Increasing value by derivative hedging

Research on relationship between firm value
and derivative hedging in UK

Master thesis for the department of Finance and Accounting Faculty of
Management and Governance

Enschede, 5 September, 2011
Zhiming Wei 1022822

Under supervision of:
Twente University Xiaohong Huang
Twente University Henk Kroon

Word count: 15480

Table of Contents

THESIS SUMMARY

This master thesis aims to contribute to our knowledge of the relationship between derivative hedging and value of oil and gas firms in UK. The main research question of this thesis is as follows: "Does derivative hedging increase the value of oil and gas firms in the U.K.? Why or why not?"

The firm's value can be determined by various factors, amongst which sales growth, net profit margin, leverage level, firm size, management capability etc. Moreover, there are a lot of definitions of firm value. In quantitative ways, firm value can be measured by Tobin's Q ratio developed by James Tobin (1969) as the ratio between the market value and replacement value of the same physical assets

As far as we know, financial crisis or subprime crisis happened in 2008. Currently, severe financial impact has happened again since Standard & Poor ratings agency has downgraded US government T-bonds, making stock market around the world plummet. Risk management subjects have been paid much more attention among many academic researchers and practitioners. One of the methods of managing the risk, such as credit risk, exchange risk, currency risk, equity risk, is to use derivatives, such as forward, futures, options or swaps, to hedge the risk exposures in financial market and markets for goods and services. Therefore, the purpose of this thesis is to delve into the relationship between derivative hedging and firm's value, especially between derivative hedging and oil and gas firms in UK.

Finally, the central question of this thesis is answered in twofold. On the one hand, the contribution of derivative hedging to firm's value can be explained in theoretical way. Many academic researchers have addressed this topic since 1980. It is shown that derivative hedging has the potential to keep cash flow stable, reduce the expected cost of financial distress, alleviate underinvestment or solve information asymmetry so as to increase firm value. On the other hand, this thesis empirically tests the relationship between derivative hedging and firms' value to corroborate or refute previous findings and furthermore give the recommendation in the end.

PREFACE

This master thesis is completed under the department of Finance & Accounting Faculty of Management and Governance of Twente University. I took great pleasure in attending the lectures and workshops of this master program, working on assignments with fellow students, and studying on subjects that match my interests very closely. It is believed that this master program is an excellent basis for beginning a career as a financial or accounting professional.

Furthermore, I would like to express sincere gratitude to my supervisor Xiaohong Huang who I thought is a pleasurable person to work with. I appreciate for her unselfish support and timely and critical feedback.

Additionally, I am also grateful for having Henk Kroon to be my second supervisor for my thesis. I already know him as a nice person to work with since he teaches one of the master courses, Accounting, Finance and Management (AFM). This time for my master thesis my experiences with Henk Kroon have been just as good, or even better.

Last but not least, I would like to thank my mum and dad for all their love, help, and support and my girlfriend, Yan Liu, for encouraging me to finish my thesis. Although they are not familiar with the topic of my thesis for even the slightest bit, they motivated me to keep up with my progression, especially at times when I faced difficulties in keeping writing thesis. Furthermore special thanks to my friend Haibin Yin for his support to my data collection and Jiwu Lu for his help for my thesis layout.

In conclusion, I wish you take pleasure in reading this thesis. Your interest is appreciated.

Enschede, 5 September, 2011

Zhiming Wei

1. INTRODUCTION

Recent surveys (Bodnar et al., 1995, 1996, 1998; Phillips, 1985; Berkman et al., 1996; Grand and Marshall, 1997; Mallin et al., 2000) find that since the mid-1980s, non-financial firms especially in U.K. and U.S. have increasingly hedged the risk exposure to foreign currency, interest rate, commodity, and equity, all being with a high level of volatility, by using derivative instrument such as forward, future, swap and options[1]. As modern finance theory has developed for decades, hedging, an investment technique designed to offset a potential loss on one investment by purchasing a second investment that retail or institutional investors expect to perform in the opposite way, is gradually considered as one of the strategies of risk management. According to Kim et al (2006), there are two kinds of hedging strategies. One is financial hedging, another one is operational hedging. Financial hedging is an investment strategy whose purpose is to offset potential losses that may be incurred by some risk factors, such as credit risks, price risks, liquidity risks, or even natural disastrous risks, through using many types of financial instruments, including stocks, ETFs, insurance, forward contracts, swaps options, many types of over the counter and derivative products, futures contracts. On the other hand, Operational hedging, which is always discussed in conjunction with financial hedging, is the course of action that hedges the firm's risk exposure by means of non-financial instruments, particularly through operational activities.

According to Smith and Stulz (1985), the rationale behind the usage of derivative instruments is that hedging can minimize the transaction cost of financial distress and lower the level of tax liability. Smith and Stulz (1985) also elucidated that managerial risk aversion also can be one of the motives for hedging. Therefore, Smith and Stulz (1985) concludes that market imperfection makes the hedging a value-enhance strategy. Furthermore, Froot et al. (1993) said that hedging can also mitigate the underinvestment problem (Myers, 1977) and it can also influence the labor market's perception about the ability of managers based on hedging and firm performance. On the other hand, Modigliani and Miller (1958) proposed that any financial policies cannot alter the firm value in the absence of market imperfection, thus indicating that there would almost be no reason for corporations to engage in hedging activities, including those strategies that use derivatives.

Based on the abovementioned, investigating the relationship between hedging and firms' value has become the popular topic of interest of many academic researchers and practitioners. The extant literatures concerning the relationship between derivatives hedging and firm value show some conflicting results. According to Allayannis and Weston (2001), "firms that begin a hedging policy experience an increase in value above those firms that choose to remain unhedged and that firms that quit hedging experience a decrease in value relative to those firms that choose to remain hedged. Furthermore, Carter et al (2006) claimed that airlines using jet fuel whose prices are highly volatile benefit from the hedging premium, supporting the findings of Allayannis and Weston. On the other hand, Jin and Jorion (2006) reported that there is generally no difference in firm values between firms that hedge and firms that do not hedge. This is the results against the findings reported by Allayannis and Weston for a sample of U.S. multinationals. Fauver and Naranjo (2010)

[1] Detailed classification of derivatives for Exchange market and OTC market is illustrated in Appendix A

found that in the presence of agency costs and monitoring problems, derivative usage has the negative effect on firm value.

Due to the conflicting findings mentioned above, it is believed that the topic of this research should be more convincing and attractive if the focus of research is on the relationship between financial hedging and firm value. So far most prior empirical researches on this topic have been done in USA, suggesting that some hedging theories may not be applied to other countries. In recent years some studies (Grand and Marshall, 1997; Mallin et al., 2001) show that European firms are more likely to do derivative hedging than US firms. It indicates that it is more important to focus on Europe than on US for doing this research. It is little known about whether the predictions of derivative hedging in the U.K. are consistent with the prediction from the corporate hedging theory made based on US settings. Therefore, it is wise to choose one of the European countries to do empirical research to improve the generalizability and external validity of hedging theory. As Spano (2007) said, UK presents very large exposure to a risk of external shocks due to its very large external assets and liabilities compared to the US and other developed countries and thus UK companies are more suitable for empirical research on this topic. Secondly, the accounting practice of the UK companies adopts a fair-value-based measure of hedging. As Graham and Rogers (2002) said, fair values provide information on the extent of price movements in derivative contracts, rather than the amount of derivatives held. Thirdly, Franks and Touros (1993) claimed that there is the difference between bankruptcy code in the US, which has strong incentives to keep the firm as a going concern even when it is worth more in liquidation, and bankruptcy code in the UK, which is more costly for shareholders and managers in the UK. Also Rajan and Zingales (1995) find that UK firms are less levered than firms in the US. Due to the aforementioned, it is believed that doing the research regarding the relation between derivative hedging and firm value in the U.K. can test and improve the validity and consistency of hedging theory. The following is the main research question:

Does derivative hedging increase the value of non-financial firms in the U.K.? Why or why not?

This research aims to contribute to our knowledge of the relationship between derivative hedging and value of oil and gas firms in UK. Another contribution derived from this research is to test whether past findings on this topic will hold still in UK setting by collecting non-financial firm and using different method of data analysis, such as univariate and multivariate test.

The remainder of research proceeds as follows: the next section reviews literature and previous empirical evidence on the determinants of firm hedging and important findings on hedging and firm value. Section 3 elucidates the research methodology I will use and what variables are involved for this research. The procedure of data collection and the size of sample pool are presented in section 4, followed by section 5, empirical findings. The conclusion and recommendation parts are given in the last section followed by appendix and reference.

2. LITERATURE REVIEW

This section provides an overview of relevant literature related to the research question. The review contains a description of the theory of derivative hedging and the findings of empirical research. The first subchapter of the literature review describes the incentives and determinants of derivative hedging. Second subsection is focused on the relationship between the derivative hedging and the firm value.

2.1 Theory of hedging incentive and determinants

Smith and Stulz (1985) claim that a value-maximizing firm can hedge for three reasons: taxes, costs of financial distress and managerial risk aversion. In the following are the rationales behind those reasons for hedging.

(1) Tax: Through the models developed in the article, they report that if effective marginal tax rates on corporations are an increasing function of the corporation's pre-tax value, then the after-tax value of the firm is a convex function of its pre-tax value. Afterwards, they arrived at the conclusion that if hedging reduces the variability of pre-tax firm values, then the expected corporate tax liability is reduced and the expected post-tax value of the firm is increased, as long as the cost of the hedge is not too large. In others words, the more convex the corporate tax liability, the better the hedging is, as long as the cost of the hedging does not exceed the benefits of hedging.

(2) Costs of financial distress: Hedging can reduce the probability that the firm encounters financial distress by reducing the variance of firm value, and thereby reduces the expected costs of financial distress. Furthermore, firm size affects firms' incentive to hedge. For example, financial distress can lead to bankruptcy and reorganization or liquidation, resulting in direct legal costs. Warner (1977) finds that those legal costs of financial distress are less than proportional to firm size, indicating that small firms are more likely to hedge. However, the transactions costs of bankruptcy are a small fraction of large firms' assets. That is, large firms can hedge by affording significant information and transaction cost scale economies.

(3) Managerial risk aversion: If a large proportion of firm is hold by the manager, one can expect the firm to hedge more, as the manager's wealth is more a linear function of the value of the firm. Furthermore, they proposed that risk-averse managers whose compensation contracts depends on the accounting earning and economic value of firm are more likely to do hedging, since shareholders make the management wealth a concave function of firm value.

Drawing on the aforementioned, this article gives us insight into the reasons of hedging risk. As far as we know, the incentives mentioned above are viewed as the factors related to the firm value. It is believed that Smith and Stulz establish the basis and fundamentals for financial risk hedging, theoretically shed light on the incentives of financial hedging, and bridge the gap between the financial hedging and firm value.

Froot et al (1993) report that the more closely correlated are their cash flows with future investment opportunities, the more the firms will hedge. It is corroborated that through the model developed in their article, they theoretically conclude that hedging can solve the underinvestment problem (Myers, 1977) by reducing the variability of cash flow in order to finance the project with positive net present value. They also said that nonlinear hedging instruments, such as options, will typically allow firms to coordinate investment and financing plans more precisely than linear instruments, such as futures and forwards. Multinational firms' hedging strategies will depend on a number of additional considerations including exchange rate exposure of both investment expenditures and revenues. And also they said that optimal hedging strategy for a given firm will depend on both the nature of product market competition and on the hedging strategies adopted by its competitors. The article of Froot et al not only theoretically analyzes and justifies for the incentives of financial hedging and but also logically answers the questions, such as "What sorts of risks should be hedged? Should they be hedged partially or fully? What kinds of instruments will best accomplish the hedging objectives?" the conclusion made by Froot et al can be considered as the complement and addition to that by Smith and Stulz (1982) to consolidate and improve modern theory of financial hedging and contribute to the research on the relation between financial hedging and firm value.

DeMarzo and Duffie (1995) formulate that hedging can reduce the amount of noise and increase the informational content in the firm's profits. Generally, the managers have superior knowledge relative to outside investors regarding the nature and extent of a firm's various risk exposure, such as the exposure to interest rate, foreign currency, commodity or equity. Financial hedging policies can solve the information asymmetry between managers and outside investors. For example, Creditors, shareholders or investors normally rely on the estimates of accounting earnings and cash flows as input to measure the managerial ability and decision and firm value. As Smith and Stulz said, hedging can decrease the variability of cash flow and increase the firm value. It is theoretically believed that the firm value can be increased by hedging program managers undertake so that it signal to the creditors the quality of management, which may result in increased debt capacity and greater tax shield. The contribution of the article by DeMarzo and Duffie is to give another theoretical perspective for hedging and fill the gap between the financial hedging and the factors related to firm value.

There are also other incentives to hedge. Nance et al (1993) suggests that investing in more liquid or less risky or imposing dividend restriction is substitution for hedging. More liquid assets or low dividend can ensure that firms are able to repay the loan to creditors, thus increasing the cost of financial distress. Additionally, Kalay (1982) finds that imposing the dividend restriction can alleviate the underinvestment problem. Furthermore, Nance et al (1993) show that firms can lower the probability of financial distress by issuing preference capital instead of debt in that default on preference shares cannot cause bankruptcy. They also articulate that firm size is one of the determinants of hedging for small and large firms. The reasons given by Nance et al are almost the same as those given by Smith and Stulz (1985). They also claim that smaller firms are more likely to have taxable income in the progressive region of the tax schedule, implying that small firms are more likely to hedge.

Tufano (1996) concludes that theorists have constructed two categories of interpretation for the incentives of hedging. The first one is shareholder maximization hypotheses. It is said that by reducing the cost of financial distress, avoiding suboptimal investment policies, lowering tax liability, hedging can increase the expected value of the firm. Another one is the managerial utility maximization hypotheses, which include managerial risk aversion, signaling of managerial skill, and alternatives to risk management as controls, such as maintaining liquid assets and lowering leverage. Tufano (1998) further formulates the theory of hedging strategies and its relation to firm value. Based on the theoretical model, Tufano (1998) said that using derivative can reduce firm value when agency costs between managers and shareholders exist.

2.2 Empirical test of the hedging incentives and determinants

To test the predictive power of hedging theory on incentives and determinants, a lot of researches have been done recently. In the following are the results derived from the empirical researches.

Nance et al (1993) find that the firms with more convex tax schedules hedge more. Firms that use the hedging instruments have significantly more tax credits and more of their income in the progressive region of the tax schedule. Their findings are consistent with tax convexity theory proposed by Smith and Stulz (1985). They also reported that their findings are consistent with the proposition that hedging and other financial policies are substitutes. They use COMPUSTAT data on the firm's use of convertible debt, preferred stock and the liquidity of the firm's asset. They find that the firms that use the hedging instruments have less liquid assets and higher dividends, which is consistent with the proposition of Nance et al.

However, Graham and Rogers (2002) report that of the 469 firms from 1995 to 1999, they find no evidence that firms hedge to reduce expected tax liability when their tax functions are convex, which is against the findings of Nance et al (1993). Their analysis does, however, indicate that firm hedges to increase debt capacity, with increased tax benefits averaging 1.1 percent of firm value. In other words, the benefits of hedging are attributable to the increase in the debt capacity, that is, the decrease in expected tax liability.

Gay and Nam (1998) extend the research on incentives of derivative usage by analyzing more closely the underinvestment hypothesis by Froot et al (1993). Through empirically test 1,000 firms from 1984 to 1995, they find that there is a positive relation between a firm's derivatives use and its growth opportunities. For firms with greater investment opportunities, derivatives use is greater when they also have relatively low cash stocks. Their findings support the underinvestment and shareholder maximization hypothesis.

Dadalt et al (2002) analyze all non-financial firms included in 1997" Database of Users of Derivatives" and find evidence that both the use of derivatives and the extent of derivative usage are associated with lower asymmetric information. They reports that analysts' earnings forecasts have significantly greater accuracy and lower dispersion. Their findings corroborate the proposition of DeMarzo and Duffie (1995) who argue that hedging reduces noise related to exogenous factors and decreases the level of asymmetric information regarding a firm's earnings.

Judge (2006) examine the determinants of foreign currency hedging by analyzing a sample of U.K. non financial firms. He finds that a firm's liquidity is also a significant determinant of foreign currency hedging which is consistent with the proposition of Nance et al (1993) that hedging and other financial policies are substitutes. He also claims that the size of the firm is positively related to the foreign currency hedging decision, implying that the larger the firm is, the more the firm hedges. This result is supportive of significant information and transaction cost of scale economies of hedging by Smith and Stulz (1985). Furthermore, the results tell us that UK firms are more concerned about financial distress than US firms, which can be viewed as one of country-specific factors for hedging. The expected financial distress costs are higher in the U.K. than they are in the U.S., because the bankruptcy code in U.K. is considered as debt holder friendly and in U.S. as shareholder friendly.

Spano (2007) empirically test 443 UK non-financial companies over the fiscal years 1999 and 2000. He reports that compared to the US, managerial strategies in the UK are likely to be less reactive to stock market volatility. Risk-averse managers whose wealth is directly affected by the firm's value use hedging instruments in a suboptimal way, thereby systematically creating gains or losses. Empirical findings indicate that companies with a higher percentage of managerial stock ownership show a strong link between expected performance and hedging, implying that managers with high stock ownership are more likely to act in the interests of the shareholders, partially mitigating the risk aversion effect.

However, Tufano (1996) finds that by investigating the companies in the gold mining industry, the theories of managerial risk aversion seem more informative than those of shareholder value maximization. The evidence shows that the managers who own more options manage less risk, but those who own more shares of stock manage more risk. Additionally, firms with lower cash balance manage more gold price risk. Tufano's finding is consistent with managerial utility hypothesis.

Supanvanij and Strauss (2010) report that by analyzing the hedging/compensation relationship of S&P500 firms during 1994-2000, they find that increases in CEO compensation is positively related increase in derivative use by firms, whereas CEO compensation in the form of options ,salary and bonus is negatively related to hedging. Compensation in the form of shares aligns the interests of the CEO with the long-term interests of the firm and increases the hedging. Compensation of options rewards risk and thus decreases hedging. Their findings support those by Tufano (1996) that the managers who own more options manage less risk, but those who own more shares of stock manage more risk.

To sum up, there are two classes of theories interpreting why managers undertake hedging activities. The first one is based on shareholder value maximization. Smith and Stulz (1985) propose that financial hedging can reduce tax payment, decrease costs of financial distress. Froot et al (1993) claim that financial hedging can reduce the variability of cash flow and solve underinvestment problem. Nance et al (1993) and Gay and Nam (1998) validate the theory of Smith and Stulz by investigating firms. Another one is based on the diversification motives for personal utility maximization for manager. Smith and Stulz (1985) suggest that hedging can alleviate managerial risk aversion. DeMarzo and Duffie (1995) formulate that hedging can reduce the amount of noise and increase the informational content in the firm's profit. Spano (2007) and Supanvanij and Strauss (2010) also substantiate the validity of the theories of Smith and Stulz 1985) and DeMarzo and Duffie (1995) through empirical analysis.

2.3 Empirical tests on the relation between derivative hedging and firm value

Prior studies already tested and corroborated the validity of the hedging theories. The findings of past researches ascertain that corporate risk management is apt to increase firm value when market imperfections such as bankruptcy costs, convex tax schedule, or underinvestment problem present. Additionally, several researches thus far have addressed the question of whether hedging achieves reasonable economic objectives, such as a direct relation between hedging and firm value, which becomes a popular subject among researchers and practitioners. Past literature has provided conflicting results on this topic.

Allayannis and Weston (2001) examine the use of foreign currency derivatives (FCD) in a sample of 720 large U.S. non-financial firms between 1990 and 1995 and analyze impact of hedging on firm value, measured by Tobin's Q. And they find significant evidence that the use of FCDs is positively associated with firm market value and that firms that face currency risk and use currency derivatives have a 4.87% higher value than firms that do not use currency derivatives. Additionally, their findings suggest that firms that begin a hedging policy experience an increase in value above those firms that choose to remain unhedged and that firms that quit hedging experience a decrease in value relative to those firms that choose to remain, which is consistent with theories that suggest the decision to hedge is value increasing. The result of univariate and multivariate tests of the differences between currency derivatives users and nonusers indicates that firms with a combination of high growth opportunities but low accessibility to internal and external financing are most likely to use currency derivatives. Their findings are consistent with the theories proposed by Froot et al (1993).

Berrospide et al (2010) also study the effect of foreign currency derivatives (FCD) hedging on corporate performance and value. They show that foreign currency hedging allows firms to both increase their capital expenditures and to smooth their investment policies. Their results of research indicate that the foreign debt capacity of a firm increases the foreign debt capacity of a firm when it uses derivatives and add more value from tax shield to the value of the firm. Therefore, they concludes that FCD hedging is positively correlated with the value of a firm, which is supportive of the findings by Allayannis and Weston (2001)

Furthermore, Carter et al (2006) investigate the US airline industry to address the direct relation between firm value and hedging. They claim that jet fuel hedging is positively related to airline firm value and that most of hedging premium is attributable to the interaction of hedging with investment. They assert that the principal benefit of jet fuel hedging by airlines comes from reduction of underinvestment costs (Froot, Scharfstein and Stein, 1993), consolidating the findings of prior researches.

Adam and Fernando (2006) examine a sample of 92 North American gold mining firms from 1989 to 1999. They find that the firms that hedge generate positive cash flows that are highly significant both economically and statistically, suggesting that derivatives transactions translate into increases in shareholder value. Their findings indicate that the bulk of the cash flow gain appears to stem from persistent positive realized risk premium, i.e., positive spreads between contracted forward prices and realized spot prices.

Bartram et al (2009) study 6,888 non-financial firms from 47 countries and they claim that the effect of derivative use on firm value is positive but more sensitive to endogeneity and omitted variable concerns. Their finding also is consistent with the evidence in Allayannis and Weston (2001).

Through investigating a sample of 119 U.S. oil and gas producers from 1998 to 2001, Jin and Jorion (2006), however, find that hedging does not seem to affect market values of the firms operating in this industry although they verify that hedging reduces the firm's price sensitivity to oil and gas prices, which did not support the findings of Allayannis and Weston.

Additionally, Fauver and Naranjo (2010) examined the derivative usage data on over 1746 firms head quartered in the U.S. during the 1991 through 2000 time period. They report that firms with greater agency and monitoring problems exhibit a negative association between Tobin's Q and derivative usage, indicating that derivative usage has a negative impact on firm value in firms with greater agency and monitoring problems. Their findings are consistent with the theoretical model proposed by Tufano (1998) but contradictory with the theory formulated by DeMarzo and Duffie (1995)

To sum up, there are mixed evidence regarding the direct relation between hedging and firm value. In my opinion, the fact that there is mixed empirical evidence on this topic can be for seven reasons as follows:

(1) Industry effect factor: Prior researches mentioned above examined the different industries, such as airline industry or oil and gas production industry. Different industry may reflect different levels of labor productivity and Q ratios across industries. For instance, labor is more productive in service industries, say relative to mining or oil gas industry, and some service industries are more profitable and grow faster than others, which justifies higher Q ratios. Or the average Q ratio of some industries is higher than other industries in spite of hedging activities. Therefore, industry-specific factors can bias the results of past researches against the hedging theories.

(2) The effect of other risk management activities on the firm value: Kim et al (2006) claim that operational and financial hedging strategies are complementary and associated with enhancing firm value. In their samples, a lot of firms not only do operational hedging but also financial hedging. Therefore, the higher Tobin's Q ratio used for measuring the firm value is either attributable to operational hedging or financial hedging, or both. Lower Tobin's Q ratio may arise from the combination of operational and financial hedging.

(3) Endogeneity: As Jin and Jorion said, higher levels of ownership are associated with higher Q ratio. Thus, this endogeneity creates the association between the Q ratio and hedging.

(4) Sample selection bias: The Allayannis-Weston sample is limited to large firms with assets greater than $500 million; The Jin-Jorion sample is limited to the firms with assets greater than $20 million. It is unclear whether hedging contributes value to the smaller firm as well, given the fixed costs of establishing risk management programs.

(5) Time-period bias: this bias can result if the time period over which the data is gathered is too long or too short. If the time period is too short, research results may reflect phenomena specific to that time period. If the time period is too long, the fundamental relationships that underlie the results may have changed. For example, the time frame of the research by Allayannis-Weston spans 5 years, from 1990-1995; Carter et al checked the airline industry during 1992-2003; Jin and Jorion examine the data from 1998-2001; Bartram et al analyze the data from year 2000 to 2001. Because the time period for Bartram et al is just one year, I believed that there can be time-period bias, indicating that higher Tobin's ratio is specific to 2000-2001.

(6) Sample size: Some prior researches study over 1,000 firms to do investigation and some examine about 30 or less. The more subject in your sample can contribute better statistical conclusion validity and power (Shadish, Cook and Campbell, 2002). Thus, the sample size can be one of the causes of divergent results.

(7) Survivorship bias: this bias is the most common form of sample selection bias. Having selected the non-financial firms in different industries and different countries, researchers only analyze the firms that exist during the time period in which research takes place. However, they did not study the firms that existed in the past but does not exist in the present, thus bias the results of research against the hedging theory.

2.4 Conclusion

According to the assumption of Modigliani and Miller (1958), financial policy can not affect and alter the firm value in the absence of market imperfection, thus indicating that there is no incentive for hedging. However, several authors theoretically discussed some factors that can be viewed as incentives or determinants inherent in the financial hedging decision-making policies and empirically tested the direct relation between derivative hedging and firm value. For example, Allayannis and Weston (2001), Adam and Fernando (2006), Carter et al. (2006), and Berrospide et al. (2008) among others find positive relation between derivative usage and firm value. However, Jin and Jorion (2006), Fauver and Naranjo (2010), and Lookman (2004) find that there is either no relation or conditional or negative relation between derivative usage and firm value. As a result of prior researches, it is convincing that the relation between firm value and hedging is mixed, thereby making the research on this topic in the future more worthy investigating.

3. RESEARCH METHOD

As mentioned at the beginning, the dataset will be based on the pool of oil and gas producers in UK. A further description of the data collection concerning the unit of analysis, timeframe and sample size will be provided in the subsequent chapter. Panel data, which are the combination of cross-sectional and time-series data, is the type of data that will be used for this study. The nature of this study is of an explanatory nature in line with the study in that a panel study aims at describing and explaining a relationship between two variables (Saunders et al, 2009).

3.1 Dependent and Independent Variables

1. Measurement of firm value: according to the prior studies on the relation between hedging and firm value, several researchers define the firm value as the dependent variable and can be measured by Tobin's Q ratio, defined as the ratio of the MV of financial claims on the firm to the current replacement cost of the firm's asset. Traditionally, Tobin's Q is calculated as the ratio of the sum of equity market value and liabilities book value to the sum of equity book value and liabilities book value. My methodology for constructing the measure of market value and replacement cost of assets is similar to the simple approximation of Tobin's Q developed by Chung and Pruitt (1994). Based on the formula they developed, the market value of the firm can be measured using the following formula

$$Q1 = \frac{MVE+PS+DEBT}{TA} \qquad (1)$$

Where MVE is the product of a firm's share price and the number of common stock shares outstanding, PS is the liquidating value of the firm's outstanding preferred stock, DEBT is the book values of long-term debt and current liabilities minus current assets and TA is the book value of the total assets of the firm.

This calculation can offer several advantages: firstly, it can produce the reliable truth when we know what truth is, because the numerator and denominator respectively represent the market value and book value of assets. Secondly, it can give relatively reasonable estimates under all possible combinations of actual corporate situations. Thirdly, it is economical in its computational process so as to make the analysis of large samples efficiently. Fourthly, it relies only on the easily available standard financial data bases. Chung and Pruitt (1994) report that the input data are readily available for calculation of Tobin's Q ratio of small and big companies. Finally, DaDalt et al (2003) conclude that employing a simple construction of Q is preferable in most empirical applications. However, this method of measuring firm value has some drawbacks. Firstly of all, this formula cannot completely capture the firm's intangible assets. A firm's intangible assets can be organizational capital, reputational capital, monopolistic rents, or investment opportunities. Management entrenchment can be also viewed as an intangible asset that generates negative value. Therefore, companies, which capitalized the intangible assets, have bigger Q ratio than the companies, which did not capitalized intangible assets. This drawback can bias against the results. Secondly, accounting methods used by companies are based on different basis. For example, some companies do the accounting on the basis of historical cost. Other companies use fair value accounting method. Therefore, differences in accounting practices can increase or decrease q in some companies relative to other companies.

Moreover, I also construct another formula of the Q ratio similar to the models used by Jin and Jorion (2006). The numerator approximates the MV of the firm by the BV of total assets minus the BV of common equity plus the MV of common equity. The denominator is the book value of total assets. In conclusion, this formula of the Q ratio is defined as follows:

$$Q2 = \frac{BV\ total\ assets - BV\ common\ equity + MV\ common\ equity}{BV\ total\ assets} \quad (2)$$

The advantage of this method is that all the information necessary is easily available to calculate Tobin's Q ratio. Moreover, it can basically give reasonable estimation for the ratio of market value to replacement cost. Because most of the companies in the sample pool do not have preferred equity, I only put common equity into numerator as a proxy for companies' equity. On the other hand, it oversimplifies the Tobin's Q. This formula only considers common equity in the numerators. It is believed that it is possible to undervalue the companies that have preferred equity or other equities payment, even if only few companies have preferred equity in the sample. Furthermore, this formula also cannot capture the value of the intangible assets as mentioned above, which can bias against the results.

2. Hedging variables: Hedging information for each firm in the sample can be obtained from 2007-2010 annual reports. As far as we know, U.K. companies have prepared the financial statement in accordance with International Financial Reporting Standards (IFRS) issued by the International Accounting Standards Board (IASB), and therefore all oil and gas producers in UK comply with IAS 39, IFRIC 9 and IFRS 16, which requires that the companies that should disclosure the situation of derivative financial assets for hedging purpose. To make the distribution of hedging variable more symmetric, I use the log of fair value of derivative financial assets recognized in financial statement as a proxy for a firm's hedging variables. To control this variable, I also use dividend dummy, which equals 1 if the firm use derivatives to hedge in the current year or 0 otherwise.

3.2 Control variables

As has been written in the literature review, the relationship between hedging and firm value may be sensitive to the endogeneity and collinearity problem, indicating that the interaction between hedging and other factors can jeopardize the validity of this study. Therefore, I need to exclude the effect of all other variables that could have an impact on firm value. Following Allayannis and Weston (2001), I include the following control variables as they used.

1. Firm size (SIZE): prior studies ambiguously gave us the evidence for firms as to whether size can increase accounting profitability. Nance et al. (1993) point out that corporate risk management might be positively related to firm size because economies of scale may apply to operational and transactions costs of hedging. The larger firms are more likely to use derivatives to hedge than the smaller firms, for larger firms can afford the large fixed start-up costs of hedging. Thus, it is important to control for size. The proxy is total assets. The reason why I use the log of total assets is that the amounts of the total asset of some big companies are much larger than those of small companies. For example, BP PLC and Ascent Resources PLC are two oil and gas producers in the sample pool. The former has total asset

of 139 billion pounds and the latter totally possesses 20 million assets. I use the log of total assets to make distribution of total asset more symmetric. According Nance et al. (1993), larger firms are more likely to use derivatives to hedge. However, Cabral (1995) proposes the theory that indicates that Tobin's Q is negatively related to size when firms are in the early stage of growth and they spend a lot as sunk costs. It is assumed that the sign between firm value and firm size is mixed. The Appendix B provides a table of the various proxies for the prediction of relation between variables and Tobin's Q ratio (a proxy for firm market value).

2. Profitability (PROF): According to Breeden and Viswanathan (1998), a better-performing or profitable company may want to hedge to lock the effects of their higher profitability. Thus, the more profitable the hedgers are, the higher Qs they have. To control for profitability, I use ROA, defined as the ratio of net income to total assets. The relation between Q ratio and ROA can be assumed as positive.

3. Access to financial markets: If companies do not have access to financial market to raise the money to finance project, the market value may still be high in that they only take positive net present value project by capital rationing method. To control this variable, I use dividend dummy, which equals 1 if the firm paid a dividend in the current year or 0 otherwise. If companies paid a dividend, it indicates that the companies is not financially constrained and may take projects with negative NPV and then may have a lower Q. It is expected to be negative relation between dividend and market value. Alternatively, dividends may be viewed as a positive signal from management. If the companies paid the dividend, it may indicate that company is profitable and management in good quality. The investors should reward companies with higher valuation, implying a positive coefficient according to Jin and Jorion (2006). Thus, it is uncertain that the relation between two variables is positive or negative.

4. Leverage (LEV): capital structure can also influence the firm value. Companies not only benefit from raising the leverage ratio but also get trouble in high leverage. To control for differences in capital structure, I use the ratio of the BV of long-term debt to the BV of common equity. It is difficult to expect the sign between two variables.

5. Geographic diversification (GD): According to Bodnar et al (1999), geographic diversification is associated with enhancing firm value. The source of an increase in firm value comes from expanding firm-specific assets and potential economies of scale for the use of these assets. To account for the geographic influence, I assign one to the firm operating in more than one country, otherwise zero. It is expected that GD and Tobin's Q are positive.

6. Investment opportunities (IO): According to Myers (1977), the value of the firms is contingent on the future investment growth. The effect of hedging can alleviate the problem of cash shortfall when taking future investment project. In other words, hedging can solve underinvestment problem by derivative hedging in terms of Froot, Scharfstein and Stein (1993). Therefore, hedgers are more likely to have sufficient cash and take larger investment opportunities and then may have higher Q ratios. I use the liquidity ratio as a proxy for investment opportunities in that liquidity ratio indicates how much liquid assets companies

have to repay the short-term debt and how sufficient cash they have.

Finally, I exclude other variables that appear in the past studies

1. Industrial effects*:* Because the sample size consists of UK companies operating in the same industry, the biases arising from the industrial effects against high or low-Q ratio will be minimized. Therefore, it needs not to control for such industry effects on Tobin's Q ratio.

2. Credit rating: According to Haushalter (2000), firms with rated debt have probably undergone more capital market scrutiny and are thus assumed to face fewer informational asymmetries than ones with no rated debt. Moreover, because companies typically get bond ratings only if they issue public debt, those that have bond rating are more likely to have access to the public debt market. Firms with a debt rating are less likely to hedge extensively, for they can raise the money through an access to public debt market and may have lower Q. it is expected that credit ratings and Tobin's Q are negative. However, the information regarding credit rating cannot be founded either in annual reports or other reliable database, so it is hardly to control for this variable in the analysis.

3. Tax convexity: According to the theory of Smith and Stulz (1985), they report that if effective marginal tax rates on corporations are an increasing function of the corporation's pre-tax value, then the after-tax value of the firm is a convex function of its pre-tax value. Afterwards, they conclude that if hedging reduces the variability of pre-tax firm values, then the expected corporate tax liability is reduced and the expected post-tax value of the firm is increased, as long as the cost of the hedge is not too large.

3.3 Correlation and regression analysis

(1) Hypothesis: According to Allayannis and Weston (2001), they claimed that the firms that hedge are rewarded with higher value of Tobin's Q. So the main hypothesis can be

H_0: hedging is not associated with higher Tobin's Q ratio.

H_A: hedging is positively associated with Tobin's Q ratio

(2) Regression analysis: Furthermore, univariate regression analyses will be conducted in the following form: Tobin's $Q_{jt}=\beta_0 + \beta_1 (hedging_{jt}) + \mu_{jt}$ (j, t=1……, N, where N is the number of firm year observation). In this analysis, β_0 is a constant and a measure for the intercept and μ_i, which contains an error term and is the residual for observation i, represents factors other than hedging that affect Tobin's Q. To investigate whether the relationship between firm value and hedging is subject to endogeneity and collinearity of other factors, the multivariate regression analysis with dummy variable will be conducted controlling for alternative measure mentioned above. The model for the multivariate regression analysis is as follows:

Tobin's $j_{jt}=\beta_0+ \beta_1*(hedgingdummy_{jt}) +\beta_2*(lnhedging_{jt})*(hedgingdummy_{jt}) + \beta_3*(SIZE_{jt}) + \beta_4*(PROF_{jt}) + \beta_5*(DIV_{jt}) + \beta_6*(LEV_{jt}) +\beta_7*(GD_{jt}) +\beta_8*(IO_{jt}) +\mu_{jt}$ (j,t= 1 . . . , N, where N is the number of firm year observation)

where

β_0 is a constant and a measure for the intercept.

β_1 measures the difference between the value of firm with hedging and the value of firm without hedging , holding other factors fixed

β_2 measures the change in lnQ with respect to lnhedging, holding other factors fixed

β_3 measures the change in lnQ with respect to firm size, holding other factors fixed

β_4 measures the change in lnQ with respect to profitability, holding other factors fixed

β_5 measures the change in lnQ with respect to dividend, holding other factors fixed

β_6 measures the change in lnQ with respect to leverage, holding other factors fixed

β_7 measures the change in lnQ with respect to geographic diversification, holding other factors fixed

β_8 measures the change in lnQ with respect to investment opportunities, holding other factors fixed

μ_i is the error term or disturbance, which contains factors other than lnhedging, firm size, profitability, dividend, leverage, geographic diversification and investment opportunities

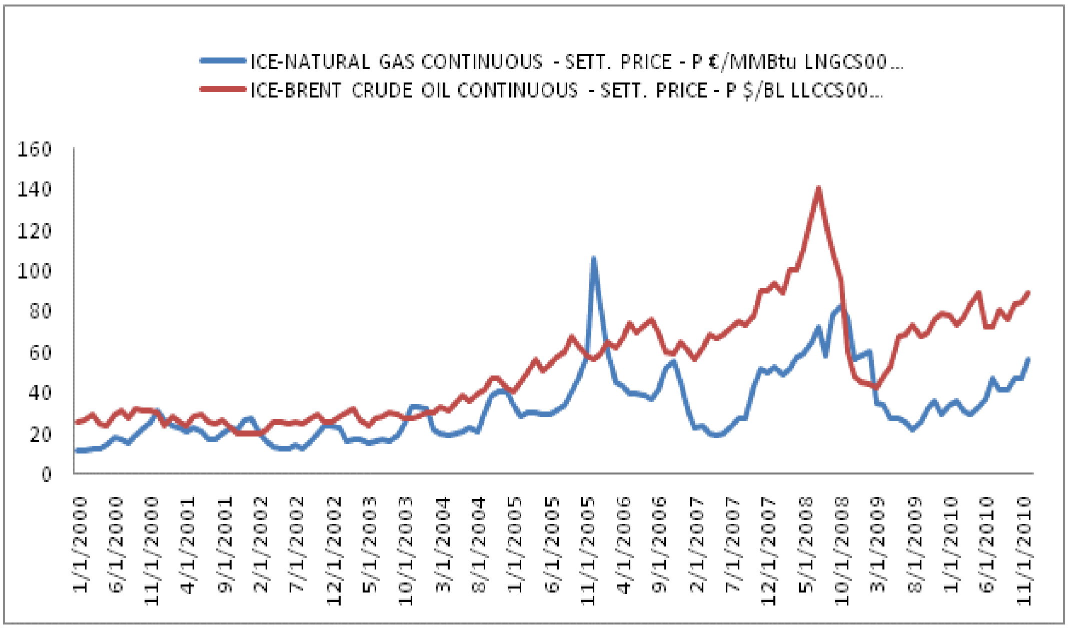
Note: in each specification, the standard errors, μ_i are clustered by firm and year.

4 DATA AND SAMPLE SIZE

This section is consists of two part. The first subsection gives the introduction of oil and gas industry in UK and illustrates the feasibility of choosing UK as the appropriate setting for the research of this topic. Second subsection gives the description of the process of data collection and the content of sample size. Afterwards it also gives the descriptive statistics for the sample pool.

4.1 UK oil and gas production industry environment

The UK oil and gas production industry offers a good environment for inspecting the effect of hedging on firm value. Firstly, the producers of oil and gas are exposed to substantial and hedgeable risk exposures. One specific risk notably troubling producers is their exposure to volatile oil and gas prices. They also have exposure to the risks from adverse movement in interest rates and exchange rates. Figure 1 shows settlement price for natural gas and crude oil at International Commodity Exchange (ICE) during 2000-2010. The mean price of natural gas is about 33 pound MMBtu and the mean price of crude oil is about 52.6 pound per barrel. Until about mid-2005, natural gas prices were not particularly unstable, but clearly that has not been the case since 2006. The price of crude oil has been volatile since 2007. The standard deviation of settlement prices for natural gas and crude oil is about 17.4 pound MMBtu and 26.5 pound per barrel.



DATA SOURCE: DATASTREAM (HTTP://ONLINE.THOMSONREUTERS.COM/DATASTREAM/)

Secondly, to avoid being contaminated by the effects of other variables not included in the analysis, the components of sample should be homogeneous. For example, the Allayannis-Weston sample covers a wealth of firms operating in different industries with different growth rates. There might be some variables influencing the Q ratios but not considered in the analysis. The oil and gas industry, as Jin and Jorion said, is more homogeneous and it can still offer substantial variation in hedging ratios. The oil and gas industry also discloses much more value-relevant information than other industries. Oil and gas reserves are measured and valued separately from other assets.

Thirdly, as mentioned in preceding paragraph, different industries are with different level of Q ratios. For instance, labor is more productive in service industries, say relative to mining or oil gas industry, and some service industries are more profitable and grow faster than others, which justifies higher Q ratios. To avoid industry diversification problem, it is better off selecting firms in the same industry to alleviate in that within the same industry, the bias arising from industry diversification can be minimized.

4.2 Sample Size

The analysis is started by identifying publicly held UK oil and gas producers, and I extract from the database of London Stock Exchange the list of firms with Standard Industrial Classification (SIC) of 533 and 537, which gives a total of 63 firms. The code of SIC gives a description of a group of companies primarily engaged in producing the same group of products or services. Major group "53" represents "Oil and Gas exploration, extraction and production." The time frame of analysis spans 2007-2010 years, a 4-year time interval.

Next, I only keep the firms that meet the following criteria: companies' headquarters must be in UK; annual reports are available from 2007-2010; MV of equity can be calculated at either the fiscal year-end or calendar year-end; and there is enough information in the annual report for the fair value of derivative for hedging purpose. The final sample consists of 63 firms or 226 observations from 2007 to 2010. The firms in the sample mainly engage in oil and gas exploration and production, but few companies also do oil and gas refining, processing, marketing, and contract drilling and oil field services. Most of corporate data, which contain information concerning market value, total assets, derivative usage etc, are derived from the database of AMADEUS Company, which specializes in collecting and compiling the data from the annual reports of firms in Europe. When information required for this research is not complete, annual reports will be used as a complement to search for the missing data.

Table 1, panel A, summarizes the sample statistics of the main variables over 2007-2010 period that are used in the thesis. The sample has a mean value of total assets of €248 million and mean value of market capitalization of €2.6 billion. The median of variable, "Profitability," indicates that over half of the companies in the sample have negative return on assets (ROA), which is proxied for profitability. Furthermore, approximately 40% of sample observations have used derivatives to hedge risk exposures in the markets, which is consistent with Phillips (1995)' survey result on, with derivative usage by larger and smaller firms ranging from 25 to 56 percent, respectively. A firm's value can be measured by Tobin's Q. After computing Tobin's Q for 226 firm-year observations, it is that the median Q1 and Q2 in our sample is 1.15 and 2.13 respectively, which is much smaller than the mean Q1 and Q2 (23.29 and 23.70), indicating that the distribution of Tobin's Q is skewed to the right side. To control for this apparent skewness, the natural log of Tobin's Q will be used in univariate and multivariate tests so that it makes comparisons across firms

There are some distinct differences between firms that use derivatives and firms that do not use them. In table 1, the firms using derivatives are intended to be higher with Tobin's Q, larger in total assets and market capitalization, have higher leverage ratios. Generally speaking, those findings are consistent with prior studies by Geczy et al. (1997) who find that derivative user firms are generally larger than nonusers, and Graham and Rogers (2002) who discovered that firms hedge to increase debt capacity and interest deductions. On the other hand, liquidity ratio, proxy as investment opportunities, indicates that firms with hedging have less sufficient cash than firms without hedging, which is inconsistent with theory of Froot et al (1993) that hedging can stabilize the cash flow to finance the project in the future, indicating that firms with hedging should have more sufficient cash than firms without hedging.

In table 2, I provide pair wise correlations of the main variables used in analysis. The majority of the pairwise correlations is below 0.5, with exception of correlation between Tobin's Q and both hedging and market capitalization and exception of correlation between hedging and Market capitalization. Of particular interest is the pair wise correlations of the firm hedging activity and Tobin's Q. there is a significantly positive correlation with derivative usage and Tobin's Q. The correlation between log of hedging and log of Tobin's Q even becomes bigger and more significantly positive. I also find significantly positive correlations between dividends and Tobin's Q, indicating that the payment of dividends is the positive signal to the outside investors from corporate management.

I also find significantly positive correlation between market cap and dividends, which also corroborate that the payment of dividend is the positive signal for corporate management. The correlation between dividend and hedging is also significantly positive. Looking at size as measured by log of total assets, there is significantly positive correlation between firm size and both geographical diversity and profitability as well as long-term debt, implying that the bigger companies are, the more profitable they will be, the more countries they operate, and the more cost of capital they can afford.

Taken together, the correlation patterns are mixed. The purpose of doing pairwise correlation is to show general profile among the variables that are used in this research. Because univariate and multivariate regression analysis are usually used by many researchers and practitioners to explain a dependent variable, firm value, as a function of a single independent variable, derivative hedging, univariate and multivariate regression analysis will be used in this thesis to delve into the relationship between firm value and other variables. In the situation where regression analysis cannot explain the relationship between firm value and hedging, non-linear regression analysis will be used as a complement to methodology part.

Table 1 Summary statistics

	No.obs.	Mean	Median	Std.dev.	Min	Max	10th percentile	90th percentile
Panel A: All Firms								
Sample description								
Q1	226	23.29	1.15	134.30	-0.66	1324	0.25	6.40
Q2	226	23.70	2.13	131.40	-0.13	1258	1.19	7.35
lnQ1	226	0.37	0.14	1.60	-4.18	7.19	-1.11	1.86
lnQ2	226	1.00	0.76	1.22	-2.02	7.14	0.17	1.99
FVhedging (€ 000')	226	7558.98	0	75937.98	0	1024526.25	0	2137.85
lnhedging	226	2.79	0	3.61	0	13.84	0	7.67
PROF	226	-8.27	-2.89	20.25	-91.67	64.18	-27.82	6.89
DIV	226	0.09	0	0.28	0	1	0	0.00
LEV	226	31.97	0	287.10	0	3204	0	16.71
GD	226	0.70	1	0.46	0	1	0	1
IO	226	6.06	2.51	10.42	0	81.62	0.29	15.12
TA (€ 000')	226	248329.40	65587.50	649813.60	296	6269214	8465.20	652378.60
Size	226	4.74	4.80	0.78	1.62	6.8	3.86	5.81
EXchange	226	1.20	1.17	0.13	1.05	1.49	1.05	1.47
LTdebt (€ 000')	226	42095	0	156799	0	1679174	0	101331.30
Mark cap (€ 000')	226	2600330.69	64145	16562834.02	816	158848841	10843.3	842969
Panel B: Firms With hedging								
Sample description								
Q1	88	36.19	1.13	159.27	-0.04	1024	0.37	7.13
Q2	88	36.90	2.08	159.27	0.80	1025	1.25	7.84
lnQ1	88	0.51	0.13	1.67	-1.62	6.93	-0.93	1.95
lnQ2	88	1.10	0.73	1.38	-0.22	6.93	0.22	2.05
FVhedging (€ 000')	88	19412.82	1220.76	121164.35	56.13	1024526.25	207.92	3755.46
lnhedging	88	7.16	7.11	1.45	4.03	13.84	5.34	8.22
PROF	88	-4.03	-1.81	16.04	-64.02	64.18	-15.38	7.88
DIV	88	0.15	0	0.36	0	1	0	1
LEV	88	75.51	1.62	457.79	0	3204	0	27.56
GD	88	0.82	1	0.40	0	1	0	1
IO	88	5.32	1.92	12.55	0	81.62	0.5	8.36
TA (€ 000')	88	409302.76	94583	924937.73	3795	6269214	11653	1089579
Size	88	5.02	4.98	0.71	3.58	6.80	4.07	6.04
EXchange	88	1.19	1.17	0.13	1.05	1.49	1.05	1.36
LTdebt (€ 000')	88	79914.17	3617.50	234065.48	0	1679174	0	224540
Mark cap (€ 000')	88	6302414.25	108728	26187850.06	2038	158848841	16625.9	5056114
Panel C: Firms without hedging								
Sample description								
Q1	138	15.06	1.18	115.47	-0.66	1324	0.08	6.28
Q2	138	15.28	2.19	109.78	-0.13	1258	1.05	7.31
lnQ1	138	0.29	0.17	1.54	-4.18	7.19	-1.25	1.84
lnQ2	138	0.95	0.78	1.10	-2.02	7.14	0.05	1.99
FVhedging (€ 000')	138	0	0	0	0	0	0	0
PROF	138	-10.97	-4.91	22.16	-91.67	42.19	-32.68	5.48
DIV	138	0.05	0	0.22	0	1	0	0
LEV	138	4.22	0	16.84	0	136.60	0	9.59
GD	138	0.62	1	0.49	0	1	0	1
IO	138	6.53	3.43	8.82	0	49.98	0.15	17.16
TA (€ 000')	138	145679.80	45741	350643.20	296	2689714	5735.10	330576.10
Size	138	4.57	4.64	0.78	1.62	6.43	3.64	5.50
Exchange	138	1.21	1.17	0.14	1.05	1.49	1.05	1.48
LTdebt (€ 000')	138	17977.83	0	63893.61	0	465085	0	51422.80
Mark cap (€ 000')	138	239581.76	45281.50	781199.51	816	6876444	6995	410240.70

This table presents summary statistics for the sample of all publicly held UK oil and gas producers over 2007-2010 whose total assets (TA) has minimum of approximately €0.2 million and maximum of €62 billion for the sample of firms with and without derivative hedging. I use the methodology of Chung and Pruitt (1994) and Jin and Jorion (2006) to calculate Tobin's Q ratio. To make Tobin's Q distribution more symmetric and comparison easier, I calculate and use natural log of Tobin's Q in univariate and multivariate regression test. The amount of fair value of derivative hedging (FVhedging) for each of companies is derived from the annual reports of companies. And I also calculate and use natural log of FVhedging to deal with skewness. Profitability (PROF) is proxied by return on assets (ROA). Dividend (DIV) is set equal to 1 if the company paid dividends that year and 0 otherwise. Leverage (LEV) is calculated by ratio of book value of long-term debt to book value of common equity. The geographical diversification (GD) dummy is set equal to 0 unless the firm is active in more than one country. Investment opportunities (IO) are proxied by liquidity ratio. The variable "Size" is natural log of total assets, which is used in regression test to compare across firms easily. The information about Exchange Rate (Exchange) is from database of AMADEUS Company, so is the amount of book value of long-term debt (LTdebt). The information regarding market capitalization (Mark cap) is from the database of London Stock Exchange.

Table 2
Pariwise correlations

	Q1	Q2	lnQ1	lnQ2	Vhedg~g	lnhedg~g	TA	Size	PROF	DIV	LEV	GD	IO	Xchange	LTdebt	Markcap
Q1	1															
Q2	0.9996*	1														
lnQ1	0.6313*	0.6320*	1													
lnQ2	0.7390*	0.7416*	0.9211*	1												
Vhedgin	0.5580*	0.5707*	0.3642*	0.4293*	1											
lnhedging	0.6221*	0.6213*	0.6593*	0.6746*	0.6595*	1										
TA	-0.0308	-0.0303	0.0231	0.000100	-0.00830	0.0789	1									
Size	-0.155	-0.147	-0.3118*	-0.3002*	0.0556	0.0146	0.5810*	1								
PROF	-0.0668	-0.0610	0.0366	0.0319	0.0651	0.0684	0.204	0.4324*	1							
DIV	0.2917*	0.2994*	0.2470*	0.2654*	0.2910*	0.4400*	0.3732*	0.3270*	0.192	1						
LEV	-0.0161	-0.0158	0.00500	0.00400	-0.00800	-0.0652	-0.0172	0.0156	0.0451	-0.0271	1					
GD	-0.0268	-0.0222	-0.0787	-0.0814	0.0624	0.00280	-0.0474	0.3035*	0.216	0.0685	0.0566	1				
IO	-0.0392	-0.0380	-0.00700	0.00610	-0.0483	-0.131	-0.115	-0.107	-0.0136	-0.0843	-0.0561	0.0103	1			
Xchange	-0.00650	-0.00650	0.128	0.139	0.0670	0.0665	-0.0659	-0.0865	-0.0531	0.00100	-0.0860	0.000700	0.0256	1		
LTdebt	-0.0321	-0.0321	0.0234	-0.0103	-0.0125	0.106	0.9426*	0.4948*	0.139	0.4297*	-0.00910	-0.0898	-0.105	-0.0527	1	
Markcap	0.7329*	0.7497*	0.5236*	0.6146*	0.7506*	0.6322*	0.0668	0.124	0.112	0.4531*	-0.0138	0.0793	-0.0736	-0.00280	0.0563	1

Significant at 10% (*) level. The numbers in the table represent pairwise correlations between each variable. The variables are defined in Table 1

5 FINDINGS OR EMPIRICAL STUDY

In this chapter, I test the main hypothesis that firms that use derivatives to hedge are more likely to have higher firm value than those that do not use derivatives. Univariate and multivariate regression analyses are coming up to analyze whether there is a positive relation between derivative hedging and Tobin's Q ratio

5.1 Univariate Tests

In this subchapter, I test the main hypothesis that firms that do hedge by derivative are rewarded by investors with high valuation. I test the hypothesis separately for the sample of firms with two different formula of calculating Tobin's Q proposed by Chung and Pruitt (1994) and Jin and Jorion (2006). As mentioned in preceding paragraph that the distribution of Tobin's Q is skewed to right side, I test my hypothesis using the natural log of Tobin's Q and natural log of fair value of derivative hedging to make the distribution symmetrical.

Firstly, Two-sample t test is used for testing whether the means of Tobin's Q of hedging firms is different from the means of Tobin's Q of hedging firms. The results of two-sample mean-comparison test with unpaired and unknown variance are shown in Appendix C. According to the results, there is no significant difference between the mean of Tobin's Q firms hedging and the mean of Tobin's Q firms not hedging since the probability is larger than 0.05. Jin and Jorion (2006) also discover that there is no evidence of systematic difference in Q ratios for hedgers and nonhedgers in univariate settings.

Secondly, Univariate regression test is used to test whether there is the relationship between hedging and Tobin's Q for hedging firm. Univariate regression model: univariate regression analyses will be conducted in the following form: $\ln Q = \beta_0 + \beta_1 * (\text{lnhedging}_i) + \mu_i$. In this analysis, β_0 is a constant and a measure for the intercept. β_1 is sloped parameter in the relationship between lnQ and lnhedging, holding the other factors in μ_i fixed. μ_i, which contains an error term and the residual for observation i, represents factors other than hedging that affect Tobin's Q. The results of univariate regression test are shown in Table 3

Table 3 univariate regression and results

	(1) lnQ1	(2) lnQ2
lnhedging	0.761***	0.641***
	(8.14)	(8.47)
_cons	-4.942***	-3.489***
	(-7.24)	(-6.32)
N	88	88
adj. R-sq	0.4287	0.4487

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Table 3 presents the relationship between the natural log of Tobin's Q and natural log of fair value of derivative hedging for the sample of firms. According to the result of univariate regression analysis, I find that there is significantly positive relation between derivative hedging and Tobin's Q. β_1, called elasticity in the log-log model, is 0.761% and 0.641%, respectively, for lnQ1 and lnQ2, implying that a 1% increase in derivative hedging increases

Tobin's Q by 0.761% and 0.641%. Furthermore, this simple linear regression can explain over 40% (R-squared) of the relation between regressor (lnheding) and regressand (lnQ).

Because the classical linear model states that Pooled OLS is meaningful if the error has a normal distribution, conditional on the explanatory variables, Normality assumption check is done for robustness. The results of test and scatter plot of error term are shown in Appendix D. According to the result of normality test, the null hypothesis can be rejected for error term since probability is smaller than significance level of 0.05, meaning that normality assumption does not hold for error term. Furthermore, the scatter plot of error terms how that the error term has a non-constant distribution, meaning that heteroskadastictiy may be inherent in panel data. Thus, it is less efficient without checking the variance of the unobservable u, error term or disturbance terms, in univariate regression to create unbiasedness of OLS. With classical linear model, the variance of the unobservable, μ, conditional on independent variable, is constant. This is known as the homoskedasticity or constant variance assumption. Heteroskedasticity is the opposite of homoskedasticity. In order to do homoskedasticity-robust check, White's Test is used to test whether this assumption is hold with this simple linear relationship to make OLS unbiased. The results of White's test for Q1 and Q2 are shown in Appendix E. According to the result of White's test, we fail to reject homoskedasticity assumption within simple linear relationship, implying that the variance of the unobservable, μ, conditional on independent variable, is constant.

Autocorrelation refers to correlation between the errors in two different time periods. To check whether autocorrelation problem exists in panel data model, Wooldridge test is used for autocorrelation in panel data. The results of test are shown in Appendix F. According to the result of autocorrelation test, the null hypothesis can be rejected for error term since probability is smaller than significance level of 0.05. Therefore, it is believed that autocorrelation problem exists within panel data sample.

Based on the results of both of univariate tests, it is concluded that once firms hedge, the higher Qs they will have. On the other hand, t-test result shows that there is no difference between firms with hedging and firms without hedging, it might be that either there are some confounding effects of other explanatory variables or there is no effect of hedging on Tobin's Q of firms, or both.

As far as the econometrics theory is concerned, univariate tests tend to be weak since they do not control for many other factors that simultaneously affect the dependent variable. Therefore in next section, multivariate regression, which examines the effects of the independent variables on dependent variable, will be used to test the main hypothesis comprehensively.

5.2 Multivariate Tests and Results

In the previous section I examined in a univariate setting the hypothesis that whether derivative hedging is positively associated with Tobin's Q ratio. However, it is believed that univariate tests tend to be weak since it is less amenable to ceteris paribus analysis. Multivariate regression analysis is more amenable to ceteris paribus analysis because it allows us to explicitly control for many other factors that simultaneously affect the dependent variable. This is important for testing economic theories when we must rely on non-experimental data. Because multiple regression models can accommodate many explanatory variables that may be correlated, we can hope to infer causality in cases where simple regression analysis would be misleading. An additional advantage of multiple regression analysis is that it can incorporate fairly general functional form relationships. In the simple regression model, only one function of a single explanatory variable can appear in the equation, implying that multiple regression model allows for much more flexibility. In this subsection, I test my hypothesis in a multivariate setting.

Multivariate regression model: multivariate regression analyses will be conducted in the following form:

$lnQ_{jt}=\beta_0 + \beta_1*(hedgingdummy_{it}) + \beta_2*(lnhedging_{it})*(hedgingdummy_{jt}) + \beta_3*(SIZE_{it}) + \beta_4*(PROF_{jt}) + \beta_5*(DIV_{jt}) + \beta_6*(LEV_{jt}) + \beta_7*(GD_{jt}) + \beta_8*(IO_{jt}) + \mu_{it}$.

where

β_0 is a constant and a measure for the intercept.

β_1 measures the difference between the value of firm with hedging and the value of firm without hedging , holding other factors fixed

β_2 measures the change in lnQ with respect to lnhedging, holding other factors fixed

β_3 measures the change in lnQ with respect to firm size, holding other factors fixed

β_4 measures the change in lnQ with respect to profitability, holding other factors fixed

β_5 measures the change in lnQ with respect to dividend, holding other factors fixed

β_6 measures the change in lnQ with respect to leverage, holding other factors fixed

β_7 measures the change in lnQ with respect to geographic diversification, holding other factors fixed

β_8 measures the change in lnQ with respect to investment opportunities, holding other factors fixed

μ_i is the error term or disturbance, which contains factors other than lnhedging, firm size, profitability, dividend, leverage, geographic diversification and investment opportunities

Table 4 presents the results of multivariable linear regression analysis under calculation of Tobin’s Q formula proposed by Chung and Pruitt (1994). Because the results of multivariable linear regression analysis under calculation of Tobin’s Q formula proposed by Jin and Jorion (2006) are similar, it is better to put them in Appendix D. In the following paragraph, the results of test under calculation of Tobin’s Q formula proposed by Jin and Jorion (2006) is put in Appendix since the results are similar to the result of test under calculation of Tobin’s Q formula proposed by Chung and Pruitt (1994), otherwise stated as necessary.

Half of the control variables are statistically significant and have expected sign. For example, the coefficients on hedging variable are statistically significant, which is consistent with the findings documented by Allayannis and Weston (2001). The log of Tobin’Q of firms without hedging is 3.9 bigger than log of Tobin’s of firms with hedging, meaning that the value of firm without hedging is bigger than the value of firm with hedging. Furthermore, like Breeden and Viswanathan (1998), I find that profitability, which is proxied by ROA (Return on Assets), has a positive sign. It means that a 1% increase in return on assets (ROA) increases Tobin’s Q by approximately 1%. Furthermore, the extent of dividend (DIV) is also significantly and positively related to Q. It means that the Tobin's Q of the firms that pay the dividend is 1.3 higher than the Tobin's Q of the firms that don't pay the dividend. I also find that there is insignificant but negative relationship between Qs and multinationality (GD), which means that the Tobin's Q of the firms that operate in more than one country is 0.04 lower than the Tobin's Q of the firms that operate in only one country. Size has a significantly negative effect on firm value, which is consistent with the finding of Allayannis and Weston (2001).

Normality assumption check also is done in multivariate settings. The results of test are shown in Appendix H. According to the result of normality test, the null hypothesis can be rejected for error term since probability is smaller than significance level of 0.05, meaning that normality assumption does not hold for error term.

Just as homoskedasticity assumption check in the univariate test, homoskedasticity assumption check should be done in the multivariate test to check whether the variance of the unobservable, μ, conditional on independent variable, is constant. White's test can also be used in multivariate setting. The results of test are shown in Appendix I. According to the result of homoskedasticity test, the null hypothesis can be rejected for error term since probability is smaller than significance level of 0.05. Therefore, it is believed that heteroskedasticity exists within panel data sample.

Multicollinearity refers to correlation among the independent variables in a multiple regression model. It is usually invoked when some correlations are "large". Therefore, multicollinearity check also is done. The results of test are shown in Appendix J. The index VIF is indicator of multicollinearity. All of VIF for each of independent variable is below 2, which shows that there is no multicollinearity problem[2] among the independent variables.

Autocorrelation refers to correlation between the errors in two different time periods. To check whether autocorrelation problem exists in panel data model, Wooldridge test is used for autocorrelation in panel data. The results of test are shown in Appendix K. According to the result of autocorrelation test, the null hypothesis can be rejected for error term since probability is 0.009 if significance level of 0.05 is chosen. Therefore, it is believed that autocorrelation problem also exists within panel data sample.

According to the results of robust checks above, it is believed that Pooled OLS is less meaningful model to capture the relationship between Tobin's Q and independent variables. Because all problems are derived from error term, it is obvious that there are some effects of unobservable firm characteristics on dependent variable and independent variable that we have to consider.

[2] Theoretically speaking, there is no definite standard against which multicollinearity can be determined. Overall, when VIF is larger than 10, it is believed that multicollinearity problem exists. Detailed information can be checked in the book of Wooldridge, J.M. (2009), Introductory to econometrics: A modern approach, Fourth edition, South-Western Cengage Learning

Table 4 Multivariate Test and Results

This table reports the results of multivariate regression of firm value, as measured by the natural logarithm of Tobin's Q under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994)., on measures of hedging behavior and other firm characteristics. It is estimated with OLS using robust standard errors that allow for panel data sample. Year dummy variables are included in the regression model, but are not reported. T-values are reported in parentheses below the coefficients. Statistical significance at 5%, 1%, and 0.1% level is indicated by *, **, ***, respectively.

	(1) lnQ1	(2) lnQ1	(3) lnQ1	(4) lnQ1	(5) lnQ1	(6) lnQ1	(7) lnQ1	(8) lnQ1
hedgingdummy	0.219	-5.230***	-4.934***	-4.892***	-3.926***	-3.946***	-3.944***	-3.942***
	(1.01)	(-6.64)	(-6.76)	(-6.83)	(-5.34)	(-5.34)	(-5.33)	(-5.29)
lnhedging		0.761***	0.766***	0.756***	0.613***	0.614***	0.615***	0.615***
		(7.14)	(7.78)	(7.82)	(6.11)	(6.10)	(6.09)	(6.05)
Size			-0.742	-0.903	-1.041	-1.040	-1.033	-1.034
			(-0.26)	(-0.09)	(-0.13)	(-0.10)	(-0.85)	(-0.79)
PROF				0.0148**	0.0140**	0.0139**	0.0140**	0.0140**
				(3.10)	(3.01)	(2.99)	(2.99)	(2.98)
DIV					1.343***	1.346***	1.341***	1.341***
					(3.97)	(3.97)	(3.95)	(3.94)
LEV						0.000101	0.000104	0.000103
						(0.34)	(0.35)	(0.34)
GD							-0.0470	-0.0467
							(-0.24)	(-0.24)
IO								-0.000230
								(-0.03)
_cons	0.288*	0.288*	3.678***	4.574***	5.127***	5.120***	5.120***	5.124***
	(2.12)	(2.35)	(6.65)	(7.44)	(8.39)	(8.36)	(8.34)	(8.19)
N	226	226	226	226	226	226	226	226

t statistics in parentheses, * p<0.05, ** p<0.01, *** p<0.001

To control for unobservable firm characteristics that may affect value, I estimate the random-effects model and fixed-effect model to decide whether they are preferred to Pooled OLS model.

Random-effects model (RE) is the unobserved effects panel data model where the unobserved effect is assumed to be uncorrelated with the explanatory variables in each time period. The results of random-effects model are shown in Appendix L. According to the result of random-effects model, the null hypothesis can be rejected since probability is below significance level of 0.05, meaning that RE model is preferred to Pooled OLS model.

Fixed-effects model (FE) is the unobserved effects panel data model where the unobserved effect is allowed to be arbitrarily correlated with the explanatory variables in each time period. The results of fixed-effects model are shown in Appendix M. According to the result of fixed-effects model, we fails to reject the null hypothesis since probability is below significance level of 0.05, meaning Pooled OLS model is not preferred to FE model. Based on the results of test above, we conclude that RE model and FE model are better than Pooled OLS model.

Because fixed effects allows arbitrary correlation with explanatory variables in each time period, while random effects does not, FE is widely thought to be a more convincing tool for estimating ceteris paribus effects. On the other hand, it is still fairly common to see researchers apply both FE and RE, and then formally test for statistically significant differences in the coefficients on the time-varying explanatory variables.

Fortunately, Hausman (1978) proposed such a test that can decide whether random effect model is preferable to fixed effect model. Therefore, Hausman test is used to decide whether RE is a preferable model. The result is shown in Appendix N. According to the result of Hauman Test, we reject the null hypothesis since probability is below significance level of 0.05, meaning RE model is preferable to FE model.

However, there is the drawback with random-effects model. RE model does not consider the autocorrelation problem, which refers to correlation between the errors in two different time periods. Because of existence of autocorrelation, it is believed that it is better to bring another econometrics specification to make the estimation more unbiased. Feasible Generalized Least Squares model (FGLS) is the model that accounts for the error variance (heteroskedasticity), autocorrelation pattern in the errors, or both, via a transformation of the original model. Thus, FGLS model is used to correct Pooled OLS and RE model for heteroskedasticity and autocorrelation in error term. The results of FGLS can be found in Appendix O. Table 5 show three models, Pooled OLS and Random-effects and FGLS. According to Table 5, I find the difference between Tobin's Q of hedging firm and that of non-hedging firm is $\beta_1 + \beta_2$ (lnhedging)= -2.122+0.311(lnhedging).

The model specification for hedging firm is:

lnQ_{jt}=4.189 + (-2.122)*1 + 0.311*($lnhedging_i$) + (-0.858)*($SIZE_i$) + (0.0133)*($PROF_j$) + (1.414)* (DIV_j) + (0.000015)*(LEV_j) + (0.25)*(GD_j) + (0.0000753)*(IO_j) +μ_i.

The model specification for non-hedging firm is

lnQ_{jt}=4.189 + (-0.858)*($SIZE_i$) + (0.0133)*($PROF_j$) + (1.414)* (DIV_j) + (0.000015)*(LEV_j) + (0.25)*(GD_j) + (0.0000753)*(IO_j) +μ_i.

FGLS model shows that once the firm wants to hedge, the hedging premium is 0.311%, which is less than the 5% documented in Allayannis and Weston (2001) and 10% in Carter et al (2006). In other words, a 1% increase in firm hedging increases Tobin's Q by about 0.311%. Furthermore, there is significantly positive relation between Tobin's Q and profitability, which is consistent with the theory of Breeden and Viswanathan (1998): more profitable firms as proxied by high ROA have higher Qs. I also find that there is statistically significantly positive relationship between dividend and Tobin's Q, which is consistent with the theory of Jin and Jorion (2006). The fact that the size has the insignificantly negative effects on Tobin's Q ratio is contradictory to the theory of Nance et al. (1993) but is consistent with findings of Allayannis and Weston (2001)

Table 5 Pooled OLS and Random-effects and FGLS

This table reports the results of Pooled OLS model and random-effects model and FGLS model under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994). Pooled OLS model is the estimation of with panel data, where the observations are pooled across time as well as across the cross-sectional units. Random-effects model is the unobserved effects panel data model where the unobserved effect is assumed to be uncorrelated with the explanatory variables in each time period. Feasible Generalized Least Squares model (FGLS) is the model that accounts for a known structure of the error variance (heteroskedasticity), autocorrelation pattern in the errors, or both, via a transformation of the original model.

	Pooled OLS lnQ1	Random-effect lnQ1	FGLS lnQ1
hedgingdummy	-3.942*** (-5.29)	-2.123** (-2.99)	-2.122*** (-4.55)
lnhedging	0.615*** (6.05)	0.331*** (3.38)	0.311*** (4.90)
size	-1.034 (-0.79)	-1.191 (-0.31)	-0.858 (-1.71)
PROF	0.0140** (2.98)	0.0116** (2.62)	0.0133*** (4.34)
DIV	1.341*** (3.94)	1.891*** (4.02)	1.414*** (4.80)
LEV	0.000103 (0.34)	0.0000143 (0.05)	0.0000150 (0.10)
GD	-0.0467 (-0.24)	0.0439 (0.16)	0.250 (1.80)
IO	-0.000230 (-0.03)	0.00561 (0.71)	0.0000753 (0.01)
_cons	5.124*** (8.19)	5.785*** (7.64)	4.189*** (7.58)
N	226	226	226
Adj R-squared	0.3621	0.3494	
Wald chi2 (8)		81.98	102.65

t statistics in parentheses, * p<0.05, ** p<0.01, *** p<0.001

5.3 Non-linear regression model and results

The extent to which econometrics has so far been developed indicates that FGLS model is the best way to correct Pooled OLS for bias from heteroskedasticy and autocorrelation. It is assumed that all assumptions for Pooled OLS are met. That is, I can use FGLS model to explain the relation between Tobin's Q and hedging. However, no one can be certain for that FGLS model is perfect model to analyze. According to the results of FGLS model, the difference between Tobin's Q of hedging firms and that of non-hedging firm is $\beta_1 + \beta_2$* (lnhedging) = -2.122+0.311*(lnhedging). In other words, Firm hedging will increase Q by -2.122+0.311*(lnhedging), which indicates that non-linear relationship is inherent in my model specification. With the suspicion to FGLS and non-linear relationship, it is necessary to devise non-linear model to estimate the relationship between Tobin's Q and hedging.

One simple way is to use polynomial model to capture this non-linear relation by adding quadratic terms to previous model specification. Non-linear regression model: non-linear regression analyses will be conducted in the following form:

$\ln Q_{jt} = \beta_0 + \beta_1 * (\text{hedgingdummy}_i) + \beta_2 * (\text{lnhedging}_i) * (\text{hedgingdummy}_{jt}) + \beta_3 * (\text{lnhedging}_i)^2 * (\text{hedgingdummy}_{jt}) + \beta_4 * (\text{SIZE}_i) + \beta_5 * (\text{PROF}_j) + \beta_6 * (\text{DIV}_j) + \beta_7 * (\text{LEV}_j) + \beta_8 * (\text{GD}_j) + \beta_9 * (\text{IO}_j) + \mu_i$.

where

β_0 is a constant and a measure for the intercept.

β_1 measures the difference between the value of firm with hedging and the value of firm without hedging , holding other factors fixed

β_2 measures the change in lnQ with respect to lnhedging, holding other factors fixed

β_3 measures the change in lnQ with respect to squared lnhedging, holding other factors fixed

β_4 measures the change in lnQ with respect to firm size, holding other factors fixed

β_5 measures the change in lnQ with respect to profitability, holding other factors fixed

β_6 measures the change in lnQ with respect to dividend, holding other factors fixed

β_7 measures the change in lnQ with respect to leverage, holding other factors fixed

β_8 measures the change in lnQ with respect to geographic diversification, holding other factors fixed

β_9 measures the change in lnQ with respect to investment opportunities, holding other factors fixed

μ_i is the error term or disturbance, which contains factors other than lnhedging, firm size, profitability, dividend, leverage, geographic diversification and investment opportunities

Table 6 Non-linear regression model and result

This table reports the results of non-linear regression model under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994) and Jin and Jorion (2006). Nonlinear regression model is depicted by quadratic functions.

	FGLS lnQ1	FGLS lnQ2
hedgingdummy	3.340**	3.745***
	(2.59)	(3.80)
lnhedging	-1.262***	-1.348***
	(-3.33)	(-4.51)
lnhedgingsq	0.111***	0.116***
	(3.98)	(5.13)
size	-0.804	-0.487
	(-0.32)	(-1.00)
PROF	0.0124***	0.00680***
	(4.12)	(3.57)
DIV	1.048***	0.746***
	(3.65)	(4.19)
LEV	0.0000172	0.0000310
	(0.19)	(0.38)
GD	0.210	0.0741
	(1.55)	(1.03)
IO	-0.000316	0.00365
	(-0.05)	(1.22)
_cons	3.954***	3.048***
	(7.26)	(8.64)
N	226	226

t statistics in parentheses
* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table 6 show results of non-linear regression FGLS models under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994) and Jin and Jorion (2006). According to Table 6, I find that Tobin's Q of hedging firm is influenced by β_1 + β_2*(lnhedging) +β_3 *(lnhedgingsq). I also find that three variables, hedgingdummy, lnhedging and squared lnhedging are consistently significant with three models. Furthermore, there is significantly positive relation between Tobin's Q and profitability, which is consistent with the theory of Breeden and Viswanathan (1998): more profitable firms as proxied by high ROA have higher Qs. I also find that there is statistically significantly positive relationship between dividend and Tobin's Q, which is consistent with the theory of Jin and Jorion (2006). I also find that there is insignificant but positive relationship between Tobin's Q and multinationality, which is consistent with the theory of Bodnar, Tang, Weintrop (1999).

According to my empirical results, I can conclude that the relationship between Tobin's Q and hedging has the U-shape, implying that there is an increasing marginal return since β_1 <0 and β_2 >0. The principles and the results of this quadratic function model are put in Appendix P and Appendix Q. According to the result of non-linear model, it shows that the firms that have hedging value below around 300,000 Euros is diminishing the value of firms and firms that have hedging value above 300,000 Euros is increasing the value of firms.

5.4 Explanation of non-linear relation

In my opinion, this relationship can be interpreted by several factors as follows:

(1) Country-specific factor (bankruptcy code): According to Judge (2006), the expected financial distress costs are higher in the U.K. than they are in the U.S. The bankruptcy code in the U.K. is perceived as debt holder friendly because it confers greater rights to creditors when reorganizing a bankrupt company's affair. If the U.K. rules make liquidation more likely for firms in financial distress, then U.K. firms potentially face higher expected costs of financial distress than firms in the U.S., suggesting that U.K. firms have a greater incentive to hedge in order to lower the expected value of these costs.

(2) Cost factor: two major components of costs are those associated with initiating and maintaining a risk management program in general, and those associated with choosing a particular derivative. If the costs are prohibitively expensive, a firm will not use any derivatives. If the costs are low enough, they can still affect a firm choice among instruments.

(3) Size: small and large firms both should hedge more. Small firms should hedge more since the bankruptcy cost is high. Large firms should hedge more, because they can afford to establish risk management program and have greater expertise.

(4) Other types of derivatives: According to Geczy, Minton, Schrand (1997), firms that use more than one or two derivatives can have greater expertise and lower transaction costs associated with derivatives trading.

(5) Nature of derivatives: For oil and gas producers, the commodity risk is easy to identify and hedge by individual investors. Hedging by the firm does not give a special advantage since investors can hedge on their own, using for instance exchange-traded futures contracts. Tufano (1996) states that using commodity derivative may not contribute to the increasing of the value of a firm.

Based on factors mentioned above, one possible explanation regarding this increasing marginal return is that costs of hedging consists of two part, one is the costs associated with initiating and maintaining a risk management program in general, and the other one associated with choosing and transacting derivatives. When small and big firms decide to hedge, the cost of hedging expected bankruptcy cost becomes bigger and more expensive when the firms hedge more since the costs associated with initiating and maintaining a risk management program in general and associated with choosing a particular derivative increase gradually. At this time, the cost is bigger than the hedging premium. When they hedge above 300,000 Euros and rely on several derivatives, the transaction cost is decreasing and unsystematic risk is also eliminated. Hence, at this time hedging premium is higher than the cost.

5.5 Conclusion

In conclusion, the findings of this section empirically give the answer to the main research question and test the relation between hedging and firm value.

The first subsection in this chapter demonstrates the result of simple regression in univariate settings. I find that there is significantly positive relationship between hedging and firm value, which is consistent with the result of hedging by Allayannis and Weston (2001) and Carter et al. (2006). However, univariate test becomes weak in that it does not allows us to explicitly control for many other factors that simultaneously affect the dependent variable.

To make unbiased estimation, multivariate tests are executed in the second subsection. Three models are used in multivariate settings. According to the results of three models, I find that Tobin's Q of firms with hedging is bigger than Tobin's Q of firms without hedging. Once the firm hedges, the hedging premium among three models is ranging from 0.6% to 0.3%, which is smaller than the 5% documented in Allayannis and Weston (2001) and 10% in Carter et al (2006). The reason why the hedging premium becomes smaller is that there exists a crucial difference between the natures of the commodity risk exposure of oil and gas producers and the foreign currency risk exposure of large U.S. multinationals. For oil and gas producers, the commodity risk is easy to identify and hedge by individual investors. Hedging by the firm does not give a special advantage since investors can hedge on their own, using for instance exchange-traded futures contracts. Tufano (1996) states that the usage of commodity derivative may not contribute to the increasing of the value of a firm. On the other hand, Geczy, Minton, and Schrand (1997) find that firms use currency derivatives to reduce the underinvestment problem and similarly Visvanathan (1998) finds that the use of interest rate derivatives may be related to value-increasing strategies. Thus, the benefit of commodity derivative hedging is not significantly bigger than that of currency or interest rate derivatives. An alternative explanation is that Allayannis and Weston (2001) investigate companies within different industries and segments. The hedging premium observed for those companies are attributed to some factors, such as informational asymmetries or operational hedges, which add value but happen to be positively correlated with the presence of derivatives. I also find that there is statistically significantly positive relationship between dividend and Tobin's Q, which is consistent with the theory of Jin and Jorion (2006). This finding is consistent with the prediction of Jin and Jorion (2006) that dividends may be viewed as a positive signal from management. If the companies paid the dividend, it may indicate that company is profitable and management in good quality. The investors reward companies with higher valuation. Size has a insignificantly negative effect on firm value. The fact that Size is negatively correlated with Tobin's Q is consistent with the theory of Bodnar et al (1999). They claim that the bigger the companies are, the more multinational they are. Further, geographic diversification could reduce firm value. When companies do business in more than one country, efficiency and effectiveness are likely to become low because of lack of corporate governance. While shareholders seek value maximization as a goal of corporate decisions, managers' objectives may differ. In particular, managers seek to act in their own self-interest, which at times may be at the expense of shareholders' interests. Extensive geographic diversification may result in a negative impact on firm value. The bigger the companies are, the more multinational they are, the more negative impact on firm value there is. In my sample, the fact that over half of oil and gas producers operate in more than one country is consistent with the theory of Bodnar et al (1999).

Because there is suspicion on FGLS reliability and on non-linear relationship, polynomial function is used to describe the effects of hedging on firm's value. Adding quadratic function to a linear relationship is one simple way to solve non-linear relationship between hedging and Tobin'Q. After doing this, I find that three variables, hedgingdummy, lnhedging and squared lnhedging are consistently significant with three models. Furthermore, there is significantly positive relation between Tobin's Q and profitability, which is consistent with the theory of Breeden and Viswanathan (1998): more profitable firms as proxied by high ROA have higher Qs. I also find that there is statistically significantly positive relationship between dividend and Tobin's Q, which is consistent with the theory of Jin and Jorion (2006). I also find that there is insignificant but positive relationship between Tobin's Q and multinationality, which is consistent with the theory of Bodnar, Tang, Weintrop (1999). More importantly, I find that the firms that have hedging value below around 300,000 Euros is diminishing the value of firms and that firms that have hedging value above around 300,000 Euros is increasing the value of firms.

6 CONCLUSIONS AND RECOMMENDATION

The previous parts provide a two-dimensional insight into the effect of hedging on firm value, one in theoretical way and another in empirical way. In order to formulate a comprehensive answer to the main question of this research, this section will give a concise conclusion that generalizes the approaches that should be taken by oil and gas producers in UK. In pragmatic way, the conclusion of this part is followed by discussion and recommendation section. Finally, this chapter will list the limitations of this research, and constructively give a number of suggestions for future research on the topic of relationship between derivative hedging and firm value.

6.1 Conclusions

"Does derivative hedging increase the value of oil and gas firms in the U.K.? Why or why not?" this question is so broad that I will give a structured answer in two ways.

In Chapter 2, the theories developed Smith and Stulz (1985) show that derivative hedging can reduce corporate tax liability and decrease the probability that the firm encounters financial distress. Froot et al (1993) proposed that hedging can reduce the variability of cash flow and solve the underinvestment problem. DeMarzo and Duffie (1995) concluded that hedging can improve the knowledge of outside investors and reduce the amount of noise and increase the informational content in the firm's profit. Nance et al (1993) also suggest that hedging can decrease the cost of financial distress. Tufano (1996) claimed that there are two categories of interpretation for the hedging. The first one is shareholder maximization hypotheses. It is said that by reducing the cost of financial distress, avoiding suboptimal investment policies, lowering tax liability, hedging can increase the expected value of the firm. Another one is the managerial utility maximization hypotheses, which include managerial risk aversion, signaling of managerial skill, and alternatives to risk management as controls, such as maintaining liquid assets and lowering leverage.

The second way to answer the main research question is by empirical study. Prior empirical researches show that there are mixed evidence regarding the indirect and direct relation between hedging and firm value. For example, Nance et al (1993) find that the firms with more convex tax schedules hedge more. Their findings are consistent with tax convexity theory. However, Graham and Roger (2002) concluded that tax convexity theory is invalid according to their research result. Furthermore, Allayannis and Weston (2001), Carter et al (2006), Berrospide et al (2010), Bartram et al (2009) find that there is statistically significantly positive relationship between derivative hedging and firm's value, as measure by Tobin's Q. However, Jin and Jorion (2006) claim that their empirical findings is not consistent with findings of Allayannis and Weston. As far as I am concerned, the fact that there is mixed empirical evidence on this topic can be attributable to seven reasons: industry effect factor, endogeneity, sample selection bias, time-period bias, sample size, survivorship bias and the effect of other risk management activities on the firm value.

According to my research result, I find that there is non-linear relationship between hedging and Tobin's Q ratio. I find that the firms that have hedging value below 300,000 Euros is diminishing the value of firms and that firms that have hedging value above 300,000 Euros is increasing the value of firms. Furthermore, there is significantly positive relation between Tobin's Q and profitability, which is consistent with the theory of Breeden and Viswanathan (1998): more profitable firms as proxied by high ROA have higher Qs. I also find that there is statistically significantly positive relationship between dividend and Tobin's Q, which is consistent with the theory of Jin and Jorion (2006). This finding is consistent with the prediction of Jin and Jorion (2006) that dividends may be viewed as a positive signal from management. If the companies paid the dividend, it may indicate that company is profitable and management in good quality. The investors reward companies with higher valuation. Size has an insignificantly negative effect on firm value. The fact that Size is negatively correlated with Tobin's Q means that according to Lang and Stulz (1994) and Bodnar et al (1999), multinational firms are likely to be larger companies. Multinational and bigger firms, due to their operations in different locations, are arguably more inefficient than smaller organization. When companies do business in more than one country, efficiency and effectiveness are likely to become low because of lack of corporate governance. While shareholders seek value maximization as a goal of corporate decisions, managers' objectives may differ. In particular, managers seek to act in their own self-interest, which at times may be at the expense of shareholders' interests. Extensive geographic diversification may result in a negative impact on firm value. The bigger the companies are, the more multinational they are, the more negative impact on firm value there is. Moreover, there is insignificantly positive relation between Tobin's Q and both geographical diversification (GD), which is consistent with the theory of Bodnar et al (2006) that a geographically diversified firm can be more valuable because of its ability to arbitrage institutional restrictions such as tax codes and financial restrictions.

In conclusion, an answer to the question of "Does derivative hedging increase the value of oil and gas firms in the U.K.? why or why not?" is that derivative hedging can conditionally increase the value of oil and gas firms in the U.K. Theoretically speaking, it can reduce corporate tax liability, decrease the probability that the firm encounters financial distress, diminish the variability of cash flow, solve the underinvestment problem, improve the knowledge of outside investors and reduce the amount of noise and increase the informational content. According to my empirical research result, derivative hedging can increase the firm value only if firms have hedging value above 300,000 Euros.

6.2 Research limitation and future research

There are several limitations to this thesis that could be addressed in future research. Firstly, the variables that I use for this thesis are subject not only to data unavailability but also to endogeneity bias from unobservable variables. For example, credit ratings and tax convexity cannot be measured since there is no reliable and valid database for those two variables and I have to omit those two variables so that there are some omitted variable biases inherent in this research.

Now, suppose that the multiple regression form is: $\ln Q = \alpha + \beta_1 (\text{lnhedging}_i) + \beta_2 (\text{SIZE}_i) + \beta_3 (\text{PROF}_j) + \beta_4 (\text{DIV}_j) + \beta_5 (\text{LEV}_j) + \beta_6 (\text{GD}_j) + \beta_7 (\text{IO}_j) + \beta_8 (\text{Credit}) + \mu_i$.

If variable “Credit” is omitted from the model, the estimator of β_1, β_2, β_3, β_4, β_5, β_6 and β_7 are biased, even if we assume independent variables are uncorrelated among them.

The formula that I use for calculating Tobin’s Q cannot completely capture the firm’s intangible assets, thus underestimating the firms’ value. Thirdly, sample selection bias is still inherent into this thesis though I try to minimize this problem. For example, my sample pool consists of oil and gas producers with total assets greater than €296,000. It is unclear whether hedging contributes value to the firm with assets smaller than €296,000. It is also uncertain that the sample size and the time framework are appropriate for this topic. Moreover, survivorship bias also exists with my research. For example, the companies that I analyze are those that are currently in existence. Last but not least, there may be data-mining bias for non-linear model, which is the practice of determining a model by extensive searching through a dataset for statistically significant patterns (that is, repeated, “drilling” in the same data until finding something that appears to work).

Overall, I see this paper as a starting point for studying the direct effects of derivative hedging on firm value under UK settings, even though this paper has several limitations. In the future, I will keep finding the way of minimizing the drawbacks inherent in the paper. I believed that such studies will complement the existing literature and trigger additional exploration of this important subject of risk management research.

6.3 Recommendation

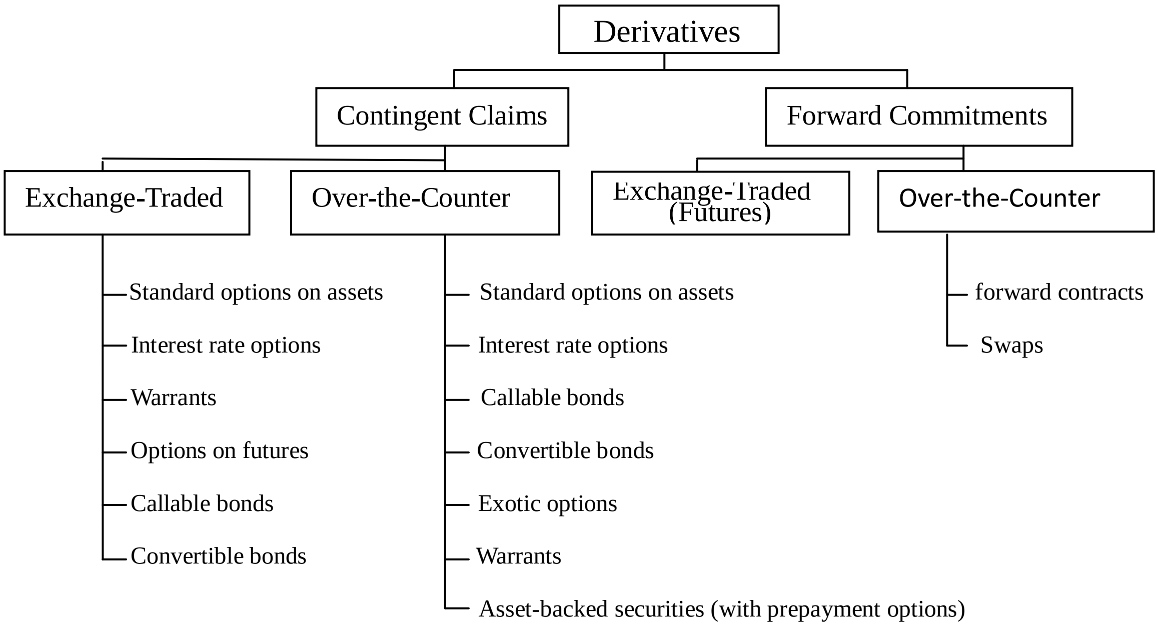
As far as we know, financial crisis or subprime crisis happened in 2008. From then on, risk management models have been paid much more attention among many academic researchers and practitioners. Without implementing the findings of empirical study into our real life, all we have done become meaningless to our financial society. Table 7 provides an overview of the recommended risk management approach with derivative hedging for oil and gas producers in UK.

Table 7 Risk management approach with derivative hedging

Phase	Name	Resolution
I	Identification	The risk management process starts identifying the factors that are exposed to risk, such as price risk, interest rate or exchange rate, default risk etc. It is top priority concerns to identify the factors that are more vulnerable and weak points
II	Assessment	After identifying the risk exposure, the extent or effects of the risk exposure in the system should be assessed to help in knowing the vulnerability of factors.
III	Prioritization	The prioritization of factors that are most vulnerable should be the next step to take.
IV	Application	After prioritization step, the management team should carefully make risk management plan (e.g. what positions the company should take with derivative, long or short? How much the company should hedge with derivative) and use derivative to hedge the risk exposure. This is the most important stage of risk management.
V	Monitoring	Monitoring this process is the last step of hedging risk since company should analyze the result to evaluate the feasibility of hedging plan.

APPENDIX

Appendix A: Classification of financial derivative



Data Source: CFA (www.cfainstitute.org/toolkit)

Appendix B: Predicted signs between explanatory variables and Tobin's Q

Predicted signs between explanatory variables and Tobin's Q

Variables	Literature review	The predicted sign on Tobin's Q ratio
Log of total assets	Nance et al. (1993)/Cabral (1995)	+/-
ROA	Breeden and Viswanathan (1998)	+
Dividend	Allayannis and Weston (2001)/ Jin and Jorion (2006)	+/-
BV of long-term debt over BV of common equity	Myers (1977)	+/-
Geographic diversification dummy	Bodnar et al (2006)	-
Industrial diversification dummy	Lewellen (1971), Bodnar et al (1999)	+/-
Credit rating dummy	Haushalter (2000)	-
Investment growth	Froot, Scharfstein and Stein (1993)	+

Appendix C: Two sample t-test results with unknown variances

Two sample t test in univariate settings under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994).

```
Two-sample t test with unequal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     138    .2884672    .1313736     1.54329     .028685    .5482493
       1 |      88    .5074186    .1784223    1.673749    .1527851    .8620522
---------+--------------------------------------------------------------------
combined |     226    .3737226    .1061158    1.595271    .1646146    .5828305
---------+--------------------------------------------------------------------
    diff |           -.2189515    .2215706               -.6562262    .2183233
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -0.9882
Ho: diff = 0                              Welch's degrees of freedom =  176.137

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.1622         Pr(|T| > |t|) = 0.3244          Pr(T > t) = 0.8378
```

According to the results of two-sample t test, we failed to reject the null hypotheses since probability is 0.3244, which is larger than significance level of 0.05. The result shows that the means of Tobin's Q of hedging firms is not significantly different from the means of Tobin's Q of hedging firms.

Two sample t test in univariate settings under calculation of Tobin's Q formula proposed by Jin and Jorion (2006)

```
Two-sample t test with unequal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     137    .9516936    .0942858    1.103586    .7652377    1.138149
       1 |      88    1.097477    .1468698    1.377761    .8055579    1.389397
---------+--------------------------------------------------------------------
combined |     225    1.008711    .0811523    1.217285    .8487917    1.168631
---------+--------------------------------------------------------------------
    diff |           -.1457839    .1745295               -.4904965    .1989286
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -0.8353
Ho: diff = 0                              Welch's degrees of freedom =  157.953

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.2024         Pr(|T| > |t|) = 0.4048          Pr(T > t) = 0.7976
```

According to the results of two-sample t test, we failed to reject the null hypotheses since probability is 0.4048, which is larger than significance level of 0.05. The result shows that the means of Tobin's Q of hedging firms is not significantly different from the means of Tobin's Q of hedging firms.

Appendix D: Normality check for error term of univariate regression

Normality assumption check for error term in univariate settings under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994)

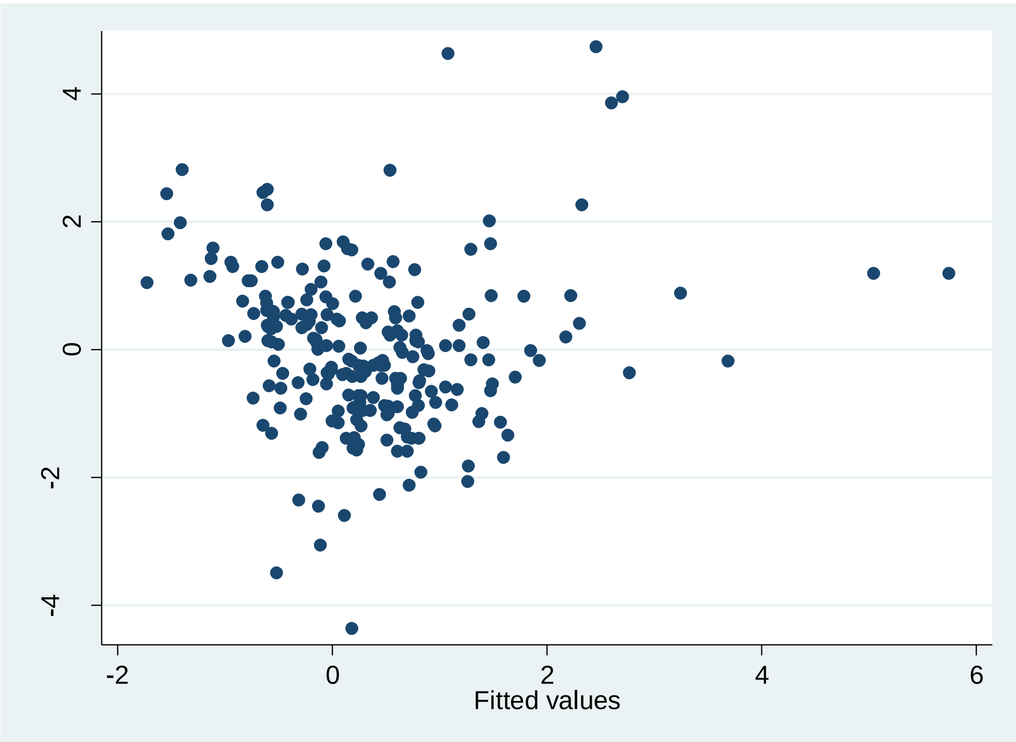
```
                    Skewness/Kurtosis tests for Normality
                                                       ------- joint ------
    Variable |  Pr(Skewness)   Pr(Kurtosis)  adj chi2(2)    Prob>chi2
-------------+-------------------------------------------------------
           e |      0.006          0.000          17.96        0.0001
```

H_0: the error term is normally distributed

H_A: the error term is not normally distributed

According to the results of normality test, we reject the null hypotheses since probability is 0.0001, which is smaller than significance level of 0.05. The result shows that the error term is not normally distributed.

Scatter plot for error term in univariate settings under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994)



Scatter plot shows that the distribution of error term is not normally distributed.

Normality assumption check for error term in univariate settings under calculation of Tobin's Q formula proposed by Jin and Jorion (2006)

Skewness/Kurtosis tests for Normality

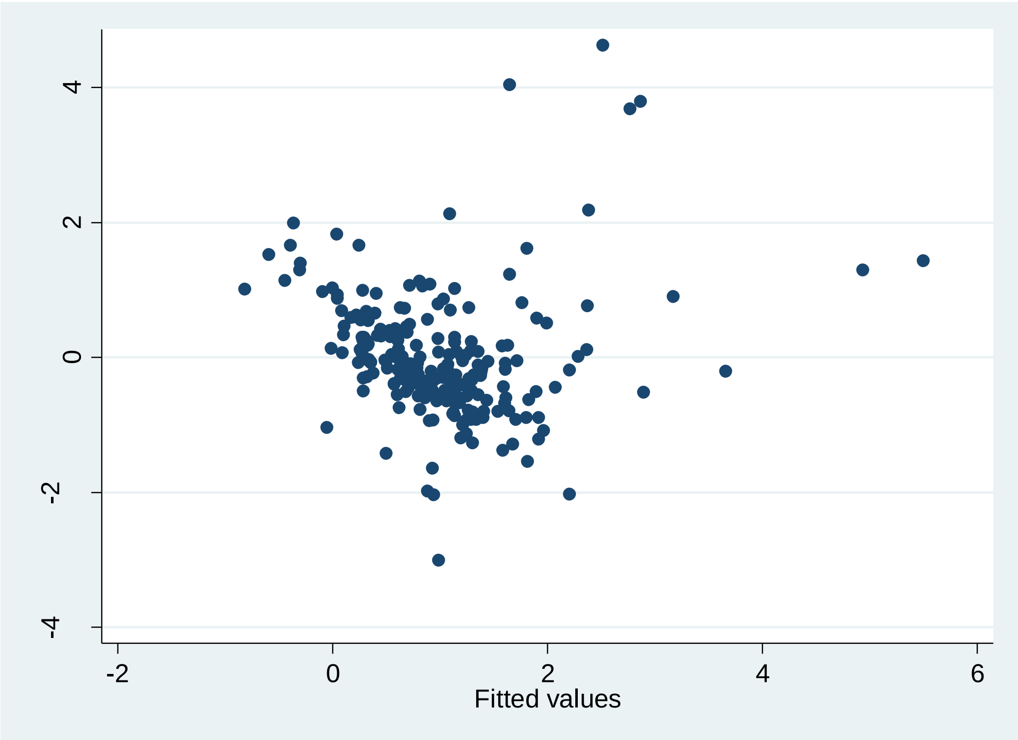
Variable	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
			------- joint	------
e	0.000	0.000	59.97	0.0000

H_0: the error term is normally distributed

H_A: the error term is not normally distributed

According to the results of normality test, we reject the null hypotheses since probability is smaller than significance level of 0.05. The result shows that the result shows that the error term is not normally distributed.

Scatterplot for error term in univariate settings under calculation of Tobin's Q formula proposed by Jin and Jorion (2006)



Scatter plot shows that the distribution of error term is not normally distributed.

Appendix E: Homoskedasticity check for error term of univariate regression

Homoskedasticity assumption check for error term in univariate settings under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994)

```
White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity

         chi2(2)      =      1.08
         Prob > chi2  =    0.5832

Cameron & Trivedi's decomposition of IM-test

---------------------------------------------------
              Source |       chi2     df      p
---------------------+-----------------------------
  Heteroskedasticity |       1.08      2    0.5832
            Skewness |       7.11      1    0.0077
            Kurtosis |       2.77      1    0.0961
---------------------+-----------------------------
               Total |      10.96      4    0.0270
---------------------------------------------------
```

According to the results of White's test, we failed to reject the null hypotheses since probability is 0.5832, which is larger than significance level of 0.05. The result shows that the variance of the unobservable, μ, conditional on independent variable, is constant.

Homoskedasticity assumption check for error term in univariate settings under calculation of Tobin's Q formula proposed by

```
White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity

         chi2(2)      =      2.33
         Prob > chi2  =    0.3127

Cameron & Trivedi's decomposition of IM-test

---------------------------------------------------
              Source |       chi2     df      p
---------------------+-----------------------------
  Heteroskedasticity |       2.33      2    0.3127
            Skewness |       7.21      1    0.0073
            Kurtosis |       2.41      1    0.1205
---------------------+-----------------------------
               Total |      11.94      4    0.0178
---------------------------------------------------
```

According to the results of White's test, we failed to reject the null hypotheses since probability is 0.3127, which is larger than significance level of 0.05. The result shows that the variance of the unobservable, μ, conditional on independent variable, is constant.

Appendix F: Autocorrelation check for error term of univariate regression

Autocorrelation check for error term in univariate settings under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994)

```
Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
    F(  1,       56) =     15.756
           Prob > F =      0.0002
```

According to the results of Wooldridge test, we reject the null hypotheses since probability is 0.0002, which is smaller than significance level of 0.05. The result shows that the correlation between error terms in different periods exists.

Autocorrelation check for error term in univariate settings under calculation of Tobin's Q formula proposed by Jin and Jorion (2006)

```
Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
    F(  1,       56) =     10.006
           Prob > F =      0.0025
```

According to the results of Wooldridge test, we reject the null hypotheses since probability is 0.0025, which is smaller than significance level of 0.05. The result shows that the correlation between error terms in different periods exists.

Appendix G: Results of multivariate regression

This table reports the results of multivariate regression of firm value, as measured by the natural logarithm of Tobin's Q under calculation of Tobin's Q formula proposed by Jin and Jorion (2006), on measures of hedging behavior and other firm characteristics. It is estimated with OLS using robust standard errors that allow for panel data sample. T-values are reported in parentheses below the coefficients. Statistical significance at 5%, 1%, and 0.1% level is indicated by *, **, ***, respectively.

	(1) lnQ2	(2) lnQ2	(3) lnQ2	(4) lnQ2	(5) lnQ2	(6) lnQ2	(7) lnQ2	(8) lnQ2
hedgingdummy	0.153	-4.434***	-4.219***	-4.190***	-3.460***	-3.478***	-3.477***	-3.500***
	(0.92)	(-7.57)	(-7.74)	(-7.81)	(-6.29)	(-6.29)	(-6.27)	(-6.28)
lnhedging		0.641***	0.644***	0.637***	0.529***	0.531***	0.531***	0.534***
		(8.08)	(8.76)	(8.80)	(7.04)	(7.04)	(7.02)	(7.03)
Size			-0.539	-0.649	-0.753	-0.753	-0.749	-0.744
			(-0.09)	(-0.81)	(-0.86)	(-0.83)	(-0.60)	(-0.50)
PROF				0.0102**	0.00956**	0.00951**	0.00956**	0.00948**
				(2.85)	(2.75)	(2.73)	(2.73)	(2.70)
DIV					1.014***	1.017***	1.015***	1.017***
					(4.01)	(4.01)	(3.99)	(3.99)
LEV						0.0000893	0.0000905	0.0000976
						(0.40)	(0.40)	(0.43)
GD							-0.0224	-0.0260
							(-0.15)	(-0.18)
IO								0.00313
								(0.51)
_cons	0.945***	0.945***	3.404***	4.021***	4.439***	4.433***	4.433***	4.390***
	(9.12)	(10.35)	(8.25)	(8.73)	(9.70)	(9.67)	(9.64)	(9.37)
N	226	226	226	226	226	226	226	226
Adj R-squared	-0.0007	0.2226	0.3308	0.3515	0.3929	0.3906	0.3879	0.3858

t statistics in parentheses, * p<0.05, ** p<0.01, *** p<0.001

Appendix H: Normality check for error term of multivariate regression

Normality assumption check for error term in multivariate settings under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994)

Skewness/Kurtosis tests for Normality

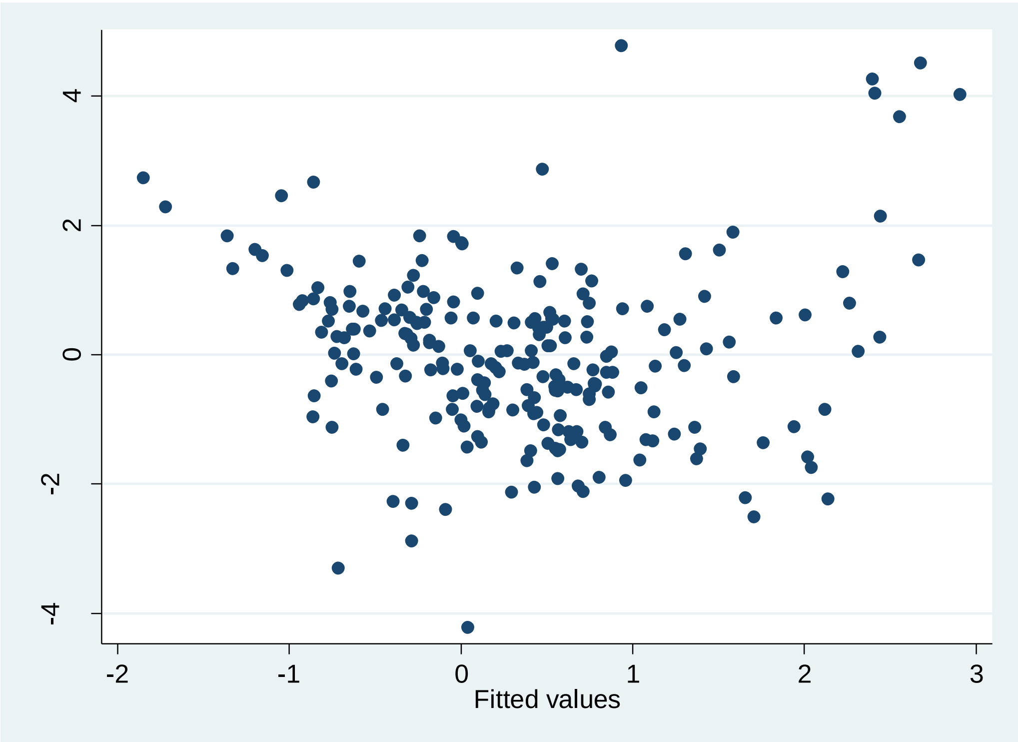
Variable	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	joint Prob>chi2
e	0.001	0.001	18.48	0.0001

H_0: the error term is normally distributed

H_A: the error term is not normally distributed

According to the results of White's test, we reject the null hypotheses since probability is 0.0017, which is smaller than significance level of 0.05. The result shows that the variance of the unobservable, μ, conditional on independent variable, is not normally distributed.

Scatter plot for error term in multivariate settings under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994)



Scatter plot shows that the distribution of error term is not normally distributed.

Normality assumption check for error term in multivariate settings under calculation of Tobin's Q formula proposed by Jin and Jorion (2006)

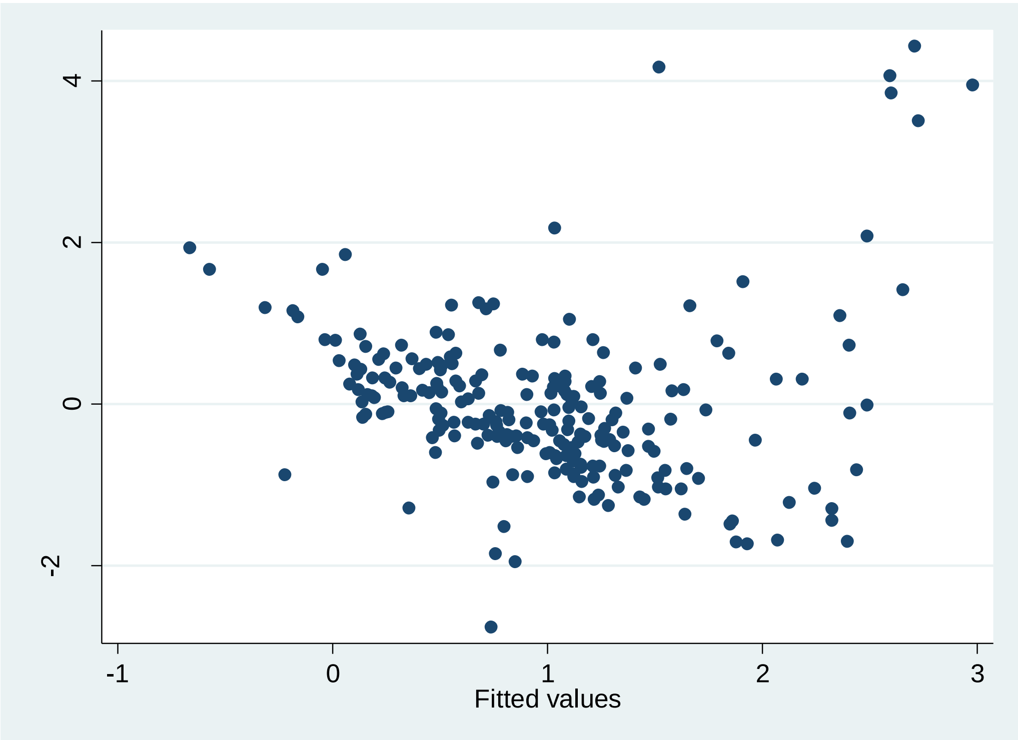
```
                    Skewness/Kurtosis tests for Normality
                                                    ------- joint ------
    Variable |  Pr(Skewness)   Pr(Kurtosis)  adj chi2(2)    Prob>chi2
-------------+-------------------------------------------------------
          e1 |      0.000          0.000           61.56       0.0000
```

H_0: the error term is normally distributed

H_A: the error term is not normally distributed

According to the results of White's test, we reject the null hypotheses since probability is smaller than significance level of 0.05. The result shows that the variance of the unobservable, μ, conditional on independent variable, is not normally distributed.

Scatter plot for error term in multivariate settings under calculation of Tobin's Q formula proposed by Jin and Jorion (2006)



Scatter plot shows that the distribution of error term is not normally distributed.

Appendix I: Homoskedasticity check for error term of multivariate regression

Homoskedasticity assumption check for error term in multivariate settings under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994)

```
White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity

         chi2(33)      =    123.40
         Prob > chi2   =    0.0000

Cameron & Trivedi's decomposition of IM-test

---------------------------------------------------
              Source |       chi2     df      p
---------------------+-----------------------------
  Heteroskedasticity |     123.40     33    0.0000
            Skewness |      41.27      7    0.0000
            Kurtosis |       6.95      1    0.0084
---------------------+-----------------------------
               Total |     171.62     41    0.0000
---------------------------------------------------
```

According to the results of White's test, we reject the null hypotheses since probability is 0.0001, which is smaller than significance level of 0.05. The result shows that the variance of the unobservable, µ, conditional on independent variable, is not constant.

Homoskedasticity assumption check for error term in multivariate settings under calculation of Tobin's Q formula proposed by Jin and Jorion (2006)

```
White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity

         chi2(33)      =    161.70
         Prob > chi2   =    0.0000

Cameron & Trivedi's decomposition of IM-test

---------------------------------------------------
              Source |       chi2     df      p
---------------------+-----------------------------
  Heteroskedasticity |     161.70     33    0.0000
            Skewness |      50.21      7    0.0000
            Kurtosis |       7.02      1    0.0080
---------------------+-----------------------------
               Total |     218.93     41    0.0000
---------------------------------------------------
```

According to the results of White's test, we reject the null hypotheses since probability is smaller than significance level of 0.05. The result shows that the variance of the unobservable, µ, conditional on independent variable, is not constant.

Appendix J: Multicollinearity check among explanatory variables

Multicollinearity Check for independent variables in multivariate settings under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994) and Jin and Jorion (2006)

```
(obs=226)

  Collinearity Diagnostics

                        SQRT                   R-
  Variable      VIF     VIF    Tolerance    Squared
----------------------------------------------------
 lnhedging      1.15    1.07    0.8681      0.1319
      Size      1.45    1.21    0.6873      0.3127
      PROF      1.25    1.12    0.7985      0.2015
       DIV      1.17    1.08    0.8566      0.1434
       LEV      1.02    1.01    0.9810      0.0190
        GD      1.14    1.07    0.8787      0.1213
        IO      1.02    1.01    0.9770      0.0230
----------------------------------------------------
  Mean VIF      1.17

                           Cond
        Eigenval          Index
---------------------------------
    1     3.8288          1.0000
    2     1.1605          1.8164
    3     0.9997          1.9570
    4     0.7676          2.2334
    5     0.6178          2.4895
    6     0.4323          2.9762
    7     0.1840          4.5617
    8     0.0094         20.2346
---------------------------------
 Condition Number        20.2346
 Eigenvalues & Cond Index computed from scaled raw sscp (w/ intercept)
 Det(correlation matrix)    0.5487
```

The index VIF is indicator of multicollinearity. All of VIF for each of independent variable is below 2, which shows that there is no multicollinearity problem[3] among the independent variables.

[3] Theoretically speaking, there is no definite standard against which multicollinearity can be determined. Overall, when VIF is larger than 10, it is believed that multicollinearity problem exists. Detailed information can be checked in the book of Wooldridge, J.M. (2009), Introductory to econometrics: A modern approach, Fourth edition, South-Western Cengage Learning

Appendix K: Autocorrelation check for error term of multivariate regression

Autocorrelation check for error term in multivariate settings under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994)

```
Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
    F(  1,       56) =     12.283
           Prob > F =      0.0009
```

According to the results of Wooldridge test, we reject the null hypotheses since probability is 0.0009, which is smaller than significance level of 0.05. The result shows that the correlation between error terms in different periods exists.

Autocorrelation check for error term in multivariate settings under calculation of Tobin's Q formula proposed by Jin and Jorion (2006)

```
Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
    F(  1,       56) =     11.073
           Prob > F =      0.0016
```

According to the results of Wooldridge test, we reject the null hypotheses since probability is 0.0016, which is smaller than significance level of 0.05. The result shows that the correlation between error terms in different periods exists.

Appendix L: Results of random-effects model of multivariate regression

Random-effects model in multivariate settings under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994)

```
Random-effects GLS regression                   Number of obs      =       226
Group variable: Code                            Number of groups   =        63

R-sq:  within  = 0.1487                         Obs per group: min =         2
       between = 0.4598                                        avg =       3.6
       overall = 0.3494                                        max =         4

Random effects u_i ~ Gaussian                   Wald chi2(8)       =     81.98
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         lnQ1 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
hedgingdummy |  -2.122675   .7088231    -2.99   0.003    -3.511943   -.7334073
   lnhedging |   .3310971   .0980355     3.38   0.001     .1389511    .5232431
        Size |  -1.190549   .1629312    -7.31   0.000    -1.509888   -.8712094
        PROF |   .0115558    .004407     2.62   0.009     .0029182    .0201934
         DIV |   1.890658   .4707052     4.02   0.000     .9680928    2.813223
         LEV |   .0000143   .0003104     0.05   0.963    -.0005942    .0006228
          GD |   .0438678    .273699     0.16   0.873    -.4925724    .5803081
          IO |   .0056103   .0079298     0.71   0.479    -.0099319    .0211525
       _cons |    5.78452   .7568037     7.64   0.000     4.301212    7.267828
-------------+----------------------------------------------------------------
     sigma_u |  .72442819
     sigma_e |  .94364384
         rho |   .3708126   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Random-effects model in multivariate settings under calculation of Tobin's Q formula proposed by Jin and Jorion (2006).

```
Random-effects GLS regression                   Number of obs      =       226
Group variable: Code                            Number of groups   =        63

R-sq:  within  = 0.2161                         Obs per group: min =         2
       between = 0.3853                                        avg =       3.6
       overall = 0.3335                                        max =         4

Random effects u_i ~ Gaussian                   Wald chi2(8)       =     83.76
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         lnQ2 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
hedgingdummy |  -1.360468    .457975    -2.97   0.003    -2.258083   -.4628538
   lnhedging |   .2065777   .0636969     3.24   0.001      .081734    .3314214
        Size |   -.930158   .1237593    -7.52   0.000    -1.172722   -.6875943
        PROF |   .0062452   .0028375     2.20   0.028     .0006837    .0118067
         DIV |   1.655189   .3943123     4.20   0.000     .8823508    2.428026
         LEV |  -.0000348   .0002113    -0.16   0.869     -.000449    .0003794
          GD |   .0663042   .2303758     0.29   0.773     -.385224    .5178324
          IO |   .0056505   .0051414     1.10   0.272    -.0044265    .0157275
       _cons |   5.178096   .5755784     9.00   0.000     4.049983    6.306209
-------------+----------------------------------------------------------------
     sigma_u |  .68308404
     sigma_e |  .57771773
         rho |  .58299125   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

H_0: Pooled OLS model is preferred to Random-effects model

HA: Pooled OLS model is not preferred to Random-effects model

According to the results of random-effects GLS regression, we reject the null hypotheses since probability is smaller than significance level of 0.05. The result shows that Random-effect model is preferred to Pooled OLS model

Appendix M: Results of fixed-effects model of multivariate regression

Fixed-effects model in multivariate settings under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994)

```
Fixed-effects (within) regression               Number of obs      =       226
Group variable: Code                            Number of groups   =        63

R-sq:  within  = 0.2180                         Obs per group: min =         2
       between = 0.1490                                        avg =       3.6
       overall = 0.1148                                        max =         4

                                                F(6,157)           =      7.29
corr(u_i, Xb)  = -0.5706                        Prob > F           =    0.0000

------------------------------------------------------------------------------
         lnQ1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
hedgingdummy |  -.8168592     .74921    -1.09   0.277    -2.296691    .6629723
   lnhedging |   .0886313   .1050664     0.84   0.400    -.1188946    .2961572
        Size |  -1.848248   .3083959    -5.99   0.000    -2.457388   -1.239108
        PROF |   .0076176   .0046216     1.65   0.101    -.0015109    .0167461
         DIV |  (dropped)
         LEV |  -.0001311   .0003793    -0.35   0.730    -.0008804    .0006182
          GD |  (dropped)
          IO |    .008981   .0084828     1.06   0.291    -.0077741    .0257361
       _cons |   9.221183   1.475316     6.25   0.000     6.307155    12.13521
-------------+----------------------------------------------------------------
     sigma_u |    1.51237
     sigma_e |  .94364384
         rho |  .71977966   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(62, 157) =      3.85            Prob > F = 0.0000
```

Fixed-effects model in multivariate settings under calculation of Tobin's Q formula proposed by Jin and Jorion (2006)

```
Fixed-effects (within) regression               Number of obs      =       226
Group variable: Code                            Number of groups   =        63

R-sq:  within  = 0.2594                         Obs per group: min =         2
       between = 0.1324                                        avg =       3.6
       overall = 0.1142                                        max =         4

                                                F(6,157)           =      9.17
corr(u_i, Xb)  = -0.4923                        Prob > F           =    0.0000

------------------------------------------------------------------------------
         lnQ2 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
hedgingdummy |  -.7350274   .4586814    -1.60   0.111     -1.64101    .1709551
   lnhedging |   .0904939   .0643237     1.41   0.161    -.0365576    .2175455
        Size |  -1.285148   .1888061    -6.81   0.000    -1.658076   -.9122205
        PROF |   .0037666   .0028294     1.33   0.185    -.0018221    .0093552
         DIV |  (dropped)
         LEV |  -.0001249   .0002322    -0.54   0.591    -.0005836    .0003338
          GD |  (dropped)
          IO |   .0055243   .0051933     1.06   0.289    -.0047335    .0157821
       _cons |   7.133539   .9032181     7.90   0.000     5.349512    8.917566
-------------+----------------------------------------------------------------
     sigma_u |  1.1747905
     sigma_e |  .57771773
         rho |  .80526308   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(62, 157) =      7.00            Prob > F = 0.0000
```

H_0: Pooled OLS model is preferred to Fixed-effects model

HA: Pooled OLS model is not preferred to Fixed-effects model

According to the results of random-effects GLS regression, we failed to reject the null hypotheses since both probability are smaller than significance level of 0.05. The result shows that Pooled OLS model is not preferred to Fixed-effects model.

Appendix N: Results of hausman test

Hausman Test in multivariate settings under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994)

```
                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       fe           re         Difference          S.E.
-------------+----------------------------------------------------------------
hedgingdummy |   -.8168592    -2.122675        1.305816         .2426632
   lnhedging |    .0886313     .3310971       -.2424658         .0377887
        Size |   -1.848248    -1.190549       -.6576996         .2618424
        PROF |    .0076176     .0115558       -.0039382         .0013918
         LEV |   -.0001311     .0000143       -.0001454          .000218
          IO |     .008981     .0056103        .0033706         .0030125
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       85.23
                Prob>chi2 =      0.0000
```

H_0: Fixed-effect model is preferable to Random-effects model

H_A: Fixed-effect model is not preferable to Random-effects model

According to the results of Hausman Test, we reject the null hypotheses since probability 0.0085, which is smaller than significance level of 0.05. The result shows that Random-effects model is preferred to Fixed-effects model.

Hausman Test in multivariate settings under calculation of Tobin's Q formula proposed by Jin and Jorion (2006)

```
                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       fe           re         Difference          S.E.
-------------+----------------------------------------------------------------
hedgingdummy |   -.7350274    -1.360468         .625441          .164918
   lnhedging |    .0904939     .2065777       -.1160837         .0243689
        Size |   -1.285148     -.930158       -.3549903         .1492322
        PROF |    .0037666     .0062452       -.0024786         .0009865
         LEV |   -.0001249    -.0000348       -.0000901         .0001222
          IO |    .0055243     .0056505       -.0001262         .0019704
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       37.93
                Prob>chi2 =      0.0000
```

H_0: Fixed-effect model is preferable to Random-effects model

H_A: Fixed-effect model is not preferable to Random-effects model

According to the results of Hausman Test, we reject the null hypotheses since probability 0.0085, which is smaller than significance level of 0.05. The result shows that Random-effects model is preferred to Fixed-effects model.

Appendix O: Results of feasible generalized least square model

Feasible Generalized Least Squares model in multivariate settings under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994)

```
Cross-sectional time-series FGLS regression

Coefficients:  generalized least squares
Panels:        heteroskedastic
Correlation:   common AR(1) coefficient for all panels  (0.4205)

Estimated covariances      =        63          Number of obs      =       226
Estimated autocorrelations =         1          Number of groups   =        63
Estimated coefficients     =         9          Obs per group: min =         2
                                                               avg =  3.587302
                                                               max =         4
                                                Wald chi2(8)       =    102.65
                                                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
        lnQ1 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
hedgingdummy |  -2.121697   .4661036    -4.55   0.000    -3.035243   -1.208151
   lnhedging |    .310513   .0633164     4.90   0.000     .1864151    .4346109
        Size |  -.8580297   .1113384    -7.71   0.000    -1.076249   -.6398105
        PROF |   .0133363    .003072     4.34   0.000     .0073152    .0193573
         DIV |    1.41446   .2945392     4.80   0.000     .8371733    1.991746
         LEV |    .000015   .0001576     0.10   0.924    -.0002939    .0003239
          GD |   .2504672   .1391153     1.80   0.072    -.0221939    .5231282
          IO |   .0000753   .0062991     0.01   0.990    -.0122706    .0124213
       _cons |   4.189072   .5523354     7.58   0.000     3.106515     5.27163
------------------------------------------------------------------------------
```

Feasible Generalized Least Squares model in multivariate settings under calculation of Tobin's Q formula proposed by Jin and Jorion (2006)

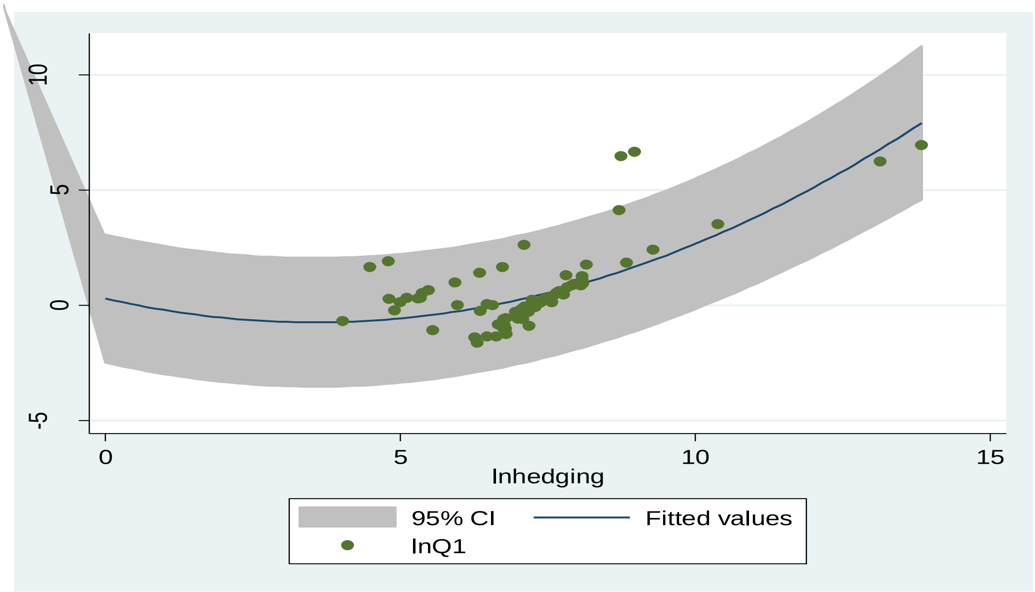
```
Cross-sectional time-series FGLS regression

Coefficients:  generalized least squares
Panels:        heteroskedastic
Correlation:   common AR(1) coefficient for all panels  (0.4243)

Estimated covariances      =        63          Number of obs      =       226
Estimated autocorrelations =         1          Number of groups   =        63
Estimated coefficients     =         9          Obs per group: min =         2
                                                               avg =  3.587302
                                                               max =         4
                                                Wald chi2(8)       =     97.22
                                                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
        lnQ2 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
hedgingdummy |  -1.651176   .3694918    -4.47   0.000    -2.375366   -.9269851
   lnhedging |   .2442498   .0518463     4.71   0.000     .1426329    .3458666
        Size |  -.5528979    .074176    -7.45   0.000    -.6982802   -.4075156
        PROF |   .0069887   .0019309     3.62   0.000     .0032042    .0107732
         DIV |   1.026851   .1812196     5.67   0.000     .6716669    1.382035
         LEV |   .0000368   .0001359     0.27   0.786    -.0002295    .0003031
          GD |   .1297055   .0804219     1.61   0.107    -.0279185    .2873295
          IO |   .0038355    .003656     1.05   0.294      -.00333     .011001
       _cons |   3.328996   .3714027     8.96   0.000      2.60106    4.056932
------------------------------------------------------------------------------
```

Appendix P: Interpretation of non-linear regression

The principle of quadratic functions

Consider the equation: y =c +bx +ax^2, where β_0, β_1, β_2 and are parameters. When b<0 and a>0, the relationship between y and x has the U-shape, implying that there is an increasing marginal return. In my non-linear regression model, the relationship between hedging and Tobin's Q is depicted in Figure 1 and Figure 2.

Figure 1 (under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994))

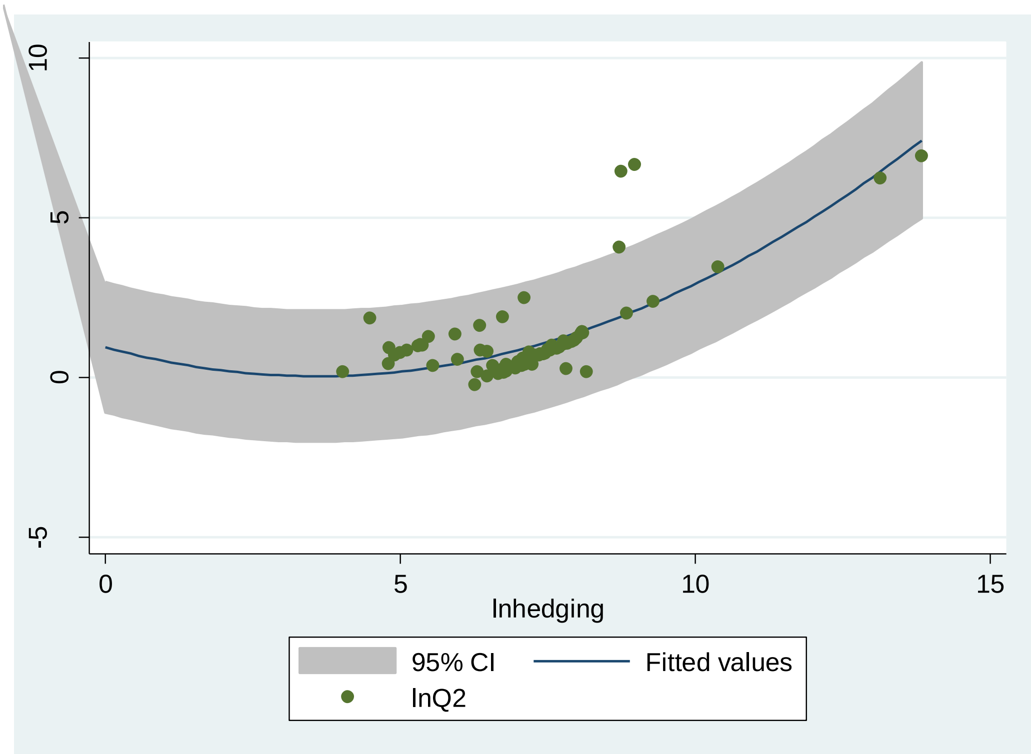


When β_1<0 and β_2>0, it can be shown that the minimum of the function occurs at the point

x*=b/(-2a)

According to my research results under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994), b= (-1.262), a = (0.111). Hence, x*=lnhedging≈5.6847. It is concluded that when firms that have value below lnhedging≈5.6847 or have a value below fair value of derivative hedging of 294,330 Euros, they are diminishing the firm's value, and when firms that have value above lnhedging≈5.6847 or have a value above fair value of derivative hedging of 294,330 Euros, they are increasing the firm's value.

Figure 2 (under calculation of Tobin's Q formula proposed by Jin and Jorion (2006))



According to my research results under calculation of Tobin's Q formula proposed by Jin and Jorion (2006), b= (-1.348), a = (0.116). Hence, x*=lnhedging≈5.8103. It is concluded that when firms that have value below lnhedging≈5.30 or have a value below fair value of derivative hedging of 333,719 Euros, they are diminishing the firm's value, and when firms that have value above lnhedging≈5.8103 or have a value above fair value of derivative hedging of 333,719 Euros, they are increasing the firm's value.

Appendix Q: Results of non-linear regression model

Non-linear regression model under calculation of Tobin's Q formula proposed by Chung and Pruitt (1994)

Source	SS	df	MS
Model	236.078417	9	26.2309352
Residual	336.521476	216	1.5579698
Total	572.599893	225	2.54488841

Number of obs	= 226
F(9, 216)	= 16.84
Prob > F	= 0.0000
R-squared	= 0.4123
Adj R-squared	= 0.3878
Root MSE	= 1.2482

lnQ1	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
hedgingdummy	1.523991	1.868019	0.82	0.415	-2.157888	5.205869
lnhedging	-.7673032	.4460302	-1.72	0.087	-1.646432	.1118257
lnhedgingsq	.0832051	.0261791	3.18	0.002	.0316058	.1348044
size	-.9967634	.130487	-7.64	0.000	-1.253954	-.7395725
PROF	.0134148	.0046026	2.91	0.004	.004343	.0224867
DIV	1.242701	.3353245	3.71	0.000	.5817738	1.903628
LEV	.0000721	.0002939	0.25	0.806	-.0005072	.0006514
GD	-.1043608	.1939839	-0.54	0.591	-.4867044	.2779829
IO	-.0005125	.0081046	-0.06	0.950	-.0164868	.0154618
_cons	4.992107	.614517	8.12	0.000	3.780889	6.203324

Non-linear regression model under calculation of Tobin's Q formula proposed by Jin and Jorion (2006)

Source	SS	df	MS
Model	150.202428	9	16.6891587
Residual	182.729656	216	.845970631
Total	332.932085	225	1.47969815

Number of obs	= 226
F(9, 216)	= 19.73
Prob > F	= 0.0000
R-squared	= 0.4512
Adj R-squared	= 0.4283
Root MSE	= .91977

lnQ2	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
hedgingdummy	1.746153	1.37651	1.27	0.206	-.9669582	4.459264
lnhedging	-.7920704	.3286718	-2.41	0.017	-1.439885	-.1442559
lnhedgingsq	.0798562	.0192909	4.14	0.000	.0418336	.1178788
size	-.7087913	.0961536	-7.37	0.000	-.8983107	-.5192718
PROF	.0089182	.0033916	2.63	0.009	.0022333	.015603
DIV	.9223738	.2470947	3.73	0.000	.4353484	1.409399
LEV	.0000678	.0002166	0.31	0.755	-.0003591	.0004946
GD	-.0812521	.1429433	-0.57	0.570	-.3629943	.2004902
IO	.0028556	.0059722	0.48	0.633	-.0089156	.0146267
_cons	4.264052	.4528267	9.42	0.000	3.371527	5.156577

References

Adam, T.R. and Fernando, C.S. (2006), Hedging, speculation, and shareholder value, Journal of Financial economics 81, 283-309

Allayannis, G. and Weston, J.P. (2001), the use of foreign currency derivatives and firm market value, the review of financial studies 14, 243-276

Aretz, K. and Bartram, S.M. (2010), corporate hedging and shareholder value, Journal of financial research 4, 317-371

Bartram, S.M. (2007), corporate cash flow and stock price exposures to foreign exchange rate risk, Journal of corporate finance 13, 981-994

Bartram, S.M., Brown, G.W. and Fehle, F.R. (2009), international evidence on financial derivatives usage, financial management, 185-206

Bartram, S.M., Brown, G.W. and Conrad, J. (2009), the effects of derivatives on firm risk and value, working paper, Lancaster University

Berkman, H. and Bradbury, M.E. (1996), Empirical evidence on the corporate use of derivatives, financial management 25, 5-13

Berrospide, J.M., Purnanandam, A. and Rajan, U. (2010), corporate hedging, investment and value, Working paper, Federal Reserve board

Bodnar, G.M., Hayt, G.S. and Marston, R.C. (1996), 1995 Wharton survey of derivatives usage by U.S. non-financial firms, financial management 25, 113-133

Bodnar, G.M., Hayt, G.S. and Marston, R.C. (1998), 1998 Wharton survey of derivatives usage by U.S. non-financial firms, financial management 27, 70-91

Bodnar, G.M., Tang, C. and Weintrop, J. (1999), both sides of corporate diversification: The value impacts of geographic and industrial diversification, working paper, John Hopkin's University

Breeden, D. and Viswanathan, S. (1998), Why do firms hedge? An asymmetric information model, working paper

Cabral, L. (1995), Sunk costs, firm size and firm growth, Journal of Industrial Economics 43, 161-172

Carter, D.A., Rogers, D.A. and Simkins,B.J.(2006), Does hedging affect firm value? Evidence from the US airline industry, Financial Management 35, 53-86

Chung, K.H. and Pruitt, S.W. (1994), a simple approximation of Tobin's q, Financial management 23, 70-74

DaDalt, P.J., Donaldson, J.R. and Garner, J.L. (2003), Will any q do? Firm characteristics and divergences in estimates of Tobin's Q, Journal of Financial Research 26, 535-551

Fauver, L. and Naranjo, A. (2010), Derivative usage and firm value: The influence of agency costs and monitoring problems, Journal of Corporate Finance 16, 719-735

Franks, J.R. and Touros, W.N. (1993), a comparison of the U.K. and U.S. bankruptcy codes, Journal of applied corporate finance 6, 95-103

Froot, K.A., Scharfstein, D.S. and Stein, J.C. (1993), Risk management: Coordinating corporate investment and financing policies, Journal of finance 48, 1629-1658

Froot, K.A., Scharfstein, D.S. and Stein, J.C. (1994), a framework for risk management, Journal of Applied corporate finance 7, 22-32

Gay, G.D. and Nam, J. (1998), the underinvestment problem and corporate derivatives use, financial management 27, 53-69

Gay, G.D., Lin, C.M. and Smith, S.D. (2010), corporate derivatives use and the cost of equity, Journal of banking& finance, 1-16

Geczy, C., Minton, B.A. and Schrand, C. (1997), why firms use currency derivatives, Journal of finance 52, 1323-1354

Graham, J.R. and Rogers, D.A. (2000), Does corporate hedging increase firm value? An empirical analysis, working paper, Northeastern University

Graham, J.R. and Rogers, D.A. (2002), Do firms hedge in response to tax incentives?, Journal of finance 57, 815-840

Grant, K. and Marshall, A.P. (1997), Large UK companies and derivatives, European financial management 3, 191-208

Griffith, J.M. (1999), CEO ownership and firm value, Managerial and decision economics 20, 1-8

Hagelin, N. (2003), why firms hedging with currency derivatives: an examination of transaction and translation exposure, applied financial economics 13, 55-69

Haushalter, D. (2000), Financing policy, basis risk, and corporate hedging: Evidence from oil and gas producers, Journal of Finance 55, 107-152

Hausman, J.A. and Taylor, W.E. (2011), Panel data and unobservable individual effects, Econometrica 49, 1377-1398

Jin, Y.B. and Jorion, P. (2006), Firm value and hedging: Evidence from U.S. oil and gas producers, Journal of finance 61, 893-919

Joseph, N.L. (2000), the choice of hedging techniques and the characteristics of UK industrial firms, Journal of multinational financial management 10, 161-184

Judge, A. (2006), why and how UK firms hedge, European financial management 12, 407-441

Judge, A. (2006), the determinants of foreign currency hedging by U.K. non-financial firms, multinational finance journal 10, 1-41

Kalay, A. (1982), Stockholder-bondholder conflict and dividend constraint, Journal of financial economics 10, 211-233

Kim, Y.S., Mathur, I. and Nam, J. (2006), Is operational hedging a substitute for or a complement to financial hedging?, Journal of corporate finance 12, 834-853

Knopf, J.D., Nam, J. and Thornton, J.H. (2002), the volatility and price sensitivities of managerial stock option portfolios and corporate hedging, Journal of finance 57, 801-813

Lang, L. and Stulz, R. (1994), Tobin's Q, corporate diversification and firm performance, Journal of Financial Economics 102, 1248-1280

Lewellen, W. (1971), a pure financial rationale for the conglomerate merger, Journal of Finance 26, 521-537

Lim, S.S. and Wang, H.L. (2007), the effect of financial hedging on the incentives for corporate diversification: The role of stakeholder firm-specific investments, Journal of economic behavior & organization 62, 640-656

Lin, B.J., Pantzalis, C. and Park, J.C. (2007), corporate use of derivatives and excess value of diversification, Journal of banking& finance 31, 889-913

Lookman, A.A. (2004), does hedging increase firm value? Comparing premia for hedging 'big' versus 'small' risks, Working paper, Carnegie Mello University

Mallin, C., Ow-yong, K. and Reynolds, M. (2001), Derivatives usage in UK non-financial listed companies, European Journal of finance 7, 63-91

Modigliani, F. and Miller, M.H. (1958), the cost of capital, corporation finance and the theory of investment, American economic review 48, 261-297

Myers, S.C. (1976), Determinants of corporate borrowing, Journal of financial economics 5, 147-175

Nance, D.R., Smith, C.W. and Smithson, C.W. (1993), on the determinants of corporate hedging, Journal of finance 48, 267-284

Nelson, J.M., Moffitt, J.S. and John, A.G.(2005), The impact of hedging on the market value of equity, Journal of corporate finance 11, 851-881

Perfect, S.B. and Wiles, K.W. (1994), Alternative constructions of Tobin's q: An empirical comparison, Journal of Empirical Finance 1, 313-341

Phillips, A.L. (1995), Derivative practices and instruments survey, financial management 24, 115-125

Pramborg, B. (2004), Derivatives hedging, geographical diversification, and firm market value, Journal of multinational financial management 14, 117-133

Purnanandam, A. (2008), financial distress and corporate risk management: Theory and evidence, Journal of financial economics 87, 706-739

Rajan, R. and Zingales, L. (1995), what do we know about capital structure? Some evidence from international data, Journal of finance 50, 1421-1460

Ross, M.P. (1996), corporate hedging: what, why and how?, Working paper, University of

California

Saunders, M., Lewis, P. and Thornhill, A. (2009), Research methods for business students, fifth edition, Prentice Hall

Shadish, W.R., Cook, T.D. and Campbell, D.T. (2002), Experimental and Quasi-experimental designs for Generalized Causal Inference, Wadsworth, Cengage Learning

Smith, C.W. and Stulz, R.M. (1985), the determinants of firms' hedging policies, Journal of financial and quantitative analysis 20, 391-405

Solomon, J.F. and Joseph, N.L. (2000), "Which corporate hedging motives are appropriate?" An institutional shareholders' perspective, International journal of finance and economics 5, 339-347

Spano, M. (2007), Managerial ownership and corporate hedging, Journal of business finance& Accounting 34, 1245-1280

Stulz, R.M. (1996), Rethinking risk management, Journal of applied corporate finance 9, 8-24

Supanvanij, J. and Strauss, J. (2010), corporate derivative use and the composition of CEO compensation, Global finance journal 21, 170-185

Tufano, P. (1996), who manages risk? An empirical examination of risk management practices in the gold mining industry, Journal of Finance 51, 1097-1137

Warner, J.B. (1977), Bankruptcy costs: Some evidence, Journal of Finance 32, 337-348

Wooldridge, J.M. (2009), Introductory to econometrics: A modern approach, Fourth edition, South-Western Cengage Learning