)	(-1.48)	(-0.26)	(-0.18)	(-0.35)
Observation	319	319	303	319	319	319
R-squared	0.124	0.123	0.142	0.124	0.127	0.138
Panel C: Dependent Variable is LnQ3						
Hedging dummy	-0.153			-0.123		
	(-2.64)***			(-1.84)*		
Delta_production		-0.146			-0.233	
		(-1.63)			(-2.28)**	
Delta_reserve			0.006			-0.493
			-0.36			(-1.17)
Log(asset)	-0.119	-0.148	-0.188	-0.121	-0.139	-0.159
	(-3.12)***	(-4.14)***	(-5.46)***	(-2.98)***	(-3.86)***	(-4.57)***
ROA	0.491	0.515	0.469	0.518	0.523	0.516
	(3.78)***	(3.95)***	(3.79)***	(3.97)***	(4.03)***	(3.95)***
Invest_growth	0.824	0.821	0.723	0.85	0.891	0.803
	(4.71)***	(4.66)***	(4.16)***	(4.79)***	(4.97)***	(4.56)***
Payout dummy	0.065	0.07	0.053	0.068	0.07	0.065
	-1.21	-1.3	-1	-1.26	-1.3	-1.2
Leverage	-0.111	-0.107	-0.105	-0.111	-0.103	-0.115
	(-4.73)***	(-4.42)***	(-4.66)***	(-4.67)***	(-4.20)***	(-4.85)***
Production cost	-0.002	-0.002	-0.005	-0.015	-0.013	-0.014
	(-0.91)	(-0.82)	(-1.69)	(-0.90)	(-0.75)	(-0.85)
Observation	319	319	319	319	319	319
	0.233	0.222	0.233	0.222	0.227	0.217

Table VII: Firm Value and Commodity Price Volatility

This table presents the pooled cross-sectional time-series least squares regression of the impact of hedging on firm value. The models are

$$Q\ ratio = \alpha + \beta_1 \times Hedging\ dummy\ \times D_B + \beta_2 \times Hedging\ dummy\ \times D_A\ + \sum_j \gamma_j \times Control\ variable_j + \varepsilon \quad (18)$$

$$Q\ ratio = \alpha + \beta_1 \times Delta\ Production \times D_B + \beta_2 \times Delta\ Production \times D_A + \sum_j \gamma_j \times Control\ variable_j + \varepsilon \quad (19)$$

$$Q\ ratio = \alpha + \beta_1 \times Delta\ Reserve \times D_B + \beta_2 \times Delta\ Reserve \times D_A + \sum_j \gamma_j \times \ Control\ variable_j + \varepsilon \quad (20)$$

The dependent variables are measured by the natural log of Q_1, Q_2, and Q_3. The sample includes 94 firms from 2005 to 2008, or a total of 322 firm-years observation. D_B is the dummy variable equal 1 if the observation in year 2005-2007 and equal 0 otherwise. D_A is dummy variable is set to 1 if the observation in year 2008 and equal 0 otherwise. Other variables remain the same as described above. *t*-statistics are reported in the parentheses. *,**,*** denote significance at the 10%, 5% and 1% levels, respectively. The coefficients relating to control variables are not reported to conserve space.

	Oil			Gas		
	1	2	3	1	2	3
Panel A: Dependent Variable is LnQ1						
Hedging - price increase	-0.017	0.059	0.036	0.048	-0.005	-0.167
	(-0.18)	(0.45)	(0.47)	(0.49)	(-0.03)	(-0.10)
Hedging – price decrease	-0.176	-0.141	0.000	-0.049	-0.019	0.131
	(-2.74)***	(-1.21)	(-0.01)	(-0.67)	(-0.15)	(0.29)
R-squared	0.071	0.052	0.039	0.049	0.044	0.044
Panel B: Dependent Variable is LnQ2						
Hedging - price increase	-0.350	-0.438	-0.014	-0.484	-0.735	-5.922
	(-3.11)***	(-2.83)***	-(0.15)	(-4.28)***	(-4.35)***	(-3.08)***
Hedging – price decrease	0.153	0.296	0.020	0.044	0.193	1.593
	(2.02)**	(2.19)**	(0.94)	(0.52)	(1.33)	(3.02)***
R-squared	0.181	0.166	0.142	0.200	0.193	0.178
Panel C: Dependent Variable is LnQ3						
Hedging - price increase	-0.376	-0.317	-0.017	-0.406	-0.590	-6.358
	(-4.22)***	(-2.56)***	(-0.24)	(-4.53)***	(-4.39)***	(-4.18)***
Hedging – price decrease	-0.096	-0.025	0.007	-0.056	-0.007	-0.229
	(-1.61)	(-0.23)	(0.42)	(-0.85)	(-0.06)	(-0.549)
R-squared	0.258	0.232	0.233	0.271	0.265	0.256

Table VIII: Hedging and Firm Value: Robustness Checks

This table presents the results of our robustness checks. Panel A presents results relating to non-linearity tests. Table B shows the results when outliers are removed. Panel C finally shows that results estimated using fixed effects.*,**,*** denote significance at the 10%, 5% and 1% levels. Coefficients relating to control variables are not reported to conserve space.

	Oil		Gas	
	1	2	1	2
Panel A: Non-linearity tests				
Q1				
Delta	-0.451	0.028	0.043	-1.142
	(-2.08)**	-0.43	-0.15	(-0.97)
$Delta^2$	0.385	-0.001	-0.071	1.48
	(2.03)**	(-0.42)	(-0.21)	-1.16
Q2				
Delta	-0.116	0.047	-0.168	1.616
	(-0.44)	-0.59	(-0.50)	-1.17
$Delta^2$	0.105	-0.001	0.002	-0.409
	-0.45	(-0.37)	-0.01	(-0.27)
Q3				
Delta	-0.3	-0.013	-0.13	-2.985
	(-1.47)	(-0.22)	(-0.49)	(-2.77)***
$Delta^2$	0.151	0.001	-0.129	2.942
	-0.84	-0.33	(-0.42)	(2.51)**

	Oil			Gas		
	1	2	3	1	2	3
Panel B: Outlier Removal						
Hedging - Q1	-0.14	-0.19	0.067	-0.03	-0.003	0.118
	(-2.33)**	(-1.53)	(-0.18)	(-0.43)	(-0.02)	-0.26
Hedging - Q2	0.05	-0.04	1.208	-0.056	-0.175	1.269
	-0.66	(-0.28)	(2.73)***	(-0.66)	(-1.25)	(2.38)**
Hedging - Q3	-0.153	-0.203	-0.213	-0.123	-0.226	-0.493
	(-2.64)***	(-1.76)*	(-0.63)	(-1.84)*	(-2.06)**	(-1.17)
Panel C: Fixed Effects Model						
Hedging - Q1	-0.136	-0.027	0.014	-0.037	-0.029	-0.106
	(-2.23)**	(-0.29)	-0.03	(-0.52)	-0.26	(-0.24)
Hedging - Q2	-0.001	0.041	1.079	-0.107	-0.088	1.125
	(-0.01)	-0.38	(2.58)**	(-1.34)	(-0.70)	(2.23)**
Hedging - Q3	-0.199	-0.11	-0.287	-0.157	-0.155	-0.484
	(-3.76)***	(-1.33)	(-0.92)	(-2.56)***	(-1.64)*	(-1.24)

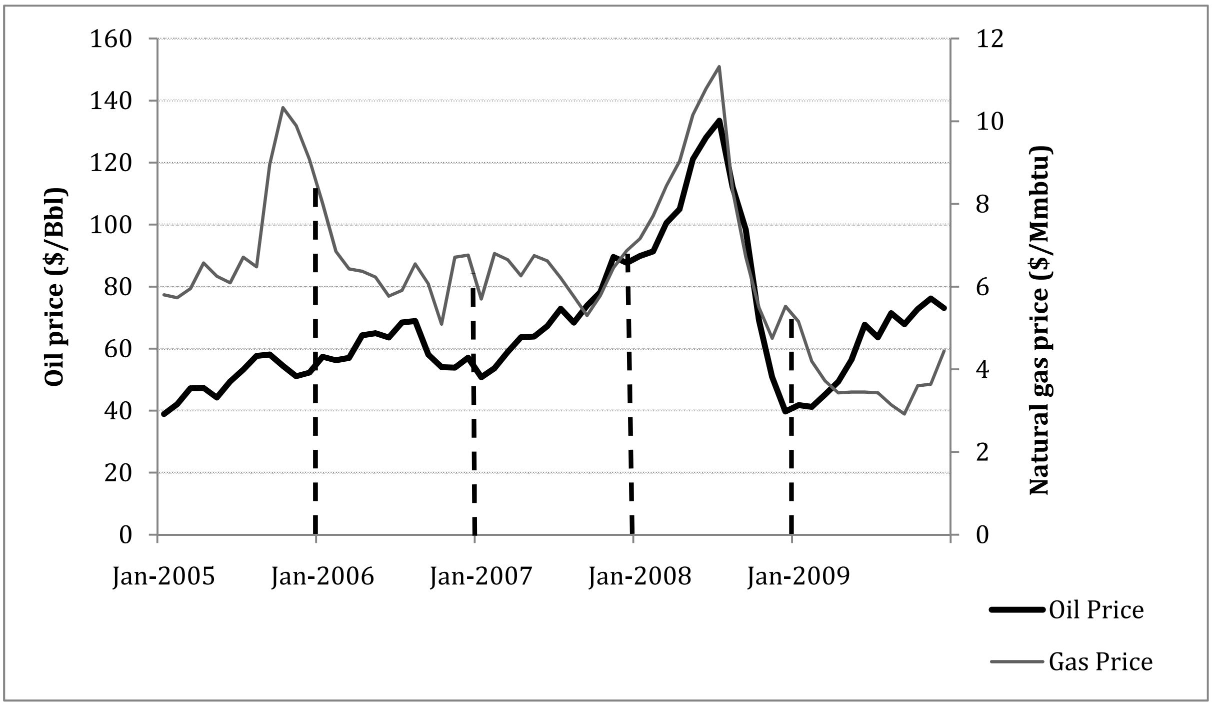

Figure I: Crude Oil and Natural Gas Prices from 2005-2009

REFERENCE

Allayannis, G Weston, J 2001, "The Use of Foreign Currency Derivatives and Firm Market Value", *Review of Financial Studies* 14, 243–276.

Bartram, S Gregory, B and Frank, F 2003, "International Evidence on Financial Derivatives Usage", *Working Paper*, University of North Carolina.

Carter, D Rogers, D, Simkins, B 2006, "Hedging and Value in the U.S. Airline Industry", *Journal of Applied Corporate Finance*, 18, 4, 21-33.

Chen, C Jin, Y and Wen, M 2008,"Executive Compensation, Hedging, and Firm Value", *Working Paper*, California State University and National Tsinghua University.

Gagnon, L Lypny, G and McCurdy, T 1998, "Hedging Foreign Currency Portfolios", J*ournal of Empirical Finance* 5, 3, 197-220.

Guay, W and Kothari, S 2003, "How Much Do Firms Hedge with Derivatives?" *Journal of Financial Economics,* 70, 423-461.

Jin, Y and Jorion, P 2006, "Firm Value and Hedging: Evidence from U.S. Oil and Gas Producers," *Journal of Finance,* 61,893-919.

Jin, Y, and Jorion, P 2007, "Does Hedging Increase Firm Value? Evidence from the Gold Mining Industry", *Working paper,* California State University-Northridge and University of California-Irvine .

Jorion, P 1990, "The Exchange-rate Exposure of U.S Multinationals." *Journal of Business* 63, 331-345.

Kapitsinas, S 2008: "The Impact of Derivatives Usage on Firm Value: Evidence from Greece", *Working Paper,* National and Kapodistrian University of Athens.

Lang, L. and Stulz, R. 1994, 'Tobin's Q, corporate diversification and firm performance', *Journal of Political Economy*, 102,1248-1280

Lookman, A 2003, "Does Hedging Increase Firm Value? Comparing Premia for Hedging "Big"versus "Small" risks." *Working Paper*, Carnegie Mellon University.

Magee, S 2008,"Foreign Currency Hedging and Firm Value: A Dynamic Panel Approach", *Working Paper*, Macquarie University.

Nance, D Smith, C and Smithson, C 1993, "On the Determinants of Corporate Hedging," *Journal of Finance,* 48, 267-284.

Rajgopal, S 1999, “Early Evidence on the Informativeness of the SEC's Market Risk Disclosures: The Case of Commodity Price Risk Exposure of Oil and Gas Producers." *Accounting Review* 74, 251-280.

Rossi, J and Laham, J, 2008 “The Impact of Hedging on Firm Value: Evidence from Brazil”, *Journal of International Finance and Economics 8*, 1.

Stulz, R 1990, “Managerial Discretion and Optimal Hedging Policies.", *Journal of Financial Economics* 26, 3-27.

Tufano, P 1996, “Who Manages Risk? An Empirical Examination of Risk Management Practices in the Gold mining Industry”, *Journal of Finance* 51, 1097-1137.