THE DETERMINANTS OF CORPORATE HEDGING FOR U.S. AND U.K. NON-FINANCIAL FIRMS

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THESIS SUMMARY

Empirical studies show that the use of derivative instruments has been increasing during the last decade, making it an important part of the firm's overall risk management profile. Financial theory suggests that risk management decisions only matter when markets are imperfect. The standard view is that firms will benefit from hedging, because hedging reduces the variability of the costs of financial distress, agency costs, and the expected tax liabilities. This thesis attempts to provide evidence on these hypotheses. This study investigates the determinants of corporate hedging by using a comprehensive dataset of US and UK non-financial firms. The two countries are of particular research interest since they have almost similar legal system for the conduct of business and their market-based financial systems and equity markets are well developed with good investor protection. The study focuses on the decision of whether or not non-financial firms from both countries benefit from corporate hedging during the period 2002-2011.

The study is motivated by the idea of whether or not the hedging policies of non-financial firms depend on the financial characteristics of those firms and the strength of their corporate governance. Indeed, our empirical results show that corporate hedging decision is closely associated with firms' financial characteristics and the strength of their corporate governance. In particular, firms are more like to engage in hedging if they have high expected tax liabilities, high expected cost of financial distress, and high expected agency costs. Firms choose to hedge to reduce the variability of cash flows in order to protect growth opportunities. More interestingly, US firms provide stronger evidence in support of for corporate hedging when the overinvestment problem exists, while UK firms provide stronger evidence for the underinvestment problem. Hedgers tended to be high-rated firms and larger firms which have a cost advantage in hedging due to economies of scale. This finding provides an explanation of why the small firms, which have more volatile cash flows, higher costs of bankruptcy, more growth opportunities, tend not to engage in hedging. We believe that this is very informative as it suggests the costs of hedging and market price dynamics alter the optimal hedging policies of those firms. Hedging is more costly for small firms; so they have different hedging policies and respond differently to hedging.

We also find that the board structure influence hedging decisions and a large board tend to be negatively associated with corporate hedging. The tendency to hedge increases as the number of non-executives grows. In addition, firms with strong corporate governance tend to hedge to reduce the variability of cash flows and the costs of financial distress. These results have theoretical and practical implications.

Keywords: risk management determinants; corporate hedging; derivatives; corporate governance; logistic regression

DEDICATION

I would like to dedicate this thesis and everything I do to my parents, who taught me perseverance and the value of knowledge. I would not be who I am today without their unlimited supply of love, patience, understanding, and daily support. It is also dedicated to my maternal grandmother. Although our time together was brief, her contributions to my life will be felt forever.

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CHAPTER 1 INTRODUCTION

Following the breakdown of the Bretton Woods system in 1973 and the adoption of the floating exchange rate regime in major developed countries, both interest rates and foreign exchange rates have become much more volatile. Under the floating rate system, the foreign exchange rates (FX) of nations are allowed to float against each other. With such a floating rate system, firms with international operations are substantially subjected to the effects of FX rate and interest rate changes. In addition, the advent of economic and financial globalisation has amplified market volatility; news gets transmitted more quickly across countries. Multinational firms are substantially affected by changes in foreign exchange rate, interest rate and commodity prices. The price changes alter the expected values of foreign denominated assets or liabilities and the competitive position of firms. Of course, purely domestic firms are also be affected by the FX rate and interest rate changes through their effects on the cost of traded inputs/outputs and on the competition from imported products (Jorion, 1991). These underlying asset price risks have become an economic problem for corporate financial management.

The risk management decision of a company affects the value and future prospect of the firm. Indeed, Stulz (1996, pp.23-24) pointed out:

The primary goal of risk management is to eliminate the probability of costly lower-tail outcomes-those that would cause financial distress or make a company unable to carry out its investment strategy.

Hedging the exposure to financial risks is one of the key tools in corporate risk management. By hedging, firms can reduce the risks caused by fluctuations in the FX rate and/or interest rates. Risk management ensures the stability in future profits and liquidity of firms.

In response to the effects of the FX rate and interest rate movements, multinational firms have employed large numbers of external (e.g., forward and option contracts) and internal (e.g., leads and lags) techniques to manage and hedge these risks. The International Swap Dealers Association (ISDA) survey (2009) indicates that more than 90% of the world's largest firms use derivatives to hedge their exposure to risk even if risk management using derivatives can also lead to financial loss[1].

There is a considerable amount of literature that explores the apparent conflict between the theory and current practice of risk management. Theoretically, if capital markets are perfect, then the hedging activities of firms should not affect the value of firms. With market imperfection, financial theories provide several theoretical explanations and positive rationales of corporate hedging. However, even though there is some evidence in support of theoretical predictions, the empirical evidence remains controversial and mixed. The divergence between theory and practice leads to a lack of clarity on the theoretical explanations or motives for the corporate hedging strategies of firms[2]. In addition, the majority of empirical studies that focus on the hedging practice focus on samples of firms from one country and provide limited cross-country evidence of corporate hedging determinants within the same period. It is unclear whether the contradiction on the empirical evidence is due to the cross-country differences or the changes of exposure management practices that occur over time. To date, very few (if any) empirical studies have examined and compared the determinants of hedging between countries with the use of large datasets covering several years. So far, the understanding of corporate hedging behaviour of firms and correspondence between theory and practice remain incomplete.

[1] For example: Airline companies (e.g. Cathay Pacific) have huge losses in fuel hedging, and German firm Metallgesellschaft AG (Stulz, 2013) and Brazilian firm Aracruz (Barreto, 2008) lost over billions of dollar following the use of hedging instruments. In contrast Laker Airways adopted a non-hedge strategy and incurred losses of US$400 million.

[2] For example, the empirical evidence for the taxation hypothesis for hedging is overall weak. Aretz and Bartram (2010) argue that this may due to the reality that the tax incentive to hedge are too small compared to other hedging factors. The results from this work show that the expected tax liabilities explain a large portion of variation in US hedgers. Therefore, the argument that the tax incentives to hedge are relatively small cannot completely explain the weak results regarding tax variables.

This thesis therefore investigates the financial and non-financial characteristics that appear to predict the corporate hedging motives of US and UK firms. A two-country study also enables us to identify differences in corporate hedging policy which can reflect differences in institutional arrangements. We employed logistic regressions to analyse the data for listed US and UK firms covering the ten year period, 2002 to 2011. These two countries have been chosen because both countries have common law legal systems, market-based financial systems, and well-developed equity markets with good investor protection. This similarities in the operational environments of these firms ease concerns over single country studies. Apart from the period of the financial crisis, both the US and UK firms enjoy a good period of financial market stability. Both countries also have strong investor protection. Our evidence for the US and the UK is generally consistent with theoretical predictions. Firms with greater growth opportunities have greater incentives to hedge to reduce the volatility of cash flows. They also hedge in response to the tax incentives, the increased agency costs, and the costs of financial distress. Prior literature (e.g. Nance et al., 1993; Joseph and Hewins, 1997; Judge, 2006) which tests the relation between leverage and hedging provides some supports for the financial distress hypothesis as predicted by Smith and Stulz (1985). Furthermore, Purnanandam (2008) extends the theoretical prediction and finds a non-monotonic relation between leverage and hedging during the 1996-1997 period for US firms. This thesis adds to the hedging literature by testing the non-monotonic relation with a much broader sample. We find that extremely high leverage and extremely long debt maturity do not support the non-monotonic relation between hedging and leverage. Our evidence suggests that when hedging is costly, the dynamics associated with the costs of hedging alters the optimal hedging policies firms. Furthermore, the prior literature poses an empirical puzzle for the effects of firm size on hedging. While some researchers predict that smaller firms would hedge more than large firms because smaller firms are riskier, empirical studies focused on US firms (e.g. Graham and Rogers, 2002; Dionne and Triki, 2013) suggest a positive relation between the size of firm and the likelihood of hedging. Our empirical results show that large firms hedge more than small firms - confirming the prior results for a broad cross-section of US firms. Our finding that credit rating is positively related with hedging for US firms provides a plausible explanation the puzzle.

There are however, significant country differences in the practice of corporate hedging and the factors that incentivise firms. Some of these differences are driven by the differences in bankruptcy codes, corporate governance, and other institutional differences. For example, though the results from both countries suggest a positive relation between firm size and hedging, our results show that the corporate hedging policy is more sensitive to economies of scale amongst US firms compared with UK firms. Additionally, it appears that US firms exhibit stronger motivation of hedging in response to the overinvestment problem, while UK firms exhibit stronger motivation in response to underinvestment costs. The fact that our sample covers the risk management policies of US and UK firms over a long period allows our analysis to capture the effect of macroeconomic change on a firm's hedging decision. Indeed, we find that the economic downturns and a financial crisis significantly influence the likelihood of hedging. Firms are more likely to hedge their exposures in response to the increasing financing costs and the volatility of cash flows.

The study also examines the joint effect of financial characteristics and corporate governance on corporate hedging policies. The results show that the board structure influences hedging decisions and the size of the board of directors tends to be negatively associated with hedging. The interaction between the board size and the CEO-Chairman duality dummy variable is significantly negative, suggesting that a powerful CEO-Chairman and a large board reduces the incentives to engage in hedging. The probability of hedging shrinks with outsiders influence and grows with manager influence over the board. In addition, corporate governance variables and financial characteristics have important consequences for corporate hedging. Firms with strong governance hedge to reduce the variability of cash flows and the costs of financial distress. Compared with prior empirical work which provides hedging insight on firm value and its relation with financial distress and/or agency costs perspective, our empirical results provide new evidence from tax and cash flow perspectives. The interaction effect of corporate governance with investment intensity and managerial incentives varies across different types of hedging strategies and

across countries. Overall, our findings underscore the importance of incorporating industry-specific and country-level factors in cross-country studies.

This thesis is organised as follows. Chapter 2 critically reviews and discusses existing literature on this topic with theory and empirical results. On the basis of the literature review, Chapter 2 also develops the hypotheses tested in our research. Chapter 3 describes the data source and sample, and discusses methodology employed. After that, Chapter 4 provides preliminary descriptive statistics, bivariate non-parametric tests, and a brief summary of empirical findings of the corporate hedging in the US and the UK. Chapter 5 presents the results of logistic regression analysis with the US sample, followed by the analysis for the UK sample in Chapter 6. Chapter 7 employs factor analysis approach to investigate financial characteristics and corporate governance mechanism on corporate hedging. Our conclusions are presented in Chapter 8, which also contains a comparison of our results with other studies and a discussion of the implications and contributions of the research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter presents a critical review of both the existing theoretical and empirical works associated with the determinants of corporate hedging. The aim of this assessment is to identify the areas which are open to research and the specific hypotheses that can be tested. There are two major sets of the arguments for and against corporate hedging. One set of arguments relies on perfect markets and determines that firms should not hedge on behalf of investors. The other set of argument predicts the gains to firms that hedge when markets are imperfect. The empirical evidence in support of hedging is ambiguous. This chapter starts with a detailed and comprehensive overview and analysis for the corporate hedging under perfect market conditions. We next consider the theoretical framework for corporate hedging and the related empirical results. We then establish the areas for our research.

The remainder of the chapter is organised as follows: section 2.2 discusses the theories that argues against corporate hedging when markets are perfect. Section 2.3 then presents the theories for corporate hedging when markets are imperfect, the associated empirical results, and the corresponding hypotheses. Section 2.4 discuss the country level factors which may affect corporate hedging policy in the difference countries. Section 2.5 reviews the relation between firm competition and risk management. The chapter ends with a conclusion.

2.2 Perfect Market and Corporate Hedging

When firms Hedge their exposures to risk, the pay using derivatives is for capital markets to bear the source of risk. In perfect markets, finance theory implies that corporate hedging cannot create value to shareholders. This is because investors will be exposed to the same or lower costs as firms if they (investors) bear the corporate risk directly. The following subsections provide extensive review and discussion about the major arguments based on perfect market assumptions, showing why perfect market theory may not work and that taking the risk within the firm may be inefficient.

2.2.1 Home-made hedging

A common re-interpretation of Modigliani & Miller's (1958) theorem implies that, in perfect markets, the value of a firm is unaffected by its hedging decision. Under this framework, external shareholders can obtain home-made hedging, consistent with the home-made leverage idea, making corporate hedging redundant. However, in imperfect markets, corporate hedging becomes relevant through its impacts on taxes, investment decisions and transaction costs, amongst others considerations. Furthermore, under the home-made hedging concept, there are certain practical considerations that largely limit investors' ability to hedge the firm's exposure. For example, individual investors are unable to hedge at the same costs as the firm as the transaction costs of hedging will be higher. The large size of derivatives is also too large to hedge the individual investor's exposure. Even if investors can afford these contracts, they lack immediate information about corporate exposures in order to implement their hedging strategies. Investors can also achieve other home-made hedges including metals, natural resources and real estate. In practice, however, since investor's cash flow and tolerance for risk are relatively low, the use of this

kind of home-made hedging is very limited. As such, home-made hedging seems impractical from the individual investor's perspective[3].

Since home-made hedging is not an efficient substitute to all investors, corporate hedging by firms could be justifiably alternative approach. Bodnar et al. (1995) find that firms tend to be less concerned about the cost of derivatives, meaning that firms have perhaps a competitive advantage relative to external investors in hedging corporate exposure. However, Solomon (1999) finds that institutional investors hedge their portfolio interests in firms even if those investee firms themselves hedge corporate exposure.

2.2.2 Parity conditions

Under the parity conditions, the future bi-lateral FX rate is determined separately by the interest rate and the inflation differential of the two countries. The four parity relations, i.e. interest rate parity (IRP), purchasing power parity (PPP), international fisher effect (IFE), and expectation hypothesis, predict the conditions under which the next period's FX is determined.

If the four parity conditions hold, then there is no reason to hedge since the value of the firm will be constant. However, the relationships may not always hold in the short term due to transaction costs, information asymmetric and government intervention, amongst other factors. Marston (1997) and Bekaert et al. (2007) find evidence to reject the null hypothesis that the IRP, PPP, IFE, and IRP relations holds. In contrast, Chinn and Meredith (2004) provide evidence to show that IRP holds. Other researchers find

[3] Despite this restriction of minimum contract size requirement of derivatives, we recognise that the institutional investors would not have the restrictions imposed by contract size or transaction costs if indeed, they wish to hedge their exposures in their investee firms.

mixed results (see Fama, 1975; Robinson and Warburton, 1980; Popper, 1993; Fletcher and Taylor, 1994; O'Connel, 1998; Bekaert and Hodrick, 2001; Tweneboah, 2010). Some of the explanations associated with the failure of the parity relations to hold include model specification, transaction costs, information asymmetry, risk aversion and government intervention, amongst others (see e.g. Baillie and Bollerslev, 2000; Baillie and Kilic, 2006; Sarno et al., 2006).

2.2.3 Unbiased Forward Exchange Rate Hypothesis

The forward rate as a predictor of the realised spot rate is considered to be one form of the expectations hypothesis. The Unbiased Forward Exchange Rate Hypothesis (UFRH) suggests that the forward rate at time period t is an unbiased predictor of the next period's (t+1) realised spot exchange rate. The UFRH suggests that forward contracts are appropriately priced, and nothing will be gained from hedging.

Whilst there are several model specifications for this prediction, the empirical validity of this hypothesis has been shown to be weak. Several empirical results reject the theoretical prediction (Baillie and Bollerslev, 1989; Crowder, 1994; Tauchen, 2001; Maynard, 2003). Usually, the forward premium/discount tends to be negative in empirical work. Several of the explanations for the existence of the negative forward premium puzzle include: (i) failure of the rational expectations hypothesis and/or risk aversion (Taylor, 1995); (ii) invalid or poor model specification and econometric implementation (Maynard and Phillips, 2001; Liu and Maynard, 2005); (iii) the actual existence of a FX risk premium that drives a wedge between the actual FX rate changes and the expected FX rate changes; (iv) political risk and risk preferences (Moore and Roche, 2010); and, (v) incomplete information processing by agents (Bacchetta and van Wincoop, 2006). As far as the UFRH is concerned, corporate hedging is a reasonable choice for firms that want to protect their exposure to foreign exchange rate risk whether or not UFRH holds.

2.2.4 Hedging and the market price of risk

According to the Capital Asset Pricing Model (CAPM) developed by Sharpe (1964), Lintner (1965) and Mossin (1966), the essential factor in pricing an asset is systematic risk. If the market risk is not systematic, it can be diversified away by investors at no cost such that there would not be any gain to firm that hedges diversifiable risk. Therefore, if the securities of two firms have the same beta in the same capital market, then no matter what the firms' hedging policies are, both firms should have the same expected of return. The volatility of profit or cash flows due to the change on market prices (e.g. FX, commodity price) should not change firm's value as the stock price should already have incorporate the effects of market price changes into stock returns. If the market risk is systematic and is priced, then any increase in the return due to hedging would only rise to a (proportionate) increase of the firm's risk. That is, the change in returns would move along the Security Market Line (SML) and firms would gain nothing from hedging.

Empirical works provide evidence that firms can only gain from hedging if financial markets are imperfect. Jorion (1990) indicates that under floating exchanges, FX rate changes are a major risk factor for multinational firms; much more so than interest rate and inflation rate change. Dumas and Solnik (1995) and Francis et al. (2008) find significant foreign-exchange risk premium on the expected rate of return. Furthermore, Joseph et al. (2015), using the three-factor CAPM to estimate FX rate and interest rate exposure and find that most firms are exposed to theses exposures at short to long return horizons. These empirical evidence suggests that hedging is beneficial in imperfect markets.

The arbitrage pricing theory (APT) states that the expected return of financial asset can be modelled as a linear function of macroeconomic factors. Under this framework, if, for example, FX rate is one of those factors, hedging policy can affect expected stock returns. Jorion (1991) finds weak empirical evidence to

support the argument that the FX rate risk is priced in the U.S. stock market. Other empirical studies (see Dumas and Solnik, 1995; Chow et al, 1997; Choi et al., 1998; and Francis et al., 2008) support the APT argument for stocks located in other countries. So the time period of the study as well as the estimation method may give rise to differences in those results. Allayannis and Weston (2001) suggest that on average, there is significant evidence of a positive relationship between the use of currency derivatives and the market value of non-financial firms. Carter et al. (2006) find additional supportive evidence that the hedging premium in the US airline industry can be as large as 10%. Overall the empirical findings regarding the pricing of the FX rate risk in the stock market is mixed. However, it would appear that corporate hedging policy matters under imperfect market conditions.

2.2.5 The value of firm

Under CAPM or APT, hedging or not hedging should not affect the firm's value. However, empirical results tend to show that the use of derivatives may, although not always, impact on the market value of firms. Guay and Kothari (2003) find that most US firms have low cash flow and market value sensitivity to risk management actions. Jin and Jorion (2006) find similar results for firms in the oil and gas industry. In contrast, Graham and Roger (2002) indicate that on average firms that increase debt capacity and also hedge experience an increases in value of 1.1 percent. Furthermore, the average volatility of the stock returns for firms that use derivatives is lower than for non-hedgers; market beta of hedgers is also 6% lower than the beta of non-hedgers (Bartram et al., 2011). Pérez-González and Yun (2013) also show that the use of weather derivatives leads to higher market valuations.

Solomon and Joseph (2000) argue that one possible reason for the overall mixed empirical evidence on the pricing of the foreign exchange rate risk premium is the misspecification of the model. Most of these studies use either the classic CAPM or APT. There is often no consistency in the use of the same model specifications, thereby leading to different conclusions. The mixed empirical findings do not necessarily

mean that corporate hedging in not beneficial, since the use of asset pricing models which by their nature are associated with perfect markets may not be useful in validating the benefits of corporate hedging when markets are imperfect. For example, Cornaggia (2013) examines the relation between hedging and productivity and shows that hedging could affect firm value by relaxing financial constraints, improving productivity, and adding value to investors who are unable to diversify nonsystematic risks. Therefore, risk management matters in practice and firms and investors can still benefit from corporate hedging.

2.2.6 Portfolio diversification and home bias

Markowitz (1952) shows that, for a given expected return, investors can minimise risk by diversification. Since prices of different assets do not necessarily move together, investors can diversify unsystematic risk by holding investment portfolio with negative correlated securities. Fama (1976) empirically supports this view.

Extending the modern portfolio theory to an international setting, assuming complete freedom of international capital movements, international diversification will enhance portfolio diversification. Levy and Sarnat (1970) as well as Lassard (1973) show how stock returns from various countries are less correlated than stock returns within national countries thereby making internationally diversified portfolios more efficient compared to domestically diversified portfolio. Indeed, investors can reduce the risk of their portfolios by diversifying securities portfolio internationally (see also Solnik, 1974; Ang and Bekaert, 2002). Internationally diversified portfolios will always generate a higher return that is accompanied with a lower risk than a domestic portfolio (Fatemi, 1984).

This evidence also suggests that the individual investors should diversify internationally, possibly to bypass the restrictions placed on the use of derivatives (see section 2.1.2). However, this argument is only valid if the volatility of FX rate changes does not increase the volatility of the stock returns. Eun and Resnick (1988) show that this is not the case for US investors since FX rate volatility enhances the volatility of international portfolios by up to 50 percent. In addition, investors may not exploit the full benefits of international diversification. Thomas et al. (2004) show that US investors held only 14 percent of their equity portfolio in foreign stock, despite the US stock market comprises of 54 percent of world market capitalisation. This is a very small improvement on the earlier study of Cooper and Kaplanis (1994) which indicates that US investors held 6 percent of their portfolios in foreign stocks. Several explanations have been put forward for the presence of this home-asset bias. These include information asymmetry, failure of PPP to hold, the FX risk, political risk, differential taxation and other dead-weight costs (see Adler and Dumas, 1983; Cooper and Kaplanis, 1994; Glassman and Reddick, 1996). Preference for the geographical proximity of investments (Coval and Moskowitz, 2002) and over-optimistic expectations of home stock performance (French and Poterba, 1991) are also other explanations for home-asset bias. Strong and Xu (2003) as well as Lütje and Menkhoff (2007) show that the home bias problem exists for fund managers in major developed economies.

In addition, bi-lateral FX rate movements are highly correlated, thereby causing the FX risk to be largely non-diversifiable. Ziobrowski and Ziobrowski (1995) find that multiple acquisitions of international securities in the same foreign country do not significantly improve the efficiency of international portfolio when exchange rates are very volatile. Since fluctuating exchange rates make foreign investment more risky, fluctuation of exchange rate diminishes the benefits from international diversification (Eun and Resnick, 1988).

Since holding international portfolio may not efficiently reduce the FX risk, hedging is therefore an alternative strategy that enables investors to substantially increase the gains from international

diversification. Firms will actively engage in hedging if corporate hedging policies can affect their cost of capital.

2.2.7 Clientele Effects Argument

Under the clientele effects argument, shareholders can reverse the hedging decisions of firms if shareholders consider them to be inappropriate. In this case, investors can choose to invest in the securities of firms whose risk management policy is consistent with their level of risk aversion. For the clientele effects argument to work, firms need to disclose their hedging policies such that investors are able to decide whether they are in agreement with such a policy. Nevertheless, risk management is an everyday activity for many firms (Solomon and Joseph. 2000). This does not mean that the hedging policies of firms are applied consistently over time. Information of the exposure of firms is not published to investors on a daily basis. Even so, investors will receive information on corporate hedging policy after the fact. Bodnar et al. (1995) show that less than half of the firms that hold derivatives regularly report their derivatives activities and only 7% of the firms report it on monthly (regularly) basis. The lack of disclosure may cause unexpected risks for investors. DeMarzo and Duffie's (1995) theoretical framework suggests that the disclosure of the hedging activities of firms provides information about earnings to investors and as such signals the managerial ability and project quality of managers.

2.3 Theories and Evidence in Support of Corporate Hedging

The above section has discussed why perfect market theory may not work and taking the risk within the firm may be inefficient. The financial literature based on imperfect market puts forward several arguments to explain why firms hedge risks they face. Based on different perspectives, the following subsections provide detailed and comprehensive discussion and analysis of the theoretical explanations which argues corporate hedging could be more efficient and valuable when the costs of bearing the risk is higher than the costs of hedging in capital market. This section also reviews the corresponding empirical evidence in the existing literature.

2.3.1 Taxation

Finance theory has identified that hedging can reduce expected tax payments of firms. Progressive tax rates and tax preference items give rise to a convex tax schedule. Since the convexity of the tax schedule enlarges the variability of taxable income, the uncertainty of the firm's expected tax liability also increases. For firms that face a convex tax schedule, net income and cash flow will drop significantly when pre-tax income is above a certain level.

Smith and Stulz (1985) argue that firms engages in hedging in order to reduce expected tax liability when the effective tax schedule is convex. By reducing the variability of taxable income the firm can reduce the expected value of tax liabilities. The reduction of expected tax liability will be greater if the effective tax schedule becomes more convex (Nance et al., 1993). Furthermore, given the fact that the income tax of firm is charge at the firm level, such tax saving from hedging cannot be achieved by investors through homemade hedging. However, empirical evidence provides relatively weak support for this hypothesis (Nance et al, 1993; Joseph and Hewins, 1997; Huang and Ryan, 2007; Chang et al., 2013; Fabling and Grimes, 2015). Graham and Rogers (2002) show that firms hedge in response to the tax benefit on debt,

but do not hedge for tax convexity. This may be because not all firms face convex tax schedules and actual tax payments are not directly predictable. Graham and Smith (1999) find that only about 50 percent of firms face a convex effective tax schedule and the distribution of potential tax savings from corporate hedging is skewed. In reality, the tax incentive to hedge may be small compared to other hedging factors (Aretz and Bartram, 2010). Even so, the tax incentive to hedge is an important unresolved issue.

More than two decades later, MacKay and Moeller (2007) as well as Frestad (2010) criticise the version of the tax hypothesis by Smith and Stulz (1985). They argue that there is a trade-off between the value of lowering cash flow volatility and the hedging gains related to cost function nonlinearities. Frestad (2010) argues that the increase of tax function convexity can increase the probability of hedging, but will not necessarily lead to higher levels of hedging. How a firm responds to higher tax function convexity depends on the type of convex cost function. Thus, previous weak evidence for taxation hypothesis may be because the proxies used were too simple (Graham and Smith, 1999).[4] The provisions such as carryforwards and tax credits broaden the range of convexity but flatten the curvature near the kink. If a firm is unable to make efficient use of the underlying tax benefits, the benefit of these provisions can be reduced.

Therefore we test the following hypothesis:

$H_{0:1}$ *There is no difference in the expected taxes of hedgers and non-hedgers. The alternative hypothesis is that there is significant difference regarding the expected taxes of hedger and non-hedgers.*

[4] Most of previous empirical studies use tax loss carryforwards (Nance et al, 1993; Mian 1996; Graham and Rogers, 2002; Bartram et al., 2009; Chang et al., 2013), tax credits (Nance et al, 1993; Bertram et al., 2009; Panaretou, 2014). These proxies do not measure the type of convex function a firm faces. The existence of tax preference items are positively associated with the likelihood of hedging.

2.3.2 The level of debt

With the existence of market imperfection, a firm can manage its debt capacity through corporate hedging. The fluctuations of market price impact on the actual cash flow firms can receive from foreign businesses and limit the ability of a firm to meet short-term liability promises. Creditors may be concerned about the total variability of cash flows where default is likely. Thus, in instances where the total variability is important, hedging may add to the firm's debt capacity.

Furthermore, levered firms pay taxes on their cash flows net of interest payments to the bondholders. The M&M theorem implies that the existence of tax, debt tax shield, and debt substitutes (DeAngelo and Masulis, 1980) can affect the optimum leverage decision of the firm. The lower the expected bankruptcy costs, the higher the expected payoffs are to the firm's claimholders. If hedging reduces the variability of a firm's future value, hedging will also lower the probability that the firm encounters financial distress and bankruptcy costs. Leland (1998) argues that by hedging, firms can increase debt capacity and interest payments deductions, and therefore the firm's value will increases. Graham and Rogers (2002) show that by increasing the firm's debt capacity and tax benefits of debts, hedging also increases the firm's value by 1.1%. Even in the absence of tax benefits of debt, there still is a positive relationship between hedging and leverage level (Lin et al., 2008). Campello et al. (2011b) find that hedgers pay lower interest rate spread and exhibit lower external financing costs. As such corporate hedging will reduce debt costs in relation to the firm's level of debt.

Thus we test:

$H_{0:2}$ *There is no difference regarding the level of debt hedger and non-hedgers. The alternative hypothesis is that the leverage level for hedgers and non-hedgers are different.*

2.3.3 Growth and investment opportunity

Under imperfect market conditions, the ability to raise external funds is restricted. In the case of a funding shortfall is relative to investment opportunities, raising external capital is costly (Lessard, 1991). For non-hedgers, the cash flows of the firm will be volatile because of operational, financial and/or investment shock (e.g. volatile commodity price, the change of interest rate, and the fluctuation of foreign exchange rate). This variability of internal cash flows leads to volatility of available cash flows for planned and unplanned investments. For example, if the cash flows generated from domestic market alone are not large enough to support the level of research expense of the firm, the variability of foreign income may constrain continued research and business operations. Indeed, the firm faces the risk of losing investment opportunity because of shortage of funds, thereby losing market share to rivals (Campello, 2003; Haushalter et al., 2007; Adam et al., 2007). Campello et al. (2010) also show that during the 2008 financial crisis, constrained firms planned deeper cuts in R&D spending. Their investment opportunities were also restricted due to the market uncertainties associated with the period. It is unclear whether active corporate hedging of the R&D expenditures associated with those investment opportunities provide the desired financing protection, as there would have been greater uncertainty with the cash flows arising from those opportunities. There is very limited empirical literature that investigates the impact of the 2008 financial crisis and growth opportunities factors on corporate hedging policies[5].

Finance literature has argued that growth and investment opportunities are key determinants of corporate hedging behaviour (Lessard, 1991; Froot et al., 1993). If external finance is more costly than internal financing, the firm should hedge to lower the variability of the shadow value of internal cash flows. Hedging eases the constraint of growth options and investment opportunities by reducing variability of internal cash flows. Therefore, the hypothesis suggests that firms which hedge should have more investment opportunities and higher R&D spending. Hedging can reduce the impact of lack of financial

[5] Chen and King (2014) examine the hedging activities in the U.S. during the period 1993 through 2008, Treanor et al. (2014a), and Treanor et al. (2014b) cover the period 1993-2008, but do not include 2009.

control since hedging reduces the variability of internal cash flows. As such, hedging ensures that the firm has sufficient available internal funds to take advantage of valuable investment opportunities and growth options (Froot et al, 1993). Lin et al. (2008) extend Froot et al.'s (1993) framework by exploring the relationship between hedging, financing, and investment decisions. The theoretical predictions of their model consistently suggests firms with greater growth opportunities hedge more. Haushalter et al. (2007) suggest that hedging the exposure to investment opportunities benefits firms in two ways: first, hedging allows firms to execute proposed projects and decrease predation risk by cash-rich rivals; and second hedging enables firms to make unplanned investment so that preventing rivals from gaining strategic advantages over the firm.

Empirical studies provide mixed results of this hypothesis. Géczy et al. (1997) find that R&D spending is significantly related to foreign exchange hedging, however, the association between the book-to-market ratios and hedging is insignificant. Growth opportunities, surprisingly, have weak influence on corporate hedging policy in German firms (Galum, 2002). Conversely, Clark and Judge (2005) show that firms with higher R&D expenses and higher capital expenditure tend to hedge more. Campello et al. (2011b) find consistent evidence that corporate hedging can ease the investment restriction of levered firms thereby increasing investment opportunities, and that hedgers generally have higher investment spending. Bates et al. (2009) find that as firms become increasingly R&D intensive, growth and investment opportunity incentives become increasingly important to corporate hedging policies.

The hypothesis suggests that firms that hedge should have more investment opportunity and higher research and development spending. Therefore we test:

$H_{0:3}$ *The null hypothesis is that there is no difference in the growth opportunities of hedgers and non-hedgers; The alternative hypothesis is that hedger have more growth opportunities than non-hedgers.*

Constrained and volatile cash flows not only directly restricts a firm's investment, but it can affect investment decisions indirectly through agency conflicts between different stakeholders of a firm. Next subsection will discuss agency costs caused by conflicts of interest in different groups of stakeholders resulting in investment distortion.

2.3.4 Agency costs and under-investment

Both constrained and volatile cash flows can lead to direct restrictions on the firm's investment opportunities through agency conflicts between different stakeholders of a firm. In the classic of Jensen and Meckling's (1976) framework, the conflicts of interest between bondholders and shareholders cause higher costs for financing and investments. Given the limited liabilities of stockholders, they may shift from low-risk investment to high-risk investment, since they will benefit when things go well at the costs of bondholders when things go bad. The added profit may only benefit the shareholders, as the bondholders require only a fixed return. The increase level of risk does affect the bondholders, since the firm increases its chance of defaulting on its debt. As such agency costs exist, the marginal cost of external funds increases with the amount of funds that are raised externally. The costs of external financing include agency costs, deadweight costs of debt, information asymmetry, underwriting fee, shift of residual rights of control, and investment distortion.

Myers and Majluf (1984) and Fazzari et al. (1988) argue that internal finance has important cost advantages over external finance thereby having a higher priority in the 'financial hierarchy'. According to the Pecking Order Theory, hedging internal cash flows can improve the corporate capital structure of a firm by reducing the costs of external financing. Froot et al. (1993) show that risk management can

increase shareholder value by harmonising financing and investment policies. Indeed, hedging can cut the cost of external financing and make the firm's investment process easier (Campello et al., 2011b). By reducing the agency costs associated with debt financing, hedging can increase the value of the firm.

Further conflicts of interest between shareholders and debtholders can arise. The agency problem can lead to underinvestment whereby managers may not always undertake investment projects that generate positive net present value (NPV) cash flows. Since bondholders normally have higher priority claims than shareholders, the increased probability of such claims arising creates incentives for the firm to underinvest. Shareholders can hardly benefit from giving more resources to management. Moreover, because managers run the firm as agents on behalf of shareholders, they tend to act in line with shareholders' interests. Therefore, if leverage is high and shareholders have only a small residual claim on a firm's assets, managers will still reject a positive NPV project (Myers, 1977).

Whilst theoretically corporate hedging can help reduce the agency costs due to conflict of interest among stakeholders, Judge (2006) find no evidence to support underinvestment costs to hedging in the UK firms. Bartram et al. (2009), examining the similar underinvestment measures with global data, find mixed support for the underinvestment hypothesis. Aretz and Bartram (2010) point out that the complex relations between risk management and other corporate policies and financial characteristics make it difficult to empirically test agency theories for corporate hedging. Growth opportunities imply greater incentives to hedge in response to severer underinvestment problems, but they are also linked to smaller overinvestment problems, reducing the incentives to hedge. Géczy et al. (1997) show that underinvestment problem might be a serious problem for levered firms with significant growth options. However, the few prior studies that examine the underinvestment hypothesis do so simply from either the leverage level perspective or the growth opportunities perspective. Therefore, the mixed evidence may be due to the complexity of the relations between hedging and different agency problems and the difficulties to estimate such firm-specific parameters using cross-sectional data. This positive rationale

for hedging may not be applied to a firm with any degree of leverage or any investment opportunities, and therefore may not be empirically significant. Lin and Smith (2007), investigating the interaction among hedging, investment and financing decisions, argue that the relations between hedging and other financial characteristics differ for firms with different growth opportunities. Some firms with significant opportunities increase their investments without increasing leverage, while some others with few investment opportunities engage in hedging to increase leverage. Thus, neither leverage nor the growth opportunities itself is able to properly capture the underinvestment problem incentives to hedge. The interaction effect of leverage and investment opportunities on hedging needs to be considered. To our knowledge, such interaction has not been empirically examined in the corporate risk management literature. We test the following:

$H_{0:4}$ *The null hypothesis is that there is no difference in the underinvestment costs of hedgers and non-hedgers. The alternative hypothesis is that the underinvestment costs are significantly different between hedgers and non-hedgers.*

2.3.5 Free cash flows and overinvestment

Whilst the underinvestment problem can cause managers to reject positive-NPV projects, in some situations, managers may even accept negative-NPV projects. Unlike the above hypothesis which focused on shareholder-bondholders conflict, the case of over-investment considers shareholder-manager conflicts.

Jensen and Meckling (1986) suggest that the agency problem can also cause an over-investment problem. When investment and sales growth increase managers' pecuniary and non-pecuniary rewards, paying out

cash via dividend, for example, decreases the free cash flows available to managers. In the argument of underinvestment incentive, the argument actually assumes shareholder protection is perfect. However, shareholders may not be able to control investment policy because of information asymmetry. If information asymmetry exists and investment decisions are not contractible, managers may seek for private benefits from investment (Morrellec and Smith, 2007). Donaldson (1984, p.3) finds that managers of large firms seek to maximise "purchasing power available to management for strategic purpose" rather than maximise the value of the firm. Thus, managers have incentives to underinvest when the level of cash flows is low, but invest more than the optimum level or even in negative-NPV projects, rather than paying out cash to shareholders when the level is high (Jensen, 1986; Stulz, 1990).

The overinvestment problem is likely to happen if a firm is holding substantial free cash flows but has a low market-to-book ratio[6]. Such a firm, although having lower underinvestment costs, normally faces higher costs of overinvestment. Corporate hedging can reduce the costs of over-investment by influencing the resources under the manager's control. Jensen (1986) argues the debt can help prevent such firms from overinvestment by reducing the available cash flows for discretionary spending by managers. The cash flows pressure from debt payment and other promised payments force mangers to use cash more efficiently rather than pursue self-interested low-return investment (ibid). Consistent with Jensen's (1986) argument, Malmendier and Tate (2005) find that overconfident managers overinvest when they have large internal funds whilst less confident managers invest less when external financing is needed. As hedging improves the debt capacity of firms, it can reduce manager-shareholders conflict by reducing the incentives to shift risk and the associated agency cost of debt (Campbell and Kracaw, 1990). Eisdorfer (2008) find that the value of debt of financially distressed firms is reduced due to the overinvestment in high-volatility periods. As such, corporate hedging can improve leverage conditions of firms by reducing

[6] In fact, many U.S. MNCs face a dilemma of how to spend excess cash nowadays, e.g. Microsoft, Exxon and Apple. Bates et al (2009) find that the cash holding of U.S. industrial firms doubles from 1980 to 2006. Although the firms holding large amounts of cash do not necessarily have over-investment problems, it is still worth discussing in this research due to the increasing trend of cash holding.

over-investment problems, especially in high-volatility periods (e.g. during a financial crisis and market turbulence).

Hedging can also ease managers' propensity to over-control free cash flows since the volatility of cash flow would be reduced. Stulz (1990) argues that the benefit that shareholders receive from investing resources to managers is negatively related to the volatility of cash flows. Therefore, corporate hedging can increase shareholders' wealth even if the firm has no debt. Morrellec and Smith (2007) show that the cost of overinvestment is important in determining the firm's hedging policy.

Overall, empirical studies have only provided limited evidence on the overinvestment hypothesis. Many of those studies examine the over-investment problem from a debt perspective, while few of them are based on free cash flows and corporate hedging consideration. This has been very little to discriminate between both types of investment decisions. As agency problems may raise either underinvestment or overinvestment costs, identifying the impact of overinvestment on hedging may be able to explain the mixed empirical results for the underinvestment argument.

The hypothesis that is tested is:

$H_{0:5}$ *The null hypothesis is that there is no significant difference in the overinvestment costs for hedgers and non-hedgers. The alternative hypothesis is that the overinvestment costs are significantly different between hedgers and non-hedgers.*

2.3.6 Hedging substitutes

Corporate hedging decision of a firm is also affected by its decisions with respect to other financial policies (Nance et al., 1993). A firm can manage its risk and costs by restructuring its assets and liabilities and/or possessing low leverage (Tufano, 1996). For example, using alternative means such as convertible debt could help to control conflicts of interest to reduce agency costs. Instead of using off-balance-sheet hedging instruments, a firm can use preferred stock to diminish the variance of net cash flows to reduce the probability of financial distress. Other substitutes include cash holding and operational hedging (see Bartram et al., 2009). A firm can manage investment predation risk and agency problem by holding more cash flows (Bates et al., 2009; Acharya et al., 2007). Haushalter et al. (2007) suggest that a firm may either hold large amount of cash or use derivatives, but not both. The hypothesis that is tested is:

$H_{0:6}$ *The null hypothesis assumes that there is no difference in the use of hedging substitutes for hedgers and non-hedgers. The alternative hypothesis is that the use of hedging substitutes is different between the firms chose to hedge and those did not.*

2.3.7 Cash flows volatility, liquidity and financial distress

Financial distress is a "low cash-flow state in which the firm incurs losses without being insolvent" (Purnanandam, 2008, p.707). Financial distress occurs if a firm has difficulty in meeting its commitments due to a shortage of cash flows. Since levered firms may run into such financial difficulties, investors worry about the costs of financial distress. As hedging reduces the variability of the firm's cash flows, it also reduces the likelihood that the firm would encounter financial distress (Smith and Stulz, 1985). Consequently, hedging decreases the expected costs of financial distress. The probability of a firm

encountering financial distress is also directly related to the size of the firm (Nance et al, 1993). Hedging becomes more valuable as the firm's fixed claims rise.

Joseph and Hewins (1997) find only weak evidence for financial distress for a sample of UK firms that hedge corporate exposure. Indeed, they find that firms hedge primarily to reduce the impact of FX rate fluctuations on operational cash flows. The weak empirical support for the financial distress motive may be due to the fact that their study examined that the largest firms in the UK. That is, financial distress as a hedging motive may be more important for smaller firms. In contrast, Bodnar et al. (1995) find that managing cash flows is the most important objective of a firm's hedging policies. Purnanandam (2008) and Bartram et al. (2009) also find empirical results to support the theoretical prediction. The hypothesis that is tested is:

$H_{0:7}$ *The null hypothesis is that there is no difference in the liquidity and the costs of bankruptcy for hedgers and non-hedgers. The alternative hypothesis is that the level of liquidity and the costs of bankruptcy are different between hedgers and non-hedgers.*

2.3.8 Managerial risk aversion and compensation

Risk aversion is also an important motive of corporate hedging. Dufey and Srinivasulu (1983) argue that the whole point of corporate hedging is to achieve a level of risk/return with which management feels comfortable with. They do not perceive hedging necessarily provides an incentive to obtain excess returns from corporate hedging activities. Unlike external shareholders the managers of firms hold all their human capital in the firm. This limits their ability to diversify their risk in the firms (Smith and Stulz, 1985). Therefore, by hedging the firm's exposure managers will also hedge their human capital in the firm. The

same principle applies to other stakeholders who hold most of the investment portfolio in the firm. Hedging the risk undertaken by the firm enables all risk-averse stakeholders to achieve higher utility. A person's utility is given by

$$U = E(r) - \frac{1}{2} A\sigma^2 \qquad (1)$$

"A" in Equation (1) is the degree of risk aversion, and σ^2 is the variance of return (Bodie et al, 2009, p.159). For risk-averse investors, managers and other stakeholders A should be positive, which implies that larger σ^2 results in lower total utility, ceteris paribus. On the other hand, reducing the variance of return σ^2 increases the total utility. By hedging the income or future cash flows of the firm is preserved, which reduces the variance of return. With the same expected return E(r), a person can still achieve higher utility regardless of whether or not those risk factors are not priced in the market.

Corporate hedging reduces the default risk of the firm by preserving the firm's future income. This makes it less risky for managers to accept job offer from firms that hedger. Consequently, managers require relatively less compensation and costly contracts when the firm hedges. Moreover, since corporate hedging reduces the volatility of a firm's total income and cash flows, it is more efficient than reducing the variance of the firm's payoffs individually.

If hedging is not allowed and if the variation in managers' income is high, risk-averse managers will require a higher income to accept employment contract from the firm (Stulz, 1984). Similarly, managers may over-hedge to protect their interest in the firm thereby reducing the firm's value. Since managers' service contracts are self-interest transactions, in the case that managers receive a fixed salary and their wealth is independent from their compensation[7], mangers may not be motivated enough to maximise shareholder's wealth. Shareholders can implement compensation contracts that are linked to the

[7] This thesis uses the same definition as given in Stulz (1984): managerial compensation is a manager's pecuniary income. In practice, however, compensation package may incorporate non-pecuniary item.

profitability of the firm if they are concerned about excessive hedging (Stulz, 1984). Smith and Stulz (1985) argue that managers would have incentives to reduce the variability of cash flows if their compensation is a concave function of the firm's value. They also predict that managers with larger amount of share ownership would be more risk averse, because shares provide linear payoffs as a function of share prices. Contrarily, those with greater option holdings would be less risk averse, since options provide convex payoffs. The global convexity of the option contract may motivate managers to be less risk averse.

May (1995) finds evidence to support the view that managers consider personal risk during corporate risk management decisions. Tufano (1996) also finds that managerial risk aversion is a major determinant of risk management policy. The hypothesis is more recently supported by empirical findings in Dionne and Triki (2013). Lievenbrück and Schmid (2014) find that managers in short-term orientation cultures are more likely to engage in hedging. Adam et al. (2015) link the empirical evidence of selective hedging (Adam and Fernando, 2006) to manager's view and personality. They find that overconfident managers are more active in hedging activities.

Manager's attitude to risk may have different effect on corporate risk management policies in different countries. While UK and US empirical studies provided support for this prediction, Bartram et al. (2009) find mixed results for managerial incentive in the global context. Interestingly, Joseph and Hewins (1997) find that the view that UK firms hedge FX rate risk to increase managerial comfort was ranked fourth on a list of 16 motives for corporate hedging. This finding suggests that managerial risk aversion plays an important role in hedging decisions.

In regards to managerial compensation incentive to hedge, Knopf et al. (2002) find positive relationship between the sensitivity of managers' total stock option portfolios to stock price of non-financial firms and its corporate hedging. Moreover, Joseph and Hewins (1997) report that hedging reduces uncertainty in

compensation to managers and employees whilst Graham and Rogers (2002) show that both the characteristics of the firm's stock and managers option holdings are important in determining cross-sectional differences in corporate hedging.

An important limitation of Stulz's (1984) managerial compensation theory is that it relies on the concave function for remuneration and that shareholders can appropriately understand risk management policies amongst firms. However, managers' compensation packages are not necessarily concave and shareholders often have little information about company's underlying risks. Indeed, it is argued that managerial incentive of hedging depends on whether detailed accounting information about corporate hedging transactions available to shareholders (see DeMarzo and Duffie, 1995). Zhang (2009) also suggests that the change in disclosure requirements of firms about derivatives use has had an effect on firm's risk management behaviour. Following recent changes in financial reporting standards, more detailed information on risk management activities are available from audited financial reports than before[8]. This enables investors, regulators and public to gain a better understanding of a firm's risk management strategies, and thus changes the influence of managerial incentives to hedge. Therefore, it is worth examining a sample covers the period since these changes.

The hypothesis we test is:

$H_{0:8}$ *The null hypothesis is that there is no difference regarding the characteristics of managerial compensation plans of hedgers and non-hedgers; The alternative hypothesis is the characteristics of managerial compensation plans are significantly different for hedgers and non-hedgers.*

[8] These changes include the approval of SEC regulation Item 305 in 1997, the introduction of FRS 13 and FAS 133 in 1998, FAS 161 in 2008, the adoption of IAS 32 and IAS 39 in 2005, and the more comprehensive international Financial Reporting Standards (IFRS) regime.

2.3.9 Firm size

Establishing a risk management structure is costly and requires large amounts of resources. Since most of those costs are fixed cost (Glaum, 2002), larger firms rather than smaller firms are more able to afford risk management programmes. Mian (1996) and Bartram et al. (2009) find consistent evidence for the argument of economies of scale. Some other literature argues that smaller firms also have the motivations to hedge more. In addition, small firms usually are more risky than large firms, since the probability of small firms encountering financial distress and their expected cost of financial distress are negatively related to the firm size effect (Nance et al., 1993). Consistent with this argument, Joseph and Hewins (1991) find that in comparison to larger MNCs smaller firms tend to over-protect corporate exposure and are more risk averse to foreign transactions and international involvement. Hennessy and Whited (2007) also find that smaller firms have higher external financing costs. If raising external funds is much more expensive than paying the capital market to bear the volatility of internal cash flows, hedging also creates value for smaller firms.

The hypothesis we test is:

$H_{0:9}$ *The null hypothesis is that there is no difference in the size of hedgers and non-hedgers; The alternative hypothesis is that the size of hedgers and non-hedgers is different.*

2.3.10 Ownership structure and corporate governance

The corporate governance frameworks and ownership structures can jointly affect hedging behaviour. Managers' propensity to hedge can be affected by corporate governance environments (Lel, 2006); so too would the ownership structure of firms (Tufano, 1996). If the protection is weak, managers tend to use

derivatives for their own benefit (Bartram et al., 2009). Firms are more likely to hedge when investors require greater transparency and better monitoring (Lel, 2012). Huston and Stevenson (2010) find a negative relation between creditors' right and firms' exposure and that a good corporate governance environment incentivises firms engage in hedging. Allayannis et al. (2012) show consistent evidence for the hypothesis that strongly governed firms are more likely to hedge with derivatives. Interestingly, Fauver and Naranjo (2010) find that hedging has negative valuation effects on the firms with weaker corporate governance and poorer monitoring conditions. These empirical findings suggest that in assessing the valuation incentive to corporate hedging, considering ownership and corporate governance effects is also important.

Therefore, the hypotheses we test:

$H_{0:10.1}$ *The null hypothesis is that there is no difference in the structure of the board of hedgers and non-hedgers. The alternative hypothesis is that the board structure is significant different for hedgers and non-hedgers.*

$H_{0:10.2}$ *The null hypothesis is that there is no difference in the strength of governance arrangements of hedgers and non-hedgers. The alternative hypothesis is that the strength of corporate governance is different for hedgers and non-hedgers.*

2.4 Country level factors

2.4.1 Financial market and legal system

Country level financial and legal discrepancy can influence the usage of derivatives. It is argued that larger economies have larger and more liquid financial markets and this in turn will provide incentives to access derivative markets. In particular, for those countries with less liquid derivative market, firms are less likely to hedge (Bartram et al., 2009). This argument seems too simplistic as it ignores the relative size of firms and their associated degree of global involvement, as well as, the relative size of financial markets and regulatory systems nearest the location of such firms. Related evidence of home country bias traders (see Abreu et al., 2011) indicates that more experienced and educated investors are more likely to access foreign markets relative to less experienced and educated investors. As such, the personal backgrounds of managers would affect the level of hedging they undertake. Additionally, Bartram et al. (2009) argue that if a country's legal system is more efficient and contracts are enforced, transaction costs of entering complex financial contracts are relatively cheaper, and therefore firms would more likely use financial derivatives. Thus, the hedging policy of a firm may also be affected by the financial markets and legal environment of a country the firm is located in.

Moreover, the difference of financial market conditions across countries and over time may also influence financial policies of firms, especially during market turbulence. Indeed, as credit is tightened and derivatives contract costs are higher during economic downturns, the cost of raising external financing and hedging are more expensive. Ivashina and Scharfstein (2010) find that bank lending fell considerably during the 2008 financial crisis due to a drop in the supply side. Campello et al. (2011a) show that credit lines are more expensive (and harder to renew) during a financial crisis. Overall, these factors have not been discussed much so far. This study will also address the issue of macroeconomic shock on the financial market.

2.4.2 Cross-country differences that affect corporate hedging and the comparison between the US and the UK

The country-level differences which directly and indirectly affect firms' financial characteristics, such as accounting standards, bankruptcy and tax codes, regulations and corporate governance codes, may cause firms to place different emphases on the factors of hedging. For example, Hakkarainen et al. (1998) show that unlike UK and US firms, Finnish firms places more emphasis on accounting than transaction exposure, a focus that is influenced by the tax arrangements in Finland. This means that the tax considerations when hedging would be more important for Finnish firms compared to UK or US firms. Joseph (2000) suggests that UK firms may prefer internal techniques when hedging translation exposure to avoid the adverse impacts of asymmetry in taxation. Later a survey by Mallin et al. (2001) shows that the risk and costs of derivative transactions is the main concern for finance directors of UK firms. This is different from their US peers, who are more concerned about the accounting treatment and market risks (Bodnar et al., 1998). Elshandidy et al. (2015) find that the UK firms tend to place emphasis on systematic risks, while the US firms place more emphasis on liquidity risk. Furthermore, Bartram et al. (2009) show that UK firms differ from US firms in terms of magnitude and types of hedging. The percentage of using of FX derivatives in the UK is higher than the percentage in US, whereas the percentage of using IR and commodity price derivatives in the US is higher then the percentage in the UK. Panaretou et al. (2013) find that the percentage of the use of derivatives in the UK is higher than the percentage in US.

Non-US firms may take different hedging strategies to control their foreign exchange exposures. Non-US firms may face greater FX exposures than US firms. For example, when the input factors are dominated in US dollars (e.g,. oil), non-US firms face greater FX risk, because the cost of goods sold is in US dollars while the sales revenue received are in other currencies. Research conducted by Clark and Judge (2003) shows that the liabilities in US dollars and Euro represented nearly 70 percent of the total

for the investigated UK firms. Intuitively, non-US firms, particularly those in the utilities and chemical indsutry, should have greater propensity to hedge and hedge more actively than US firms. Bodnar and Gebhardt (1999) find that German firms are more likely to use derivatives than US firms. Similarly, Bartram et al. (2009) shows that the percentage of dervatives users in Australia, Japan and the UK is higher than the percentage of derivatives users in the US. In addtion, the hedging strategy varies as to whether the firm is a "net importer" or "net exporter" across domestic currency appreciations and depreciations (Muller and Verschoor, 2006). Koutmos and Martin (2003) argue that firms respond asymmetrically to exchange rate movements. Furthermore, Clark and Mefteh (2011) find that the exposures with respect to the US dollar and non-USD currencies are asymmetric and different.

In addition, different financial reporting frameworks also affect corporate hedging activities. It is well known that US accounting regulations are rules based whereas, those of the UK are principles based. In terms of the attributes and the quantity of risk disclosure, Abraham and Cox (2007) find that UK firms cross-listed in the US provide more risk disclosure. Consistently, Doblet et al. (2011) find that US firms generally provide more risk disclosure than UK firms, Lins et al. (2011) finds that firms' risk management policy and hedging instruments usage are significantly affected by reporting standards. Also, not surprisingly, they find that active hedgers are more likely to be affected by change of reporting standards. Therefore the differences on financial reporting standards may also affect firms' risk management policy.

Prior research shows that the differences on bankruptcy code influence firms' capital choices. The UK is normally considered as creditor-friendly. Davydenko and Franks (2008) point out that, in the UK, secured creditors take over the control right in bankruptcy procedures and have wide discretion to sell the defaulted firm's assets. In contrast, US is considered to be more debtor-friendly, since debtors and creditors collectively have control rights. The US bankruptcy code affords some rights to equityholders in the process of bankruptcy. Since capital structure choice affects corporate hedging policy, accordingly, cross-country variations in capital structures can result in different propensity of hedging. Judge (2006)

finds that financial distress costs factor has a stronger influence on corporate hedging for UK firms compared to US firms. However, strong creditor rights in bankruptcy also lower corporate risk-taking, and therefore, reduce high-cash-flow risks projects and leverage level (Acharya et al., 2011a). Acharya et al. (2011b) find that firms in the UK were less leveraged than US firms during 1990 to 2002. Therefore, one can also expect that UK firms have lower costs of financial distress than US firms. Accordingly, creditor-friendly bankruptcy codes do not necessarily induce stronger incentives to hedge. Thus there is a puzzle in the literature as to whether the different findings regarding the financial distress hypothesis of hedging are due to cross-country differences.

2.5 Competition and Hedging

Unlike financial firms, the principal activity of non-financial firms is the production of market goods and non-financial services. Intuitively, hedging makes sense to firms engaged in the production of goods and services. Such firms also need to maintain their market share through competitive pricing. The literature associated with pricing-to-market (see e.g., Kasa, 1992; Knetter, 1989; 1994) suggests that firms will alter their product prices in line with FX rate changes in order to retain market share. Such price adjustments can also take place in the presences of corporate hedging.

Bolton and Scharfstein (1990) suggest that the degree to which firms can finance investment with internally generated funds is an essential determinant of product-market success. Fluctuation of the FX rate can adversely affect costs and internally generated cash flows of a firm, subsequently shifting the level of the firm's net profit, competitive position and market value. As discussed in the previous section, the aggregate investment of a firm is influenced by its hedging decision. If firms adjust their output levels in response to production costs and investment costs, the equilibrium output price is affected by the total

investment of the financially constrained firm (Adam et al., 2007). Conversely, given the total available funds, the expected production cost as an input factor for future output function, is interdependent with future investment cost. Hence, product market considerations are important determinants of corporate hedging behaviour (Haushalter et al., 2007). The literature associated with pricing-to-market (see e.g., Kasa, 1992; Knetter, 1989; 1994) suggests that firms will alter their product prices in line with FX rate changes in order to retain market share. Such price adjustments can also take place in the presences of corporate hedging.

Raith (2003) documents that product market competition and managerial incentives are jointly determined as part of industry equilibrium. He shows that given a certain level of competition, a firm with cost advantages can more easily attract business from its rival. In addition, greater competition also leads to an increase in the volatility of profit and future cash flows uncertainty. As such, firms with greater product market competition have a greater incentive to hedge risky positions.

Taking into account the industry structure, Williamson (2001) finds significant exposure to exchange rate shocks in the automotive industry. Moreover, there is significant time-variation in exchange rate exposure, which is consistent with intra-industrial changes in the competitive environment (Williamson, 2001). Since investment and R&D spending can influence a firm's competitive position, hedging decisions can affect the competitive advantage of firms and their market share. Haushalter et al. (2007) show that for the firms that have a higher degree of interdependent growth options with rivals, the use of derivatives increases. Derivative usage would therefore reduce some of the uncertainty associated such cash flows and competition.

However, many previous studies focus on the relation between financial characteristics and corporate hedging, while few of them consider from a firm's economic prospects. While there is extensive literature on managing transaction exposure, only limited research considers the intrinsically more important link

between a firm's production and investment decisions with the incidence of foreign exchange risk (Booth and Rotenberg, 1990). As such, identifying the impact of industry competition on corporate hedging may be able to explain the overall mixed empirical results for corporate hedging behaviour.

2.6 Conclusion

Previous studies provide a number of theories regarding the determinants of corporate hedging. Overall, only a few of those theories are consistently supported by empirical evidence. This leaves a further set of theories to explore in this study. We aim to provide a more rigorous set of tests to confirm their validity. For example, tests of the taxation hypothesis often do not employ variables that represent actual tax payments and/or their variability or expected tax payments. Such studies do not allow for the possibility that tax amounts shown in the financial reports do not represent actual taxes paid over the relevant period. Our analysis will employ estimation methods that enable us to capture more closely estimates that capture the variability of taxation and expected tax payments. The next chapter identifies the theories that will be investigated in this thesis.

CHAPTER 3 DATA SOURCES, SAMPLING, METHODOLOGY AND DESCRIPTIVE STATISTICS

3.1 Introduction

Chapter Two discusses the existing literature in relation to corporate hedging. This chapter presents a detailed discussion of the data sources and the sampling procedures as well as the definitions of the variables under consideration. It also discusses the empirical methodology and justifies the selection of countries. The chapter is organised as follows. Section 3.2 details the data sources and sampling procedures. Section 3.3 discusses the definition of variables and measurements. Section 3.4 discusses the empirical methodology. A justification for cross-country comparison study is provided in Section 3.5 and a brief summary is included in Section 3.6.

3.2 The Samples and Data Sets

The data was collected from two sources: (i) the annual report and financial statements which were accessed via the companies' websites and the US Security and Exchange Commission (SEC) EDGAR company fillings database; and (ii) Datastream and CRSPSift-Compustat merge database. It is reliable and consistent to use information from the companies' audited financial reports and databases together. Firms in the banking, insurance, pension, and brokerage industry were excluded from the sample because

they act as intermediaries during hedging or they provide risk management instruments to non-financial firms.

The research is interested in the group corporate hedging activities in the US and the UK with centralised treasury and thus concentrates on the parent companies rather than subsidiaries. The annual accounting data was collected for the entire period from 2002 and 2011. Many previous empirical studies investigate the hedging behaviour of large firms. However, as discussed earlier, empirical evidence has shown that the size of a firm is highly associated with corporate hedging and other corporate policies. In order to increase cross-sectional variations in the firm characteristics, we included some smaller firms to achieve a more balanced sample. This initial screening resulted in more than 6000 listed firms in the US and UK. From this initial dataset, due to the time-consuming task involved in manually collecting derivative usage, foreign debt usage, operational hedging, and other hedging data, we selected 698 listed firms in the Fortune 500, S&P 500, and S&P 1500 indices. Similar to previous studies, we exclude the firms in the financial services (i.e., SIC 6000-6999). We selected 521 listed firms in the FTSE 100, FTSE 250 and FTSE All Share indices. The sample was constructed by matching firms which published annual reports for the period and the available accounting data for that period on the Datastream or CRSPSift database. For the period of time, the full data set comprises of 550 non-financial companies firms in the US and 452 firms in the UK, all of which are listed on the either New York Stock Exchange, NASDAQ, or the London Stock Exchange. Some firm years are dropped from the sample for assorted reasons, such as unlisted in early years of the period or delisting[9]. This results in the final sample consist of 4025 firm-year observations for the US and 3064 firm-year observations for the UK. They were grouped into those that hedge and those that do not hedge using information/indicators in the notes of their published financial reports for the period. Firms which specifically mentioned using financial derivatives such as options, forward contracts, swaps and futures to hedge financial exposures (e.g. FX exposure, interest rate risk and liquidity risk) or/and foreign currency debt are classified as hedgers. Similarly, firms which

[9] If firms are unlisted or delisted, their accounting data is not available in the Datastream or CRSPSift database.

referred that they do not hedge were classified as non-hedgers. Subsequently, two dummy variables were created and used to represent hedgers and non-hedgers respectively. The number of observations classified as hedgers over the period 2002-2011 for the US and UK are 2932 and 2076 respectively, whereas the observations classified as non-hedgers over the period are 1093 and 988 respectively.

The advantage of using financial reports and secondary data is that all data are consistent, precise and standardised according to accounting standards. Audited annual reports of these firms are available on the Internet (e.g. the companies' websites). The existing standards of financial reporting require those firms to disclose information on hedging policy and financial instruments they used. The group risk management policy can be found in management reports or/and in the Notes of the Financial Statement section.

3.3 Variable Definitions and Measures

3.3.1 Dependent variable

The tests are undertaken statistically by testing for differences amongst firms that hedge and those that do not. The majority of variables in this research have been commonly used in past empirical papers (e.g. Nance et al., 1993; Géczy et al., 1997; Judge, 2006; Panaretou, 2014) to measure hedging activity with a hedging dummy, making the empirical results consistent and comparable.

Our dependent variable is a binary dummy variable. Firms are classified into groups of 'hedge' and 'not hedge'. To search the reports we undertook manual searches. Firms which specifically mention in their annual reports to using financial derivatives such as options, forward contracts, swaps and futures to hedge financial exposures (e.g. FX exposure, interest rate risk and liquidity risk) or/and foreign currency debt for hedging purpose are classified as hedgers. Similarly, firms which refer that they do not hedge are classified as non-hedgers. Then two dummy variables are created and used to represent hedgers and non-hedgers respectively. The dependent variable is coded as a "1" for hedger, and "0" for those firms that do not hedge.

3.2.2 Determinants of corporate hedging

According to Smith and Stulz (1985), if firms face a convex tax schedule, either because of increasing marginal tax rates or the presence of tax preference items, they will hedge in order to reduce the expected tax liabilities. Previous studies have used dummy variable of tax loss carry forwards (e.g. Mian, 1996; Nance et al., 1993) and tax credits (Panaretou, 2014; Bartram et al., 2009) to measure tax progressivity. The existence of tax preference items are positively associated with the likelihood of hedging. However, Graham and Smith (1999) point out that the use of these dummy variables to capture tax incentives is too simple. This is because the provisions such as carryforwards and tax credits broaden the range of convexity but flatten the curvature near the kink. If a firm is unable to make efficient use of the underlying tax benefits, the benefit of these provisions can be reduced. Therefore, this study follows the standard approach of using dummy variables but also uses a direct measure of taxable income to capture tax incentives.

The variables that have been used to test the hypothesis are the marginal tax rate (*MTR*), effective tax rate (*TXR*), a dummy variable of net operating loss carryforwards (*NOL*), and investment tax credits (*ITC*) to exam the hypothesis of taxation. The marginal tax rate is obtained from Graham's database of simulated corporate marginal tax rates[10]. Net operating loss carryforwards and investment credits are obtained from COMPUSTAT of item 52 and item 51 respectively. The data of marginal tax rate, net operating loss carryforwards and investment tax credits is not available for UK firms. Therefore, we have used effective tax rate with the UK sample. We expected a positive relation between hedging and the variables measuring tax incentives to hedge.

Hedging eases the constraint of growth option and investment opportunity by reducing the variability of internal cash flows. Therefore, the research used the total expenditure on research and development of a firm to market value of that firm (*RDMV*), research and development expenditure to total assets (*RDTA*), and the Tobin's Q (*TOBINQ*)[11] to measure growth option and investment opportunity sets. All the three variables are expected to be positively related to hedgers.

When firms are highly leveraged and the firm value is low, shareholders may still reject valuable projects if the benefits of taking these projects accrue to bondholders (Myers, 1977). The agency hypothesis on hedging suggests that risk management can increase shareholder value by harmonising financing and investment policies (Froot et al., 1993). In addition, Myers argues that a firm can control the problem by shortening the maturity of its debt. Based on this argument, the research used the total debts to total assets ratio (*LEVTA*), debt maturity (*DEBTMATU*) and the dummy variable of high Tobin's Q (*HIQ*) as indicators of the *underinvestment* problem. The dummy variable *HIQ* is coded as a "1" if the value of Tobin's Q falls into the top one-third of the sample, and "0" otherwise. The underinvestment problem is more pronounced when a firm has a higher leverage level in its capital structure; firms with higher

[10] This study uses the before-interest-expense simulated rate.
[11] Tobin (1969) suggest that the rate of investment is a function of Q.

leverage are more likely to hedge (Nance et al., 1993). Therefore, we also included an interaction term *HIQ× LEVETA* in the tests to capture the *underinvestment* problem incentives to hedge when a firm has valuable investment opportunities. We expected a positive relation between hedging and the variables measuring the costs of underinvestment.

This study followed Froot et al.'s (1993) framework, which assumes that hedging has no significant impact on the expected level of internal wealth of a firm. The optimal hedge ratio can be negative when investment opportunities are extremely sensitive to the risk variables. More realistically, since the supply-side barriers lead to higher costs of using derivative financial instruments, it is impossible for low-rated firms to take large positions in derivatives because of the lower credit risks involved. In that case it may make sense for a firm to actually keep its exposure unhedged, so as to have sufficient cash flows when large positive NPV investments are required (Froot et al., 1993). To substantiate this inference, we interacted *TOBINQ* with low rating dummy variable (*LR*) to examine whether the effect of investment incentive on hedging substantially differs across credit ratings. The interaction term is expected to be negatively related to hedging decisions.

The variables that have been employed to measure over-investment are the free cash flows over total assets (*FCF*), capital expenditures to total assets (*CAPEXTA*), capital expenditures to property, plant and equipment (*CAPEXPPP*), and the dummy variable of low Tobin's Q (*LOQ*) as indicators of overinvestment problem. Similar with the dummy variable *HIQ*, *LOQ* is coded as a "1" if the value of Tobin's Q falls into the lower one-third of the sample, and "0" otherwise. We included an interaction term *LOQ× FCF* in the tests to capture the *overinvestment* problem incentives to hedge when a firm has low quality investment opportunities. Because the debt can help prevent such firms from overinvestment by reducing the available cash flows for discretionary spending by manager (Jensen, 1986), we created an interaction term *LOQ× LEVETA* to examine the hypothesis. We expected a positive relation between hedging and the variables measuring the costs of overinvestment.

The variables that have been employed in the study to measure financial distress are interest coverage ratio (*INCOV*) and current ratio (*CURR*). The bankruptcy measure is Altman's Z-score (*Z-Score*). We expected a negative relation between hedging and the variables measuring liquidity, but a positive relation between the hedging decision and Altman's Z-score.

The size of a firm is measured by the natural logarithm of market value (*LogMV*), total assets (*LogTA*), and pre-tax income (*LogPTI*). The efficiency is measured by the return on assets (*ROA*). We do not offer any expectations about the sign of these variables measuring size.

Corporate hedging behaviour is also affected by its decisions with respect to other financial policies (Nance et al., 1993). A firm could manage its risk and costs by restructuring its assets and liabilities and/or possessing low leverage (Tufano, 1996). The hedging substitute variables that have been used are the cash to assets ratio (*CASH*), the dividend yield (*DY*), and the amount of convertible debt held to the total debts in a firm (*CONVERDEBT*). Issuing convertible debts and altering dividend payout policies could help to control conflicts of interest to reduce agency costs and to reduce the probability of financial distress. Firm may hold large amount of cash, instead of using derivatives, to protect its growth opportunities and investments (Haushalter et al., 2007). Therefore, we expected a positive relation between hedging and the variable measuring dividend payout, but a negative relation between hedging and the use of convertible debt and cash holdings. However, as pointed out by Opler et al. (1999), the relationship between cash holdings and hedging can be confounded by endogeneity. Most of the variables that are empirically associated with high levels of cash holding are also the variables associated with low debt. Thus, this study created a high leverage dummy variable, *HI_LEV*, which equals to "1" if the value of total debts is above the medium. Its interaction with cash holdings variable, *HI_LEV×CASH*, captures the effect of cash holdings on corporate hedging policies, amongst those firms with higher leverage level and therefore higher hedging needs.

The board structure variables that have been employed to test $H_{0:10.1}$ are the size of the board of directors (*BoardSize*) and the non-executive directors to total number of directors on the board (*NED*). The corporate governance variables consist of the dummy variable of separating Chairman and CEO position (*SEPARATION*), dummy variable of whether CEO compensation of a firm link to total shareholder return (*LINKTSR*), dummy variable of whether a firm's shareholders have the right to vote on the remuneration of executives (*VOP*), computed corporate governance index (*CGI*), proportion of non-executives in the audit committee (*ADCI*), proportion of non-executives in the compensation committee (CPCI), and proportion of non-executives in the nomination committee (*NMCI*). The corporate governance index (*CGI*) is computed as the sum of *NED*, *SEPARATION*, *VOP* and the dummy variables of presence of audit committee, compensation committee and nomination committee. Board structure of a firm and how well the firm is controlled affect the way a company is directed and preserves interests of different stakeholders. Corporate governance practice can ease the impact of manager's personality and subjective propensity on hedging decision. Therefore, we expected a negative relation between *BoardSize* and hedging. We expected a positive relation between the variables measuring the strength of corporate governance and hedging.

Table 3-1 Description of Proxy Variable

What we want to measure	Variable	Variable Definition	Expected Sign
Expected tax liabilities	*TXR*	The effective tax rate. The variable is calculated by dividing the total tax expense of a firm by its pre-tax income	+
Tax convexity	*NOL*	Dummy variable of net operating loss carryforwards	+
Tax convexity	*ITC*	Investment tax credits	+
The tax benefit on debt when firms hedge	*MTR*	The before-financing simulated marginal tax rate used in Graham et al. (1998)	+
Growth and investment opportunities	*RDMV*	Total R&D expenditures divided by market value	+
	RDTA	Total R&D expenditures divided by total assets	+
	TOBINQ	Market value of assets over book value of assets; it indicates	+
Costs of underinvestment problems	*LEVTA*	Total debts divided by total assets	+
	DEBTMATU	The average debt maturity of a firm using the model reported in Eisdorfer (2008): Debt maturity = (0.5×Book value of short-term debts + 5×Book value of long-term debts) / Total debts	+
	HIQ	The dummy variable is set equal to one if the value of Tobin's Q falls into the top third of all Qs in the sample, and zero otherwise. It indicates if a firm has profitable investment opportunities	+
Costs of overinvestment problems	*FCF*	The free cash flows divided by Total assets	+
	CAPEXTA	Capital expenditures divided by Total assets	+
	CAPEXPPP	Capital expenditures divided by the total property, plant and equipment	+
	LOQ	The dummy variable is set equal to one if the value of Tobin's Q falls into the lower third of all Tobin's Qs in the sample, and zero otherwise.	+
Manager's risk aversion and risk taking	*STKComp*	The total stock-based compensation divided by the market value	+
	STKOPT	The total stock option compensation expense divided by the market value	+
	EXEComp	The total senior executives compensations divided by the market value	+
Costs of financial distress	*INCOV*	Interest coverage ratio: EBIT / Interest expense	-
	CURR	Current ratio: Current assets / Current liabilities	-
Bankruptcy	*Z-Score*	The Altman's Z-score model (Altman 1968) for predicting bankruptcies is: Z-score = 1.2×(working capital/Total assets) + 0.6×(Market value of equity/Total liabilities) + 0.999×(Sales/Total assets)	-
Size	*LogMV*	The natural logarithm of market value	?
	LogTA	The natural logarithm of total assets	?
	LogPTI	The natural logarithm of pre-tax income	?
FX exposure	*INTLOP*	International operating income divided by the total operating income	+
Profitability	*ROA*	The return on assets = Net income/Total assets	+
Sensitivity of stock price	*BETA*	The systemic risk of a firm for the fiscal year (obtained from Compustat)	+
	PRIVOL	A measure of a stock's average annual price movement to a high and low from a mean price for each year. from Datastream)	?
Low credit ratings	*LR*	The dummy variable is set equal to one if the S&P Long-term domestic issuer credit rating of a firm is lower than BBB B	-
Hedging substitutes	*CASH*	Cash divided by total assets	-
	DY	Dividend yield	+
	CONVERDEBT	The total amount of convertible debts held divided by debts	-
Strength of corporate governance	*BoardSize*	The number of directors in the board	-
	NED	The number of non-executive directors divided by the total number of directors in the board	+
	SEPERATION	The dummy variable is set equal to one if the position of CEO and the Chairman of the board are separated, and zero otherwise.	+
	CGI	The corporate governance index	+
Economic downturns and market turbulence	*Year2002*	The year dummy variable is set equal to one if the annual data is for the year 2002, and zero otherwise	+
	Year2003	The year dummy variable is set equal to one if the annual data is for the year 2003, and zero otherwise	+
	Year2007	The year dummy variable is set equal to one if the annual data is for the year 2007, and zero otherwise	?
	FCRISIS	Dummy variable of 2008 financial crisis. It equals to one if the annual data is for the year 2008 or year 2009, and zero otherwise.	?

(Continued)

Table 3-1 (Continued)

Industry	*CONSTD*	The dummy variable is set equal to one if a firm is in the construction industry (SIC 1520-1799) in the US	?
	TRANSD	The dummy variable is set equal to one if a firm is in the transportation, communications, electric, gas and sanitary services industry (SIC 4000-4971) in the US	-
	MANUFD	The dummy variable is set equal to one if a firm is in the manufacturing industry (SIC 2011-3999) in the US	?
	RETAILD	The dummy variable is set equal to one if a firm is in the retail trade industry (SIC 5211-5999) in the US	?
	OIL	The dummy variable is set equal to one if a firm is in the oil&gas industry (ICB 100) in the UK	?
	MATERL	The dummy variable is set equal to one if a firm is in the basic materials industry (ICB 1000) in the UK	?
	INDUS	The dummy variable is set equal to one if a firm is in the industrials industry (ICB 2000) in the UK	?
	CONSUMG	The dummy variable is set equal to one if a firm is in the consumer goods industry (ICB 3000) in the UK	?
	CONSUMS	The dummy variable is set equal to one if a firm is in the consumer services industry (ICB 5000) in the UK	?
	TELECOM	The dummy variable is set equal to one if a firm is in the telecommunications industry (ICB 6000) in the UK	?
	UTILIT	The dummy variable is set equal to one if a firm is in the utilities industry (ICB 7000) in the UK	-

3.4 Research Methodology

Because of the nature of the research, the quantitative approach has been used to analyse data. A number of theoretical hypotheses, which are measured by refined proxies to hedge, are tested. The dataset is then analysed and interpreted. Measurements are employed on the basis of hypotheses for the determinants of corporate hedging. The subjectivity of qualitative approach may weaken findings from qualitative research when researchers try to generalise conclusion based upon a single case or small sample. Therefore, the quantitative approach is more suitable to conduct the research in terms of the reliability and validity of findings.

Some prior empirical studies investigate corporate hedging behaviour and derivative usage by utilising questionnaire surveys instead of secondary data from databases. In terms of this method, however, a relatively low response rate is the most serious limitations for research in this area[12], which can significantly affect sample size. The low response rate could also raise the issue of respondent bias. For those firms which do not hedge their exposure, their managers may have less motivation to complete the questionnaire. Moreover, conducting a survey is time consuming and it is difficult to control the quality of questionnaires. In particular, because of a lack of prompting or supervision, questionnaires may be partially answered, creating a problem of missing data for the variables that are created (Bryman and Bell, 2007). Respondents may have different interpretation and criteria on the attitude-related questions, making the actual results inconsistent and less reliable. Following recent changes on accounting treatment and improvement on the derivatives instrument disclosure, we have been able to collect detailed information on corporate hedging activities from audited financial reports. On account of the limitations

[12] Nance et al (1993) had a response rate of 31.6%, Dolde (1995) had a response rate of 51.3%, Joseph and Hewins (1997) had a response rate of 51.9%, Pramborg (2005) had a response rate of 26%, and Clark and Judge (2006) had a response rate of 42.2%; Bodnar et al (1995; 1998), doing 3 series survey in 1994,1995 and 1998, had response rate which dropped from 26.5% to 20.7%

of a survey-based study and the advantage of audited data, this research has utilised desk-based research method.

The research employs econometric techniques and models, including descriptive statistics analysis, nonparametric test (Mann-Whitney test and Kruskal-Wallis test), factor analysis, and logistic regression to analyse chosen data through SPSS. These econometric techniques and models give estimations on different prospects.

3.4.1 Descriptive statistics

Descriptive statistics describe the main characteristics of the data sets, including the size, mean, standard deviation, skewness and kurtosis of dependent and explanatory variables. Descriptive statistics provides a general picture of the individual variable, determining the suitability or otherwise of multivariate statistical tests.

3.4.2 Non-parametric tests

The study utilised Mann-Whitney approach to test the null hypotheses that hedgers and non-hedgers have equal mean ranks of the financial characteristics. In the studies dealing with corporate risk management, the sample could be biased to the extent that sampled firms are relatively large corporations while firm size itself is an explanatory factor to hedging. To test for sample selection bias, the research conducted Kruskal-Wallis statistic to compare the coefficients of all variables in terms of their size (total assets). Kruskal-Wallis test is very similar to the Mann-Whitney test method, but it permits more than two groups. It tested the null hypothesis that the mean ranks of the variables for hedgers and non-hedgers are significantly different.

3.4.3 Specification and multivariate tests

Logistic regression analysis is used to test the relation between the likelihood of hedging and firm-and industry-level factors. In the standard OSL model, the variables are continuous with several observations for both the dependent and the explanatory variables. The logistic regression applies in the cases where the dependent variable is binary or dichotomous (Hosmer and Lemeshow, 2013). In this case, our dependent variable is binary, as firms are classified into groups of 'hedge' and 'not hedge'. The dependent variable is coded as a "1" for hedger, and "0" otherwise for those firms do not hedge. Results from logistic regression present the probability of hedging to the determinants of corporate hedging.

The model specification is presented below:

$$\Pr(Y=1|X_1,X_2,X_3,X_4,\ldots X_{n-1},X_n)=F(\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\ldots\beta_{n-1}X_{n-1}+\beta_nX_n)$$

$$=\frac{1}{1+e^{-(\beta_0+\beta_1X_1+\ldots..+\beta_nX_n)}}$$, where β_0 is the constant parameter, the right-hand side explanatory variables Xs are the proxy measures of firm characteristics based on hypotheses, and β_n is the parameter of the nth independent variable.

The parameters of the logistic regression are estimated based on the maximum log likelihood method. In this study, the *p*-value of variables which is less than 0.1 in logistic model is recognised as statistically significant. That is, if the *p*-value of a variable is less than 0.1, the variable is recognised as a significant determinant of corporate hedging decision and we will see if the sign of coefficient β of that variable is consistent with theoretical prediction.

3.4.4 Factor analysis

The traditional paradigm of using logit test can be criticised. As discussed in the studies conducted by Géczy et al. (1997) and Aretz and Bartram (2010), the endogeneity of variables measuring potential incentives for hedging is one of the empirical challenges and potential shortcomings, which may limit the conclusions drawn from existing hedging evidence. Some of the independent variables measuring different corporate policies and characteristics, such as leverage, investment opportunities, dividend, cash holdings, and management compensations are, amongst themselves, highly correlated. This can be made simultaneously with the decision of hedging. The presence of high correlation among the variables can adversely impact on the empirical results, which in turn can lead to unreliable inferences. However, most empirical studies on corporate risk management fail to account for the endogeneity and the simultaneity. In addition, studies using other techniques such as simultaneous equations models also face significant identification problems (Aretz and Bartram, 2010).

Though we recognise that it is almost impossible to eliminate all the endogeneity problems, it is essential to minimise the problems when empirically examine the determinants of corporate hedging. To address these problems, in this study, we have used factor analysis approach to identify the independent dimensions of the data. In particular, factor analysis has been used as a data reduction tool, which "derives a set of uncorrelated variables for further analysis when the use of highly inter-correlated variables may yield misleading results in regression analysis" (Kim and Mueller, 1978, p.6). In other words, factor analysis aims to identify a number of groups and the underlying factors to represent variables with similar characteristics. As a results, a smaller set of latent variables represent correlated variables and would be relatively independent of one another. The procedure was estimated using the maximum likelihood and the variables were rotated using the varimax method.

3.5 Justification for Cross-country Comparison

Existing literature has focused on samples of firms from one country and provides limited evidence on cross country comparison of corporate hedging determinants within the same period. Notable exceptions are Bodnar and Gebhardt's (1999) study which includes a comparative suvey amongst US and German non-financial firms, a recent study from Bartram et al. (2009) on derivative usage in 50 countries including the US, and Lel's (2012) study on cross-country currency hedging and corporate governance. The evidence of cross-country differences suggest that our understanding of corporate hedging behaviour remains incomplete. Yet it is unclear whether the contradiction on the empirical evidence is due to the cross-country differences or the changes that have occurred over time. This study explores the relationship between financial characteristics and corporate hedging for firms in the US and UK over a longer period. The two countries are chosen because there are important similarities that make the comparison meaningful. Amongst other things, both the US and the UK are often described as Anglo-Saxon countries and have almost similar legal system for the conduct of business, market-based financial systems, and well-developed equity markets with good investor protection. The study therefore eases the concern over the contrary results across countries are because US enjoys a large and stable financial market with strong investor protection. In addition, they show the most advanced regulation on risk disclosure, allowing for distinct access to detailed information on risk management activities from audited financial reports. The study provide a more direct and effective comparison of cross-country corporate hedging behaviour. The results here provide a broad confirmation of theoretical and prior empirical literature on the determinants of hedging. The remaining sections summarise the findings by the hypotheses of hedging.

3.6 Summary

This chapter describes the data sources and sampling procedures. It also provide a detailed discussion of definitions of the variables under consideration. This chapter also discusses the empirical methodology used in the empirical analysis. In addition, it provides justification for the selection of countries.

CHAPTER 4
SUMMARY of US and UK EMPIRICAL RESULTS

4.1 Descriptive Statistics

Table 4-1 presents the descriptive statistics for the explanatory variables used in this study over the period 2002 to 2011. Panel A of Table 4-1 shows the statistics for the US firms, and Panel B shows the statistics for the UK firm. The means of natural logarithm of market value (*LogMV*) and logarithm of total assets (*LogTA*) for the hedgers are higher than non-hedgers. In addition, the mean of *LogMV* for US firms is larger than the mean for the UK firms. Consistently, the means of *TOBINQ* for US hedgers (1.814) and non-hedgers (2.297) are also higher than then means for the UK hedgers and non-hedgers (0.637 and 1.000 respectively). By contrast, the mean of *LogTA* and the fixed assets ratio (*FATA*) for the UK firms are higher than the means for the US firms. The means of leverage ratio (*LEVTA*) for the US hedgers and non-hedgers (0.275 and 0.176 respectively)are higher than the means for the UK hedgers (0.234) and non-hedgers (0.128). This suggests that US firms in our sample generally are more leveraged than UK firms, which is not surprising. It is noticeable that the stock prices of US firms appear to generally be more volatile than UK firms. In addition, it appears that the mean of the price volatility for US hedgers (28.091) is lower than the mean for US non-hedgers (34.279), whereas the situation for the UK hedgers and UK non-hedgers are just the reverse (mean of price volatility is 5.582 and 3.476 respectively). As regards the corporate governance measures, the mean value for the size of US firms' board of directors is higher than the mean value for the UK firms, suggesting that US firms generally have large board than the UK firms. US firms also appear to have higher proportion of non-executive directors sitting on the board. By contrast, the mean of *SEPARATION*, the dummy variable for whether a firm separate the responsibility of Chairman and CEO, is much larger for the UK sample (0.878 for hedgers and 0.809 for

non-hedgers) than the US sample (mean = 0.320 and 0.390 respectively). It suggests a difference on the leadership structure in the major US firms and UK firms. The variables for all groups of firms tend to exhibit skewness and kurtosis. This suggests that the observations that are obtained for the particular explanatory variables are not normally distributed. Parametric statistical approach may generate results that are inefficiently estimated. As such, we use the non-parametric tests to test the hypotheses.

Table 4-1 Summary Statistics of US and UK Hedgers and Non-Hedgers

Panel A: US firms

	Hedgers					Non-hedgers				
Variables	N	Mean	SD	Skewness	Kurtosis	N	Mean	SD	Skewness	Kurtosis
LogMV	2926	9.1043	1.4324	-0.0502	0.2393	1085	7.8388	1.2756	-0.1595	0.5166
LogTA	2930	9.2972	1.2577	-0.0037	0.6500	1093	7.6324	1.3567	-0.0157	0.2429
LogPTI	2622	6.7207	1.4679	-0.1114	0.2819	936	1.9717	0.9908	-0.8803	-0.0998
FATA	2930	0.5381	0.2556	-0.6964	-0.2328	1093	0.5159	0.2193	-0.3153	-0.3288
RDMV	2916	0.0302	0.2121	33.7979	1400.0030	1085	0.0159	0.0390	3.9502	19.2971
RDTA	2932	0.1956	0.0384	5.1763	55.4820	1093	0.0278	0.0657	4.7798	41.9210
CASH	2932	0.0777	0.0772	2.0966	8.2487	1093	0.1324	0.1253	1.4684	2.5344
LTDTA	2929	0.2368	0.1636	1.6281	7.1170	1080	0.1556	0.1671	1.3576	2.2736
DEBTMATU	2932	4.2037	1.0781	-2.3603	5.6895	1076	3.3912	1.9586	-0.8814	-0.9596
LEVTA	2932	0.2745	0.1753	1.3006	4.9837	1093	0.1755	0.1798	1.4551	3.8957
Z-Score	2929	3.5417	3.8571	10.2074	176.4495	1081	5.9835	7.3945	5.1712	45.2898
INCOV	2906	14.8938	22.9170	2.7003	6.7438	1068	31.7862	38.7572	0.9845	-0.7655
CURR	2872	1.6236	1.0126	4.8925	45.9850	1072	2.5633	2.3307	6.3311	81.3803
FCF	2930	0.0664	0.0710	-0.8889	16.6573	1093	0.0582	0.1062	-2.8571	26.1160
TOBINQ	2930	1.8137	1.0398	3.9251	28.1229	1093	2.2968	1.4886	2.4657	10.8471
CAPEXTA	2930	0.0506	0.0516	5.0612	44.5801	1093	0.0543	0.0510	2.0199	5.3531
CAPEXPPP	2924	0.0987	0.0726	4.1956	30.3271	1093	0.1187	0.0826	1.7543	5.2848
SPRATING	2932	11.0100	4.6770	-0.7694	0.0669	1093	5.6400	5.2000	0.5052	-1.2004
MTR	2932	0.3234	0.0739	-2.6461	6.1400	1093	0.3026	0.0948	-1.9390	2.5510
NOL	2932	0.4200	0.4940	0.3037	-1.9091	1093	0.3900	0.4890	0.4370	-1.8124
ITC	2932	7.5335	42.9499	8.1579	80.9719	1093	1.5579	24.7492	19.8251	417.4006
DY	2932	1.4929	1.7249	1.5792	3.5852	1093	0.6371	1.1202	3.0336	13.4452
CONVERDEBT	2932	0.0608	0.1738	3.6255	13.6515	1093	0.1085	0.2727	2.4801	4.7201
ROA	2930	0.0516	0.0790	-2.1170	24.9267	1093	0.0450	0.1294	-3.9106	26.3485
FI	2929	0.3618	2.5419	20.0803	542.0046	1091	0.1700	4.3323	-22.8178	525.9394
STKComp	2919	1.3825	4.9300	9.0829	113.8293	1092	1.4606	6.8909	9.3509	109.2960
BETA	2852	0.3677	33.1322	24.4962	734.3563	1068	1.3628	2.3962	26.7087	813.3751
PRIVOL	2579	28.0913	10.2494	0.9651	0.9516	1002	34.2793	11.2966	0.7771	0.3436
BoardSize	2374	10.9743	2.1670	0.1870	0.3984	884	9.5283	2.3442	1.3589	5.8699
NED	2290	86.0596	7.5380	-1.5871	3.0770	871	80.6498	10.6967	-1.4563	4.2734
CGI	2363	4.4185	0.8056	-0.6897	3.1584	870	4.1621	1.0556	-0.7743	1.0053
LINKTSR	2932	0.4800	0.5000	0.0792	-1.9951	1093	0.3000	0.4600	0.8500	-1.2799
SEPARATION	2363	0.3200	0.4680	0.7580	-1.4266	870	0.3900	0.4870	0.4732	-1.7801
VOP	2932	0.1800	0.3850	1.6540	0.7362	1093	0.1500	0.3590	1.9426	1.7770

Panel B: UK firms										
	Hedgers					Non-hedgers				
Variables	N	Mean	SD	Skewness	Kurtosis	N	Mean	SD	Skewness	Kurtosis
LogMV	1949	6.6661	1.9005	0.2269	-0.1762	856	4.4588	1.6547	0.2549	0.2808
LogTA	2062	13.7018	1.8354	0.1684	-0.1041	968	10.9890	1.9102	-0.0503	0.2872
LogPTI	1824	11.1420	1.9392	0.2155	0.2473	608	9.1787	1.9022	-0.2043	1.4351
FATA	2061	0.6433	0.6213	9.5948	111.5096	968	0.9292	1.5818	3.9598	15.7360
RDMV	914	2.9050	2.8714	0.6983	-0.6199	322	2.8525	3.0815	0.6979	-0.8897
RDTA	2002	1.3272	2.4235	1.8943	2.5925	929	0.7329	1.9450	3.0605	8.6691
CASH	2062	2.9342	3.0867	.6776	-0.8890	968	1.8467	2.6733	1.5204	0.9978
LTDTA	2062	1.3139	2.4884	2.2091	3.5780	969	1.3367	2.5436	1.9504	2.5866
DEBTMATU	2063	3.5317	1.7062	1.1202	32.8431	977	1.8932	1.9328	0.4253	-1.5136
LEVTA	2062	0.2338	0.1791	1.1650	3.0596	968	0.1279	0.2343	4.2258	27.6486
Z-Score	2061	1.8055	1.1498	-0.4545	6.9503	968	0.2320	4.8625	-5.7744	53.3247
INCOV	2051	17.4522	27.3443	2.2146	3.6862	965	23.3491	35.3466	1.4498	0.4736
CURR	2062	1.4991	1.4639	18.5735	589.1823	966	3.8324	6.5085	5.7626	46.5226
FCF	2057	0.0582	0.0785	-2.3856	21.5775	941	-0.0778	0.3958	-5.5292	55.0956
TOBINQ	2061	0.6373	0.4609	11.5990	174.9263	968	0.9998	1.9519	4.6766	34.7480
CAPEXTA	2062	3.2693	2.9543	0.5405	-0.8396	968	3.0362	3.0519	0.6966	-0.7837
CAPEXPPP	2052	1.2513	2.5352	2.3025	3.7585	966	2.0935	18.4397	22.4796	548.3635
TXR	2061	30.3063	135.1403	23.8040	746.0602	967	2.9490	451.5738	-30.0527	924.0149
DY	1848	0.5582	0.8870	4.2037	24.2726	631	0.1939	0.5790	6.9850	55.2178
CONVERDEBT	2014	0.0631	0.5560	12.3456	163.7522	736	0.0473	0.2613	12.5776	230.5833
ROA	2060	2.8572	3.8421	-0.3302	0.0716	945	1.0978	3.8648	0.0580	0.6205
FOI	2076	4.0939	33.4260	-21.4047	796.2657	987	1.6073	25.3371	-7.8123	193.1981
STKComp	2076	1.7339	3.4569	5.0343	41.9672	988	0.9808	10.2778	27.9643	834.0467
STKOPT	2076	0.0015	0.0034	9.2428	154.0726	988	0.0022	0.0102	-3.9822	219.5328
EXEComp	2076	2.0679	4.3179	6.4119	62.9560	988	1.0536	4.5009	10.1257	136.4275
BETA										
PRIVOL	2018	5.5817	12.4748	18.3673	446.9413	905	3.4758	14.0740	14.9961	301.8231
BoardSize	1316	9.2660	2.4952	0.7250	0.1245	373	7.6113	1.9362	0.7854	0.6683
NED	1383	59.2010	19.7381	-1.6494	3.0672	388	52.8586	19.4294	-0.8662	1.3333
CGI	1295	4.2903	0.7146	-0.1088	0.3693	265	4.0906	0.7683	-0.4590	0.1918
LINKTSR	2076	0.5125	0.5000	-0.0501	-1.9994	988	0.1457	0.3530	2.0110	2.0481
SEPARATION	1412	0.8775	0.3280	-2.3049	3.3175	388	0.8093	0.3934	-1.5806	0.5008
VOP	1383	0.3557	0.4789	0.6033	-1.6384	384	0.2266	0.4192	1.3115	-0.2813
ADCI	2076	59.9114	48.5299	-0.4120	-1.8145	985	34.3222	46.9667	0.6540	-1.5533
CPCI	2076	58.1811	46.9317	-0.3845	-1.7773	985	33.7195	46.5602	0.6757	-1.5180
NMCI	2076	39.5795	39.8505	0.1577	-1.7127	985	22.3987	38.1031	1.2185	-0.3202

4.2 Non-parametric Estimation

To test hypothesised relation stated in the Section 4.2, the study utilises the non-parametric Wilconxon-Mann-Whitney test for the differences between hedgers and non-hedgers based on ranks. The results of this test are reported in Table 4-2. Column 2 provides the hypothesised expectations, where "H" stands for "hedgers" and "NH" stands for non-hedgers. Column 3 and 4 is the mean ranks for US hedgers (US H) and non-hedgers (US NH), and column 6 and 7 are the ranks for UK hedgers (UK H) and non-hedgers (UK NH).

It can be shown that the test rejects the null hypothesis for underinvestment problem, financial distress and taxation (*p*-value <0.100). So, as expected, there are differences in the financial characteristics of hedgers and non-hedgers. Hedgers are less liquid, have more debts, longer debt maturity and more tax liabilities. The results generally reject the null hypothesis that hedgers and non-hedgers face same level of growth opportunities. Hedgers have significantly higher R&D expenditure than non-hedgers. However, the mean ranks for *TOBINQ* is more complex. UK hedgers appear to have higher mean rank than non-hedgers, but the mean rank of *TOBINQ* for the US hedgers is surprisingly lower than the one for non-hedgers. This result, however, is consistent with the US firms evidence by Mian (1996). The possibility considered is the small-firm premium[13]. This will be discussed further with Kruskal-Wallis test later on.

Table 4-2 also shows that the test is significant for the overinvestment measures. The hypothesis relation is not always in the expected direction. For example, both US hedgers and UK hedgers have higher mean ranks for free cash flows to total assets (2035.743 vs. 1948.377 for the US, and 1632.849 vs. 1208.656 for the UK), consistent with hypothesised expectation. However, the finding that non-hedgers exhibit higher capital expenditure to plant, property and equipment (*CAPEXPPP*) is contrary to the expectation.

[13] For example, it is well-known that on average the stock price of small firms outperforms the price of large firms.

The alternative investment intensity measure, capital expenditure to total assets (*CAPEXTA*), just loads higher mean rank for UK hedgers (1542.840 vs. 1457.261). As such, we cannot firmly reject the null hypothesis that there is no difference on the investment intensity between hedgers and non-hedgers.

Table 4-2 Mann-Whitney Test for US and UK Hedgers and Non-Hedgers

Variables	Hypothesised Expectation	Mean Rank		Z-statistic	Mean Rank		Z-statistic
		US H	US NH		UK H	UK NH	
Growth options							
RDMV	H>NH	2087.4448	1768.6747	-8.4288[a]	620.9956	611.4161	-0.4143
RDTA	H>NH	2076.3426	1843.0819	-6.1607[a]	1521.7395	1345.8811	-5.8590[a]
TOBINQ	H>NH	1903.2234	2303.5970	-9.7257[a]	1646.9592	1234.0413	-12.1174[a]
Underinvestment							
LEVTA	H>NH	2210.0866	1484.3102	-17.6259[a]	1741.7005	1033.6555	-20.8084[a]
DEBTMATU	H>NH	2052.4258	1873.9066	-4.3301[a]	1741.3076	1054.2503	-20.1964[a]
FATA	H<NH	2063.7894	1873.1683	-4.6318[a]	1550.2826	1439.8786	-3.2399[a]
Overinvestment							
FCF	H>NH	2035.7336	1948.3774	-2.1220[b]	1632.8493	1208.0021	-12.4714[a]
CAPEXTA	H>NH	2010.8184	2015.1674	-0.1056	1542.8400	1457.2614	-2.5107[b]
CAPEXPPP	H>NH	1930.1860	2219.8435	-7.0448[a]	1377.8492	1775.0592	-11.6796[a]
Managerial incentives							
STKComp	H>NH	2102.2456	1748.7257	-9.2578[a]	1676.9422	1228.9960	-15.0538[a]
STKOPT	H<NH				1545.2288	1505.7540	-1.2236
EXEComp	H>NH				1715.5395	1147.8947	-18.2752[a]
Financial Distress							
ZScore	H<NH	1846.3595	2436.6957	-14.3282[a]	1637.7885	1253.5671	-11.2753[a]
LTDTA	H>NH	2187.2361	1510.7690	-16.4214[a]	1655.0919	1220.0170	-12.8427[a]
CURR	H<NH	1771.6731	2510.5364	-18.1294	1343.8930	1864.4105	-15.3092[a]
INCOV	H<NH	1902.6249	2218.4429	-7.6956[a]	1503.0007	1352.9844	-4.4097[a]
SPRATING	H<NH	2309.2751	1218.2347	-26.7002[a]			
Taxation							
MTR	H>NH	2108.8088	1755.9904	-8.7462[a]			
TXR	H>NH				1625.3583	1278.2239	-10.1872[a]
NOL	H>NH	2030.2439	1966.7429	-1.8059[c]			
ITC	H>NH	2035.1698	1953.5288	-6.0026[a]			
Size							
LogMV	Undetermined	2276.4831	1276.5682	-24.2925[a]	1667.5672	800.6151	-26.1067[a]
LogTA	Undetermined	2358.3581	1081.9963	-31.0111[a]	1853.2362	796.0661	-31.0157[a]
LogPTI	H>NH	2251.7244	1372.6157	-21.3630[a]	1381.4507	721.6480	-20.0648[a]
Substitutes							
DY	H>NH	2186.9932	1546.2589	-16.1148[a]	1398.4072	776.0753	-18.9322[a]
CONVERDEBT	H<NH	2020.1601	1993.7928	-0.8904	1372.6152	1383.3940	-0.7984
CASH	H<NH	1872.7306	2389.2763	-12.5427[a]	1563.6440	1412.9452	-4.4213[a]
Profitability							
ROA	H>NH	1974.0592	2113.7077	-3.3923[a]	1646.9376	1189.2312	-13.4273[a]
FI	H>NH	1334.7471	1222.2860	-3.0804[a]	1731.9000	1111.5415	-18.3417[a]
PRIVOL	Undetermined	1622.3356	2225.1173	-15.6619[a]	1672.9779	991.5541	-20.1825[a]
BETA	Undetermined	1895.3491	2134.4799	-5.8898[a]			
Corporate Governance							
BoardSize	H<NH	1798.2502	1176.3179	-16.9336[a]	918.7451	584.8164	-11.7815[a]
NED	H>NH	1730.9817	1186.6739	-15.0057[a]	937.7787	701.4381	-8.0568[a]
CGI	H>NH	1667.6676	1479.3822	-5.5175[a]	797.0046	699.8453	-3.5160[a]
LINKTSR	H>NH	2108.9393	1755.6404	-9.9972[a]	1713.6869	1151.7874	-19.4153[a]
SEPARATION	H>NH	1589.9592	1690.4454	-3.3095[a]	913.7309	852.3505	-3.4570[a]
VOP	H>NH	2029.1603	1969.6496	-2.2306[b]	908.8037	749.6680	-4.7702[a]
ADCI	H>NH				1659.5901	1259.9817	-13.3463[a]
CPCI	H>NH				1651.5894	1276.8442	-12.1393[a]
NMCI	H>NH				1638.3148	1304.8218	-10.7735[a]

The statistic of all the corporate governance measures is significant (p-value < 0.100), allowing us to reject the null hypotheses that there is no difference in board structure and the strength of corporate governance between hedgers and non-hedgers. The mean rank of *NED*, *CGI*, *LINKTSR*, and *VOP* for hedgers are higher both in the US and the UK, consistent with the hypothesised expectation. The finding illustrates that hedgers generally exhibit stronger corporate governance. The only aspect of the corporate governance that is contrary to the prediction is from the size of board of directors (*BoardSize*). Corporate governance theories suggest a smaller board yields more effective monitoring and stronger governance, and therefore higher likelihood of hedging. However, our table shows that the mean rank of *BoardSize* for hedgers is higher than the mean rank for non-hedgers.

The above Mann-Whitney test exams whether there is significant difference between hedger and non-hedgers, but it does not pull out the effect of size. Given that hedgers exhibit significant economies of scale in Table 4-2, it raises the concern that the relations for the explanatory variables between hedgers and non-hedgers are driven by the size effect. To pull out size effect, We separated the sample into three equal groups based on total assets. Kruskal-Wallis test is employed to test for differences among the six groups: small hedgers, small non-hedgers, middle hedgers, middle non-hedgers, large hedgers, and large non-hedgers. Table 4-3 Panel A and Panel reports the results from Kruskal-Wallis test for the US and UK firms respectively. Note that, by capturing the size effect, all of the statistics are significant at 10% level.

Large firms generally have higher tax liabilities because of higher taxable income. Therefore, it is not surprising to find that hedgers exhibit more tax liabilities given that large firms are more likely to be hedgers. Table 4-3 provides support that hedgers exhibit more tax liabilities after pulling out size effect. The mean ranks of *MTR*, *NOL*, and *ITC* for small hedgers, middle hedgers and large hedgers are all higher than the corresponding groups of non-hedgers. The mean ranks of corporate governance measures are

generally higher for hedgers. The effect of size on the corporate governance does not influence the conclusion that hedgers are better governed.

Table 4-3 Panel B shows provides support that all of the three groups of UK hedgers exhibit higher R&D expenditures. Panel A shows similar results for the middle-size and large US hedgers. It is noticeable, however, that the small-size US hedger appears to have lower R&D spending than small non-hedgers. Likewise both the mean ranks of *TOBINQ* for the small US hedger and UK hedgers are lower than the ranks for small non-hedgers, suggesting that small hedgers in the US and UK have few valuable growth opportunities. This is surprising because smaller firms are like to have greater informational asymmetries and are more liquidity constrained.

Table 4-3 also shows that mixed results for the relation for the debt maturity between hedgers and non-hedgers. In the US, small hedgers appear to have longer debt maturity, whereas middle-size hedgers and large hedgers appear to have shorter debt maturity compared to the middle and large non-hedgers. Consistent with the results for debt maturity, the mean ranks of liquidity measures for middle-size and large hedgers are slightly higher than the mean ranks for non-hedgers. In the UK, by contrast, hedgers are generally have longer debt maturity than non-hedgers.

Table 4-3 Kruskal-Wallis test for the hedgers and non-hedgers by size group							
Panel A: US firms							
Variables		Mean Rank					Chi-Square
	Small H	Small NH	Middle H	Middle NH	Large H	Large NH	
Growth options							
RDMV	1791.5372	1902.4432	2168.7181	1483.2739	2147.4613	1344.1441	169.4377[a]
RDTA	1824.2230	1997.4046	2139.1396	1508.1383	2130.9211	1370.0811	134.9795[a]
TOBINQ	2188.4593	2554.2558	1903.4771	1760.6748	2241.0614	2253.6937	272.2457[a]
Underinvestment							
LEVTA	1951.3628	1279.7545	2302.3855	1830.1529	2241.0614	2253.6937	438.9178[a]
DEBTMATU	2138.4690	1730.1034	2148.7366	2257.7233	1921.1395	2122.9189	85.4858[a]
FATA	1735.6805	1677.0464	2146.4057	2213.7621	2137.1611	2607.4685	161.5430[a]
Overinvestment							
FCF	2143.5053	2085.0664	2154.2824	1724.0801	1875.3324	1406.3649	87.2430[a]
CAPEXTA	1986.2584	1988.1269	1936.3705	1995.1058	2089.9020	2233.9505	15.0499[a]
CAPEXPPP	2151.6832	2302.7146	2146.1092	1879.4061	1874.0110	1769.3153	96.7332[a]
Managerial incentives							
STKComp	1660.2326	1748.2062	2003.9304	1608.8956	2391.8888	1852.7636	284.0045[a]
Financial Distress							
ZScore	2449.7044	2680.2829	1864.8678	2026.0537	1550.5309	1487.7706	572.2779[a]
LTDTA	1916.1619	1300.3623	2292.7987	1858.4805	2212.9890	2334.5092	409.5820[a]
CURR	2290.7034	2799.5545	1905.8771	2036.2789	1398.7074	1370.3874	782.6416[c]
INCOV	2139.9216	2337.4427	1797.3160	2012.2791	1890.437	1789.5766	122.8289[a]
SPRATING	1537.4655	889.9207	2192.6661	1791.1359	2768.4471	2440.8559	1412.4535[a]
Taxation							
MTR	1933.3319	1702.1798	2152.6476	1701.5583	2145.8198	2216.5811	113.5933[a]
TXR							
NOL	2021.1115	2005.8698	2173.2987	1915.9223	1898.8763	1771.8649	277.0427[a]
ITC	1935.5000	1935.5000	1947.8828	1935.5000	2158.0915	2098.1351	2300.8491[a]
Size							
LogMV	1056.9388	870.5335	1976.0035	2009.0000	3314.4617	2796.3333	2300.8491[a]
LogTA	850.3257	540.4343	2011.8040	2013.0801	3371.6839	3140.0946	3601.5577[a]
LogPTI	1275.2540	1021.9111	1949.2828	1949.8641	2977.8287	2728.5766	1690.6221[a]
Substitutes							
DY	1594.6584	1418.7899	2077.2172	1631.1311	2557.0883	2270.0360	619.6282[a]
CONVERDEBT	2025.4284	1948.7951	1992.1498	2099.0170	2039.9125	2099.8288	10.0756[c]
CASH	1949.0929	2613.9330	1987.5414	2093.6286	1728.6233	1342.1486	321.8306[a]
Profitability							
ROA	2115.3929	2237.8409	1946.7996	1879.4515	1933.3621	1672.1171	55.2406[a]
FI	1867.6531	1567.3950	2279.0776	1721.4272	2213.1233	1402.6306	274.5093[a]
PRIVOL	2088.4490	2353.4490	1771.8729	2187.3333	1307.8703	1413.0196	535.2586[a]
BETA	1909.6008	2186.8742	2120.6656	2084.7670	1682.9104	1859.8468	129.8964[a]
Corporate Governance							
BoardSize	1232.4306	889.3398	1604.1449	1614.9844	2115.9205	2006.0735	751.1272[a]
NED	1279.2645	1023.7607	1668.7196	1297.8770	1905.3153	1937.0758	430.8686[a]
CGI	1455.9069	1418.4592	1693.6995	1670.8620	1690.1165	1455.9069	56.9427[a]
LINKTSR	1525.9035	1615.7436	2071.6982	2039.6165	2407.9882	2192.2928	459.1272[a]
SEPARATION	1755.6791	1766.4672	1611.6286	1648.5703	1525.2442	1337.2500	83.4331[a]
VOP	1797.7531	1929.4240	2038.1229	2043.2233	2123.9337	2097.3108	61.8125[a]

(Continued)

Panel B: UK firms							
Growth options							
RDMV	682.6641	624.5398	639.5508	549.5667	575.9811	559.0000	15.0919[a]
RDTA	1757.9050	1463.2100	1487.5841	1098.3533	1462.7817	1055.5455	123.5148[a]
TOBINQ	1152.8221	1225.2169	1628.1186	1344.9440	1840.2153	958.0694	312.8527[a]
Underinvestment							
LEVTA	1211.7471	942.1184	1659.8093	1211.8513	1997.2410	1302.2917	668.7068[a]
DEBTMATU	1184.9250	900.7500	1703.6779	1260.9418	1931.5803	1780.0927	655.5247[a]
FATA	1093.9868	1302.9902	1406.5464	1635.1466	1832.4836	2073.0972	287.9960[a]
Overinvestment							
FCF	1798.3698	1109.9922	1726.3054	1381.1762	1496.6161	1541.9437	228.1970[a]
CAPEXTA	1539.3294	1453.8373	1539.5226	1470.4116	1546.8229	1446.4653	6.4137
CAPEXPPP	1577.9971	1842.6917	1349.4296	1685.9935	1328.7516	1448.3611	174.8956[a]
Managerial incentives							
STKComp	1053.2971	1046.2259	1560.0335	1544.5366	1954.4156	1685.4653	694.4205[a]
STKOPT	1410.1721	1483.2711	1505.5535	1547.9332	1582.6432	1430.61111	13.9814[a]
EXEComp	976.7471	916.7605	1637.5503	1482.3103	1999.4154	2014.72222	925.8423[a]
Financial Distress							
ZScore	1927.1294	1125.0663	1797.7784	1498.4440	1402.3090	1649.5833	306.1227[a]
LTDTA	1448.2853	1099.5113	1647.3758	1438.7392	1733.6961	1628.3611	234.4399[a]
CURR	1783.3676	1942.0174	1438.7384	1578.9353	1103.4300	2057.3056	435.0087[a]
INCOV	1654.8985	1194.8972	1569.1794	1675.6019	1375.7843	1687.7958	117.5011[a]
Taxation							
TXR	1698.7691	1110.9623	1673.7835	1638.6853	1559.1810	1656.9375	191.1980[a]
Size							
LogMV	637.5077	502.9456	1373.0196	1253.6683	2267.6924	2065.8689	2079.5608[a]
LogTA	669.1888	417.0941	1540.1888	1402.5065	2535.5465	2336.9444	2718.9700[a]
LogPTI	486.8272	389.6113	1128.7362	996.1751	1912.1683	1860.7768	1714.0916[a]
Substitutes							
DY	1090.6589	622.5452	1328.6793	1024.0484	1555.4691	1003.2364	507.3328[a]
CONVERDEBT	1340.6139	1372.6689	1330.7563	1356.0092	1412.8413	1510.8472	46.8842[a]
CASH	1410.9118	1403.7922	1592.1914	1435.8987	1595.1200	1423.3958	32.2045[a]
Profitability							
ROA	1552.8732	1043.7105	1688.0625	1475.5241	1646.9111	1593.9014	244.4649[a]
FI	1504.2147	1005.4344	1685.1933	1327.5259	1803.5523	1236.7014	383.0114[a]
PRIVOL	1187.8923	720.8314	1518.1929	1392.5903	1945.3679	2098.3125	852.1309[a]
Corporate Governance							
BoardSize	345.6548	400.4367	623.9881	611.6623	1091.1864	982.3413	529.0285[a]
NED	589.8222	628.0337	797.7616	742.6065	1026.1652	772.7609	152.8380[a]
CGI	527.6765	611.1379	729.6189	741.1336	839.1397	747.1639	53.0663[a]
LINKTSR	983.2941	982.7304	1532.8376	1388.7026	2081.0803	1732.6250	1080.8109[a]
SEPARATION	1006.7281	885.0059	901.0625	952.1013	912.6106	765.6429	24.2144[a]
VOP	614.1222	705.5692	874.4756	845.1581	940.9307	876.0362	66.9133[a]
ADCI	895.4118	1050.5324	1487.0103	1617.0302	2034.5344	1864.6042	922.3582[a]
CPCI	900.6881	1077.2428	1494.6881	1633.4914	2008.0719	1805.0486	793.0585[a]
NMCI	994.2647	1147.4577	1452.4240	1608.6918	1979.7146	1599.0486	621.8959[a]

4.3 Summary of Empirical Findings

4.3.1 Findings regarding growth opportunities

The study finds that firms in the US and the UK firms with greater growth opportunities have greater incentives to hedge to reduce the volatility of cash flows and potential predation risk. We found that the optimal hedge ratio is negative when investment opportunities are extremely sensitive to the risk variables. The growth opportunities motivation for hedging substantially differs across different level of credit rating. High-rated firms undertake hedging to limit the possibility that rating fall below certain level which the firm would start giving up valuable projects. On contrary, low-rated firms tend not to hedge when they have greater investment opportunities. It is noticeable that the use of derivative among UK firms are less sensitive to the change of R&D spending than US firms. In addition, the use of interest rate derivatives in the UK does not appear to be significantly affected by the R&D spending of a firm.

4.3.2 Findings regarding agency problem hypothesis

Given that growth and investment policies affects corporate hedging policy and that investment and financing decisions are interdependent, intuitively, the investment distortion by the conflict between the main stakeholders will also affect corporate hedging policy under imperfect market. The study provides additional evidence for the hypotheses based on two forms of agency problems, shareholder-bondholder conflicts and shareholder-manager conflicts. Both of the US and UK firms hedge to reduce the agency costs arising from overinvestment and underinvestment problem. Firms with longer debt maturity are more likely to hedge. The interaction between debt maturity and fixed assets ratio is significantly negative in the UK models, suggesting that the effect of debt maturity on UK firms' hedging policy differs depending on the asset tangibility (collateralisability). Notwithstanding that this interaction effect is not significant for the US firms, the regression with US sample shows a significantly negative estimate for

the interaction of large firm dummy variable and debt maturity. This is consistent with the evidence from the UK. Furthermore, we found that the underinvestment incentive of hedging among firms with high underinvestment costs are stronger and more significant (higher Wald statistics) than the firms with moderate Tobin's Q both in the US and the UK. However, US firms are less sensitive to underinvestment problem than UK firms.

Contrary to the theoretical prediction, empirical results from the UK shows a negative relation of long-term debt and hedging, while there is no such evidence in the US. The plausible explanation is that, under the creditor-friendly environment in the UK, firms with high costs of financial distress may issue less long-term debt. Such exogeneity, in turn, results in a negative sign of long-term debt in the model. Such effect is insignificant in the US because, under the equity-friendly legal framework, US firms face lower bankruptcy costs compared to their UK counterparts. The creditor-friendly environment in the UK offers a typical framework for such an analysis since their firms are expect to have high exogenous financial distress costs.

Firms in the US and the UK hedge to reduce the costs of overinvestment problem of high free cash flows. For firms using resources poorly, likelihood of hedging increases as free cash flows increase. It appears that the currency hedging among US firms is more sensitive than UK firms to the increase of free cash flows when the costs of overinvestment are high. In addition, US firms with higher investment intensity also appear to have stronger propensity of hedging. Overall, evidence with US sample presents stronger motivation of hedging in response to the overinvestment problem, while evidence with UK sample presents stronger motivation in response to underinvestment costs. This is not surprising, given that under the creditor-friendly environment in the UK creditors, especially the secured creditors, have more claims on a firm's assets in the process of bankruptcy, and that the equity-friendly environment in the US induces lower bankruptcy costs. Alternatively, the differences may also reflect the fact of powerful managers of

US firms (e.g. Chhaochharia and Grinstein (2007) shows that most of CEOs of US firms also chair the board).

4.3.3 Findings regarding managerial risk aversion and compensation

Having shown that, with the existence of information asymmetry and market imperfection, firms hedge to reduce agency costs, the study also examines the managerial based motives on hedging policy. A firm's managers decide hedge or not to maximise shareholders interest in a firm, but they also consider their own interest when making risk management decision. Firms use stock-based compensation to align shareholder/manager interests. The study finds that the managerial motive is an important determinant of corporate hedging policy among US and UK firms. And, not surprisingly, multinational hedgers generally pay higher compensation to their managers than domestic non-hedgers. The evidence from US also relates managerial motives for hedging to overinvestment problem. The results suggest that, with high level of free cash flows, managers who received more stock-based compensation have stronger propensity to hedge. This is consistent with the finding of strong overinvestment incentive amongst US firms. By contrast, regression with UK sample does not present similar result, which might reflect a stronger corporate governance mechanism in the UK. Interestingly, however, the results with US sample shows a positive relation between stock-based compensation and hedging, while the results with UK sample shows a negative relation. One plausible reason is that the data is provided by different database and includes different items. Alternatively, it might reflects the different risk preference of managers in the two countries.

4.3.4 Findings regarding costs of financial Distress

The empirical analysis shows a non-monotonic relation between costs of financial distress and the likelihood of corporate hedging. Firms with higher leverage are more likely to engage in hedging. By contrast, more liquid firms and firms with strong ability to pay interest are less likely to hedge. However, when the costs of financial distress are extremely high, the distinction between financial distress and bankruptcy disappears, while the costs of hedging on liquidity may worsen the financial states of a firm. As a result the marginal benefit of hedging diminishes along with ex-post risk management motivations.

It is noticeable that Altman Z-Score is positively related to hedging decision in UK firms, whereas the results are more complicated from the US sample. We found a positive relation between Z-Score and hedging decision, consistent with the results from UK. However, the estimate becomes negative after introducing a low rating dummy variable. The likelihood of hedging among firms rated BBB or above increases as the likelihood of bankruptcy increases. In contrast, the likelihood of hedging among firms below investment grade increases as the likelihood of bankruptcy decreases, because hedging is more costly for firms with high bankruptcy risk. The evidence suggests that, when hedging is costly, the dynamics associated with the costs of hedging alter the optimal hedging policy of a firm. Firms have different hedging policies in response to the same hedging motivation. The effect of credit rating on UK firms' hedging policy is not tested because the credit rating data is available for part of firms. Nevertheless, given the fact that UK firms generally make less use of ratings than its US counterparts (Duff and Einig, 2009), we believe that US offers a better framework for such an analysis than UK.

4.3.5 Findings regarding taxation hypothesis

The empirical analysis with US sample finds additional supporting evidence for taxation hypothesis for hedging. Firms with higher expected tax liability and tax preference items are more likely to engage in hedging. The results suggest that, in general, firms place more emphases on tax benefit from increased debt capacity by hedging than tax function convexity. The results also imply that managers of purely domestic firms and multinational firms have different emphasis when making actual hedging decisions. In addition, managers may emphasise different objects in terms of types of hedging. It appears that firms are more likely to hedge their foreign exchange exposure with the existence of NOL carryforwards, whereas not significantly response to the increasing simulated marginal tax rate. By contrast, the decision of interest rate hedging appears to be very sensitive to the change of marginal tax rate, which is consistent with the notion that firms hedge to increase the debt capacity and the interest deductions. However, the logistic results with UK sample do not support the taxation hypothesis, as evidenced by the insignificant coefficients on the effective tax rate. The results do not support the explanation of increasing tax benefit on debt, either.

4.3.6 Findings regarding hedging substitutes

Considering hedging substitutes, the empirical evidence support the notion that firm alter their dividend payout policy to avoid default on financial obligations. The results from both US and UK suggest that likelihood of hedging is higher for firms with higher dividend yield. By contrast, firms which issue more convertible debts to control agency problem are less likely to engage in hedging. Exception is the domestic model with US sample, which shows negative estimate of dividend yield. We consider this finding as support for liquidity hypothesis rather than contradiction to substitute hypothesis. Purely domestic firms which pays higher dividend are less likely to hedge because, only the highly liquid firms can afford high dividend.

In the light of increase in cash holding in recent years, the study also examines the influence of cash holding on corporate hedging. We found that holding large amount of cash does not necessarily equivalent to adverse impact on hedging. In general, US firms holding more cash are less likely to hedge. In particular, international hedgers hold more cash than domestic non-hedgers. Domestic firms tend to hold more cash rather than to issue convertible debts to avoid the costs of accessing capital markets. However, cash holding is positive to currency hedging. Contrary to the evidence from US, empirical analysis with UK sample rejects the substitute relation between cash and hedging. Hedging is more likely to happen in the firms with higher level of cash.

4.3.7 Findings regarding firm size and industry

The empirical study shows that firm size matters to corporate hedging, consistent with the hypothesis of economies of scale. Though the results from both countries suggest a positive relation between size and hedging, the corporate hedging policy is more sensitive to economies of scale in the US than UK. Prior literature poses an empirical puzzle for the effect of firm size on hedging. While theories of hedging suggest smaller firms should be more likely to hedge because of their higher riskiness, empirical results show that large firms hedge more than small firms. Our finding with that credit rating is positively related with hedging in the US is consistent with the economies of scale and may be able to explain the puzzle. The effect of credit rating on UK firms' hedging policy is not tested because the credit rating data is available for part of firms. Empirical evidence from the two countries also suggests that size matters when it comes to the relation between hedging and debt maturity.

The industry that a firm operates in also affects hedging policy in the two countries. Firms in the regulated industries, which considered to have lower level of information asymmetries, have lower incentives to

undertake hedging. This finding is consistent across countries. It appears that US firms in the construction industry, retailed industry and services industry have lower incentive to hedge. This reflects that such firms are likely to have less of an international presence compares with (say) manufacturing firms and technological firms. In contrast, UK firms in the retailed industry have higher incentive to hedge. The differences suggest that industry-specific characteristics associated with increased foreign exchange rate exposure or incentives for optimal risk reduction on hedging may vary across countries. The possible reason is the systematic differences across countries. That is, the findings from previous empirical studies are likely to be industry-driven or country-driven, which may explain the mixed empirical evidence among previous studies. Therefore, one should carefully consider the country-level differences and industry effects on corporate hedging study.

4.4 Conclusion

In conclusion, Chapter 5 and Chapter 6 present important insights into the influence of firm-specific financial characteristics, industry conditions and macroeconomic environment on corporate hedging decision over time. Evidence from the US and the UK mostly are consistent and strongly support the hypotheses for hedging. Hedging theories hold across countries. There are, however, significant country differences in the way that place emphasis on different hedging incentives and in terms of type of hedging. These differences are mainly driven by the differences on bankruptcy codes, corporate governance, and other institutional differences. Our findings underscore the importance of incorporating industry-specific and country-level factors in cross-country studies. The following two chapters provide detailed discussions of the determinants of hedging by US non-financial firms and UK non-financial firms.

CHAPTER 5

US FIRMS AND THEIR FINANCIAL CHARACTERISTICS

5.1 Introduction

Existing studies on the determinants of corporate hedging suggests that firms choose to hedge in a real world with market imperfections in response to the volatilities and costs from risk arising from financial exposures. This chapter identifies US firm's incentives to hedge using Logistic (logit) regression analysis for the hypotheses presented in Chapter 3. In an earlier chapter, the justifications for considering the corporate hedging problem in the contexts of both the UK and US firms was provided. So this chapter presents additional evidence on the hedging behaviour of US firms with some refined data, such as classifying firms more specifically into hedgers with international operation and with domestic operation only, non-hedgers with international operation and with domestic operation only. This additional analysis for US firms is possible because of the larger data set that is available.

The remainder of this chapter is organised as follows. Section 5.2 presents the logistic results for the determinants of corporate hedging activities and the empirical evidence for the hedging hypotheses. Section 5.3 provides conclusion of the empirical evidence and its implications.

5.2 Multivariate Analysis – Binary Logistic Analysis

5.2.1 Regression Diagnostics

First of all, we consider the diagnostic tests for our estimates since this will enable us to assess the reliability of the results. Panel B of each table shows the diagnostic tests for our logistic regressions. In general, the diagnostic tests indicate that the logistic regressions provide a reasonable good fit to the data. So, the Hosmer and Lemeshow test is insignificant at acceptable level[14]. Also, the Omnibus statistics are significant (p-value ≤ 0.01), suggesting that the coefficients of the logistic regressions besides the intercept are significant.

To assess the performance of the logistic regression models, we also utilise a naïve proportional chance model (see Morrison, 1969 and Joy and Tollefson, 1975). For example, on the basis of the proportional chance criterion, the percentage of correct classification is $\left[\left(\frac{1024}{3852}\right)^2+\left(\frac{2818}{3852}\right)^2\right]=0.606$ and $\left[\left(\frac{1024}{3852}\right)^2+\left(\frac{2828}{3852}\right)^2\right]=0.610$ for Equation (1) and Equation (2) respectively. The maximum chance criterion for the two equations are 0.733 and 0.334 respectively. Given that 83.6 percentage and 83.9 percentage correct classification in Equation (1) and (2), the discriminant functions performed significantly better than both the maximum and proportional chance models at a 1 percentage level. The rest of models also appear to reject the null hypothesis that the logistic regressions do not outperformed a naïve proportional chance model. So overall, these are good diagnostic results.

[14] The *p*-value of Hosmer and Lemeshow test is greater than 0.10 for all models, except Model (9) whose p-value is 0.066.

However, the Studentized residuals and the Standardised residuals are significant using the Kolmogorov-Smirnov statistic. So the residuals are non-normally distributed. Since the analysis uses Maximum Likelihood method with large sample, the parameter estimates are still unbiased. We therefore interpret our logistic regression results in the following sections.

5.2.2 Baseline Model

We start with the model estimated with all sampled US firms regardless if a firm operates internationally or domestically. We later separate the firms into more refined groups. In what follows, our analysis and results apply only to Equation (1) and (2) of our baseline models. The coefficients of this logistic regression model are estimated using Maximum Likelihood method, with the results reported in the first four columns of Table 5-1. This is similar in approach to our UK analysis. The first two columns provides the results for Equation (1) which omits nonlinear and interaction effects. The third and fourth columns report the results for Equation (2), which includes curvilinear and interaction effects. The number of observations in Equation (1) and (2) is different as cases are dropped due to missing values.

The coefficient for *LogTA* is significant (*p*-value $\leq$0.01) and positive and has the highest Wald statistic in both Equation (1) and (2), indicating that the economies of scale is the most important determinant of hedging for our sample firms. Since large firms have the advantage in being able to afford the cost of risk management programmes, they are more like to undertake corporate hedging. The coefficient for *ROA* is statistically significant in both regressions at least at the 5% level. The positive coefficient implies that derivative use is positively related with the efficiency of using a firm's assets to generate earnings – meaning that hedging minimises that variable of *ROA* and in turn enhances firm profitability.

Table 5-1 Logistic regression results for Baseline Model

	Equation (1)		Equation (2)		Equation (3)		Equation (4)	
Variables	Coefficient	ME	Coefficient	ME	Coefficient	ME	Coefficient	ME
Constant	-7.5218 [a]		-8.6427[a]		-9.5950 [a]		-8.5616[a]	
	(0.4797)		(0.7322)		(0.7546)		(0.7976)	
LogTA	2.3413 [a]	0.3405	2.7714[a]	0.3890	2.8060 [a]	0.3546	3.1072[a]	0.3290
	(0.1099)		(0.1803)		(0.1820)		(0.2073)	
ROA	2.1060 [a]	0.3063	1.2885[c]	0.1809	1.3730 [c]	0.2034	1.7921[b]	0.1898
	(0.6925)		(0.6984)		(0.7145)		(0.7445)	
RDMV	2.1714	0.3158					5.1414[c]	0.6044
	(1.3360)						(2.7612)	
DEBTMATU	0.1149[a]	0.0167	0.1633[a]	0.0229	0.3195[b]	0.0812	0.1396 [a]	0.0426
	(0.0413)		(0.0456)		(0.1482)		(0.0487)	
LargeFirm			0.6853	0.0966	-0.7342	-0.0097	1.5740[b]	-0.0057
			(0.4782)		(0.4830)		(0.6953)	
LargeFirm×DEBTMATU			-0.2865[a]	-0.0402	-0.2909[a]	-0.0225	-0.4856[a]	-0.0571
			(0.1018)		(0.1030)		(0.1477)	
FATA	-2.1292 [a]	-0.3097	-2.3484 [a]	-0.3296	-2.5580 [a]	-0.3518	-3.0928 [a]	-0.3699
	(0.2705)		(0.2932)		(0.2967)		(0.3672)	
CURR	-0.3902 [a]	-0.0567	-0.3719 [a]	-0.0522	-0.3534 [a]	-0.0460	-0.4018 [a]	-0.0417
	(0.0562)		(0.0615)		(0.0620)		(0.0658)	
FCF	1.8281 [b]	0.2659	0.6457	0.0906	0.6294	0.0829	-0.1633	-0.0024
	(0.8217)		(0.9137)		(0.9128)		(1.0159)	
LEVTA	2.8089 [a]	0.4085						
	(0.3777)							
STKComp	0.0315 [a]	0.0046	0.0277[c]	0.0039	0.0273 [c]	0.0032	0.0295[b]	0.0023
	(0.0104)		(0.0142)		(0.0144)		(0.0150)	
STKComp × FCF			0.3239 [b]	0.0456	0.3299[b]	0.0466	0.3499 [b]	0.0474
			(0.1564)		(0.1483)		(0.1593)	
CAPEXPPP	2.4550 [a]	0.3571	2.2372 [a]	0.3140	2.4311 [a]	0.3308	2.8780 [a]	0.3043
	(0.7753)		(0.8224)		(0.8305)		(0.9560)	
ITC	-0.0029 [c]	-0.0004	-0.0044 [a]	-0.0006	-0.0055 [a]	-0.0007	-0.0070 [a]	-0.0008
	(0.0017)		(0.0017)		(0.0017)		(0.0017)	
MTR	1.9590 [a]	0.2849	1.5458 [b]	0.2170	1.5004 [b]	0.2064		
	(0.6147)		(0.6299)		(0.6355)			
NOL	0.2087 [b]	0.0300	0.1839 [c]	0.0256	0.1530	0.0227		
	(0.0989)		(0.1012)		(0.1024)			
Z-Score	0.0413 [a]	0.0060	-0.2007 [a]	-0.0282	-0.1889 [a]	0.0253	-0.1968 [a]	-0.0262
	(0.0152)		(0.0576)		(0.0580)		(0.0664)	
LR			-0.0600	-0.0084	-0.1026	-0.0163	1.1398	-0.0007
			(0.2201))		(0.2228)		(0.2564)	
LR × Z-Score			0.2621 [a]	0.0368	0.2506[a]	0.0331	0.2666 [a]	0.0332
			(0.0570)		(0.0575)		(0.0659)	
LEV × HIQ			4.9855 [a]	0.6998	5.1125[a]	0.6588	3.8846 [a]	0.5088
			(0.7362)		(0.7390)		(0.7004)	
LEV × MIQ			3.4185 [a]	0.4798	3.8008[a]	0.4872	2.3241 [a]	0.3057
			(0.5942)		(0.5902)		(0.5459)	
LEV × LOQ			2.9885 [a]	0.4195	3.2855[a]	0.4101	2.1656 [a]	0.2799
			(0.5832)		(0.5860)		(0.5204)	
TOBINQ			0.3743 [b]	0.0465	0.3195[b]	0.0486	0.3857 [b]	0.0526
			(0.1495)		(0.1482)		(0.1689)	
LR × TOBINQ			-0.5520 [a]	-0.0249	-0.5066[a]	-0.0245	-0.6509 [a]	-0.0241
			(0.1569)		(0.1559)		(0.1774)	
INCOV	-0.0074 [a]	-0.0011	-0.0045 [c]	-0.0006	-0.0048 [c]	-0.0006	-0.0058 [b]	-0.0007
	(0.0023)		(0.0025)		(0.0025)		(0.0027)	
CASH			1.0567	0.1483	0.3633	-0.0194	-0.2500	0.0294
			(0.8041)		(0.8157)		(0.7890)	
HI_LEV			-0.0620	-0.0087				
			(0.1850))					
CASH × HILEV			-2.5403 [b]	-0.3566	-3.1263	-0.4062		
			(1.2324)		(1.2503)			
CASH × RDMV							-22.4660[c]	-2.6408
							(12.4283)	
DY							0.0875[c]	0.0041
							(0.0508)	
CONVERDEBT	-0.7697 [a]	-0.1120	-0.7554 [a]	-0.1060	-0.8894 [a]	-0.1161	-0.8381 [a]	-0.1025
	(0.2190)		(0.2244)		(0.2273)		(0.2412)	
Year2002	0.6157 [a]	0.0759	0.6356 [a]	0.0749	0.6573 [a]	0.0731	0.7485 [a]	0.0748
	(0.1726)		(0.1784)		(0.1804)		(0.2052)	
Year2003	0.5652 [a]	0.0707	0.5884 [a]	0.0703	0.6183 [a]	0.0704	0.5840 [a]	0.0621
	(0.1656)		(0.1694)		(0.1713)		(0.1911)	
Year2007							-0.3042[c]	-0.0390
							(0.1774)	
FCRISIS	0.2495 [b]	0.0346	0.2636 [b]	0.0351	0.2549 [b]	0.0343		
	(0.1251)		(0.1276)		(0.1288)			
CONSTD	-1.1371	-0.2226	-1.2267 [a]	-0.2387	-1.2159[a]	-0.2125	-1.2325 [a]	-0.2075
	(0.3184)		(0.3210)		(0.3206)		(0.3308)	
TRANSD	-1.8917 [a]	-0.3767	-1.9358 [a]	-0.3790	-1.7107 [a]	-0.3403	-2.0184 [a]	-0.4082
	(0.1682)		(0.1731)		(0.1763)		(0.2043)	
RETAILD	-1.2759 [a]	-0.2395	-1.2787 [a]	-0.2342	-0.9983 [a]	-0.1654	-0.6688 [a]	-0.0962
	(0.1399)		(0.1403)		(0.1468)		(0.1718)	
SEVD	-1.3273 [a]	-0.2550	-1.3330 [a]	-0.2503	-1.1534 [a]	-0.2096	-1.0289 [a]	-0.1780
	(0.1510)		(0.1563)		(0.1604)		(0.1792)	
INTL DUMMY		0.1784			1.0288[a]	0.1784		
					(1.1483)			

(Continued)

Panel B Summary Statistics (Continued)				
Number of Observation	3852	3852	3852	3409
Omnibus model test	1560.289	1627.646[a]	1675.707	1610.319[a]
-2 Log likelihood	2894.700	2833.532	2785.472	2255.752
Cox &Snell R	0.334	0.345	0.353	0.376
Nagelkerke R	0.486	0.502	0.514	0.555
Hosmer &Lemeshow test	6.198	12.310	16.158[a]	6.428
Percentage correctly classified	83.6[a]	83.6[a]	84.0[a]	85.9[a]
K-S test on studentized residuals	0.224 [a]	0.210[a]	0.215 [a]	0.210[a]
K-S test on standardized residuals	0.285 [a]	0.275[a]	0.231 [a]	0.320[a]

[a] ,[b] and [c] denote statistical significance at a 1-, 5- and 10-percent level, respectively.

The regressions provide strong support for the agency problem related hypotheses, including underinvestment hypothesis and overinvestment hypothesis. In the classic Jensen and Meckling's (1976) stockholder-bondholder conflict, the conflicts of interest between bondholders and shareholders cause higher costs for financing and investments. Hedging internal cash flows can improve corporate capital structure of a firm by reducing the costs of external financing, which in turn harmonises financing and investment policies (see Froot et al., 1993). This also means that hedgers are less likely to underinvest and positive NPV projects will be undertaken are the returns for such investments will go to investors rather than lenders. Similarly, hedgers are less likely to engage in non-profitable projects. Consistent with the underinvestment hypothesis, the results show that the coefficients for RDMV which proxies for growth opportunity and the leverage ratio (*LEVTA*) are positive and statistically significant (see Equation (1)). The marginal effect is an increase in the probability of hedgers of 31.6% and 40.9% respectively. This suggests that use of hedgers are more likely to be firms with higher R&D spending and higher level of debt. Corporate hedging will reduce the riskiness and variability of the associated internal cash flows and in turn reduce underinvestment costs. The weighted average of the length of debts held by a firm, *DEBTMATU*, is highly significant in both models and is positively correlated with hedging. The findings are in line with Leland (1998) and suggest that firms with longer debt maturities should have stronger incentive to hedge, since they are more likely to face serious stockholder-bondholder conflict.

Bartram et al. (2009) find a negative relation between debt maturity and hedging. This result is in contrast to our positive coefficient for *DEBTMATU*. Prior work also reports a positive relation between debt maturity and firm size. Barclay and Smith (1995) find that firm size and bond rating are positively correlated with debt maturity. Similarly, Stohs and Mauer (1996) find that firm size is positively correlated with debt maturity. Therefore, our positive coefficient for *DEBTMATU* may simply be because the large firm in our sample, generally have longer-term asset maturity, but has nothing to do with the agency cost incentive for hedging. We explore this argument by using a dummy variable to take on a value of one for total assets above the median, *LargeFirm*, zero, otherwise. Surprisingly, the coefficient

for *LargeFirm* is not significant. Using the *LargeFirm*, we construct an interaction term for *DEBTMATU* which relates to size (*LargeFirm* ×*DEBTMATU*). We find that the estimated coefficients for *LargeFirm* ×*DEBTMATU* are all significant and negative in line with Bartram et al. (2009) who to not interact for size. So size matters when it comes to the relation between hedging and debt maturity. Small firms with longer debt maturity are more likely to engage hedging. By contrast, the increase in the length of debt maturity in large firms actually decreases the probability of hedging. The marginal effect is 4.0%. This finding could be consistent with the notion that large firms generally have higher credit rating and pay lower rate of interest. Large firms which hold more long-term fixed rate borrowings are less exposed to change of cash flows from changes in market price. Such firms are less likely to hedge as they have lower external financing costs and are less likely to suffer in underinvestment problem.

Conditioned on the firms that have high-growth opportunities, the coefficient for the interaction term for *LEV* × *HIQ* is positive and significant in the Equation (2). This indicates a tendency for firms to hedge in order to reduce costs of underinvestment when the leverage ratio increases. The result is in line with Gay and Nam (1998) and Géczy et al. (1997) argument that under investment problem might be a serious problem for levered firms with significant growth options. Interestingly, the interaction has the highest marginal effect in the model. For the firms whose Tobin's Q falls into the top one-third of the sample, a one percent increase on the total leverage over total assets of a firm yields an significant increase of 70.0 percent in the probability that a firm uses hedging instruments.

Yet, even if shareholder-bondholder conflict are alleviate, managers may invest in negative NPV projects to maximise managers' personal utility rather than maximise the value of firm. Prior literature that explore agency cost incentives for hedging occasionally tests underinvestment with little regard for overinvestment problem. Our results provide support for the overinvestment hypothesis in relation to hedging. The coefficient for *CAPEXPPP* is highly significant and positive in both regressions, suggesting that firms having higher investment intensity tend to undertake more hedging. The marginal effect is an

increase in the probability of hedging of 35.7 percent and 31.4 percent in Equation (1) and Equation (2) respectively. The positive coefficient of *FCF* shows that high free cash flows contribute to the incentive to hedge. A one percent increase in the free cash flows yields a statistically significant increase of 26.6 percent in the probability that a firm uses hedging instruments. The results consistently provide primarily supporting evidence for the hypothesis that firm will hedge if it is holding substantial free cash flows and want to reduce the cost of overinvestment. This variable becomes insignificant in Equation (2) following the inclusion of interaction term.

Given the importance that prior work attribute to leverage in a hedging domain (Joseph and Hewins, 1997; Smith and Stultz, 1985), we interact leverage with different levels of Tobin Q High (*HIQ*), Medium (*MIQ*) and Low (*LOQ*). The coefficients for leverage and overinvestment indicator, *LEV* × *LOQ*, are positive and significant in all cases. For the firms which are very like to face overinvestment problem, that is, a low Tobin's Q, the probability of hedging increases with the rise of total level of leverage. This is consistent with Jensen's argument (1986) that firms using leverage to control overinvestment problem. Simultaneously higher level of debt increases the costs of underinvestment and financial distress, which provides motives of hedging. Notice that the marginal effect 42.0 percent of *LEV* × *LOQ* is smaller than the effect of *LEV* × *HIQ*. That is, the increase of leverage has stronger effect on hedging for underinvestment problem than for overinvestment problem. The plausible explanation is that underinvestment problem is caused by costly external financing, whereas overinvestment problem arises from excess free cash flows and therefore firms are less concerned about leverage. Firms determine their leverage ratio and hedging policy by weighting these costs and benefits against each other.

The few prior studies that examine the underinvestment hypothesis do so simply from the leverage level perspective. However, according to the underinvestment hypothesis in the Froot et al. (1993) framework, firms will hedge in response to the potential underinvestment cost on the assumption that, hedging has no significant impact on the expected level of internal wealth of the firm. The optimal hedge ratio can be

negative when investment opportunities are extremely sensitive to the risk variables. More realistically, since the supply-side barriers leads to higher costs of using derivative financial instruments (e.g. diseconomies and transaction costs of derivatives contract[15]), it is impossible for low-rated firms to take large positions in derivative because of the lower credit risks involved. In that case it may make sense for a firm to actually keep its exposure unhedged, so as to have sufficient cash flows when large positive NPV investments are required (Froot et al., 1993)[16]. To substantiate this inference, we interact *TOBINQ* with low rating dummy variable (*LR*) to examine whether the effect of investment incentive on hedging substantially differs across credit ratings. The regression results show that the probability of using hedging instruments increase with the Tobin's Q for high-rated firms. It is consistent with the argument that firms engage hedging to limit the possibility that rating fall below certain level which the firm would start giving up valuable projects (Nocco and Stulz, 2006). On contrary, Low-rated firms are less likely to hedge, nor does Q increase, implying that firms whose credit ratings are lower than BBB tend not to hedge when they have greater investment opportunities. The plausible explanation considered is that firms rated below BBB are not at investment grade and regarded as having significant speculative characteristics (Standard & Poor's, 2012), and therefore it is difficult and expensive for such firms to engage in financial hedging contracts. It is consistent with the notion that the investment motivation for hedging substantially differs across different level of credit rating. Bearing in mind that in practice firms make risk management decision and other financial decisions simultaneously, the negative sign of the *LR* × *TOBINQ* interaction term may also due to the debt maturity structure for borrowers with lower rating. Low-rated borrowers prefer long-term debt to reduce liquidity risk of short-term debt (Diamond, 1991) while it also introducing agency cost at the same time, therefore they hedge to increase debt capacity and to reduce the ex-post costs of liquidity risk and financial distress.

[15] Emerson Electric Co. states in its 2011 10-K statement that their derivatives counterparties can require immediate full collateral, if the debt credit ratings fall below pre-established levels. CenterPoint Energy Inc. has similar statement in its 2011 10-K form that, the firm might be required to post cash collateral under its hedging arrangements if credit rating were downgrade.

[16] Specifically, in this study it is the level of positive Tobin's Q the indicator of whether a firm have large positive NPV investment opportunities.

The results also provide strong evidence for financial distress hypothesis. The coefficient for *CURR* is negative and significant implying a negative association between liquidity and hedging. This is also consistent with theoretical prediction (Smith and Stulz, 1985; Froot et al., 1993) and the results from prior empirical studies (e.g. Nance et al., 1993; Bartram et al., 2009)). The marginal effect is a decrease in the probability of hedging of 5.7% and 5.2% respectively. The stronger ability to pay short-term obligations, the lower the need to hedge to reduce the expected financial distress. Equation (1) and (2) show that firms hedge not only in response to the potential costs of financial distress, but also to increase their debt capacity. The coefficients for *INCOV* are consistently negative and significant in both logit regressions, indicating that high level of leverage or relatively low ability to pay off its interest expense contributes to the incentive to hedge.

Altman's Z-score is significant at 1% with a surprisingly positive sign in Equation (1), which is contrary to theoretical prediction. However, the coefficient is negative and significant in Equation (2), consistent with financial distress hypothesis for hedging. The plausible reason for the change of coefficient sign is the inclusion of low credit rating dummy variable and its interaction term with Z-score in the second regression. For firms with BBB credit rating or higher, Altman's Z-score is negatively associated with corporate hedging activities. The higher the distress cost is, the more likely a firm engages hedging. And, more interesting, the coefficient derived from the interaction term *LR* × *Z-score*. This term has positive and statistically significant coefficient of 0.2621 (p-value$\leq$0.01) with a marginal effect of 3.7 percent, suggesting a positive relation between Altman's Z-score and hedging for firms with low ratings. These results have three interesting implications. First, when the credit rating below investment grade, firms that have better financial state are more likely to use hedging instruments. The possible reason is that such firms are highly sensitive to the ongoing uncertainties or the exposure to adverse business, financial, or economic conditions. Since credit rating is commonly used appraisal schemes in the financial market (Campbell and Kracaw, 1980; Hseuh and Kidwell, 1988; Baker and Mansi, 2002) and a low rating indicates low credit quality and poor-quality information available, low credit rating also brings unfavourable signal to market. Therefore firms have motivations to utilise hedging as a positive signal to

the market that the firm is hedging its ongoing uncertainties or exposure to adverse business and financial conditions and improving its financial state. Second, high distress costs reduces the tendency of hedging in low-rated firms, as the distinction between financial distress and bankruptcy diminishes along with any ex-post hedging motivations. This is consistent with Purnanandam's (2008) predictions of a U-shaped relation between financial distress costs and hedging and a negative relation between costs of financial distress and hedging for highly leveraged firms. Third, low-rated firms with high risk of financial distress are less likely to hedge due to the supply-side barriers of hedging. This evidence is consistent with prior research findings that supply-side barriers limit access to hedging (Bodnar et al., 1998; Guntay et al., 2004). Furthermore, the finding that credit rating influences hedging may explain why theories of hedging suggest smaller firms should be more likely to hedge because of their higher riskiness, whereas, empirical results show that large firms hedge more than small firms (see Bodnar et al., 2009; Dionne and Triki, 2013). More importantly, going back to the essence of hedging theory, the evidence empirically supports Stulz (1984) and Smith and Stulz (1985) arguments in terms of the cost of financial distress and bankruptcy implications. When hedging is costly, hedging can still be beneficial but the total holdings of hedging instruments may decrease. The costs of hedging and market price dynamics alters the optimal hedging policies of those firms. Prior studies examining hedging motives rarely take the supply-side factors and the costs of hedging into account. The evidence from this study suggests that, when hedging is much more costly for some firms than others, firms have different hedging policies in response to the same hedging motive.

Another interesting finding is from the significant empirical results for taxation hypothesis. The coefficient for marginal tax rate (*MTR*) is positive and statistically significant, which is consistent with theoretical prediction (Smith and Stultz, 1985) and the findings from Graham and Rogers (2002). Our result suggests that higher expected tax liability motivates firms to hedge. The marginal effect is an increase of 28.5 percent in Equation (1) and 21.7 percent in Equation (2). The *ITC* is statistically significant predictor in both regressions as expected, but it is negatively associated with hedging. Consistent with Smith and Stulz (1985) argument about tax convexity incentive to hedge, Equation (2)

finds that the tax convexity proxy *NOL*, a zero/one dummy variable where one representing the existent of net operating loss carry forwards and zero otherwise, is significantly positive. Notice that *MTR* has higher Wald statistic than *NOL*, implying that the tax convexity incentive from NOL carryforards is behind the effect from overall tax liabilities. This result is also consistent with Graham and Rogers (2002)'s findings that firms place more emphases on tax benefit from increased debt capacity by hedging, rather than hedge in response to tax function convexity. The relatively small Wald statistic of *NOL* may be able to explain why many empirical studies have insignificant NOL carryforward variable. Our evidence implies that firms do hedge in response to tax function convexity, but due to the complexity and variety of tax code in practice, it is not as important as debt capacity side factor.

We examine the impact of hedging substitutes on corporate hedging decisions by testing firms' dividend yields and convertible debts over total leverage (*CONVERDEBT*). Consistent with prediction the Equation (1) finds that dividend yield id positively associated with hedging, whereas the convertible debt ratio have negative impact on hedging. The results are also in line with Nance et al. (1993) argument. Another noticeable result is the cash holding and high leverage ratio dummy variable interaction effect on hedging. Haushalter et al. (2007) suggest that a firm may either hold large amount of cash instead or use derivatives to protect its growth opportunities and investments. However, the relationship between cash holding and hedging can be confounded by endogeneity. As pointed out by Opler et al. (1999), most of the variables that are empirically associated with high levels of cash holding are also the variables associated with low debt. Our prior results show lower probability of hedging when the leverage level is lower. Thus the negative estimation of cash is not sufficient to prove a substitute relationship between cash and hedging. We test the relation between hedging and the cash holding, amongst those firms with higher leverage level and therefore higher hedging needs. The coefficient of the *HI_LEV×CASH* is significantly negative with the marginal effect of a decrease of 35.7 percent in the probability of hedging. The result provides additional evidence for Froot et al. (1993) and Gay and Nam (1998) underinvestment hypothesis for hedging. When the costs of external financing is high, investment funds are highly sensitive to internal cash flows. For such firms, high level of cash reserve will reduce the motivation for hedging

driven by the need to cope with adverse impact of financial price on investment. The result is also consistent with Acharya et al. (2007) argument that cash holding could be an alternative of derivatives if they provides with similar benefits. This may occur, for example, firms borrow a lot from the foreign markets where financial hedging is not available or too expensive, so that they utilise hedging substitutes to reduce the adverse impacts from unhedged risks.

The estimated parameter for *STKComp* is always significantly positive, suggest that the probability of hedging is positively related to the after-tax stock compensation scaled by the total number of employee in the firms (*STKComp*). Managers hedge to reduce the volatility of their compensation packages, which is consistent with Rogers (2002) and Knopf et al. (2002). The interaction term of STKComp and free cash flows ratio *STKComp×FCF* exams the interaction effect of stock compensation and overinvestment problem on hedging. The coefficient is coefficient significant and positive, which is consistent with prior prediction. This is interesting because it provides additional empirical evidence for Stulz (1984) and Smith and Stulz (1985) argument of managerial compensation theory for hedging, , which suggests that if the payoff is a function of the value of the firm, then hedging can benefit both risk-averse managers and the firm. Prior empirical studies (such as Tufano, 1996; Rogers, 2002) which find supporting evidence for managerial incentive hypothesis for hedging do not take into account the agency problem. Yet stock-based compensation schemes should align managers with shareholders' interests and managers should have lower incentives to overinvest. Our evidence is consistent with the theoretical prediction of positive relation between free cash flows and stock-based compensation. Since the manager-shareholders conflict are severer with the increase of free cash flows, the result suggests that, the motivation for hedging increases as the costs of overinvestment problem increases especially when managers receive more stock-based compensation. The marginal effect is an increase of 4.6 percent on the probability of hedging.

To examine the industry effect, this regression also includes industry indicators based on two-digit SIC code. The results show that four industry indicators, *CONSTD*, *TRANSD*, *RETAILD*, and *SEVD* are

significantly (*p*-value $\leq$0.01) negatively associated with derivative usage. Firms in construction industry (i.e., SIC codes 1500-1799), transportation, communications, electric, gas and sanitary services industry (i.e., SIC codes 4000-4999), retail trade industry (i.e., SIC codes 5200-5999), and services industry (i.e., SIC codes 70-89) are less likely to hedge. The corresponding marginal effects are various degree of decrease ranging from 22.3 percent to 37.9 percent on the probability of hedging. The results also indicate significant difference among industries on corporate hedging policy. These results are partly consistent with Mian (1996) and Bertram et al.'s (2008) findings that there are much more non-hedgers than hedgers in the construction industry, transportation industry and services industry. This result reflects that such firms are likely to have less of an international presence compares with (say) technological firms. However, the results are contrary to prior empirical evidence that firms hedge more in the retail trade industry and utility industry.

Both of the regressions include year dummies to capture potential macroeconomy impacts on for hedgers and non-hedgers and to gain more insights into the corporate hedging behaviour over time. The dummy variable of *Year2002*, *Year2003* and *FCRISIS* are always positive as predicted and statistically significant (*p*-value < 0.10), indicating that corporate hedging decisions were impact during those years and the financial crisis. The probability of hedging in the US firms generally increase about 7.0 percent in 2002 and 2003 and increase about 3.5 percent during 2008-2009 financial crisis years (based on the marginal effects in Equation (2). This suggests that firms are more likely to hedge their risk of exposure during the period of financial market downturn in response to tightened credit and the increase of cost of external financing. It is noticeable that the marginal effect of *FCRISIS* is much lower than the other two year dummies and is almost the lowest among all predictors in the model.

5.2.3 International Model

The baseline model provides an overall view for the determinants of corporate hedging policies amongst all sampled firms. However, it does not distinguish between multinationals and local firms that operate entirely domestically within hedger/non-hedger group. In fact, multinationals may hedge differently with purely domestic firms since purely domestic firms may not have measurable foreign exchange rate exposure. Whereas hedging theory is about firms that consciously choose not to hedge despite having risk exposures and those that hedge. Not allowing for this distinction may cause distortions in the results.

To better understand corporate hedging decision we re-estimate our logistic regressions using a dummy variable of 1 for international firms with risk exposures and 0, otherwise (*INTLDUMMY*). If the foreign involvement of a firm does not influence its hedging decision, the predictor should not be significant in the model. Therefore, we test the null hypothesis that there is no difference on the international involvement of hedgers and non-hedgers.

Table 5-1 fifth and sixth columns present the regression results of the Equation (3), which includes *INTL DUMMY* as an explanatory variable. The Hosmer and Lemeshow test is not significant at 1% level, indicating that Equation (3)'s estimates fit the data at an acceptable level. The results reject the null hypothesis stated above. The estimated coefficient of international indicator, *INTLDUMMY*, is positive and statistically significant at 1% level, with a high Wald statistic. It indicates that international indicator is an important factor in determining hedging. Firms with foreign involvement are more likely to engage derivatives to hedge their risk exposures than firms without foreign involvement.

To better characterise the story, Equation (4) examines US firms hedging policy in more detailed groups. Specifically, by excluding purely domestic firms, the model examines the determinants of hedging in the group of firms with foreign involvement. So the dependent variable of Equation (4) is the dummy variable

of hedging or not and the selection variable is international dummy. Table 5-1 seventh and eighth column present the regression results of Equation (4) on the condition that -2 log likelihood are maximised.

Most of the results from this model are consistent with those of the baseline model (in section 5.2.2.) The results confirm the role of growth opportunities motive in hedging, and suggests that the holding more cash reduces the motivation of financial hedging. Table 5-1 shows that *RDMV* and *TOBINQ* are significantly positive, indicating that firms with greater growth opportunities are more likely to engage hedging. R&D spending presents strong influence on US firms' hedging policy. The marginal effect of R&D on hedging is the strongest in the model, with an increase of 60.4 percent on the probability of hedging. By contrast, the marginal effect of TOBINQ is much smaller, with just about 4.5 percent increase on the likelihood. Dividend yield (*DY*) is significant (p-value <0.1) and positive (0.088) in this model. Considering hedging substitutes, the likelihood of hedging is higher for firms with higher dividend yield, if they want to maintain both dividends and investment[17]. A one percent increase in the dividend yield of the firm yields an increase of one percent in the probability that a firm uses hedging instruments. The possible reason that dividend yield becomes statistically significant in this model is that firms operating internationally generally experience higher variability in their cash flows and therefore exhibit significant desire to hedge. Consistent with the positive sign of *DY*, *CASH* × *RDMV* is statistically significant in this model and is negatively associated with hedging. It is consistent with the precautionary motive for holding cash and suggests that firms choose either to hedge or hold more cash to better protect their growth opportunities. This finding are also in line with the second hypothesis of Gay and Nam (1998) that firms with high investment opportunities and high level of cash holding will leads to less use of financial hedging than similar firms with low cash holding. Notice that the interaction of *CASH* and high leverage dummy variable is not statistically significant in this model. The cash-to-assets ratio does not significantly affect hedging policy for the firms with high debt-to-assets ratio. It rejects that hypothesis that high-

[17] Prior literature such as predicts dividend yield to be a substitute for hedging in two ways. Firms may alter their dividend payout policy to avoid default on financial obligations. Other literature (e.g. Aretz and Bartram 2010; Dionne and Triki, 2013) points out a negative relation between dividend and hedging, because firms paying out dividends are highly liquid firms and have few incentives to hedge. Our regression results support the first prediction. In an unreported regression, the interaction term of dividend yield and interest coverage ratio is significantly negative.

levered firms hold cash as a substitute for hedging to protect themselves against adverse cash flows shocks. The interaction term *LR* × *TOBINQ* remains significantly negative, suggesting that low-rated firms tend not to hedge when they have greater investment opportunities. The investment incentive for hedging substantially differs across different levels of credit rating. The investment tax credit (*ITC*) is always significant but surprisingly negative, notwithstanding the small coefficient and marginal effect. The possibility consider is that large number of "zero" value in the investment tax credit variable.

The regression provides further evidence that firms hedge in response to potential costs of financial distress. *CURR* remains negative and significant to hedging at the 1 percentage level. The main effect of Z-score is significantly negative and its interaction term with low credit rating dummy variable is significantly positive. These results imply that our explanation on the costs of financial distress incentive for hedging is robust under international context. Low-rated firms hedge to protect its competition position in product market and to take advantage of signalling benefits of hedging.

The results for underinvestment hypothesis are also consistent with prior findings. *DEBTMATU* and *LEV* × *HIQ* remains statistically significant and positive as it is in the baseline model. The marginal effect of DEBTMATU increase from 2.3 percent to 4.3 percent, but the marginal effect of the interaction term weakens from 70.0 percent to 1.7 percent and 51 percent respectively. Comparing with the results from the baseline models, regression of the international model also provide additional evidence for the overinvestment hypothesis. The coefficients for *FCF* and *CAPEXPPP* are significantly positive, and the interaction term *LEV* ×*LOQ* are positive and significant. The estimated coefficientfor *FCF*×*HI_CAPEXPPP* is positive and significant, indicating that the overinvestment incentive to hedge is significant and positive for those firms with higher costs of overinvestment. In addition, such motivation is stronger when free cash flows increases in the firms whose investment intensity is higher than the sample median. The marginal effect is an increase of percent on the probability

US firms are found to be less likely to hedge in 2007 – the start of the 2008 financial crisis. This is surprising, given the fact that interest rate spread widened after mid-2007 (Angelini et al., 2011), and the finding that the propensity of hedging becomes stronger with tightened credit and the increase of cost of external financing. The possibility considered is that firms speculate on the interest rate movements (see Faulkender, 2005). Notice that the marginal effect of the dummy variable is just 3.9 percent, and its Wald statistic is also relatively small. This indicating that this year dummy is a less important predictor amongst others. *FCRISIS*, which is significant in the baseline model, is not significant in the Equation (4). This is consistent with the notion that international firms are large enough to engage operational hedging and natural hedge in their risk management programmes to bear the tightened credit. The evidence suggests that international firms have greater propensity of undertaking hedging because they have significant exposures, but their hedging policy is less likely to be affected by the economic downturn.

5.2.4 International Hedgers v.s. Domestic Non-hedgers

The euqations in previous sections present a comprehensive view of the determinants of hedging amongst U.S. non-financial firms. Equation (1) and Equation (2) includes both international and domestic firms. Equation (4) distinguishes between firms with international operation and those that do not to provide more robust insights on the corporate hedging behaviour. This section intends to examine the hedging decisions between international hedgers and domestic non-hedgers. The dependent dummy variable is coded as 1 for multinational hedgers with risk exposures and 0 for domestic non-hedgers. Theoretically, purely domestic firms may choose not to hedge because they are much less exposed. International firms are significantly exposed to variety of risk. Tus international firms chose to hedge and seek to mitigate exposures to an acceptable lesser extent to which similar with the level of exposure the domestic non-hedgers undertake. Therefore we should expect the model shows insignificant results for most of

predictors. Table 5-2 presents the estimated regression results of the third logistic model using the method of maximum -2 log likelihood.

The LogTA is reasonably statistically significant at 5% level, since firms operating internationally generally larger than purely domestic firms. It is not surprising to find that *STKComp* is significantly positive, since multinational firms generally pay higher compensation to their managers. The coefficient for the operating loss carryforwards (*NOL*) dummy variable has a significantly positive coefficient, while the marginal tax rate (*MTR*) is statistically insignificant. It is noticeable that the coefficient for *ITC* which is negative in our previous models is positive in this model and is statistically significant. The positive coefficients for *NOL* and *ITC* are consistent with the prediction and suggest that the multinational firms have greater tax-based incentive to hedge. The change on the sign of *ITC* coefficient may due to the significant reduction on the zero-value cases, corroborating our prior inference on the negative *ITC* coefficient. The fact that tax preference items are significant in the model while the simulated marginal tax rate is not may suggest market imperfection and difference between tax return data and financial statement data (see Graham and Mills, 2008). The tax preference items incurred from foreign operations cannot reduce US tax liabilities. Firms operating internationally and firms operating domestically face different tax functions, and such differences cannot be eliminated through financial hedging. The results also imply that managers of purely domestic firms and multinational firms have different emphasis when making actual hedging decisions.

Table 5-2 Logistic regression results

	Equation (5)		Equation (6)		Equation (7)		Equation (8)	
Variables	Coefficient	ME	Coefficient	ME	Coefficient	ME	Coefficient	ME
Constant	-1.5985		-1.5879		-3.5924[a]		-4.0439[a]	
	(0.8469)		(0.9727)		(1.0232)		(1.0756)	
LogTA	-0.6907[c]	-0.0035	0.8798[a]	0.0034				
	(0.3969)		(0.2273)					
LogMV	1.4616[a]	0.0073						
	(0.3387)							
DEBTMATU					0.3343[b]	0.0671	0.3988[b]	0.0773
					(0.1442)		(0.1630)	
FCF	8.2507[a]	0.0413	7.9902[a]	0.0310				
	(1.6723)		(1.6529)					
DY					-0.1830[b]	-0.0368	-0.2106[a]	-0.0408
					(0.0774)		(0.0813)	
STKComp	0.8231[c]	0.0041	0.8142[a]	0.0032	0.8787[a]	0.1765	0.9800[a]	0.1900
	(0.2346)		(0.2312)		(0.2754)		(0.2872)	
CAPEXPPP	4.1983[a]	0.0210	4.4169[a]	0.0171			3.3930[c]	0.6578
	(1.4433)		(1.4127)				(1.8108)	
ITC	0.0148[b]	-0.0001	-0.0147[b]	-0.0001	0.0186[a]	0.0037	0.0219[a]	0.0043
	(0.0068)		(0.0067)		(0.0070)		(0.0073)	
MTR					3.6511[b]	0.7333	2.9810[c]	0.5779
					(1.7066)		(1.7434)	
NOL	0.6966[a]	0.0034	0.6429[a]	0.0024				
	(0.2140)		(0.2103)					
Z-SCORE	-0.0828[b]	-0.0004	-0.2095[a]	-0.0008			0.1353[c]	0.0262
	(0.0371)		(0.0666)				(0.0744)	
LR			-0.9231	-0.0042				
			(0.3327)					
LR × Z-Score			0.2090[a]	0.0008				
			(0.0656)					
LEVTA	4.6012[a]				5.7043[a]	1.1456		
	(0.7793)				(0.9957)			
LEV × HIQ			10.5144[a]	0.0408			8.4769[a]	1.6433
			(1.9932)				(2.2447)	
LEV × MIQ			4.4316[a]	0.0172			7.6082[a]	1.4749
			(0.5459)				(1.2690)	
LEV × LOQ			2.6685[a]	0.0104			6.2287[a]	1.2075
			(0.7703)				(1.1662)	
TOBINQ					0.4421[c]	0.0888		
					(0.2443)			
RDMV	21.0593[a]	0.1055	23.3839[c]	0.0908				
	(7.0382)		(6.6914)					
CASH	5.6428[a]	0.0283	6.6535	0.0258	-11.9046[a]	-2.3908	-12.2534[a]	-2.3754
	(1.5464)		(1.6068)		(3.4826)		(3.6205)	
CONVERDEBT	2.6246[a]	0.0131	-2.3926[a]	-0.0093				
	(0.8317)		(0.8366)					
FCRISIS					0.6068[c]	0.1111	0.7598[b]	0.1302
					(0.3535)		(0.3606)	
TRANSD	-2.0512[a]	-0.0257	-2.2839[a]	-0.0252				
	(0.3500)		(0.3554)					
RETAILD	-2.5843[a]	-0.0423	-2.5116[a]	-0.0310	-0.8270[a]	-0.1735	-1.0677[a]	-0.2193
	(0.2648)		(0.2646)		(0.3220)		(0.3392)	
SEVD	-2.2963[a]	-0.0353	-2.2443[a]	-0.0262	-1.1607[a]	0.3717	-1.8776[a]	-0.4275
	(0.3150)		(0.3159)		(0.4456)		(0.4680)	
Panel B Summary Statistics								
Number of Observation	2805		2805		434		434	
Omnibus model test	399.999		418.279[a]		180.331[a]		193.389[a]	
-2 Log likelihood	844.063		825.663		387.705		374.647	
Cox &Snell R	0.133		0.139		0.340		0.360	
Nagelkerke R	0.371		0.387		0.466		0.493	
Hosmer &Lemeshow test	7.091		5.392		6.033		5.242	
Percentage correctly classified	94.4[a]		94.6[a]		79.3		80.2	
K-S test on studentized residuals	0.364[a]		0.367[a]		0.133[a]		0.125[a]	
K-S test on standardized residuals	0.435[a]		0.437[a]		0.153[a]		0.151[a]	

[a], [b] and [c] denote statistical significance at a 1-, 5- and 10-percent level, respectively.

The coefficient for *RDMV* is significant positive, confirm the prior finding that firms operating internationally hedge to cope with the adverse impact of variability in the cash flows on their growth opportunities. The results for underinvestment and overinvestment hypotheses are mixed. The coefficient for assets tangibility measure by *FATA* and debt maturity is insignificant at 10% level. In contrast, *LEV* ×*HIQ*, *LEV* × *LOQ* and *FCF* are statistically significant at 1% level.

The evidence in Table 5-2 also shows that the liquidity variables are statistically insignificant, whereas the coefficients of financial distress proxies, *Z-score*, *LR*, and *Z-score*× *LR*, remain statistically significant. The negative sign of *LR* and *Z-score* suggest that domestic firms that do not engage hedging have lower ratings but lower costs of financial distress. Considering that purely domestic firms are rarely exposed to the fluctuations in foreign exchange rate, it is not surprising that they have less pressure on liquidity and lower costs of financial distress.

To our knowledge, this is the first study to distinguish between hedgers with international involvement and specifically allowing for non-hedgers operating domestically on influencing corporate hedging decisions. Purely domestic firms normally have less variability in the cash flows generated by assets in place. Multinational firms face more financial exposures and therefore more volatile if not hedge. In the world of capital market imperfection, this variability in internal cash flows, in turn, results in both variability in the amount of investment spending and the costs of external financing. Thus multinational firms have motivations to engage hedging to mitigate exposures to be less risky like purely domestic non-hedgers. The mixed results on investment-based and financial distress costs hypothesis for hedging suggest that multinational firms cannot eliminate but can mitigate variability of cash flows to an acceptable level through financial hedging. In other words, financial hedging is not a perfect solution for managing financial price risks. Accordingly, firms may utilise alternative techniques, such as issuing convertible debt or retaining high level of cash stock. Consistently, the regression finds that *CONVERDEBT* and *CASH* is significantly positive in the model.

5.2.5 Domestic Hedgers v.s. Domestic Non-hedgers

Since multinationals conduct business in different countries, their net revenue and profitability are affected by adverse market and economic conditions. Since purely domestic firms do not operate internationally they are not exposed to measurable financial risk would not be exposed, except in terms of commodity prices. Such firms would also have fewer substitute options to financial hedging. The limited geographic concentration means that the ability to diversify financial risk is limited. In that case it may make sense for domestic firms to manage market risk differently. Therefore it is important to examine the determinants of corporate hedging decision among purely domestic firms and multinationals. So the dependent variable of Equation (7) and Equation (8) is a binary variable which equals to 1 if a domestic firm hedges, 0 otherwise.

Table 5-2 Equation (7) and (8) presents the regression results. Overall, the diagnostic tests show reasonably good performance for the logistic models. Regression results provide mixed empirical evidence compared to the baseline model and international models. One plausible reason is the relatively smaller sample size. There are only about 44 domestic firms in total in our sample, 16 of which are non-hedgers and 28 are hedgers. Secondly, domestic firms should be less exposed, and therefore their incentives to hedge are not as strong as multinational firms. Nevertheless, this model still provides interesting evidence for the corporate hedging behaviour.

The results show that domestic firms hedge to reduce costs of underinvestment problem. *DEBTMATU* and *LEVTA* are both significantly positive, indicating that domestic firms with higher and longer debts have stronger propensity to hedge. *LEV* × *HIQ* is consistently significant and positive. The coefficient of

CAPEXPPP and *LEV* × *LOQ* are positive and statistically significant, but *FCF* is not significant, providing mixed evidence for overinvestment incentive. It is noticeable that domestic model is the only one model that finds insignificant estimate of *FCF*. The evidence suggests that firms hedge to reduce underinvestment costs. Overinvestment costs provides weak motives for domestic firms. This is not surprising since monitoring multinational firms are more costly due to the complexity of their business operations and information asymmetry (Doukas and Pantzalis, 2003; Lin et al., 2009). Multinational firms are more sensitive to higher agency costs than domestic firms, and therefore have greater desire of hedging. The situation arises because of the higher financial risks posed by the impacts of the variability in financial markets on firm value and cash flows. This finding supports the notion that hedging lowers information asymmetry and the costs of related agency problems. It also implies that hedging should be more beneficial for multinational firms.

The evidence in Table 5-2 suggests that domestic firms utilise hedging instruments to mitigate costs of financial distress. It is noticeable that the coefficient of DY is significantly negative. The negative sign is opposite to the hypothesis that firms alter their dividend payout policy to ease the concern over financial distress. On the other hand, it is in line with the prediction of negative association between dividend yield and hedging, since only highly liquid firms can commit themselves to paying out dividends. Credit rating does not influence domestic firms' hedging policy. Neither the continuous variable of the S&P long-term domestic issuer credit rating (*SPRATING*) nor the low-rating dummy variable *LR* is significant in the model.

Consistent with taxation hypothesis, the estimates of investment tax credit (*ITC*) and simulated marginal tax rate (*MTR*) are both significantly positive. The marginal effect is an increase of 0.4 percent and 57.8 percent respectively on the probability of use hedging instruments. This suggests that domestic US firms hedge price risks in response to tax-based incentives. Domestic firms may also utilise other means as substitutes of financial hedging. The tests show that the coefficient of *CASH* is always negative and

statistically significant, whereas the coefficient of *CONVERDEBT* is not significant. The results suggest that domestic firms tend to hold more cash rather than to issue convertible debts to avoid the costs of accessing capital markets. The 2008-2009 financial crisis dummy *FCRISIS* is positive and statistically significant, consistent with prior prediction in Chapter 3. Purely domestic firms have strong incentive to hedge during the periods of economic downturn, since domestic firms cannot diversify the adverse impact from domestic economy, and therefore are more sensitive to market volatility.

5.2.6 Foreign Exchange Hedging

Next, we examine the use of currency derivatives for a sample of U.S. firms that have ex ante exposure to foreign exchange rate risk. The dependent variable is a binary variable which equals to 1 if a firm hedge its foreign exchange rate exposures, 0 otherwise. The selection variable is the dummy variable of foreign exchange rate exposure. Logistic regressions are estimated using linear variable only (Equation (9)) and including both linear and interaction terms (Equation (10)). The results are shown in Table 5-3. The *p*-value for goodness of fit is 0.066 and 0.300 for Equation (9) and (10) respectively, indicating that the model fit the data at acceptable level.

Consistent with hypothesis and the results in the previous models, Table 5-3 shows that the coefficient for *RDMV* is significantly positive. US firms with more growth opportunities are more likely to hedge their foreign exchange rate (FX) exposures. *DEBTMATU* and its squared term is statistically significant in Equation (10). The positive coefficient of DEBTMATU is consistent with underinvestment problem hypothesis. The marginal effect is an increase of 10.3 percent in the probability of currency hedging. The negative coefficient of the squared term of debt maturity (*SQDEBTMATU*) suggests a nonmonotonic

relation between debt maturity and hedging. The possible explanation is that, because most firms normally hold hedging instruments normally in short term to medium term, at extremely long maturity, the marginal benefit of hedging decreases and thus firm loses risk management incentive. This finding is also consistent with the negative interaction term *LargeFirm* ×*DEBTMATU*. The coefficient for the interaction term *LEV* × *HIQ* is not significant. This finding is surprising as, according to underinvestment problem hypothesis, firms with valuable investment opportunities and more debts should have greater motivation to reduce the volatility of their foreign cash flows.

The overinvestment problem hypothesis is supported because the coefficient of free cash flow ratio is significantly positive at 5% in Equation (9) and its interaction with dummy variable for low Tobin's Q is significant and positively related with FX hedging in Equation (10). The investment intensity is also positively related with FX hedging. Again, the results indicate that firms which are expected to have high overinvestment problem are more likely to use currency derivatives to eliminate high expected agency costs of equity. It is noticeable that the interaction term *FCF* × *LOQ* is significantly positive and has the strongest marginal effect 75.9 percent in the model, implying that the use of FX hedging instruments is very sensitive to the increase of free cash flows when the expected costs of overinvestment is high. By contrasts, the marginal effects of underinvestment proxies are much smaller. Given that the fact that the corresponding interaction term for underinvestment problem, *LEV* × *HIQ*, is insignificant, the finding that the results present strong hedging motivation for overinvestment problem and relatively mild motivation for underinvestment problem is interesting. The plausible explanation is that multinational firms are more difficult to monitor. The result reflects the concern over overinvestment problem with the growing cash holding in US firms and the large amount of cash held by foreign subsidiaries in recent years (Bates et al, 2009).

Table 5-3 Logistic regression results for FX hedging and IR hedging

	Equation (9)		Equation (10)		Equation (11)		Equation (12)	
Variables	Coefficient	ME	Coefficient	ME	Coefficient	ME	Coefficient	ME
Constant	-8.0759[a] (0.4488)		-8.8309[a] (0.5201)		-4.4339[a] (0.4292)		-5.7655[a] (0.4893)	
LogTA	2.2656[a] (0.1202)	0.5619	2.5610[a] (0.1298)	0.6369	0.9299[a] (0.0914)	0.2317	1.0168[a] (0.0976)	0.2535
FATA	-1.3977[a] (0.2118)	-0.3466	-1.4556[a] (0.2180)	-0.3620	-1.3013[a] (0.2071)	-0.3242	-0.9919[a] (0.2005)	-0.2473
DEBTMATU			0.4150[b] (0.1694)	0.1032	0.0782[c] (0.0413)	0.0195	0.9173[a] (0.1717)	0.2287
SQDEBTMATU			-0.0636[b] (0.0280))	-0.0158			-0.1350[a] (0.0269)	-0.0337
FCF	1.6005[b] (1.6723)	0.3969	-0.0901 (0.9211)	-0.0224			1.5666[c] (0.8116)	0.3905
DY					0.0676[b] (0.0286)	0.0168	0.0501[c] (0.0281)	0.0125
STKComp	-0.0194[c] (0.0103)	-0.0048	-0.1103[a] (0.0246)	-0.0274	0.0248[a] (0.0097)	0.0062	0.0255[b] (0.0100)	0.0064
FCF × STKComp			1.0092[a] (0.2414)	0.2510				
CAPEXPPP			1.5270[c] (0.7842)	0.0171	1.4426[b] (0.6719)	0.3594	1.8107[b] (0.7211)	0.4514
CURR	-0.3102[a] (0.0557)	-0.0769	-0.3545[a] (0.0624)	-0.0882	-0.2602[a] (0.0566)	-0.0648	-0.2002[a] (0.5985)	-0.0499
IRC	-0.0110[a] (0.0021)	-0.0027	-0.0091[a] (0.0024)	-0.0023	-0.0139[a] (0.0023)	-0.0035	-0.0132[a] (0.0024)	-0.0033
MTR					1.6514[a] (0.5361)	0.4114	1.6990[a] (0.5386)	0.4236
NOL	0.4629[a] (0.0898)	0.1140	0.0221 (0.2263)	0.0055	-0.1314[c] (0.0794)	-0.0327	-0.1766[b] (0.0798)	-0.0440
Z-Score	0.0604[a] (0.0117)	0.0150	0.0705[a] (0.0136)	-0.0175	0.0602[a] (0.0138)	0.0150	0.0537[a] (0.0134)	0.0134
SPRATING	0,0288[b] (0.0115)	0.0072			0.0683[a] (0.0105)	0.0170	0.0497[a] (0.0109)	0.0124
LEVTA					2.2494[a] (0.2977)	0.5604		
LEV × HIQ							1.9229[a] (0.3939)	0.4794
LEV × MIQ							1.7285[a] (0.3510)	0.4309
LEV × LOQ							3.2167[a] (0.3737)	0.8019
FCF × LOQ			3.0537[b] (1.3367)	0.7594			-5.2759[a] (1.4070)	-1.3153
RDMV	2.0593[b] (0.9156)	0.1055	1.8167[b] (0.9091)	0.4518	1.2640[b] (0.5741)	0.3149		
ROA	0,9809 (0.6124)	0.2433	2.4841[a] (0.8523)	0.6178	1.8229[b] (0.5956)	0.4541	1.2562[b] (0.6255)	0.3132
LogPTI			-0.2474[a] (0.0805)	-0.0615				
NOL × LogPTI			0.1651[c] (0.0865)	0.0410				
CASH	2.7690[a] (0.6268)	0.6867	2.0519[a] (0.7114)	0.5103	-2.0392[a] (0.6085)	-0.5080	-1.6297[a] (0.5985)	-0.4063
CASH × HILEV			2.1096[b] (0.8656)	0.5246				
CONVERDEBT	-0.5187[b] (0.2106)	-0.1286	-0.7195[a] (0.2236)	-0.1789	-0.9258[a] (0.2151)	-0.2307	-1.0293[a] (0.2164)	-0.2566
BETA					0.0049[c] (0.0028)	0.0012		
Year2002	0.231 (0.1545)	0.0567						
CONSTD							-0.8256[b] (0.4097)	-0.1993
TRANSD	-1.5907[a] (0.1820)	-0.3645	-1.8091[a] (0.1860)	-0.4004			-0.4126[a] (0.1256)	-0.1028
RETAILD	-0.6973[a] (0.1772)	-0.1722	-0.7298[a] (0.1794)	-0.1796				
SEVD	-0.7097[a] (0.1811)	-0.1752	-0.8596[a] (0.1856)	-0.2098				
MANUFD	0.6394[a] (0.1408)	0.1574	0.6338[a] (0.1402)	0.1564				
Panel B Summary Statistics								
Number of Observation	3428		3410		3666		3666	
Omnibus model test	1451.654[a]		1492.900[a]		1115.852[a]		1185.415[a]	
-2 Log likelihood	3280.211		3211.346		3946.694		4011.159	
Cox &Snell R	0.345		0.355		0.262		0.270	
Nagelkerke R	0.461		0.474		0.351		0.361	
Hosmer &Lemeshow test	14.671[c]		10.686		12.413		6.443	
Percentage correctly classified	76.6[a]		76.4[a]		73.6[a]		73.2	
K-S test on studentized residuals	0.102[a]		0.099[a]		0.154[a]		0.161[a]	
K-S test on standardized residuals	0.083[a]		0.080[a]		0.123[a]		0.133[a]	

[a], [b] and [c] denote statistical significance at a 1-, 5- and 10-percent level, respectively.

The table also shows that *NOL* remains positively related to the FX hedging, consistent with the tax-based findings in prior sections. And, more interestingly, its interaction term with pre-tax income (*LogPTI*) is statistically significant in Equation (10). This result suggests that with the existence of tax preference items, firms that have higher taxable income have higher propensity to hedge FX exposures. Consistently, *ROA* is also positively significant at 1% level in Equation (9), suggesting that a firm with better performance are more likely to execute FX hedging to protect its earnings. However, we find no evidence that the simulated book marginal tax rate significantly affects the use of FX derivatives.

While the evidence in Table 5-3 shows that liquidity and the ability to meet interest payment obligations is negatively related with FX hedging, the coefficient for the Altman's Z-Score is significantly positive. The coefficient of bond rating is significant and positive in Equation (9), too. This is surprising, because the financial distress based argument suggests that low-rated firms and firms with high distress risk have greater desire of hedging their FX exposures. The result is similar to the Equation (1) in the earlier section, but in the previous section, the coefficient of Z-score changes to negative after including the significant low bond rating dummy variable (*LR*) in Equation (2). This does not appear to occur, however, in either Equation (9) or Equation (10). Therefore there is no evidence that the positive sign of *Z-score* is biased. By contrast, the continuous bond rating variable (*SPRATING*) is significant and positive in Equation (9), and *Z-score* remains significantly positive in Equation (10), consistent with the positive sign in Equation (9). The finding challenge financial distress hypothesis but suggests that firms with high financial distress risks are less likely to engage FX hedging. Though the results offers some support for costs of financial distress theory for hedging, it also raises the question as to whether the economies of scale and distress costs hypothesis are jointly effective in practice.

5.2.7 Interest Rate Hedging

This section examines the determinants of corporate hedging when US firms use interest rate risk derivatives only. The comparison is between firms that hedge their interest rate exposures and those do not. The dependent variable is a dummy variable of the use of interest rate derivative. Interest rate hedging is largely associated with debt issuance, whereas many FX hedging aims to reduce the transaction-based exposures Therefore, we expect that debt-related evidence is stronger in this model. The fifth and sixth column of Table 5-3 provides the results for Equation (11) which omits nonlinear and interaction effects. The last two columns report the results for Equation (12), which includes curvilinear and interaction effects.

Table 5-3 shows leverage ratio (*LEVTA*) and debt maturity (*DEBTMATU*) are significantly positive. The results suggests that firms with more debts and debts with longer maturity have greater desire of IR hedging. And, noticeably, the marginal effect of *LEVTA*, an increase of 56.0 percent in the probability of using interest rate derivatives, is the highest effect in the Equation (11). In addition, the marginal effects of *LEVTA* and *DEBTMATU* on IR hedging are larger than the effects on FX hedging. This finding is consistent with Belghitar et al. (2008) evidence in the UK. Among all models in our analysis on US firms, the marginal effects of the two leverage variables in IR models are the strongest. The costs of financial distress from change of interest rate provides stronger motivation on using interest rate instruments than other types of hedging instruments[18].

Table 5-3 also shows that *CONVERDEBT* and *DY* are both significant in Equation (11) and (12). The negative coefficient for convertible debt and the positive sign of dividend yield are consistent with

[18] The results shows very strong leverage incentives of using IR derivatives. Though it offers support for costs of financial distress theory for hedging, it also raise question that are the positive correlation between leverage and use of IR derivatives driven by the large benefits from successful speculation (see Faulkender, 2005; Chernenko and Faulkender, 2011). This will be further discussed later in this section.

hedging substitute hypothesis. Notice that the marginal effect of convertible debt on IR hedging is much stronger than the effect by altering dividend payout policy. This may be because IR hedging aims to reduce the interest rate exposure to firm's debt obligations.

Chernenko and Faulkender (2011) argue that the use of derivatives for hedging not change significantly from year to year, assuming that a firm's exposure to interest rate risk of their operations is stable over time. Consistent with this argument, the regressions shows no year dummy variable is statistically significant in the model. IR model is the only model finds significant estimate for stock price sensitivity measurement (*BETA*). The positive coefficient indicates that firms which are more sensitive to market risk are more likely to engage IR hedging. This is not surprising, given the common notion that firms engage hedging aiming to reduce the adverse impact from market prices fluctuation on the firm.

5.3 Conclusion and Implications

The study employs logistic regression to examine possible determinants for corporate hedging decision. Apart from the baseline model, we examine hedging behaviour in more detail according to specific groups. The baseline model provides an overall view for the determinants of corporate hedging policies amongst all sampled firms. Section 5.2.2 examines the determinants of hedging only amongst multinationals. Section 5.2.3 examines the hedging decisions amongst firms that operate in different context, and Section 5.2.4 tests the determinants of corporate hedging decision among domestic firm, apart from multinationals. These tests, together, help to gain robust insights on the determinants of corporate hedging decision. Overall, the conclusions for most of hypotheses from previous section are unaffected by the alternative proxies and models. Compared the results in the four models, we conclude that multinational firms do behave differently with domestic firms on the derivatives use for hedging, but that does not change the majority of our conclusions on the determinants for hedging. The last two sections examines corporate

hedging behaviour by types of risk exposures. Firms appear to place different emphasis on different type of hedging.

The study finds that larger firms are more likely to use derivatives, implying the existence of economies of scale in the costs for establishing and managing a hedging program. *LogTA* is shown to be significant and positive in the most of the models except Equation (7) and (8). Economies of scales also appears to lead to higher probability of hedging because the transaction is less costly. Low rated firms having high financial distress risk may not be able to use derivatives because the costs of hedging is too high. Nevertheless, the study finds strong evidence consistent with financial distress hedging. The liquidity condition of a firm is negatively correlated with corporate hedging activity, whereas the high expected costs of financial distress provides significant incentive for hedging. When the simultaneity of credit rating and leverage is controlled, we find that the credit rating on the debt and the costs of financial distress interactively determine hedging decision of the firm. In the case of low rated firms may also hedge as signalling to market and investors. This is in line with DeMarzo and Duffie (1995). When hedging is costly, market price dynamics affects the total benefits from holding derivatives and thus the optimal hedging policy.

The study finds evidence consistent with underinvestment problem hypothesis. Conflicts of interest between bondholders and stockholders and high expected cost of underinvestment provide strong incentive to hedge. The incentive is even stronger among the firms with high Tobin's Q, and it is robust in alternative models. The results also suggest that, it is important and more precise to identify firms which are more likely to encounter underinvestment problem to test underinvestment hypothesis.

While many previous studies just examine the agency costs on underinvestment, the models also provide strong evidence on another less well-explored hypothesis, alleviating the overinvestment problem through hedging. It is proved that the empirical evidence supporting overinvestment are robust. Firms which face

low underinvestment costs but high expected overinvestment costs hedge to alleviate overinvestment problem, regardless of whether the firm is multinational or the type of hedging.

Following Smith and Stulz (1985) taxation argument for hedging, we also find that firms hedge in response to tax convexity and managerial risk aversion. The different proxies used to test taxation hypothesis are all statistically significant. Due to the limited access of database we do not use alternative proxy for managerial risk aversion and managerial compensation, but we tested the hypothesis in different models. Almost all models tested provide consistent evidence that derivative usage is positively related with the level of stock compensation in the firm, except the evidence for FX hedging model.

Our study also presents important insights into the influence of industry conditions and macroeconomic environment on corporate hedging decision over time. While the results for industry indicators are mixed, the results for the year dummies suggest that different economic environment influences corporate hedging decision differently.

CHAPTER 6
Determinants of Derivatives Usage in amongst U.K. firms

6.1 Introduction

The results in the previous chapter provide consistent evidence with most of theoretical explanations for corporate hedging under imperfect markets. However, those theoretical explanations may not be support in financial markets that are subject to different regulatory and accounting arrangements. To illustrate, for example, Hakkarainen et al (1998) show that unlike UK and US firms, Finnish firms places more emphasis on accounting than transaction exposure, a focus that was influenced by the tax arrangement in Finland. This means that the tax considerations when hedging would be more important for Finnish firms compared to the UK or US firms. Similarly, Judge (2006) show that financial distress costs factor has stronger influence on corporate hedging for the UK compared to the financial distress factor for the US firms. Whilst, the accounting and financial regulations in the UK are more closely aligned with those of the US than (say) Finland, it is well know that the US accounting regulations are rules based whereas, those of the UK are principles based. Koutmos and Martin (2003) argue that firms respond asymmetrically to exchange rate movements. and Clark and Mefteh (2011) find that the exposures with respect to the US dollar and non-USD currencies are asymmetric and different. This differnence and other differences can give risk to the differences in our results for US and the UK and as such makes a case for also examining corporate hedging motives for the UK firms. This chapter attempts to investigate and provide evidence for UK non-financial firms on both the determinants of corporate hedging and the choice of types of derivatives. By providing additional evidence from the UK, this chapter facilitates comparisons with our results from the US sample but also the extant empirical literature.

Before discussing the empirical results in detail, some broad observations are in order. The results from this study provide strong support for several explanations for corporate hedging. All the logistic regression models provide a good fit to the data based on the Hosmer and Lemeshow significance statistics, classificatory efficiency statistics, and other measures. Another feature of the logistic regressions is the fact that they not only provide strong evidence to support nearly all theories for hedging, but also provide consistent results and new evidence for the recently published literature about corporate hedging. The structure of this chapter is as follows. Section 6.2 provides the logistic regressions for the determinants of corporate hedging. Section 6.3 provides conclusion of the empirical evidence and its implications.

6.2 Multivariate Analysis – Binary Logistic Analysis

6.2.1 Baseline Model

This baseline logistic regression is estimated for all the firms in the sample regardless if a firm operates internationally or domestically. We estimate the coefficients of this logistic regression model using the method of maximum -2 log likelihood, with the results reported in the Table 6-1. The sample size drops due to missing values on accounting data. The first two columns report the regression omitting nonlinear variables and the third and fourth columns reports the regression with both linear and curvilinear effects. Overall, the result provides strong evidence for most of the theories. The -2 log likelihood of Equation (13) and Equation (14) is 1942.184 and 1984.729 respectively. The Hosmer and Lemeshow test of both models are not significant (*p*-value > 0.10), indicating the statistical goodness-of-fit of the models. The omnibus statistics are significant (p-value $\leq$ 0.01) suggesting that the coefficients of the logistic regressions besides the intercept are significant. The overall percentage of cases that are correctly predicted by the logistic model is 83.9% and 84.2% respective, which show strong predictive power.

Table 6-1 Logistic regression results for Baseline Model

	Equation (13)			Equation (14)		
Variables	Coefficient	ME	WS	Coefficient	ME	WS
Constant	-8.3136[a]		207.442	-8.7467[a]		261.526
	(0.579)			(0.541)		
DY	0.1573[a]	0.0236	27.492	0.1447[a]	0.0265	24.225
	(0.030)			(0.029)		
LogTA	0.6490[a]	0.0973	186.127	0.6612[a]	0.121	229.610
	(0.048)			(0.044)		
FATA	-0.2120[a]	-0.0318	10.514	-0.1189	-0.0218	2.118
	(0.066)			(0.082)		
RDTA	0.2881[a]	0.0432	79.288	0.2428[a]	0.0444	66.563
	(0.032)			(0.030)		
DEBTMATU	0.1391[a]	0.0209	13.535	0.1702[a]	0.0311	16.451
	(0.038)			(0.042)		
DEBTMATU×FATA				-0.0566[c]	-0.0104	
				(0.034)		
Z-Score	0.1276[b]	0.0191	6.165	0.0687	0.0126	1.764
	(0.052)			(0.052)		
INCOV	-0.0034[c]	-0.0005	2.836			
	(0.020)					
CURR	-0.1739[a]	-0.0261	18.816	-0.1162[a]	-0.0213	10.406
	(0.040)			(0.036)		
Year2002	0.7543[b]	0.0896	3.836	0.6979[c]	0.1062	3.261
	(0.385)			(0.386)		
INDUS	0.5772[a]	0.0810	16.542	0.5554[a]	0.0962	15.478
	(0.142)			(0.141)		
CONSUMG	0.5943[a]	0.0763	7.679	0.7287[a]	0.1131	11.224
	(0.215)			(0.218)		
CONSUMS	0.7392[a]	0.0902	7.455	0.8981[a]	0.1321	10.554
	(0.271)			(0.276)		
TELECOM	-0.9738[a]	-0.1874	7.580	-1.0266[a]	-0.2271	7.965
	(0.355)			(0.364)		
UTILIT	-1.2403	-0.2512	6.218	-1.3343[a]	-0.3038	8.157
	(0.496)			(0.467)		
LTDTA	-0.0475[b]	-0.0071	4.726			
	(0.022)					
LEVTA	1.0345[a]	0.1550	6.880			
	(0.395)					
SQLEVTA				-4.1525[a]	-0.7601	20.806
				(0.910)		
LEV×HIQ				4.8820[a]	0.8936	40.462
				(0.767)		
LEV×MIDQ				4.0503[a]	0.7414	36.019
				(0.675)		
FCF	.9196	0.1378	2.283			
	(0.609)					
FCF×LOQ				3.6057[a]	0.6600	15.830
				(0.906)		
FCF×Z-Score				-0.2998[b]	-0.0549	3.946
				(0.151)		
STKComp	-0.0105[c]	-0.0016	2.868	-0.0084	-0.0015	1.858
	(0.006)			(0.006)		
EXEComp	-0.0340[c]	-0.0051	9.038	-0.0491[a]	-0.0090	10.609
	(0.011)			(0.015)		
LINKTSR	0.5906[c]	0.0857	13.021			
	(0.164)					
LINKTSR×INTLOP				0.0178	0.0033	1.768
				(0.013)		
LINKTSR×EXEComp				0.0712[a]	0.0130	7.436
				(0.026)		
Panel B Summary Statistics						
Number of Observation	2745			2846		
Omnibus model test	1338.117[a]			1522.600[a]		
-2 Log likelihood	1942.184			1984.729		
Cox &Snell R	0.386			.414		
Nagelkerke R	0.553			.585		
Hosmer &Lemeshow test	5.176			10.359		
Percentage correctly classified	83.9[a]			84.2[a]		
K-S test on studentized residuals	11.290[a]			10.702[a]		
K-S test on standardized residuals	9.898[a]			9.206[a]		

[a], [b] and [c] denote statistical significance at a 1-, 5- and 10-percent level, respectively.

Because the agency costs depend on the bankruptcy rules (Acharya et al., 2011b) and the UK bankruptcy rules are relatively more creditor-friendly than the US rules, UK firms have high expected costs of financial distress. Therefore we expect that financial distress proxies appear to be very significant in the model. Consistent with the prediction, the coefficients for current ratio (*CURR*) are both negative and significant at 1% level. Interest coverage ratio is negatively significant at 10% level in Equation (13), indicating a negative relation between hedging and the liquidity position of a firm. The results are in line with Judge (2006) who finds that the avoidance of financial distress is a strong motive for hedging among UK firms. Judge (2006) also finds that the incentives of reducing financial distress cost are more important for his sample of UK firms than samples of previous US studies. This conclusion, however, is not supported by our results. Comparing with the results from US sample, the marginal effect of *INCOV* (-0.0005) is almost the same with the marginal effect of *INCOV* (-0.0011) in US baseline model (see Table 6-1), but the marginal effect of *CURR* in this model are lightly smaller. Overall, the marginal effects of the two variables are not very different. *Z-score* is insignificant and decline in the final Equation (14), whereas the interaction term *Z-score*× *FCF* is very significant (p-value<0.05) and negative. It indicates that the relation between financial distress incentives and hedging also depends on the level of free cash flows of the firm. As a lower *Z-score* implies a higher probability of bankruptcy, the negative coefficient implies that, for firms with low free cash flows, the expected cost of financial distress is expected to have a stronger positive effect on hedging. The marginal effect of the interactive term is -0.055. Overall, the results provide consistent evidence to support view that the incentive to hedge arises from the cost of financial distress, but it does not show any evidence that this incentive have a stronger effect on UK firms than on US firms.

The significant positive coefficient leverage ratio (*LEVTA*) implies that the firms hedge in response to the expect distress costs arising from high leverage. One percent increase in the total level of leverage to total assets yields a significantly increase of 15.5 percent possibility of engaging hedging. Purnanandam (2008) finds a non-monotonic relation between leverage and hedging. He argues that due to the costs of financial distress leveraged firms have a strong incentive to hedge, but such an incentive disappears for firms with

extremely high leverage due to the risk-shifting incentives. At very high leverage, the financial distress costs are so high that the distinction between financial distress and insolvency disappear and thus shareholders lose risk management motivation. Consistent with this prediction, the Equation (14) shows that the estimated coefficient of *SQLEVTA* is significant (p-value ≤ 0.01) and negative, indicating a negative relation between extremely high leverage and the probability of engaging in hedging activities.

Géczy et al. (1997) point out that exogenous financial distress costs affects a firm's debt choice. If a firm with high cost of financial distress choose a low long-term debt ratio, then its hedging activities is expected to be negatively correlated with long-term debt ratio. The creditor-friendly environment in the UK offers a typical framework for such an analysis since their firms are expect to have high exogenous financial distress costs. Interestingly, the logistic regression shows a significant negative coefficient for long-term debt over total assets (*LTDTA*), implying that the long-term debt ratio is negatively correlated with hedging. This is opposite to that predicted by the financial distress hypothesis. The negative coefficient of *LTDTA* is in line with Géczy et al (1997) finding that the long-term debt ratios of currency hedgers are lower than those of non-hedgers. Leland (1998) argues that the long-term debt has lower hedging benefits and is less incentive-compatible with hedging than short-term debt, which might be another explanation of the negative coefficient.

Our results are also consistent with those of Stulz (1984) and Smith and Stulz (1985) for the cases of managerial risk aversion and managerial compensation. This is because the coefficients of stock based compensation (*STKComp*) in both the linear and nonlinear baseline models are negative and statistically significant. So here, stock based compensation is negatively related to the probability of hedging. Thus, the findings are consistent with the early hypothesis that bonus or stock option provisions of compensation plans make the manager's expected utility to be convex. When manager's utility is convex, manager will behave more like a risk-taker and choose to bear the risk to achieve higher expected income. A one percent increase in the after-tax stock compensation yields a slightly decrease of 0.2 percent in the probability

that a firm uses hedging instruments. The results, however, is contradict to the results from previous chapter, which indicate that the similar measure *STKComp* is positively associated with hedging in US firms. The contradiction may due to the difference of the two measures[19]. The senior executives' compensation (*EXEComp*) is another proxy of managerial risk aversion. The higher the manager's claims on the firm are, since the risk of claims are nondiversifiable for individual, the more likely that manager decides to hedge. Surprisingly, the results show a significantly negative relationship between *EXEComp* and hedging. The plausible explanation is that, since this variable is the total compensation paid to senior executives of the firm, it also includes the stock based compensation plan for the senior executives. That is, the variable *EXEComp* can be a convex function of the firm value because it has already included the effect of stock based compensation plan on manager's utility function.

The situation changes when CEO compensation is linked to shareholder's benefits in a firm. The coefficient of *LINKTSR*×*EXEComp*, interaction term between dummy variable of CEO compensation links to total shareholder return and total senior executives compensation, is positively correlated with dependent variable and statistically significant at a 1% level. It indicates that, when the managerial wealth is highly undiversified, the higher managerial wealth becomes, the more likely managers would hedge to decrease the volatility of the firm profits on their end-of-period wealth. A one percent increase on the total amount of senior executive compensation of the firm yields a significant increase of 1.3 percent in the probability that a firm engage hedging. In contrast, for the UK firms which do not link the shareholder return to its executive compensation plans, a one percent increase on the amount of executive compensation leads to a decrease in the probability of hedging. Another interaction term *LINKTSR*×*INTLOP*, which interacts international operating income of a firm with CEO compensation link to total shareholder return is positive but insignificant. Between the two interaction terms, *LINKTSR*×*EXEComp* is significant and has a higher Wald statistic compared with *LINKTSR*×*INTLOP*.

[19] The stock compensation expense of U.S. firms includes stock bonus, deferred compensation, amortization of deferred compensation, non-cash compensation expense and the stock-based compensation to employees and non-employees, according to Compustat. The total stock-based compensation of U.K. firms is the total fair value of all the stock options and restricted stock awarded to the employees of the company during the year, according to Datastream.

To our knowledge, this is the first study in the literature to test the effect of manager risk aversion on corporate hedging decisions when managerial wealth in a firm is closely link to shareholder's return.

The results indicate that there is a positive size effect on hedging. The estimated coefficient of natural log of total assets is positive and significant at 1% level, which is consistent with economies of scale hypothesis. The regressions show that the number of growth opportunities is positively associated with corporate hedging. *RDTA* has positive coefficient for hedging and is highly significant for Equation (13) and Equation (14), consistently with our empirical results for US firms. The UK firms with greater investment opportunities hedge more to reduce the potential predation risk. It is noticeable that growth opportunity proxy is highly significant and has third highest Wald statistic in the model, which is much higher than that of growth opportunity proxy in the US baseline model (see Section 5.2.2). However, the marginal effect of growth opportunities incentive for this model is much smaller than the marginal effect in the US baseline model, implying that the use of derivative among UK firms are less sensitive to the change of R&D spending than US firms. This might due to the differences arise from how investment varies with internal cash flows across interest rate environments. In addition, as UK yield curve is less volatile than US yield curve (Verdelhan, 2010), the change of interest rate has less influence on the investment funds. Thus the hedging policy of UK firms is less sensitive to the change of R&D spending.

The regressions provide strong support for the agency problem based hypotheses. *DEBTMATU*, the measure of the weighted length of debts held by a firm, is highly significant in both models and positively correlated with hedging. Like the analyses for the US firms, Equation (14) includes squared term of debt maturity, *SQDEBTMATU*, and additional variable to examine the moderation by interacting size proxy, *LogTA*, multiplicatively with and the dummy of debt maturity lower than median. Though the signs of coefficients are consistent, *SQDEBTMATU* and *LogTA*×*LMATU* are insignificant and withdrawn to get a better final model. The interaction term between high total assets dummy and debt maturity is not significant either. The only interaction found to be statistically significant is the interaction terms between

debt maturity and fixed assets, *DEBTMATU×FATA*, indicating that the effect of debt maturity on corporate hedging differs depending on the fixed assets ratio of the firm. Since long debt maturity indicates greater agency costs, the negative sign of the coefficient implies that firms with fewer fixed assets should have greater agency cost incentive of hedging. This is consistent with finance theory. Asset tangibility have been found to be positively correlated with leverage and debt maturity (see Barclay et al., 2003; Dang, 2011).Therefore firms with more fixed assets should have greater debt capacity and longer debt maturity, while firms with a fewer fixed assets should have more restricted borrowing capacity and therefore more likely to raise shareholder-bondholder conflicts. Consequently firms with low fixed assets ratio have higher need of hedging to reduce investment distortions associated with debt financing.

Theoretically levered firms with high-investment opportunities may experience high agency costs of underinvestment. Thus the regression examines interaction between high Tobin's Q dummy, which as an indicator of underinvestment, and the debt ratio. The coefficient is positive and significant, with the strongest marginal effect of 0.894 and a high Wald statistic. If a firm face high expected costs of underinvestment, the incentive to hedge to mitigate underinvestment problem is significant and is positively related to the total level of debt in the firm. The estimated coefficient on *LEV×MIQ* is also positive and statistically significant, suggesting that firms which have moderate level of Tobin's Q hedge with the increase of leverage, alleviating costs of underinvestment. However, compare with those firms with high Tobin's Q, the underinvestment incentive of hedging among firms with moderate Tobin's Q lighter and less important (a smaller marginal effect and a lower Wald statistic). The findings are perfectly consistent with the regression results from US sample.

The estimated coefficient of free cash flows to total assets (*FCF*) is marginally significant at 10% and is positive in Equation (13), indicating potential motive of hedging in response to overinvestment problem. However, high free cash flows would increase the probability of overinvestment problem if the free cash flows is used to engage in manager's self-interest activities rather than positive net present value projects.

To test the overinvestment hypothesis we need to distinguish between overinvesting and underinvesting firms. Thus we add an interaction term between unfavourable investment opportunities, a dummy variable of low Tobin's Q, and *FCF*, in Equation (14) to test the hypothesis. The regression finds that the interaction term is highly significant and positively correlated with hedging, whereas the *FCF* is not significant. It indicates that the possibility of hedging of overinvesting firms increases with the free cash flows. The marginal effect of interaction is an increase in the probability of hedging of 66.0 percent.

To examine the industry effect, this regression also includes industry indicators based on two-digit SIC code. The model shows that four industry indicators, *INDUS*, *CONSUMG*, *CONSUMS*, *TELECOM*, and *UTILIT* are significantly (*p*-value $\leq$0.01) associated with the use of derivatives. Firms in the industrial industry (*INDUS*), consumer goods industry (*CONSUMG*), and consumer services industry (*CONSUMS*) are more like to engage hedging activities because these industries are highly competitive. Firms in the telecommunications and utilities are less likely to hedge. The corresponding marginal effects are also negative. These results are consistent with Bertram et al. (2009) findings that that derivatives usage rates are high in the retail trade industry and utilities industry, but contrary to the finding that consumer goods industry has lowest usage rates.

Both of the Equation (13) and (14) show that the coefficient of year 2002 dummy variable is positive and statistically significant at 10% level, consistent with the results from US analyses. The result suggests that economic downturn influences firm's hedging behaviour on downside risk. Compared with US results in the previous chapter, however, the regressions do not provide evidence that UK firm's hedging decisions are influenced by 2008-2009 financial crisis. The plausible explanation is that the financial crisis has limited impact on non-financial firms in the UK.

6.2.2 International Hedgers v.s. International Non-hedgers

Baseline model provides an overall view for the determinants of corporate hedging policies amongst all sampled firms. In fact, multinationals may hedge differently with purely domestic firms since purely domestic firms do not have foreign exchange rate exposure, whereas hedging theory predict firms choose hedge or not on the assumption that a firm has risk exposure then they choose to hedge such risk exposure or not. Therefore, the empirical evidence may not match precisely given certain characteristics of firms and the operational activities. To better understand corporate hedging decision and to be more clinical about our results, we add the international dummy as an explanatory variable into the baseline model. If the foreign involvement of a firm does not influence its hedging decision, the predictor should not be significant in the model. Therefore, we test the null hypothesis that there is no difference on the international involvement of British hedgers and non-hedgers.

Table 6-2 presents the regression results of the model including international indicator. The Hosmer and Lemeshow test *p*-value is not significant as before, indicating that the goodness-of-fit of the regression is acceptable. The results reject the null hypothesis stated above. The estimated coefficient of international indicator, *INTL DUMMY*, is positive and statistically significant at 1% level, with third highest Wald statistic 77.874. These results indicate that the international indicator is an important factor in determining hedging indeed. Multinational firms are more likely to engage derivatives to hedge their risk exposures. The results imply that our concern of mismatch problem may exist in the baseline model indeed.

To better characterise our analysis, we therefore examine hedging behaviour in more detailed groups. Specifically, by a sample of firms which excludes purely domestic firms, the model examines the determinants of hedging only amongst multinationals. Table 6-3 presents the regression results of international model on the condition that -2 log likelihood are maximised. Overall, the result provides strong evidence for most of the theories, apart from some others with mixed results. Again the Hosmer

and Lemeshow test confirms a good model fit (*p*-value > 0.10). The Omnibus statistic is significant (p-value ≤ 0.01) suggesting that the coefficients of the logistic regressions besides the intercept are significant.

The regressions find that size effect proxy *LogTA* remains significant and is positively correlated with hedging. It is still the most important variable in the model. That is, large multinationals are more likely to use derivatives than small multinationals. Return on assets (*ROA*) is statistically significant in Equation (16) and has positive coefficient, indicating that high firm performance motivates the use of derivatives. That is, firms with good performance tend to use derivatives to manage its financial risk to protect such achievement. By contrast, the coefficient of Tobin's Q is not significant. A plausible explanation is that accounting rates of return like *ROA* are widely used and highly important in determining executive compensation. Managers have incentives to make corporate risk management decisions in such a way as to affect *ROA* and, thus their compensation.

As before, the strong support for the agency costs hypothesis still holds. Coefficients of *DEBTMATU* in Equation (16) and (17) are both positively significant, suggesting that there is a positive association between hedging decision and long debt maturity choice. Holding longer weighted length of debts provides incentives for firms to engage in hedging to reduce costs of shareholders-bondholders conflict. It is interesting to notice that once we control for the international operation dummy, the estimated coefficient of interaction term *DEBTMATU*×*FATA* is not statistically significant. Given that the asset tangibility variable *FATA* is not significant either, the insignificance of the interaction term most likely reflects the fact that multinational firms are financed with less external debt in countries with underdeveloped capital markets and employ internal capital markets (Desai et al, 2004). And as such assets tangibility as an important determinant of a firm's ability to finance externally (Almeida and Campello, 2007) become less important. *LEV*×*HIQ* remains positively and highly significant (*p*-value < 0.01), and has stronger marginal effect (0.605) than that in the US international model (0.509).

Table 6-2 Logistic regression includes dummy variable of international operation

Variables	Coefficient	Equation (15) ME	WS
Constant	-11.5976[a] (0.676)		207.442
DY	0.1450[a] (0.030)	0.0247	23.315
LogTA	0.7154[a] (0.047)	0.1205	242.847
FATA	-0.1074 (0.080)	-0.0186	1.824
RDTA	0.2396[a] (0.030)	0.0406	63.414
DEBTMATU	0.1623[a] (0.043)	0.0275	14.365
DEBTMATU×FATA	-0.0020 (0.035)	-0.0002	0.003
Z-Score	0.0659 (0.051)	0.0112	1.661
CURR	-0.1132[a] (0.036)	-0.0191	9.874
Year2002	0.7002[c] (0.398)	0.0977	3.083
INDUS	0.6222[a] (0.145)	0.0981	18.411
CONSUMS	0.9893[a] (0.227)	0.1323	18.897
CONSUMG	0.9534[a] (0.280)	0.1267	11.622
TELECOM	-1.0003[a] (0.370)	-0.2081	7.300
UTILITD	-1.5969[a] (0.480)	-0.3559	11.078
SQLEVTA	-4.3929[a] (0.919)	-0.7442	22.798
LEV×HIQ	5.3484[a] (0.783)	0.9071	46.607
LEV×MIDQ	4.1194[a] (0.689)	0.7000	35.641
FCF×LOQ	4.1099[a] (0.930)	0.6968	19.484
FCF×Z-Score	-0.1566 (0.139)	-0.0271	1.265
STKComp	-0.0095 (0.006)	-0.0016	2.377
EXECOM	-0.0500[a] (0.015)	-0.0084	11.045
CompLINK×INTLOP	0.0109 (0.013)	0.0019	0.739
CompLINK×EXEComp	0.0751[a] (0.027)	0.0128	7.744
INLT DUMMY	2.2292[a] (0.253)	0.4990	77.874

Panel B Summary Statistics	
Number of Observation	2841
Omnibus model test	1590.834[a]
-2 Log likelihood	1906.290
Cox &Snell R	0.429
Nagelkerke R	0.606
Hosmer &Lemeshow test	9.108
Percentage correctly classified	84.5[a]
K-S test on studentized residuals	10.680[a]
K-S test on standardized residuals	9.086[a]

[a] ,[b] and [c] denote statistical significance at a 1-, 5- and 10-percent level, respectively.

Table 6-3 Logistic regression results for international hedgers and non-hedgers

	Equation (16)			Equation (17)		
Variables	Coefficient	ME	WS	Coefficient	ME	WS
Constant	-8.6305[a] (0.625)		192.733	-8.6276[a] (0.631)		186.489
DY	0.1336[a] (0.031)	0.0167	18.803	0.1288a (0.031)	0.0156	16.743
LogTA	0.6569[a] (0.052)	0.0823	165.085	0.6432[a] (0.052)	0.0778	151.341
RDTA	0.2688[a] (0.033)	0.0337	66.829	0.2594[a] (0.033)	0.0314	62.593
DEBTMATU	0.1477[a] (0.040)	0.0185	13.695	0.1031[b] (0.043)	0.0125	6.02
DEBTMATU×HICAPEXP				0.0685[c] (0.040)	0.0083	2.859
INCOV	-0.0043[b] (0.002)	-0.0005	4.246	-0.0035[c] (0.002)	-0.0004	2.745
CURR	-0.1248[a] (0.039)	-0.0156	10.793	-0.0933[a] (0.036)	-0.0113	6.556
Year2002	0. 8222[b] (0.417)	0.0783	3.964	0.8214[c] (0.427)	0.0752	3.661
INDUS	0.7806[a] (0.144)	0.0893	28.964	0.7137[a] (0.149)	0.0792	22.25
CONSUMG	1.4509[a] (0.259)	0.1207	31.510	1.4365[a] (0.262)	0.1152	30.619
COMSUMS	1.5058[a] (0.311)	0.1210	23.174	1.5113[a] (0.318)	0.1165	22.249
TELECOM	-0.6499[c] (0.383)	-0.1001	2.866	-0.6682 (0.407)	-0.1003	2.542
UTILIT	-1.3378[a] (0.509)	-0.2459	6.614	-1.7094[a] (0.517)	-0.3293	11.054
LTDTA	-0.0545[b] (0.023)	-0.0068	5.435	-0.0373 (0.024)	-0.0045	2.617
LEVTA	1.2505[a] (0.419)	0.1568	9.016			
SQLEVTA				-3.8033[a] (0.850)	-0.4599	18.781
LEV×HIQ				5.0028[a] (0.817)	0.6050	34.505
LEV×MIQ				3.7976[a] (0.738)	0.4592	23.768
FCF	2.6812[a] (0.599)	0.3361	20.375	1.0020 (0.689)	0.1212	1.759
FCF×LOQ				3.6059[a] (1.099)	0.4360	11.898
STKComp				-0.0116[c] (0.007)	-0.0014	3.118
EXECOM	-0.0406[a] (0.012)	-0.0051	11.437	-0.0405[a] (0.012)	-0.0049	8.232
LINKTSR	0.8613[a] (0.170)	0.1030	22.005	0.8714[a] (0.189)	0.1004	23.029
ROA	0.0274[c] (0.016)	0.0034	2.865	0.0289[c] (0.017)	0.0035	3.238

Panel B Summary Statistics		
Number of Observation	2609	2609
Omnibus model test	1342.277[a]	1393.254[a]
-2 Log likelihood	1704.286	1653.309
Cox &Snell R	0.402	0.414
Nagelkerke R	0.584	0.601
Hosmer &Lemeshow test	12.864	10.340
Percentage correctly classified	85.2[a]	85.7[a]
K-S test on studentized residuals	12.690[a]	12.735[a]
K-S test on standardized residuals	10.164[a]	10.168[a]

[a] ,[b] and [c] denote statistical significance at a 1-, 5- and 10-percent level, respectively.

FCF remains positively significant (*p*-value < 0.01) in Equation (16) and (15) but becomes marginally significant in Equation (17), with a marginal effects of 0.336 and 0.121 respectively, indicating that international firms do hedge in response to the overinvestment costs caused by high free cash flows held by managers. The interaction term *FCF*×*LOQ* is positively significant, suggesting firms which potentially face high overinvestment costs are more likely to engage hedging.

The evidence supports the financial distress hypothesis, consistent with our findings in the baseline model. Both the two liquidity measures *CURR* and *INCOV* are negatively significant in Equation (16) and Equation (17), as predicted in Chapter 3. The high current ratio implies high liquidity and the high interest cover ratio implies strong ability to pay financial obligations and relatively low risks of financial distress. Thus the negative coefficients imply that firms with lower expected costs of financial distress are less likely to hedge. According to the results of Equation (17), one percent increase in the interest coverage ratio leads to a slight decrease of 0.04 percent in the possibility of hedging. A one percent increase in the current ratio yields a decrease of 1.13 percent in the probability that a firm uses hedging instruments. The finding is consistent with our findings from the US, which show that the marginal effect of the interest coverage ratio is weaker than the marginal effect of the current ratio. This implies that the hedging policies of firms in the US and the UK are not highly sensitive to the change on the ratio, though the policies are significantly affected by the ability to pay interest on outstanding debts of a firm. This might reflect the fact that many firms set an acceptable minimum for interest coverage in their day-to-day financial management practices.

All of the leverage measures for financial distress hypothesis are statistically significant. The estimated coefficient of *LTDTA* is negative, consistent with results in section 6.2.1. *LEVTA* is found to be positively correlated with corporate hedging, while its squared term *SQLEVTA* is negatively correlated with hedging. These results are consistent with baseline model results. It is worth noting that *SQLEVTA* has almost the

strongest marginal effects (0.460) in the Equation (17). Assuming that leverage is proxy for the expected costs of financial distress, the high marginal effect implies that when a firm holds extremely high level of the debt, the expected costs of financial distress are so high that the distinction between financial distress and insolvency diminishes, and therefore the incentives of ex-post hedging fall substantially. In brief, regression results indicate that the cost of financial distress is an important determinant of hedging.

Managerial risk aversion hypothesis is the only hypothesis for which mixed support is found. *LINKTSR* is statistically significant and positively correlated with hedging, indicating that firms are more likely to hedge when the manager's benefits in the firm are highly undiversified with shareholders' return. However, *LINKTSR×EXEComp*, which is positively significant in baseline model, is insignificant in this model. The interaction between *LINKTSR* and Tobin's Q is positively correlated with hedging, but is not statistically significant either. It suggests that the effect of firm value on hedging is not different for whether manager's compensation is link to total shareholder return or not. Despite of the empirical evidence that hedging can increase the value of the firm (e.g. Allayannis and Weston, 2001; Bartram et al., 2011; Allayannis et al., 2012), adding value is not significant determinant of hedging for those firms which align shareholder/manager interests. The possible explanation is that the definition of hedging employed in this model includes all forms of derivative users rather than currency derivative users. *STKComp* and *EXEComp* are negatively and significant, consistent with our previous results.

The coefficient for *RDTA* is positive and significant, with the third highest Wald statistic among all explanatory variables. So growth opportunities remain an important determinant for hedging under an international context. *DY* is significant and has positive coefficient, consistent with the hedging substitute hypothesis. Hedging is more likely for firms with higher dividend yield. According to Equation (17), one percent increase in the dividend yield gives a decrease of 1.6 percent in the probability that a firm uses hedging instruments. The logistic results do not support Smith and Stulz (1985) tax explanation for hedging, as evidenced by the insignificant coefficients on the effective tax rate and low-tax dummy

variable. The results do not support Graham and Rogers (2002) explanation of increasing tax benefit on debt.

6.2.3 Foreign Exchange Rate Hedging

Next, we examine the use of currency derivatives for a sample of UK firms that have ex ante exposure to foreign exchange rate risk. The dependent variable is the dummy variable of the use of currency derivatives. The selection variable is the dummy variable of foreign exchange rate exposure. Logistic regressions are estimated using linear variable only (Equation 18) and including interaction terms (Equation 19). The results are shown in Table 6-4. Our diagnostic tests shows that the estimates are reliable. Overall, the results provide strong evidence for most of the hypotheses in the Chapter 3, apart from the hedging substitute hypothesis which is evidenced by mixed results.

Consistent with hypothesis and the results in the previous models, regressions find that high expected costs of agency problem provides strong motivation for hedging its foreign exchange rate (FX) exposure. To our knowledge, this is the first literature using UK sample to find strong evidence for overinvestment cost explanation for FX hedging. Most of UK empirical studies examining agency costs hypothesis focus on the underinvestment explanation for FX hedging (e.g. Joseph and Hewins, 1997; Judge 2006; Bartram et al., 2009). Free cash flows ratio and its interaction with dummy variable for low Tobin's Q are both highly significant (p-value<0.1 in Equation (18) and Equation (19), respectively) and positively correlated with dependent variable. Again, the results indicate that firms which are expected to have high overinvestment problem are more likely to use currency derivatives to eliminate high expected agency costs. It is interesting to note that $FCF \times LOQ$ has the second strongest marginal effect 0.897 in the model, implying that the use of currency derivatives is very sensitive to the increase of free cash flows when the expected costs of overinvestment is high. It is noticeable that this marginal effect of $FCF \times LOQ$ in Equation (19) is strongest among all the equations.

Table 6-4 Logistic regression results for FX model

		Equation (18)			Equation (19)	
Variables	Coefficient	ME	WS	Coefficient	ME	WS
Constant	-9.4453[a] (0.561)		182.419	-9.4324[a] (0.550)		303.882
LogTA	0.7215[a] (0.045)	0.1591	162.648	0.7098[a] (0.044)	0.1582	266.298
FATA	-.2707[a] (0.079)	-0.0597	11.809	-0.0881 (0.086)	-0.0196	0.015
RDTA	0.2820[a] (0.028)	0.0622	99.386	0.2786[a] (0.028)	0.0621	96.151
DEBTMATU				0.1789[a] (0.050)	0.0399	12.854
DEBTMATU×FATA				-0.1908[a] (0.062)	-0.0425	9.578
CAPEXPTA	0.0275 (0.018)	0.0061	2.448			
CURR	-0.0381 (0.024)	-0.0084	2.469	-0.0713[b] (0.029)	-0.0159	6.131
Year2002	0.6507[b] (0.329)	0.1264	3.918	0.7259[b] (0.340)	0.1408	4.548
INDUS	0.6517[a] (0.127)	0.1358	26.492	0.6286[a] (0.124)	0.1338	25.763
CONSUMG	1.0554[a] (0.213)	0.1920	24.474	1.2337[a] (0.212)	0.2196	33.739
CONSUMS	1.1737[a] (0.233)	0.2064	25.403	1.2365[a] (0.232)	0.2180	28.483
OIL	-0.5808[b] (0.272)	-0.1371	4.574	-0.4723[c] (0.271)	-0.1114	3.036
MATERL	-0.5168[a] (0.197)	-0.1206	6.895			
LTDTA	-0.0379[c] (0.021)	-0.0084	3.393	-0.0497[b] (0.021)	-0.0111	5.799
LEVTA	0.7704[a] (0.297)	0.1700	6.732			
SQLEVTA				-0.7962 (0.520)	-0.1775	0.126
LEV×HIQ				1.3303[a] (0.473)	0.2965	7.914
FCF	3.2492[a] (0.551)	0.7163	34.795	2.1256[a] (0.649)	0.4738	10.743
FCF×LOQ				3.2930[a] (0.993)	0.7340	11.006
STKOPT	-18.8959[c] (10.606)	-4.1660	3.175			
EXEComp	-0.0222[b] (0.010)	-0.0049	4.719	-0.0181[c] (0.010)	-0.0040	3.135
LINKTSR	0.4177[a] (0.144)	0.0904	8.372			
LINKTSR×INTLOP				0.0315[b] (0.014)	0.0070	5.163
LINKTSR×TOBINQ				0.2519[c] (0.014)	0.0561	3.574
ROA	0.0295[b] (0.014)	0.0065	8.372	0.0345[b] (0.014)	0.0077	5.934
CASH	0.0355[b] (0.018)	0.0078	4.039	0.0375[b] (0.018)	0.0084	4.346
LOWTAX×IGEAR				-0.0345[c] (0.021)	-0.0077	2.83
Panel B Summary Statistics						
Number of Observation	2736			2729		
Omnibus model test	1379.317[a]			1397.941[a]		
-2 Log likelihood	2240.757			2211.464		
Cox &Snell R	0.396			0.401		
Nagelkerke R	0.540			0.546		
Hosmer &Lemeshow test	9.175			8.467		
Percentage correctly classified	81.0[a]			81.3[a]		
K-S test on studentized residuals	8.718[a]	[a]		6.966[a]		
K-S test on standardized residuals	6.545[a]			6.452[a]		

[a], [b] and [c] denote statistical significance at a 1-, 5- and 10-percent level, respectively.

The results also strongly support underinvestment explanation for hedging. The coefficient for *DEBTMATU* is highly positively significant (*p*-value<0.01). It is interesting to note that, though the interaction term between debt maturity and fixed assets ratio *DEBTMATU×FATA* is insignificant in the international model, it has positively significant (*p*-value<0.01) coefficient in Equation (19). That is, the incentive of hedging FX exposures to alleviate costs of underinvestment becomes stronger with lower fixed assets ratio.

Managerial risk aversion and management compensation are found to be important determinant of currency hedging. The dummy variable of whether the manager's compensation of a firm is link to total shareholder return, *LINKTSR*, and its interaction terms *LINKTSR×TOBINQ*, *LINKTSR×INTLOP*, *LINKTSR×EXEComp* remain statistically significant in Equation (18) and Equation (19) (*p*-value ≤ 0.086). Linking managers' compensation to shareholder's benefits provides strong incentives to hedge FX exposures. According to the results, it will yield 9.04 percent increase in the likelihood of using currency derivatives. It is interesting to notice that, contrary to results that *LINKTSR×INTL* is statistically insignificant in baseline model, estimated coefficient of the interaction term is significant (*p*-value=0.050) and positively correlated with FX hedging. It implies that, though manager may not hedge in response to personal-wealth exposures affected by a firm's foreign operations, manager typically hedges to reduce exposures to exchange rate market risk. Similarly, the interaction between *LINKTSR* and Tobin's Q, which is not significant in the international model, is positively correlated with FX hedging and is statistically significant (*p*-value<0.1). This is the only one equation that shows that *LINKTSR×TOBINQ* is statistically significant, which implies that the effect of firm value on hedging is different for whether manager's compensation is link to total shareholder return or not. That is, a firm is more likely to hedge its FX risk with high Tobin's Q if it links managerial compensation to shareholder's return. This is consistent with Allayannis and Weston (2001), Mackay and Moeller (2007) and Allayannis et al. (2012) findings that hedging can increase the value of the firm. Between the two interaction terms of *LINKTSR*, *LINKTSR×INTLOP* has the higher Wald statistic but smaller marginal effect than *LINKTSR×TOBINQ*.

ROA is also positively significant at 5% level in Equation (18) and Equation (19), suggesting that a firm with better performance are more likely to execute ex-post FX hedging to protect its earnings.

The probability of financial distress also affects FX hedging, but the support is not as strong as in the baseline model. Equation 18 shows *LEVTA* is statistically significant (p-value<0.01) and positively correlated with FX hedging, indicating that firms hedge their FX risk to reduce the costs of financial distress (see also Purnanandam (2008) for the US firms). Consistently, the liquidity proxy *CURR* is negative and significant, indicating that since firms with high current ratio have enough resources to pay short-term obligations their needs to reduce costs of financial distress throughout hedging are decline. However, like Joseph and Hewins (1997), we find no evidence from the UK sample that interest coverage ratio is statistically significant on FX hedging. Surprisingly, the squared term of leverage *SQLEVTA* is negatively but not significantly. This implies that the negative relation at extremely high level of leverage is not very significant on determining the use of currency derivatives.

Interestingly, the regressions find evidence for supporting tax explanation for hedging. Among all models in this chapter, Equation for FX hedging is also the only one model that finds significant tax variable. According to Smith and Stulz (1985), if hedging is costly, which is more practical in the reality, hedging will still increases firm value only if transactions costs of hedging do not exceed the benefits of hedging. However, when the tax liabilities are low and hedging is costly, hedging does not always leads to significant benefits. Our results shows that estimated coefficient of interaction term between *LOWTAX* dummy variable and gearing ratio is negative (-0.033) and marginally significant. It is consistently with Haushalter (2000) and Graham and Rogers (2002) findings that tax incentive to hedge is also related to increasing debt capacity, and considering that there is positive relation between debt levels and tax rates (Graham et al., 1998), leverage and tax rate are be jointly determined with the corporate hedging activities. That is, if the tax rate of the firm drops to the lower third tax rates in the sample, ceteris paribus, the probability of using FX hedging instruments does not increase with the level of leverage increases. It

implies that if the tax liabilities are relatively small, the tax incentive to hedge is actually weakened. The corresponding unreported interaction term *HITAX*×*IGEAR* is positively correlated with hedging, but is not statistically significant.

The FX hedging model is also the only model finds weak evidence for hedging substitute hypothesis. The coefficient of *DY* is insignificant in Equation (18) and Equation (19), indicating that the payout policy of a firm does not affect the use of currency derivatives. The cash-asset ratio *CASH* has positively significant coefficient (*p*-value ≤ 0.050) in the Equation (18) and (19), implying that holding large amount of cash does not necessarily equivalent to negative impact on hedging. That is, the result rejects the hypothesis of substitute relationship between cash and hedging. This result is consistent with Judge's (2006) finding that firms with higher cash are more likely to hedge with derivatives. [20]

6.2.4 Interest Rate Hedging

This section examines the use of interest rate derivatives to hedge the exposure of interest rate risk among domestic and multinational U.K. firms (Equation (20)) and Equation (21)) and using both linear and interaction terms. The diagnostic tests are acceptable. The Interest Rate Hedging (IR) models provide similar analysis to that in FX models except the dependent variable is the dummy variable of the use of interest rate derivative. Table 6-5 reports the logistic regression for currency hedging. Since interest rate (IR) hedging aims to reduce the interest rate exposure to firm's debt obligations, the results for leverage related variables are strong.

[20] Judge (2006, pp417) defined cash ratio as the total cash and cash equivalents divided by current liabilities. Cash ratio is a better proxy for liquidity condition of a firm, while the cash-assets ratio used in this study has been the preferred measure of cash holding in many finance studies. However, since Judge (2006) classifies the cash ratio as proxy for hedging substitutes, we believe the results are still comparable.

Table 6-5 Logistic regression results for interest rate hedging

Variables	Equation (20) Coefficient	ME	WS	Equation (21) Coefficient	ME	WS
Constant	-10.2786[a] (0.844)		148.425	-9.0105[a] (0.820)		120.723
LogTA	0.6568[a] (0.097)	0.1627	46.038	0.4823[a] (0.095)	0.1191	25.967
LogMV	0.1587[c] (0.087)	0.0393	3.299	0.2376[a] (0.087)	0.0587	7.418
DY	0.0961[a] (0.025)	0.0238	14.851	0.1024[a] (0.026)	0.0253	15.829
TOBINQ	0.1609c (0.098)	0.0399	2.699			
FATA	-0.2012[b] (0.095)	-0.0498	4.526			
DEBTMATU	0.2558[a] (0.040)	0.0634	40.277	0.5827[a] (0.163)	0.1440	12.801
DEBTMATU×FATA				-0.0494[c] (0.029)	-0.0122	2.838
INCOV	-0.0119[a] (0.003)	-0.0030	19.858	-0.0092[a] (0.003)	-0.0023	11.446
CURR	0.2946[a] (0.054)	-0.0730	29.825	-0.2090[a] (0.056)	-0.0159	6.131
TELECOM	-1.063[b] (0.429)	-0.2538	6.128	-1.3094[a] (0.411)	-0.3050	0.001
UTILIT	-0.9745[c] (0.516)	-0.2345	3.568	-0.9732[c] (0.507)	-0.2351	3.685
CONSUMS				0.5434[b] (0.230)	0.1287	5.603
OIL	0.4093 (0.309)	0.0985	1.751			
CONVERDEBT	-1.1535[a] (0.429)	-0.2858	7.229	-0.9933[b] (0.471)	-0.2454	4.446
Z-Score	0.1211[b] (0.058)	0.0300	4.422			
LEVTA	3.3549[a] (0.467)	0.8313	51.614	7.1437[a] (0.894)	1.7648	63.845
SQLEVTA				-5.4423[a] (1.055)	-1.3445	26.62
LEV×LOQ				-5.0334[a] (0.975)	-1.2435	26.652
FCF	1.5608[b] (0.717)	0.3868	4.734	2.2515[a] (0.707)	0.5562	10.155
FCF×STKComp				-0.5736[a] (0.471)	-0.1417	7.872
STKComp	-0.0343[c] (0.020)	-0.0085	3.072			
EXEComp	-0.0330[a] (0.012)	-0.0082	7.197	-0.0293[b] (0.012)	-0.0072	5.945
LINKTSR						
LINKTSR×INTLOP				0.0275[c] (0.015)	0.0068	3.237
CASH	0.0434[b] (0.019)	0.0108	5.109			
PRIVOL	-0.0167[b] (0.008)	-0.0041	4.376			

Panel B Summary Statistics		
Number of Observation	2597	2603
Omnibus model test	1654.951[a]	1710.853[a]
-2 Log likelihood	1915.654	1869.406
Cox &Snell R	0.471	0.482
Nagelkerke R	0.631	0.645
Hosmer &Lemeshow test	11.751	12.865
Percentage correctly classified	83.4[a]	83.4[a]
K-S test on studentized residuals	23.974[a]	18.580[a]
K-S test on standardized residuals	4.286[a]	4.211[a]

[a] ,[b] and [c] denote statistical significance at a 1-, 5- and 10-percent level, respectively.

The results in Table 6-5 show similar strong results for financial distress hypothesis to that in the baseline models. Coefficients of liquidity ratios *INCOV* and *CURR* are highly significant at 1% level in Equation (20) and Equation (21), indicating a negative relationship between liquidity and interest rate hedging. The leverage ratio *LEVTA* is positively correlated with hedging as expected, and *SQLEVTA* is negatively correlated with hedging. Both the two variables are highly significant (p-value<0.01) and have strong marginal effects in Equation (21). In addition, among all models in our analysis on the UK firms, the marginal effects of the two leverage variables in IR models are the strongest. This suggests that the cost of financial distress provides larger marginal change on the likelihood of interest rate hedging with derivatives than that hedging of other types of exposures. *LEVTA* also has the highest Wald statistic in both models as expected, indicating that cost of financial distress is the most important determinants of interest rate hedging. UK firms use interest rate derivatives to hedge the exposure to changes in interest rate relates to their debts in order to reduce the costs of financial distress.[21]

Consistent with hypothesis that hedging can alleviate cost of overinvestment arising from free cash-flows agency problem, the results show that *FCF* is significant (p-value ≤ 0.05) and positively correlated with the use of IR derivatives in Equation (20) and Equation (21). The marginal effects are also strong. Interestingly, we find a negative and highly significant (p-value<0.01) relation between IR hedging and the interaction term between leverage and the dummy variable of low Tobin's Q. In addition, Equation (21) is the only equation which we find a statistically significant relation with the interaction term *LEV×LOQ*. The interaction term is the second most important independent variable in the model and has the third strongest interaction effect and marginal effect after *LEVTA* and *SQLEVTA*. The results are consistent with Jensen's (1986) argument that the debt can help to alleviate overinvestment problem by reducing the available cash flows for discretionary spending which, in turn, reduces the incentive to hedge to control these agency costs of free cash flows (Morellec and Smith, 2007). For firms which are expected

[21] The results shows very strong leverage incentives of using IR derivatives. Though it offers support for costs of financial distress theory for hedging, it also raise question that are the positive correlation between leverage and use of IR derivatives driven by the large benefits from successful speculation (see Faulkender, 2005; Chernenko and Faulkender, 2011). This will be further discussed later in this section.

to have high costs of overinvestment, high level of debt reduces the possibility of using interest rate derivatives. Correspondingly we find a positive relation between the use of IR derivatives and *LEV*×*HIQ*, the interaction term between leverage and the dummy variable of high Tobin's Q [22]. The interaction term between free cash flows and stock-based compensation is statistically significant at a 1% level in Equation (21) but surprisingly has a negative coefficient. The negative correlation implies that the incentive to use IR derivatives to reduce overinvestment costs is greater when the total stock-based compensation of employees of a firm is lower.

The coefficient for *DEBTMATU* is positive and significant in Equation (20) and Equation (21). This result is consistent with hypothesis that hedging can alleviate cost of underinvestment arising from shareholder-bondholder conflicts. In addition, the square term and the interaction term of *DEBTMATU* with fixed assets ratio (*FATA*) are also significant (p-value ≤ 0.100) and negatively correlated with the use of IR derivatives (see Equation (21)). The negative relation between IR hedging and *DEBTMATU*×*FATA* implies that, for firms holding low fixed assets, the incentive of reducing cost of underinvestment has strong positive effect on hedging. The negative sign of the coefficient of *SQDEBTMATU* indicates there is a nonlinear relation of debt maturity and IR hedging. The extremely long debt maturity lowers the likelihood of IR hedging.

Contrary to the regression results from FX hedging (Equation (18) and Equation (19), the results from IR hedging regressions provides strong evidence for hedging substitute hypothesis. The coefficients are significant (p-value < 0.05) in Equation (20) Equation (21). The negative coefficient for convertible debt suggests that the use of convertible debts reduces the incentives of hedging to control agency costs of shareholder-bondholder conflicts. Dividend yield is statistically significant at 1% level and positively correlated with IR hedging, indicating that the firms that pay high dividends are more likely to hedge use interest rate derivatives. The marginal effect of *CONVERDEBT* on interest rate hedging is much stronger

[22] However, this interaction term is not statistically significant so it is not presented in the final model.

than that of *DY*. This may be because interest rate hedging aims to reduce the interest rate exposure to firm's debt obligations.

The evidence shows UK firms hedge interest rate exposure due to the economies of scale. The coefficients for *LogTA* and *LogMV* (see Table 6-5) are both positive and statistically significant (*p*-value ≤ 0.10). However, there is no support for the growth opportunities and taxation hypotheses. The plausible explanation is that the interest rate in the UK is less volatile than the rate in the US (Verdelhan, 2010). Compare to the US firms, the adverse impact from the change of interest rate on the investment funds and debt capacity of a UK firm is smaller. Thus the tax incentives and growth opportunities incentives of interest rate hedging are weak in the UK. This finding implies country differences in the way that the macroeconomic factors influence corporate hedging policy. In addition, no year dummy variable is statistically significant from zero in the IR model, suggesting that the influence of macroeconomy on IR hedging is not significant. Chernenko and Faulkender (2011) argue that the use of derivatives should not change significantly from year to year, assuming that a firm's exposure to interest rate risk of their operations is stable over time. Consistently, the regressions do not find any evidence that UK firms use IR derivatives to manage earnings or performance.

6.3 Summary and Implications

The main objective of this chapter was to examine the determinants of corporate hedging amongst the UK firms. The baseline model provides support for several theoretical explanations for corporate hedging behaviour. The second model, estimating under international operating context, provides insights on the determinants of corporate hedging. The third and fourth models assess the problem in terms of the types of risk exposures. All the models provide new evidence that largely support theoretical predictions.

We find that UK firms hedge to reduce the agency costs arising from overinvestment and underinvestment problem. Proxies of high agency costs of overinvestment, such as free cash flow and its interaction term with dummy variable of low Tobin's Q, are highly significant in all models and are positively correlated with hedging. The results also imply that the use of FX derivatives is very sensitive to the increase of free cash flow when the expected costs of overinvestment is high. Proxies of high agency costs of underinvestment, such as debt maturity and interaction terms of dummy variable of high Tobin's Q, are also highly significant in all models and has positive correlation with hedging. Interestingly, we find that the effects of underinvestment on hedging are stronger for UK firms compared with US firms. Also, the effects of overinvestment incentives of US firms are stronger than those of UK firms. These findings are in line with Franks et al. (1996) argument that the legal arrangements in the UK are very creditor-friendly, thereby increasing the cost of underinvestment. Similarly, the equity-friendly nature of US legal arrangements increases the probability of overinvestment.

There is also support for the financial distress motives. Firms with high liquidity position and the ability to meet expected dividend stream are less likely to engage hedging, consistent with previous empirical findings. There is a positive relation between leverage and hedging for firms with moderate level of debt, but such relation become significantly negative for the firms which holding extremely high level of debt. However, we fail to find evidence that the incentives of hedging to reduce costs of financial distress are

stronger in the UK firms than the US firms. One possible reason is that managers are aware of the high expected costs of financial distress when making financing decisions, and therefore they are less concern about such problems when making ex-post hedging decisions.

We also find a positive relation between the size of firm and hedging. Economies of scale in the costs for establishing and managing a hedging programme. It is the most important determinant of using derivatives and hedging foreign exchange rate risk in our models, but is less important on the use of interest rate derivatives. Similarly, firms with high growth opportunities tends to hedge their financial risks, but such incentive does not significantly influence the use of interest rate derivatives.

Our results support the managerial risk preference theory for hedging. A firm is more likely to hedge when managerial claims are linked with shareholder's return. The marginal effect of this incentive on hedging is even stronger under international operating context, where firms face more complicated exposures of market risks than domestic operating environment. Consistently, the results show that, for firms whose manager's compensation linked to the shareholder's wealth, the higher international operating income is, the more likely that the firm will use hedging instruments. In addition, in line with the findings that hedging affects firm value from previous literature, our empirical results from FX model suggests that manager hedges in response to manage firm value. A firm with high Tobin's Q is more likely to hedge its FX risk if manager's compensation link to shareholder's benefits in the firm. The incentive compensation package can change manager's risk preference and increases manager's incentives to take on risky projects. As such, incentive compensation such as stock-based compensation including stock options is negatively related to hedging.

Overviewing the results, we conclude that multinational firms behave differently from domestic firms on the use of derivatives for hedging. Domestic and international markets present different risk to firms that hedge although our conclusions for not change substantially.

CHAPTER 7
FINANCIAL CHARACTERISTICS OF FIRMS AND CORPORATE HEDGING: A FACTOR ANALYSIS APPROACH

7.1 Introduction

The previous chapter shows that firms have incentives to use derivatives to ease agency conflicts and managerial risk aversion. Derivatives can be used for hedging to mitigate risks for all investors. However, managerial self-interest can also enforce excessive corporate hedging, especially when firms have poor corporate governance arrangements. The previous chapters also suggest that corporate governance is endogenous to corporate hedging decisions and other financial policies. In this chapter, emphasis is given to the impact of corporate governance on the relationship between the firm's financial characteristics and the corporate hedging. We hypothesise that internal (firm-level) and external (country-level) corporate governance characteristics influence a firm's motivation to use derivatives. To do this, we examine US and UK firms. This will allow us to identify the internal corporate governance characteristics of an individual firm which determine hedging behaviour and will provide a further insight into corporate hedging behaviour. We expect that the characteristics of agency conflicts, board structure and executive compensation for US and UK firms will also differentiate hedging behaviour. The purpose of this chapter, therefore, is to analyse the impact of firm-level corporate governance on firms' use of derivatives in the US and the UK. A factor analysis approach is employed at first to extract the main dimensions of variation in financial characteristics. This approach enables us to identify the determinants of corporate hedging in terms of the financial variables that give rise to the greatest variability in the financial performance of the sample of firms. We also perform the factor analysis to form a basis for comparison. The impact of corporate governance variables on the financial variables correlated with these factors is then assessed through logistic regressions.

7.2 Factor Analysis

We explore a principal components factor analysis approach to extract the main dimensions of variation in the firms' financial characteristics for US and UK hedgers and non-hedgers. Section 7.2.1 discusses the empirical results for firms that undertake all forms of hedging compared with non-hedgers. The form of hedging activity undertaken by firms can affect their financial performance. Therefore, section 7.2.2 presents the results for foreign exchange rate hedging against non-hedgers, while section 7.2.3 discusses the results for interest rate hedging. We ignore other forms of hedging because of the small sample size.

7.2.1 Firms using all types of hedging instruments

Table 7-1 shows the loadings from the factor analytical results for both US and UK firms that hedge and those that do not hedge. Here, we do not make a distinction between the forms of hedging undertaken by firms. Panel A of Table 7-1 shows that for US firms, the factor loadings for any one variable exceed 0.4 in absolute value whether or not the firm is a hedger. The variables for US hedgers load onto six factors and they explain up to 60% of the total variation in the data compared to 63% for non-hedgers.

For US hedgers, factor 1 captures 18.59% of the variation in the data and loads heavily onto the *Z-score* and interest coverage ratio, but has moderate negative loadings on leverage and debt maturity. This factor appears to capture financial distress. It implies that hedgers have more variability in financial distress and as such are more likely to hedge to reduce the risk of financial distress (Smith & Stultz, 1985). So, this finding is consistent with theory. Notice that the coefficients for the *Z-score*, *INCOV* and *TOBINQ* are highest (above 76%). These variables give hedgers the greatest variability. Pérez-González and Yun (2013) find that US firms that use weather derivatives increase their market-to-book ratios by at least 6%, whereas Jin and Jorion (2006) do not find that risk management affects the value of firms (see Guay and

Kothari, 2003). In our case, the Tobin's Q is closely related to book-to-market ratio and since we find strong variability for Tobin's Q for hedgers, our results indirectly support Pérez-González and Yun's (2013) finding. Consistently, factor 1 also contains a tax variable simulated marginal tax rate (*MTR*) with a positive loading of 0.322, as reducing the variability of expected tax liability increases the post-tax value of the firm. Notwithstanding the small loading, the importance of this result is consistent with Smith and Stulz (1985) and Graham and Rogers (2002), who find that leverage incentives of hedging appear to be tax motivated, providing empirical support for the taxation hypothesis for hedging.

Factor 2 is a size factor, with heavily positive loadings on the natural logarithm of total assets and market value, and S&P long-term debt ratings which arguably reflect the size of firm. The contract costs of derivatives may increase if a hedger's credit rating is below a certain level, resulting in higher costs of hedging.[23] Thus it is not surprising that debt credit rating generates a large variation amongst the determinants of hedging for hedgers. For the size variables, economy of scale has great explanatory power in elucidating the variation amongst US hedgers. The fact that size and credit ratings are positively correlated with factor 2 suggests that firms with a higher rating are among the largest in the sample, which is not surprising.

Factor 3 appears to represent the hedging substitutes variable. Factor 4 loads heavily onto capital expenditure ratios and loads mildly on free cash flow. Since the two capital expenditure ratios are investment measures indicating whether managers attempt to increase the size of their firms and free cash flow is a proxy for overinvestment, we interpret factor 4 as the agency problems factor. Factor 5 loads onto fixed assets over total assets (*FATA*) and investment tax credit. It is an investment opportunity and taxation factor, whereas factor 6 is a R&D and beta (systematic risk) factor. We can interpret factor 6 as a growth opportunities factor. If firms hedge, then systematic risk will be reduced; however, firms also hedge to reduce investment distortions (see Froot et al., 1993), which can have implications for growth opportunities. Notice that beta loads heavily onto factor 1 for non-hedgers, so in this regard non-hedging

[23] For example, Emerson Electric Co. and CenterPoint Energy Inc. reported in their 10-K statement that additional collateral might be required if the rating were downgraded.

creates more variability for non-hedgers, which is expected. The results are surprising because the investment- cash flow factors are expected to explain most variance amongst hedgers. However, the empirical results show that the cash flow related factor, agency problem factor and growth factor are just the fourth and sixth factors for US hedgers respectively. The possibility considered is that the variable *ROA* captures part of the cash flow variability. The situation in non-hedgers is the opposite and will be discussed below.

Factor 1 for US non-hedgers has positive loadings on return on assets, free cash flow ratio, and simulated marginal tax rate, and negative loading on R&D expenditure. These explanatory variables account for 15.49% of the variability in the data. This can be interpreted as an investment and tax related factor. Notice that only *ROA* and *MTR* also have loadings on factor 1 for hedgers, implying that *ROA* and tax liability are important for both groups of firms. This might explain why prior empirical research has found mixed results on the taxation hypothesis for hedging. The financial distress measure for hedgers does not also load unto factor 1 for non-hedgers, so financial distress is less important for non-hedgers. Notwithstanding the negative and low loading, R&D is surprisingly in factor 1 this time, compared with its earlier location, which is loaded onto the last factor for the US hedgers. Taken together, the results suggest that hedgers do not vary on the growth opportunities, but non-hedgers vary largely along the growth and cash flows. A plausible explanation is that hedgers hedge their cash flow to protect their valuable growth opportunities, so that the ex-post R&D spending and cash flow are less varied.

Factor 2 and factor 4 are related to leverage and financial distress. Leverage and financial distress have less explanatory power for the US non-hedgers compared with results for hedgers, where the financial distress factor explains the largest portion of the variance. Factor 3 is the size factor. Non-hedgers are less concerned about the credit ratings, maybe because of lower levels of debt or an absence of derivative contracts costs. Factor 5 can be identified with the agency problem, factor 6 with hedging substitutes.

Table 7-1 Factor Analysis for firms that use all forms of hedging compared with non-hedgers[a]

Panel A: Factor Loadings for US hedgers and non-hedging

	Hedgers						Non-hedgers					
Variable	1	2	3	4	5	6	1	2	3	4	5	6
Zscore	0.837									0.596		
INCOV	0.804							0.555				
TOBINQ	0.761							0.668				
ROA	0.640						0.861					
LEVTA	-0.554							-0.480				
DEBTMATU	-0.554							-0.551				
MTR	0.322						0.676					
LogTA		0.907							0.830			
LogMV		0.888							0.859			
SPRATING		0.704							0.735			
CONVERDEBT			0.677									0.522
CURR			0.554							0.836		
CASH			0.548					0.721				
SKTComp			0.430							0.691		
CAPEXTA				0.858							0.880	
CAPEXPPE				0.709							0.686	
FCF				-0.589			0.796					
FATA					0.790			-0.754				
ITC					-0.759							-0.618
DY					-0.415							-0.691
R&D						-0.705	-0.491					
BETA						0.575						
VP	18.585	11.609	8.086	8.005	7.099	6.098	15.486	14.114	10.836	8.073	8.048	6.862
CVP	18.585	30.194	38.280	46.285	53.385	59.482	15.486	29.600	40.436	48.509	56.557	63.419

Panel B: Factor Loadings for UK

	Hedgers							Non-hedgers						
Variable	1	2	3	4	5	6	7	1	2	3	4	5	6	7
LogMV	0.922								0.741					
LogTA	0.883								0.759					
DY	0.649								0.718					
TOBINQ		0.795									0.391			
LEVTA		0.772								0.641				
CURR		-0.552									0.670			
DEBTMATU		0.485								0.778				
Zscore			0.693					0.878						
FCF			0.690					0.843						
INCOV			0.544							-0.558				
FATA			-0.446									0.727		
CASH				0.667										0.604
CAPEXTA					0.694								0.728	
CONVERDEBT					0.479								0.514	
R&D					-0.441									0.441
CAPEXPPE					-0.320						0.602			
ROA						-0.733						0.443		
STKComp						0.616							-0.433	
TRX							0.821							0.554
VP	12.280	11.951	10.118	6.365	6.256	5.864	5.395	12.836	9.541	8.761	7.651	6.393	6.257	5.647
CVP	12.280	24.231	34.349	40.714	46.971	52.835	58.230	12.836	22.377	31.138	38.789	45.182	51.44	57.086

[a]For each variable and factor, we attribute the variable with the highest factor score as primarily loading onto the specific factor. Having identified this variable and factor score, the remaining factor scores are set to zero.

Table 7-1 Panel B reports the loadings on the factors in the UK sample. The results for firms in the UK are generally consistent with those of the US. We find that the size factor has strong explanatory power in both the US and the UK. The first factor in the UK hedgers is size, on which the natural log of market value (*LogMV*) and total assets (*LogTA*) load heavily, capturing 12.28% of total variance. The fact that dividend yield and *LogMV* and *LogTA* are positively correlated suggests that dividend may relate to those variables (see Denis & Osobov, 2009; Fama & French, 2001). UK hedgers also have higher dividend variability than US hedgers. Since UK firms pay a higher dividend compared to US firms (Ferris, Sen, & Unlu, 2009), this in turn may suggest that dividend payment in the UK is more variable.

Factor 2 has positive loading on leverage variables and negative loading on current ratio, representing the leverage factor. So, leverage has strong effects for UK hedgers, but not as strong as for US hedgers. This finding is unexpected for UK hedgers since, unlike the US, the UK bankruptcy code favours the rights of creditors or even the largest creditor much more than in the US, thereby forcing the UK firm into bankruptcy more quickly than in the US (see also Franks & Touros, 1993). Thus, given the financial regulatory environment of the UK, we would have expected UK firms to show more variability on leverage measures than US firms. Our finding also contradicts the suggestion of Judge (2006) that financial distress cost factors are more significant for UK firms than for US firms, because UK bankruptcy codes are in favour of creditors' rights, which results in higher expected costs of financial distress in the UK. However, a creditor-friendly bankruptcy system may prompt firms to maintain a reasonable debt level, resulting in a reduction of expected costs of financial distress. An alternative view for our results can be that because of the UK bankruptcy code, UK firms hedge more than US firms, thereby reducing the variability of these measures much more than for US firms. However, survey-based results show that a larger proportion of US firms hedge both interest and FX rate exposure than UK firms.[24] However, a creditor-friendly bankruptcy system may prompt firms to maintain a reasonable debt level, resulting in a reduction of expected costs of financial distress.

[24] Almost a similar percentage of UK firms hedge FX rate (71.79%) and interest rate (68.22%) exposures (Panaretou, 2014). These percentages contrast with the percentages of US firms that hedge. Bodnar, Hayt and Marston (1998) show that 83% of US firms use derivatives to manage FX rate risk, whereas 76% also use derivatives to manage interest rate risk, interest rate risk being the second most important risk managed by US firms.

For Factor 3, *Z-score* has the highest loading of 0.693, followed by free cash flow ratio (*FCF*) with a loading of 0.690. Fixed assets ratio (*FATA*) has a negative loading on factor 3. A firm's level of fixed assets should be positively related to its debt level. Conversely, a higher level of debt lowers the free cash flow and increases the costs of financial distress. Thus *FATA* is negatively related to *Z-score* and *FCF*. The leverage and financial distress factors (i.e. factor 2 and factor 3) have less explanatory power for the UK hedgers compared with the US. Bargeron, Lehn and Zutter (2010) find that the incidence of corporate fraud and managements' preferences of risk taking reduces after the Sarbanes-Oxley Act of 2002. In addition, the US firms' cash holding has increased since then, as compared with UK firms. Our results may imply that the change of regulation environment influences the motives for corporate hedging. Having said that, leverage and financial distress costs still explain a large portion of the variability in UK hedgers.

Factor 4 has only one loading on cash holding. The highest loading of factor 5 is on capital expenditure over assets. The loadings range from -0.320 to 0.479 for the rest of the variables. Thus, this can be identified with investment. Factor 6 can be identified with managerial incentive and factor 7 with taxation. The fact that the tax factor has relatively small explanatory power is consistent with Joseph's (2000) prediction that tax measures for UK hedgers should have a lower degree of variability.

UK non-hedgers have large variability in agency costs. Factor 1 for UK non-hedgers captures 12.84% of total variance. *Z-score* and free cash flow/total assets (*FCF*) are the only variables that load onto factor 1. The finding that both *Z-score* and *FCF* have high positive loading scores for factor 1 is consistent with Jensen's (1986) free cash flow theory. Those variables only load onto factor 3 for hedgers. Firms face a trade-off between debt benefit of controlling an overinvestment problem from high free cash flow and the high financial distress costs from increasing debt. These costs differ across UK non-hedgers and affect their hedging policies. Factor 2 for UK non-hedgers can be identified with size, factor 3 with leverage, factor 4 with investment, factor 5 with managerial incentive and factor 6 with risk taking. Factor 7 can

represent cash flow and tax. Note that tax explains a large portion of variation in US firms, while it is much less important in the UK firms. Such a difference may be due to different tax measures and tax code differences between the UK and US.

Overall, the results from factor analysis suggest that US and UK hedgers and non-hedgers have different levels of variability on the measures. The theories for hedging predict that corporate hedging will lead to different outcomes for hedgers and non-hedgers. If the financial characteristics of hedgers and non-hedgers differ because some firms hedge and others do not, then this should lead to differences in the variability of the financial measures. This is exactly what we find for both US and UK firms. So the strategies of hedging or not hedging lead to different outcomes. Hedgers are mostly influenced by financial distress, tax and size, while non-hedgers are mostly influenced by cash flow, investment, tax and financial distress. Non-hedgers have more variability in cash flow and less variability in financial distress than hedgers. In the next section, we separate out the firms according to the specific derivative instrument use. In this case, the following analysis is limited to firms that only use FX rate derivatives or interest rate derivatives, since the samples for use of other types of derivatives is too small.

7.2.2 Firms only using FX hedging instruments

A second, more focused factor analysis is conducted for firms that use FX rate derivatives only compared with non-hedgers. This approach is adopted because prior work suggests that the choice of derivatives use has different effects on financial performance (Joseph, 2000). Table 7-2 Panel A reports the loadings on the factors for US firms. The results are not very different from the results from all forms of hedging. Factor 1 captures 12.73% of the variation, ranging from a loading of 0.62 on *Z-score* to a loading of 0.73 on return on assets (*ROA*), which reflects profitability and is closely associated with cash flow. This factor appears to capture cash flow and financial distress. The second factor, capturing 14.23% of the variation, has negative loading on cash to total assets, and positive loading on ratings, fixed assets ratio and dividend

yield. These variables appear to capture cash holding. That is, the first two factors appear to captures a firm's cash flow and the expected costs of financial distress. This suggests that financial distress remains a strong explanatory power for variation for US currency hedgers. Interestingly, however, cash flow appears to become an important factor and explains a large portion of the variation. It can be argued that because firms tend to hedge their foreign exchange rate exposure from operation to reduce the variability of cash flow, the weak results of cash flow in the all-type hedging sample is due to the mixture of currency hedging and other types of hedging.

Compared with results from the all-type hedging sample, the size factor slightly weakens, moving from the second factor to the third factor for US currency hedgers. This may be because firms with significant international operation normally have large foreign exchange rate exposure, and therefore are more likely to hedge foreign exchange rate risk.

Factor 4 has positive loadings on convertible debt, current ratio and stock-based compensation expense, which arguably affect the hedging that risk-averse managers undertake. This can be interpreted as the hedging substitutes factor. Factor 5 captures growth opportunities and tax, with a loading of 0.891 on *Beta* which arguably reflects firms' cost of accessing equity capital, 0.433 on *MTR*, and a negative loading on R&D expenditure. This suggests that firms with higher volatility and costs of accessing equity capital have lower R&D expenditure. FX hedgers face cross-sectional variability in firms' costs of equity financing and marginal tax rate, but such variability is not as significant as it is in financial distress and cash flows. It is noticeable that the explanatory power of marginal tax rate on variation in US hedgers largely decreases in this subsample, as compared with previous results. This result can imply that US hedger firms do not place as strong an emphasis on tax as on the other types of hedging (e.g. interest rate hedging and commodity hedging), if indeed hedging leads to reduced variability of financial measures. In general, prior studies do not find strong support for tax measures as a determinant of hedging (e.g. Allayannis & Ofek, 2001; Géczy et al., 1997). Factor 6 captures investments and has the least variability for hedgers. This finding does not provide strong support for investment distortions (see Froot et al., 1993).

Table 7-2 Factor Analysis for firms that use only FX derivatives compared with non-hedgers[a]

Panel A: Factor Loadings for US firms

	Hedgers						Non-hedgers					
Variable	1	2	3	4	5	6	1	2	3	4	5	6
Z-Score	0.752									0.605		
INCOV	0.505						0.695					
TOBINQ	0.709						0.668					
FCF	0.707							0.849				
ROA	0.668							0.859				
CURR	0.631									0.834		
CASH		-0.731					0.622					
FATA		0.640					-0.690					
DY		0.620										-0.560
SPRATING		0.613							0.718			
LogTA			0.839						0.891			
LogMV			0.819						0.831			
SKTComp			0.602							0.662		
LEVTA				0.735			-0.644					
CONVERDEBT				0.735								0.725
DEBTMATU				0.632			-0.691					
BETA					0.891							0.602
R&D					-0.846							0.430
MTR					0.433			0.652				
CAPEXTA						0.841					0.891	
CAPEXPPE						0.663					0.716	
VP	15.969	14.231	10.194	10.077	8.701	7.515	15.848	13.350	11.477	8.448	8.360	8.257
CVP	15.969	30.199	40.394	50.471	59.172	66.687	15.848	29.198	40.675	49.123	57.484	65.740

Panel B: Factor Loadings for UK firms

	Hedgers							Non-hedgers						
Variable	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Z-Score	0.801							0.611	-0.476					
INCOV	0.773								-0.647					
FCF	0.653							0.580						
LEVTA	-0.635		0.413						0.753					
DEBTMATU	-0.600								0.664					
FATA	-0.469			0.457							0.766			
LogMV		0.899						0.786						
LogTA		0.875						0.890						
STKComp		0.594												0.868
CONVERDEBT		0.447										0.569		
TOBINQ			0.703							0.404				
CURR			-0.711							0.623				
CAPEXTA				0.801								0.668		
CAPEXPPE				-0.444						0.626				
ROA					0.763					-0.533				
CASH					0.589								0.594	
DY						0.699		0.309				-0.332	-0.397	-0.365
R&D						0.594							0.410	
TXR							0.786						0.483	
VP	15.822	13.263	7.265	6.559	6.517	6.495	6.495	13.787	10.519	8.440	6.748	6.424	5.761	5.566
CVP	15.822	29.085	36.350	42.909	49.426	55.922	61.954	13.787	24.305	32.745	39.492	45.916	51.677	57.243

[a]For each variable and factor, we attribute the variable with the highest factor score as primarily loading onto the specific factor. Having identified this variable and factor score, the remaining factor scores are set to zero.

We find that factor analysis results for US FX non-hedgers are almost the same as for hedgers. Financial distress, cash flow and size factors continue to capture a large portion of variations. However, *MTR*, the simulated marginal tax rate, is the second factor for FX non-hedgers. This is interesting, because the position of *MTR* is exactly the opposite of its position for FX hedgers, suggesting that FX non-hedgers have more variability on tax. Investment factor and hedging substitutes are the fifth and sixth factors for non-hedgers.

Table 7-2 Panel B reports the loadings on the factors for the UK sample. The financial distress factor remains the first factor for UK hedgers and the second factor for non-hedgers, capturing 15.8% and 13.8% of total variance respectively. UK firms choose to execute hedging for their foreign exposure because of greater variability on the costs of financial distress. This is consistent with the results from the US sample.

Size is the second most important factor for FX-only hedgers. The fourth factor loads onto investment intensity ratios and therefore represents investment intensity. Factor 5 loads onto *ROA* and *CASH*, capturing cash flows. It appears that cash flow only has moderate explanatory power on the variation in the UK FX hedgers. Compared with the magnitude of cash flow factor for non-hedgers, in which the cash flow factor explains an even smaller percentage of total variance, UK FX hedgers have larger variability in the cash flows. Such a finding is consistent with the interpretation that firms eliminate some, but not all of the variability in cash flows to a reasonable, lesser extent by hedging.[25]

[25] Readers should note that this factor analysis is for FX-only hedging. It does not include the cases that hedge FX and other types of exposure. The results from this factor analysis do not mean FX hedgers do not have large variability in cash flow. In an unreported factor analysis which includes all FX hedgers, we find that cash flow is the second factor for hedgers, suggesting that FX hedgers have large cash flow variability form foreign exchange exposure.

7.2.3 Firms only using interest rate hedging instruments

The third factor analysis is conducted for the interest rate-only hedging sample, which contains firms that only hedge or do not hedge their interest rate (IR) exposure. Table 7-3 Panel A and Panel B report the loadings on the factors for the US and the UK respectively. The results shows that the size factor explains the largest portion of variations in the interest rate hedgers, followed by leverage and financial distress as the second and third factors. Factor 4 captures the costs of overinvestment and factor 5 represents the investment factor. These two factors are both closely associated with cash flow. That is, interest rate hedgers emphasise the costs of financial distress more than the variability of cash flows. This is consistent with expectation, since interest rate hedging is largely associated with tailoring debt and the costs of debt financing (Bodnar et al., 1998; Li & Mao, 2003; Visvanathan, 1998).

Not only is financial distress the most important factor for US interest rate hedgers, but it also explains large proportion of variability for non-hedgers. Factor 1 for IR non-hedgers captures liquidity and factor 4 represents the financial distress factor. Together, the two factors capture 24.31% of total variance, which is almost as large as the two financial distress costs factors for IR hedgers. The results suggest that both IR hedgers and non-hedgers face large variability in the costs of financial distress. Interest rate hedging does not eliminate variability, but it allows firms to reduce the variability to a reasonable, lesser extent, which is equivalent to non-hedgers.

Factor 2 for the US IR non-hedgers loads on *FCF*, *ROA* and *MTR*, capturing 13.35% of total variance. Thus this factor captures cash flow and tax, suggesting that non-hedgers have greater variabilities in cash flow and tax. This result is consistent with the results from FX non-hedgers. The hedging substitutes factor has relatively small explanatory power, as it does for all-type non-hedgers and FX non-hedgers.

Table 7-3 Factor Analysis for firms that use only interest rate derivatives compared with non-hedgers[a]

Panel A: Factor Loadings for US firms

	Hedgers						Non-hedger					
Variable	1	2	3	4	5	6	1	2	3	4	5	6
LogTA	0.908								0.891			
LogMV	0.836								0.831			
SPLTDRating	0.757								0.718			
FATA	0.580		-0.546				-0.690					
SKTComp		0.827								0.662		
DEBTMATU		-0.666					-0.691					
IRCOV		0.657					0.695					
CURR		0.495	0.453							0.834		
LEVTA			-0.717				-0.644					
MTR			0.589					0.652				
Z-Score			0.551	0.462						0.605		
ROA			0.524					0.859				
CURR		0.495	0.453							0.817		
FCF				0.865				0.849				
TOBINQ				0.851			0.668					
CAPEXTA					0.846						0.891	
CAPEXPPE					0.743						0.716	
DY					-0.410							-0.560
CONVERDEBT						0.716						0.725
CASH						0.633	0.622					
R&D						0.534						0.430
BETA												0.602
VP	13.085	11.897	11.194	9.600	9.054	7.538	15.848	13.350	11.477	8.448	8.360	8.257
CVP	13.085	24.982	36.175	45.775	54.829	62.367	15.848	29.198	40.675	49.123	57.484	65.740

Panel B: Factor Loadings for UK firms

	Hedgers							Non-hedgers						
Variable	1	2	3	4	5	6	7	1	2	3	4	5	6	7
LogMV	0.862							0.786						
LogTA	0.884							0.890						
STKComp	0.656				-0.331									0.868
CAPEXPPE	0.333									0.626				
Zscore		0.798						0.611	-0.476					
IRCOV		0.753							-0.647					
LEVTA		-0.722	-0.331						0.753					
DEBTMATU		-0.508					-0.340		0.664					
CURR			0.829							0.623				
TOBINQ			-0.666	-0.392						0.404				
FATA			0.641				0.355				0.766			
R&D				0.767									0.41-	
DY					0.719			0.319				-0.332	-0.397	-0.365
TXR				0.392	0.413								0.483	
CONVERDBET					0.372							0.569		
CAPEXTA						0.738						0.668		
ROA				0.330		-0.660				-0.533				
FCF		0.302				0.390	-0.382	0.580						
CASH							0.831						0.594	
VP	12.768	12.644	9.419	7.407	6.819	6.365	6.256	13.787	10.519	8.440	6.748	6.424	5.761	5.566
CVP	12.768	25.412	34.831	42.238	49.057	55.422	61.677	13.787	24.305	32.745	39.492	45.916	51.677	57.243

[a]For each variable and factor, we attribute the variable with the highest factor score as primarily loading onto the specific factor. Having identified this variable and factor score, the remaining factor scores are set to zero.

For UK firms, *LogTA*, *LogMV*, stock-based compensation expense (*STKComp*) and *CAPEXPPE* load onto factor 1, thereby capturing 12.77% of total variance. The results imply a couple of possible interpretations. The fact that size variables and *STKComp* are positively correlated implies that large firms pay higher stock-based compensation to their managers, which is not surprising. Managers hedge to reduce the volatility of their compensation packages, which is consistent with Rogers (2002) and Knopf, Ham and Thornton (2002). In addition, the positive association between *STKComp* and the investment intensity variable *CAPEXPPE* suggests that stock-based compensation aligns managers' and shareholders' interests and promotes high investment intensity. It is unclear why this alignment seems so strong mainly for firms that use interest rate derivatives and not, say, FX rate derivatives. These results may also relate to managerial self-interest (see Stultz, 1985). The increase of investment exposes managers to more risk. To the extent that managers are undiversified with respect to firm-specific wealth, they are exposed to more risk than diversified shareholders. Accordingly, the higher variability on the investment intensity also promotes interest rate hedging. Consistent with the results from hedgers, we find that the investment factor (factor 3) and the managerial incentive factor (factor 7) explain less variability in IR non-hedgers.

The size factor retains strong explanatory power for the variation for non-hedgers. The second factor is the financial distress factor, capturing 10.52% of the total variance. The cash flow factor is shown to explain a small portion of variation in hedgers and non-hedgers. The possibility considered is that the hedgers in this sample are less involved in the international economy and therefore have lower cash flow variability. Factor 5 for UK hedgers positively loads onto *CAPEXTA* and *CONVERDEBT* and negatively loads on *DY*. Therefore it can be identified as the hedging substitutes factor. Although prior empirical studies have different predictions on the direction of the relationship of dividend variable with hedging, our results support the prediction of negative relationship between dividend payment and hedging. A firm can alter its dividend policy in response to the volatility of available cash flows for investments. The effective tax rate (*TXR*) is negatively related to *DY*, in line with the notion that tax liabilities affect firms' dividend policy. *STKComp* is also negatively related to *DY*, consistent with the contracting hypothesis

that, given the certain level cash flow in the firm, the greater the dividend paid out, the more restrictions on the investment during the period, and, in turn, the less likely that the firm ties compensation to the effect of managers' decisions on firm value.

7.2.4 Summary

In summary, hedgers have greater variabilities in financial distress costs and size, while non-hedgers have greater variabilities in tax, leverage and cash flows. The second factor analysis shows that cash flow appears to an important factor and explains a large portion of the variation in FX hedgers. Firms tend to hedge their foreign exchange rate exposure from operation to reduce the variability of cash flow; the weak results of cash flow in the all-type hedging sample may be due to the mixture of currency hedging with other types of hedging. The empirical results suggest that the magnitude of variability on tax across different types of hedging is different. The taxation factor is strong in the first analysis, but weak in the second and moderate in the third. Yet it is important to bear in mind that hedgers in the second and third factor analyses are the firms that only hedge one type of exposure, while firms which hedge more than two types of exposure are excluded. In other words, hedgers in the first factor analysis hedge more actively and intensively than hedgers in the second and the third factor analyses. Therefore, the high explanatory power of the marginal tax rate in the all-type hedging suggests that firms which hedge more actively and intensively have greater variability in the tax rate than light hedgers. Factor analysis, however, does not provide information regarding the effect of each factor on the corporate hedging decisions. Therefore, a logistic regression approach is employed in the next section.

7.3 Hedging and Corporate Governance

This section presents logistic regression results based on the factor analysis, augmenting these results with our corporate governance measures. The approach to using the factor analysis results is as follows. Since a set of variables loads heavily onto each factor, the variables within that set are highly correlated. This means that any one of those variables is needed for the logistic regression. So, we select the variable with the highest factor score for each factor across hedgers and non-hedgers to include in the logistic regression. This approach is similar in all respects to the method used by Joseph and Hewins (1991). The approach also has the advantage of including variables that are uncorrelated in the analysis, as this will provide more reliable results compared to including several variables that are highly correlated (at least for each set of hedgers and non-hedgers).[26] We then augment the variables chosen from the factor analysis and construct interaction terms with the corporate governance measures. The results that follow are presented below.

[26] In some cases, we have more than one variable per factor when we combine hedgers and non-hedgers for estimating the logistic regression.

7.3.1 US results for the logistic regression

Table 7-4 first two columns report the logistic regression results for US firms that use all types of derivatives. Overall, the diagnostic tests show reasonably a good performance for both models. For example, the -2 log likelihood is 2357.690. The Hosmer and Lemeshow test is not statistically significant (p-value > 0.10), indicating the statistical goodness-of-fit of the model is good. The omnibus statistics are significant (p-value ≤ 0.01), suggesting that the coefficients of the logistic regressions besides the intercept are significant. Finally, our logistic regression performs better than a proportional chance model using a 1% level, with an overall percentage of 82.5% of cases correctly classified. Normality is, however, highly significant using the Shapiro-Wilks test and Kolmogorov-Smirnov tests (p-value ≤ 0.01). Since the analysis uses the maximum likelihood method with a large sample, the estimates are still unbiased.

Before proceeding with the interaction terms, we examine the effect of financial factors when corporate governance is modelled as an exogenous factor. The coefficient for the variable measuring the proportions of non-executive board members on the board, *NED*, is positive and statistically significant, suggesting that the likelihood of corporate hedging in US firms increases as outside directors gain influence. A one per cent increase in the non-executive director ratio yields a significant increase of 2.9 per cent possibility of engaging hedging. This result is consistent with the theoretical prediction that good governance motivates firms to hedge the market effectively to protect shareholders' wealth. The *CGI*, a corporate governance index which is based on seven internal corporate governance characteristics, however, is statistically insignificant in the model. This makes our conclusion mixed. However, the insignificant main effect of *CGI* may be due to the interaction of *CGI* in the model. In an unreported regression result, we find that the estimated coefficient of *CGI* is positive and statistically significant at 5% level.

Table 7-4. Logistic regressions for firms that use all forms of derivatives compared with non-hedgers

Country	US		UK	
Variable	Coefficient	Marginal Effect	Coefficient	Marginal Effect
Constant	-22.2218[a] (5.7057)		-14.3178[a] (2.9268)	
NED	0.1866 [a] (0.0659)	0.0286	0.0102 (0.0142)	0.0007
CGI	-0.2853 (0.2578)	-0.0437	1.3201[b] (0.6556)	0.0863
Separation			0.2517 (0.2517)	0.0178
BoardSize			0.2506[a] (0.0649)	-0.0164
CompLinkTSR			1.0982[a] (0.2003)	0.0921
LogMV	0.1591 (0.2213)	0.0244	1.5049[a] (0.4419)	0.0984
CGI × LogMV			-0.2742[a] (0.0972)	-0.0180
LogTA	6.0594[a] (1.3374)	0.9289	0.7035 [a] (0.1362)	0.0460
NED × LogTA	-0.0455 [a] (-0.0455)	-0.0070		
R&D	49.8451[a] (20.7037)	1.7619		
NED × R&D	0.6486 [a] (0.2469)	0.0994		
CGI × R&D	1.9840 (1.4364)	0.3041		
FATA	-1.7822 (1.5390)	-0.2732	1.6180[c] (0.9030)	0.1058
CGI × FATA	0.3152 (0.3361)	0.0483	-0.5131 [b] (0.2257)	-0.0335
CURR	-1.4042 [a] (0.5220)	-0.2152	-0.2558 [a] (0.0592)	-0.0167
NED × CURR	0.0151 (0.0062)	0.0023		
Z-Score	-0.4138 [a] (0.0969)	-0.0634	0.5168 (0.3404)	0.0338
CGI × Z-Score	0.0830 [a] (0.0200)	0.01272		
NED × Z-Score			-0.0111 [b] (0.0055)	-0.0007
DebtMatu			-0.5378 [c] (0.2867)	-0.0352
CGI × DebtMatu			0.1589 [b] (0.0660)	0.0104
CAPEXTA	-1.0234 (1.1552)	-0.1569	0.0546 [c] (0.0310)	0.0036
DY	0.4918 [a] (0.1915)	0.0754		
CGI × DY	-0.0767 [c] (0.0429)	-0.0117		
CONVERDEBT	-0.7812 (3.3162)	-0.1198		
NED × CONVERDEBT	0.0257 (0.0352)	0.0039		
CGI × CONVERDEBT	-0.0767 (0.3135)	-0.0767		
ROA	2.7389 [a] (0.7428)	0.4199	-0.2806 [a] (0.1048)	-0.0183
NED × ROA			0.0027 [c] (0.0016)	0.0002
Separation × ROA			0.1527 [b] (0.0670)	0.0100
PRIVOL	0.0842 (0.0541)	0.0129	-0.1969 [a] (0.0589)	-0.0129
NED × PRIVOL	-0.0010 (0.0006)	-0.0002		
BoardSize × PRIVOL			0.0188 [a] (0.0059)	0.0012
Summary statistics				
Number of Observation	2970		1465	
Omnibus model test	1142.316[a]		485.078 [a]	
-2 Log likelihood	2357.690		821.568	
Cox &Snell R	0.319		0.282	
Nagelkerke R	0.461		0.478	
Hosmer &Lemeshow test	13.410		10.705	
Percentage correctly	82.5 [a]		88.5	
K-S test on studentized residuals	11.290[a]		12.205 [a]	
K-S test on standardized residuals	9.898[a]		10.702 [a]	

[a] ,[b] and [c] denote statistical significance at a 1-, 5- and 10-percent level, respectively.

The board structure also influences other financial policies of a firm, and therefore jointly influences hedging policy. Coles et al. (2008) predict a positive relationship between R&D expenditure and the proportion of inside directors on the board, because inside directors have more firm-specific knowledge than outside directors. They argue that a high fraction of inside directors in R&D-intensive firms is helpful for selecting appropriate growth and investment strategies. To examine how board structure and growth opportunities factors jointly relate to corporate hedging in the US, we created a set of interaction variables. Interestingly, the regression finds a significant and positive relationship between hedging and the interaction term between R&D expenditure and the proportion of non-executive directors on the board. This result suggests that firms whose boards are more independent are more likely to hedge to protect available growth opportunities. This may be because, unlike insiders who have firm-specific knowledge, greater outside representation may have a high cost of acquiring information and may be less effective in monitoring firms with high growth potential. Therefore R&D intensive firms with a more independent board will be even more likely to execute hedging to protect their valuable investment opportunities. These results imply that the directors in US firms are actively involved in firms' hedging decisions. This is consistent with the hypothesis that, if outside directors monitor effectively, firms will hedge in the interests of the shareholders. Given the certain level of R&D spending, a one per cent increase in the non-executive director ratio yields a significant increase of 9.9 percent possibility of engaging hedging. The interaction effect of *CGI* and R&D is marginally significant and positively correlated with hedging.

We also include an interaction term defined as the proportion of non-executive directors and the variable measuring free cash flow held in the firm. We further include two interaction terms, defined as the proportion of non-executive directors and free cash flow, and the proportion of *NED* and leverage, to test the outsider influence on the agency costs incentive, but both interaction terms are statistically insignificant. The coefficient of the interaction term is significantly different from zero but is negative.

Turning our attention to the interaction effect of financial distress costs and corporate governance on hedging, we find several interesting results. Prior empirical work on corporate governance and hedging (e.g. Fauver & Naranjo, 2010; Lel, 2012) finds influence of financial distress and corporate governance on the use of derivatives, but provides mixed evidence for the joint effect on hedging. Our regression finds a significant joint effect of financial distress and corporate governance on hedging. Estimated coefficients of the interaction term *NED*×*CURR* and *CGI*×*Z-score* are both significantly positive. The results suggest that the effect of financial distress on the use of derivatives is stronger as a firm's level of corporate governance increases. Firms with strong governance have a strong incentive to hedge in response to the decreased liquidity and cash holding and increased costs of financial distress. The positive marginal effects of both interaction terms indicate that the positive impact of corporate governance will strengthen with shareholder concern about increasing costs of financial distress. In addition, since *MTR* and *ROA* are dominated and positively related to *Z-score*, according to the factor analysis, the results also imply that firms with strong governance also hedge to reduce the variability of their post-tax cash flow, which in turn increases the value of the firm's and shareholders' wealth. Compared with prior empirical work which provides insight into hedging on firm value from a financial distress and/or an agency costs perspective, our empirical results provide new evidence from the tax and cash flow perspectives.

The implications from the interaction of dividend policy and corporate governance are mixed. The main effect of dividend yields is positively associated with hedging, which suggests that firms that exhaust their liquidity by paying higher dividends are more likely to engage in hedging, consistent with prior literature (e.g. Bartram et al., 2009; Lel, 2012). In contrast, the coefficient of its interaction term with *CGI* is significantly negative. The plausible explanation is that strong internal corporate governance influences managerial incentives to hedge and reduces information asymmetry problems and monitoring problems. Firms with a high dividend yield hedge to reduce the variability of cash flow, but they may also hedge to eliminate the noise in the firm's dividend stream if the level of information asymmetry is high (DeMarzo & Duffie, 1995). Strong governance reduces information asymmetry and reduces the cost of capital which, in turn, eases the need for corporate hedging. Thus, the effect of the payout policy on hedging will be less

positive if corporate governance is strong. This finding is different to Fauver and Naranjo's (2010) findings that the interaction terms of derivative usage and agency costs and monitoring problem variables are negatively related to firm valuation. However, they use the entrenchment index and the monitoring index rather than the corporate governance index to measure the level of corporate governance. The absence of the interaction term of corporate governance in the derivative usage model may be another reason. The negative effect on the derivative may be driven by managers' speculation and self-interest.

The interaction term of non-executive director ratio (*NED*) and *LogTA* is significant and negative. *LogTA* is the dominant variable of size factor and is positively related to the credit rating variable. The result suggests that a high representation of non-executive directors on the board makes the size effect on hedging less positive. This is consistent with the implication from the negative interaction effect of *CGI×DY* that strong governance reduces information asymmetry and eases the need for hedging. Large firms and firms with good credit ratings are more transparent and have less information asymmetry.

The estimated coefficient of *ROA*, the dominant variable of cash flow factor, is highly significant (*p*-value <0.1) and positive, suggesting that firms hedge to reduce the volatility of cash flow and costs of agency problems caused by excess cash flow. However, the regression does not find evidence that the impact of corporate governance has significant influence on the cash flow incentive for hedging. The combination of excess cash and weak shareholder rights protection does not significantly influence corporate hedging decisions. All the interaction between *ROA* and corporate governance measures entered at the beginning of the regressions are insignificant and withdrawn. This suggests that higher firm profitability can lead to a higher probability of hedging, but a firm's level of corporate governance does not significantly change such an incentive for hedging. The possibility considered is that corporate governance does not significantly impact the cash holding (Bates et al., 2009), nor does the presence of excess cash change the relationship between governance and profitability (see Harford et al., 2008).

The results for price volatility and corporate governance do not provide significant evidence for the effect of price volatility on hedging and the combination effect of price volatility and corporate governance on

corporate hedging. This implies that, controlling for the amount of stock-based compensation package for managers, managers in US firms do not have strong incentives to hedge to reduce the volatility of share price.

7.3.2 UK results for the logistic regression

Table 7-4 columns 3 and 4 report the regression results for firms in the UK. The results strongly support the hypothesis that strong corporate governance has a positive effect on corporate hedging. The dummy variable indicating whether the CEO's compensation is linked to total shareholder return (*LINKTSR*) is significantly positive as predicted, with a relatively high marginal effect of 9.2% and the highest Wald statistic in the model. By aligning managers' wealth portfolio with shareholders' return in the firm, managers' incentive to hedge increases. This becomes the most important incentive to hedging in the UK after controlling for corporate governance effects, implying that the managerial incentives play a very important role in making corporate hedging decisions. Consistent with our expectation, the interaction effect of the managerial incentive factor and corporate governance is positively correlated with hedging in the UK.

CGI is statistically significant at 5% level and is positively associated with hedging. The coefficient of *BoardSize* is significantly negative, indicating that firms with a larger board are less likely to engage in hedging. The marginal effect is a decrease in the probability of hedging of 1.6%. This result is in line with the notion that larger boards tend to be more easily controlled by managers and be more costly for outsiders to monitor investment decisions, but have less variability on corporate performance (Boone et al., 2007; Cheng, 2008; Guest, 2009; Jensen, 1993). If managers are influential in the firm, then the firms can face less monitoring. This means that managers will have more flexibility and freedom to decide on hedging and may in turn take on more risks. Because larger boards tend to make less extreme decisions

and have less variable corporate performance, the variability in cash flow is lower which, in turn, reduces hedging needs.

Such an effect of powerful management on reducing the hedging incentive shrinks with outsiders' influence and grows with managers' influence on the board. The situation that the CEO is the main insider on the board may actually increase a CEO's decision-making power on the board and weaken the monitoring efficiency of outside directors (Liu & Jiraporn, 2010) and board effectiveness (Adams et al., 2005; Faleye, 2015). An increase in the proportion of non-executive directors on the board does not necessarily lead to an improvement in internal governance and shareholder protection, because changes in the number of non-executive directors may not have a large impact on the power of the CEO to influence decisions. It is, therefore, interesting to further test the effect of powerful managers and board size on corporate hedging behaviour.

In an unreported alternative model, we include an interaction between the CEO-Chairman duality dummy variable (*DUAL*) and *BoardSize*. We find that the coefficient of *DUAL* and *BoardSize* is significantly negative, indicating that a powerful manager and a large board reduces incentives to engage in hedging. The estimated coefficient of the interaction term is significantly positive, indicating that the effect is stronger in a situation where the CEO also chairs a large board. This finding supports our expectation that the negative effect of powerful managers on corporate hedging grows with managers' influence on the board. We do not find similar evidence from the US sample, as *BoardSize* is statistically insignificant to US firms. Having said that, however, this is consistent with the argument of Coles et al. (2008) that smaller boards are not necessarily optimal for all firms. Thus, the effect of board size is not 'one size fits all'.

Note that *PRIVOL* is insignificant in the US but has a significant negative effect on hedging in the UK. This implies that UK firms with high stock price volatility are less likely to engage in hedging. The

marginal effect is a decrease in the probability by 1.3%. The possibility considered is the clientele effect. It appears that such a negative effect on hedging is stronger in firms with a larger board.

The previous section finds a significant joint effect of financial distress factor and corporate governance on hedging decisions in US firms. The effect of financial distress on hedging is stronger as a firm's level of corporate governance increases. Firms with strong governance have a strong incentive to hedge in response to the decreased liquidity and cash holding and increased costs of financial distress. We find consistent evidences in the UK. The likelihood of hedging is higher when the cost of financial distress is high and the board is more independent, with a relatively small marginal effect of 0.7%. Likewise, strongly governed firms are more likely to hedge market risk with longer debt maturity, with a slightly stronger marginal effect of 1.0%.

We do not find evidence that the impact of corporate governance has significant influence on the cash holding incentive and investment factor for hedging. The combination of cash factor and shareholder rights protection does not significantly influence corporate hedging decisions. All the interactions of *CASH* and *CAPEXTA* with corporate governance measures entered at the beginning of the regressions are insignificant and withdrawn, but the coefficient of *CAPEXTA* is significantly positive. This suggests that higher investment intensity can lead to a higher probability of hedging, but a firm's level of corporate governance does not significantly change such incentives to hedge. This is consistent with our findings in the US.

7.4 Corporate Governance and Currency Derivatives

To shed light on the impact of corporate governance on explaining variations in use of currency derivatives in the US and the UK, we run a logistic regression in which the dependent variable is the currency hedging dummy instead of the general hedging dummy in the previous section. In this analysis, we include only firms that used FX rate derivatives. Our explanatory variables are based on the factor analytical results as before, but for those based on FX rate derivatives and non-hedgers (see Table 7-2). The first four columns in the Table 7-5 present the regression results for the US firms (Equation (22) and (23)), and the last four columns present the results for the UK firms (Equation (24) and (25)).

Table 7-5 shows that the logistic regression provides a good fit to the data based on the Hosmer and Lemeshow test (*p*-value > 0.100). The regression confirms that board independence promotes firms to hedge FX exposures. The separation of the responsibility of CEO and Chairman is significantly positive to FX hedging in the UK, but this effect is not significant in the US. A plausible explanation is that, historically, separation of the positions of CEO and Chairman is common corporate governance practice in UK firms, whereas CEO duality predominates in the US.

For the US logistic regression, *CGI* and *NED* are positive and both highly significant at 1% level. The accounting variables are statistically significant after controlling for corporate governance. The *Z-Score* is insignificant. The significant results are consistent with the regression results in the previous chapter, providing further evidence that the size of a firm, agency problem, tax, cash flow and cash holdings are the important determinants for foreign exchange hedging. The regression finds that price volatility (*PRIVOL*) is positively associated with hedging. Since the volatility of stock returns increases with the volatility of foreign exchange rate movements (Bartov et al., 1996; Joseph et al., 2015), this can increase the need for hedging by firms. *PRIVOL* remains statistically significant and positive in Equation (23), which controls for the interaction effect of corporate governance and a firm's financial characteristics. It is also noticeable that *PRIVOL* has the second largest Wald statistic amongst all independent variables,

indicating the high significance of the variable in the FX hedging model. A one per cent increase in price volatility will lead to a 0.4% increase of the possibility of FX hedging. In the Equation (24) and Equation (25), however, the *PRIVOL* are not significant, suggesting that the volatility of stock price does not affect the hedging policies in the UK firms. This finding therefor raises a further research question as to, compared to the US firms, whether or not the volatility of foreign exchange rate movements has smaller association with the volatility of stock prices in the UK markets.

Consistent with the results in Section 7-3, Table 7-5 Equation (23) finds strong evidence for a corporate governance and financial distress effect on FX hedging. The main effects of *Z-score* and *CURR* are significantly negative, indicating that high liquidity and low financial distress costs are negatively related to FX hedging. The interactions with corporate governance variables, *NED×CURR* and *CGI×Z-Score*, are significantly positive at 1% level and 5% level respectively. The results suggest that good governance promotes firms to hedge foreign exchange rate exposure in response to the expected distress costs arising from high leverage and low liquidity. *CURR*, which dominates financial distress and the managerial incentive factor, is positively associated with *STKComp* in the factor analysis. Therefore the positive coefficient of *CURR×CGI* also implies a positive interaction effect of corporate governance and stock-based compensation on FX rate hedging. This is consistent with the notion that derivatives are used for hedging purposes. Prior studies find that performance-based compensation may increase managers' speculation and risk-taking incentive, reducing the intention of hedging (Guay, 1999; Rogers, 2002). Strong corporate governance and reporting transparency can increase internal monitoring and reduce information asymmetry, which in turn can reduce those problems caused by performance-based compensation. Supanvanij and Strauss (2006) find that when transparency of derivatives reporting is improved, managers who are paid larger stock compensation tend to hedge more. Our results suggest that managers who are paid larger stock compensation tend to engage more strongly in FX hedging.

Table 7-5. Logistic regressions for US and UK firms that use FX rate derivatives compared with non-hedgers

Model	Equation (22)		Equation (23)		Equation (24)		Equation (25)	
Variable	Coefficient	ME	Coefficient	ME	Coefficient	ME	Coefficient	ME
Constant	-14.3562[a] (1.2228)		-8.8701[a] (2.2907)		-22.2218[a] -5.7057		-10.4738[a] (`.9084)	
NED	0.0268 [a] (0.0102)	0.0035	-0.0304 (0.0246)	-0.0039	0.1866 [a] -0.0659	0.0032	0.0398 [b] (0.0185)	0.0094
CGI	0.3049 (0.0971)	0.0402	0.1497 (0.1294)	0.0191			-0.2092 (0.2150)	-0.0495
Separation					1.8998 [a] (0.3852)	0.2749	2.7384 [a] (0.5319)	-0.4108
LINKTSR					1.6223 [a] (0.2286)	0.3216	2.0772 [a] (0.2940)	0.4462
ADCI							0.0166 [b] (0.0077)	0.0039
LogTA	2.2150[a] (0.1899)	0.2924	2.2074 [a] (0.1933)	0.2814	0.4566	0.0936	0.2506[a] 0.2064 [a] (0.1097)	0.0725
CASH	3.5012 [a] (0.8707)	0.4621	-9.6157 (10.2565)	-1.2257			0.2361 (0.1504)	0.0559
NED × CASH			0.1597 (0.1212)	0.0204			-0.0044[a] (0.0025)	-0.0010
CAPEXTA	-5.1039 [b] (2.1204)	-0.6737	19.5447 (15.5703)	2.4913			-0.3460 [a] (0.1814)	-0.0819
NED × CAPEXTA		-0.3002 (0.1870)	-0.3002 (0.1870)	-0.0383			-0.0044 [c] (0.0025)	0.0017
LEVTA					-3.5930[a] (0.8863)	-0.7370	-4.0579 [a] (1.1046)	-0.9608
CURR			-2.5325 [a] (0.9805)	-0.3228				
NED × CURR			0.0297 [a] (0.0114)	0.0038				
Z-Score	0.0216 (0.0148)	0.0029	-0.1988 (0.0942)	-0.0253			0.8118[b] (0.3907)	0.1922
CGI × Z-Score			0.0468 [b] (0.0199)	0.0060				
NED × Z-Score							-0.0159 [a] (0.0062)	-0.0038
FATA					-0.2984 [a] (0.1077)	-0.0612	-0.3869 [a] (0.1262)	-0.0916
STKComp							0.4169 [a] (0.1539)	0.0987
CGI × STKComp							-0.0847 [a] (0.0319)	-0.0201
ROA	1.4958 [c] (0.8738)	0.1974	-4.7235 (3.6161)	-0.6021	0.0695 [b] (0.0287)	0.0142	0.0550 [c] (0.0335)	0.0130
NED × ROA			0.0751 [c] (0.0455)	0.0096				
PRIVOL	0.0305 (0.0082)	0.0040		0.0039				
Summary statistics								
Number of Observation	1289		1270		559		449	
Omnibus model test	277.142[a]		303.757 [a]		177.503 [a]		170.226	
-2 Log likelihood	1094.814		1058.471		551.580		443.908	
Cox &Snell R	0.193		0.213		0.272		0.316	
Nagelkerke R	0.295		0.323		0.373		0.426	
Hosmer &Lemeshow test	8.026		8.450		5.941		11.688	
Percentage correctly	80.8		80.4		75.3		78.4	
K-S test on studentized residuals	11.290[a]				12.205 [a]			
K-S test on standardized residuals	9.898[a]				10.702 [a]			

[a] ,[b] and [c] denote statistical significance at a 1-, 5- and 10-percent level, respectively.

By contrast, financial distress factor and its joint effect with board independence are shown to have a negative impact on hedging for the UK. This is surprising and makes the interpretation difficult, considering that the financial distress costs factor is shown to explain a large portion of the variance in the factor analysis. The possibility considered is that there are large variations in financial distress costs amongst both UK hedgers and non-hedgers that use FX rate derivatives. Because hedgers hedge their foreign exchange rate exposures, the ex-post costs of financial distress are reduced, resulting in a negative correlation between distress costs and FX hedging.

Table 7-5 also shows a significant interaction effect between corporate governance and cash flow. *NED*×*ROA* is statistically significant at 10% level and is positively correlated with FX hedging in Equation (23). Since *ROA* is a profitability measure, the result is consistent with the notion that shareholders' interests can be protected better with a more independent board of directors. When the board is more independent, US firms are more likely to engage in FX hedging to reduce the volatility of after-tax cash flow. The result also supports the taxation hypothesis for hedging, since *ROA* is also the dominant variable for cash flow and taxation factor and is positively associated with *MTR*. *NED*×*CAPEXTA* is marginally significant and has a negative effect on FX hedging. Because good corporate governance can help ameliorate agency costs, particularly when free cash flow is high, an overinvestment problem will become less influential on the use of currency derivatives when the level of governance is high.

7.5 Corporate Governance and Interest Rate Hedging

Table 7-6 reports the impact of corporate governance when firms use interest rate derivatives. The first two columns present the results for the US firms and the third and fourth column present the results for the UK firms. The corporate governance index, *CGI*, remains positively associated with the use of interest rate derivatives and is statistically significant (*p*-value <0.1) in the US, but is insignificant in the UK. Surprisingly, the coefficient of the Separated CEO-Chairman dummy variable is significantly negative for both US and UK firms. So, firms run by powerful CEOs are more likely to engage in IR hedging. When the CEO chairs the board of the firm, price volatility is negatively related to interest rate hedging. When the positions of CEO and chairman of the board are separated, stock price volatility is positively associated with interest rate hedging. This suggests a positive influence of corporate governance on hedging to reduce the firm's risk.

The interaction between corporate governance variables and overinvestment factor appears to have important consequences for corporate hedging in the US. *NED*×*FCF* and *Separation*×*FCF* are both significant at 5% level and positively correlated with IR hedging. The marginal effect is 0.032 and 0.728, respectively. In contrast, the coefficient of interaction of *CGI* and *FCF* is significantly negative, with a relatively strong marginal effect of -0.267. This indicates that firms overseen by a more independent board tend to hedge their interest rate exposures to reduce the cost of overinvestment caused by a high level of free cash flows, whereas strong corporate governance may alleviate the agency problem of overinvestment and ease the need for hedging. At the same time, well governed firms are more likely to engage in IR hedging to reduce the variability of cash flow.

Compared with US, cash flows factors and agency problem factors are insignificant in the UK. *CAPEXTA* is positive but insignificant in the UK after controlling for corporate governance variables. Note, however, that its interaction with corporate governance index, *CGI*, is significantly negative. Weakly governed UK firms with higher investment intensity are more likely to engage in IR hedging. This is the reverse of the

expectation, since strong governance should encourage hedging so that firms can fund profitable investment internally and avoid costly external financing. Chernenko and Faulkender (2011) find that IR derivatives are used to hedge to avoid costly external financing but also to speculate. Though this study identifies hedgers as those firms which clarify that they use derivatives to hedge rather than to speculate, it might be the case that managers also use derivatives for speculation. The negative sign of the interaction may be because managers in the weakly governed firms use IR derivatives for speculation while they may still report their purpose for hedging[27].

Results from the UK show a negative coefficient on leverage and a negative coefficient on its interaction with *CGI*, but a positive coefficient on its interaction with *NED*. This suggests that for firms overseen by a more independent board, the probability of engaging in IR hedging increases with the increase of expected costs of financial distress, whereas weakly governed firms with greater expected financial distress costs are less likely to engage in IR hedging. Results from the US are in line with the latter finding. Lel (2012) finds that firms with high distress costs are prevented from accessing derivatives for hedging because of their high credit and counter-party risks. This explanation is reasonable, since our results shows that economies of scale and high ratings have a strong positive influence on hedging.

[27] Géczy (2007) find that IR speculation is positively associated with weaker firm-level corporate governance.

Table 7-6. Logistic regressions for or US and UK firms that use FX rate derivatives compared with non-hedgers

Country	US		UK	
Variable	Coefficient	Marginal Effect	Coefficient	Marginal Effect
Constant	-5.0597[a] (1.2347)		-7.5712[B] (3.7627)	
NED	-0.0036 (0.0121)	-0.0004	-0.1161 (0.0142)	-0.0136
CGI	0.1361 (0.1392)	0.0173	0.4968[b] (0.6435)	0.0581
Separation	-2.1278 [a] (0.6058)	-0.2387	-1.2877 (0.6850)	-0.1891
BoardSize			-0.7684[a] (0.2129)	-0.0900
LINKTSR			0.6917 (0.5033)	0.0796
ADCIndp			-0.0227 [a] (0.0086)	-0.0027
LogTA	0.8591[a] (0.1827)	0.1094	1.6261 [a] (0.2918)	0.1902
RDTA			-0.1579 (0.1476)	-0.0185
FATA	-1.7822 [a] (1.5390)	0.2149	0.2473[c] (0.1470)	0.0289
CGI × FATA			[b]	
CURR			-2.5732 [b] (1.1096)	-0.3010
NED × CURR			0.0528 [a] (0.0118)	0.0062
CGI × CURR			-0.4937 [b] (0.2283)	-0.0578
CASH			0.0237 (0.0687)	0.0028
LEVTA	2.4588 [a] (0.4538)	0.3130		
CAPEXTA	5.7498 [a] (1.7297)	0.7319	0.1796 (0.4042)	0.0210
NED × CAPEXTA			0.0098 (0.0063)	0.0011
CGI × CAPEXTA			-0.1746 [b] (0.0931)	-0.0204
DY			-4.2179 [c] (2.3930)	-0.4935
CGI × DY			1.8794 [a] (0.6901)	0.2199
FCF	-9.5869 (8.1548)	-1.2203		
NED × FCF	0.2478 [B] (0.1177)	0.0315		
CGI × FCF	-2.0950 [C] (1.1162)	-0.2667		
Separation × FCF	5.7172 [B] (2.6716)	0.7278		
ROA	-9.7231[b] (4.3541)	-1.2376		
CGI × ROA	2.3030 [b] (0.9699)	0.2931		
STKComp	0.6574[a] (0.2535)	0.0837		
NED × STKComp	-0.0076 [b] (0.0032)	-0.0010		
PRIVOL	-0.0595 [a] (0.0130)	-0.0076	-0.6213 [b] (0.2741)	-0.0727
Separation × PRIVOL	0.0458 [a] (0.0172)	0.0058		
BoardSize × PRIVOL			0.0596 [b] (0.0303)	0.0062
Summary statistics				
Number of Observation	1288		297	
Omnibus model test	261.053[a]		209.919 [a]	
-2 Log likelihood	1085.139		180.542	
Cox &Snell R	0.183		0.507	
Nagelkerke R	0.283		0.693	
Hosmer &Lemeshow test	6.614		8.886	
Percentage correctly	80.7[a]		88.9	
K-S test on studentized residuals	11.290[a]		12.205 [a]	
K-S test on standardized residuals	9.898[a]		10.702 [a]	

[a] ,[b] and [c] denote statistical significance at a 1-, 5- and 10-percent level, respectively.

7.6 Conclusion

In summary, this chapter has utilised the factor analysis approach to distinguish the financial and corporate governance characteristics of US and UK firms that hedge and do not hedge. The factor analysis results show that the variables that show the most variability for hedgers do not always have the same variability for non-hedgers. So the effect on hedging or not hedging does not have a linear relationship with the variability of the firm, contrary to theoretical predictions. This result holds across both US and UK firms, although there is also strong variability in the relative importance of the variables across countries. In general, financial distress costs, tax factor and size factor explain the largest portion of variation in hedgers, whereas hedging substitutes factor, agency problem factor and growth opportunities factor have less explanatory power. We find that the factors motivating firms to use currency derivatives are not exactly the same as those which motivate them to use foreign exchange rate hedging and interest rate hedging. It appears that the factors that motivate firms to hedge currency risks arise from variability of cash flow, financial distress costs and economies of scale. Firms tend to hedge their foreign exchange rate exposure from operation to reduce the variability of cash flow, whereas, the important factors that motivate firms to hedge interest rates risk appear to be economies of scale and high distress cost. Interest rate hedgers emphasise the costs of financial distress more than the variability of cash flows, since interest rate hedging is largely associated with tailoring debt and the costs of debt financing. We also find that there are differences between the corporate hedging behaviour of US and UK firms. Regulations and country-level factors, such as tax codes, bankruptcy codes and culture, influence the hedging decisions of US and UK firms. The costs of financial distress have a positive influence on hedging decisions in the US. In the UK, the economies of scale factor has a strong positive influence on hedging.

We use the factor analytical results to estimate our logistic regression. Our approach in choosing the variables enables us to estimate logistic regressions when the financial characteristics of the firms are not correlated. This leads to more reliable results. Logistic regression results suggest that corporate

governance mechanisms affect hedging decisions. The proxy variable for the independence of board is significant. Independent directors have a role in monitoring managers and protecting shareholders' interests in the firm. The board structure also influences hedging decisions and a large board tends to be negatively associated with hedging. The probability of hedging increases with outsiders' influence and shrinks with managers' influence on the board.

In addition, empirical results show that the interaction between corporate governance variables and financial characteristics have important consequences for corporate hedging. Firms with strong governance hedge to reduce the variability of cash flows and costs of financial distress. Compared with prior empirical work which provides hedging insights into firm value from a financial distress and/or agency costs perspective, our empirical results also provide new evidence from the tax and cash flows perspectives. The interaction effects of corporate governance with investment intensity and managerial incentives on hedging vary across different types of hedging and across countries.

CHAPTER 8 CONCLUSIONS

8.1 Introduction

Financial theories provide several theoretical explanations and rationales of corporate hedging with imperfect market. Though there is some evidence in support of theoretical predictions, the empirical results are overall controversial and mixed. The divergence between theory and practice leads to unclear guidance on the theoretical explanations or motives for the corporate hedging strategies of firms. In addition, the majority of empirical studies that focus on hedging practices focus on samples of firms from one country and provide limited cross-country comparisons for corporate hedging determinants within the same period. It is unclear whether the contradiction on the empirical evidence is due to the cross-country differences or the changes of exposure management practices that occur over time. To date, very few (if any) empirical studies have examined and compared the determinants of hedging between countries with the use of large datasets covering several years. So far, the understanding of the corporate hedging behaviour of firms and correspondence between theory and practice remain incomplete.

This study attempts to fill the gap by providing broad empirical evidence on the determinants of corporate hedging for US and UK non-financial firms. The study examined the financial characteristics that appear to predict the corporate hedging motives of US and UK firms. Additionally, the study utilised corporate governance proxies to examine the joint effect of financial characteristics and corporate governance on corporate hedging policies. A two-country study enables us to identify the differences in corporate hedging policies. Our findings and contributions are generalised in the following sections.

8.2 Financial Characteristics and Corporate Hedging

This thesis investigates the financial and non-financial characteristics that appear to predict US and UK firms hedging decisions and compares the evidence from the two countries. We employ logistic regression to analyse the data from listed US and UK firms covering a ten year period (2002-2011). The two countries are chosen because both countries have a common law legal system, a market-based financial system as well as well-developed equity markets with good investor protection. This eases the concern that the mixed results across countries are due to US enjoying a large and stable financial market with strong investor protection. The use of large data set makes it possible to overcome small sample problems, which have troubled many comparative studies utilising survey responses data.

Our evidence for US and UK firms is mostly consistent and strongly supports the hypotheses for hedging. Hedging theories hold across countries. Firms with greater growth opportunities have greater incentives to hedge to reduce the volatility of cash flows. Firms also hedge in response to the tax incentives, the increase of agency costs, and the costs of financial distress. Consistent with prior literature (e.g. Géczy et al., 1997; Lin et al., 2008), we find that US and UK firms with greater growth opportunities have greater incentives to hedge to reduce the volatility of cash flows and potential predation risks. We also find that the extremely high leverage and the extremely long debt maturity eliminate the motivation of hedging. Our evidence suggests that, when hedging is costly, the dynamics associated with the costs of hedging alters the optimal hedging policy of a firm. Furthermore, prior literature poses an empirical puzzle for the effect of firm size on hedging. While theories of hedging suggest smaller firms are more likely to hedge because of their higher riskiness, our empirical results show that large firms hedge more than small firms. Our findings that credit rating is positively related with hedging in the US provide a plausible explanation to the puzzle. The factor analysis results show that, in general, financial distress costs, tax factor and size factor explain the largest portion of variation in hedgers, whereas hedging substitutes factor, agency problem factor and growth opportunities factor have less explanatory power.

There are, however, significant country differences in the practices of hedging and the factors that incentivise firms. These differences are mainly driven by the differences on bankruptcy codes, corporate governance, and other institutional differences. For example, though the results from both countries suggest a positive relation between size and hedging, the corporate hedging decision is more sensitive to economies of scale in the US than UK. Additionally, it appears that US firms exhibit stronger motivation of hedging in response to the overinvestment costs, while UK firms exhibit stronger motivation of hedging in response to underinvestment costs. Our analysis also captures the effect of macroeconomic change on a firm's hedging decision. We find that the economic downturns and the financial crisis significantly affect the likelihood of hedging.

The study also examines the joint effect of financial characteristics and corporate governance on hedging decisions. It shows that the structure of the board influences hedging decisions and the size of the board tend to be negatively associated with hedging. The probability of hedging increases as the number of non-executives grows. A powerful CEO-Chairman and a large board reduces the incentives to engage in hedging. In addition, corporate governance variables and financial characteristics have important consequences for corporate hedging. Firms with strong governance hedge to reduce the variability of cash flows and costs of financial distress. Compared with prior empirical work which examines the value of a firm and the value of hedging from financial distress and/or agency costs perspective, our empirical results provide new evidence from tax liabilities and cash flows perspectives. The interaction effects of corporate governance with investment intensity and managerial incentives vary across different types of hedging and across countries.

8.3 Contributions

Our study makes the following major contributions to the literature. First, this study adds to the limited empirical research on the corporate hedging activities across different countries. By analysing the dataset of listed US and UK firms covering a ten year period, we find that there are significant country differences in the practice of corporate hedging and the factors that incentivise firms. These differences are driven by the differences in bankruptcy codes, corporate governance, and other institutional differences. These findings may provide a possible explanation why previous empirical studies focussing on different countries find controversial and mixed results. The contradiction on the empirical evidence may be due to the cross-country differences.

Second, our study contributes to risk management literature by shedding light on the financial variables that give rise to the greatest variability in the financial performance of firms. The factor analysis results show that the variables with the most variability for hedgers do not always have the same variability for non-hedgers. So the effect on hedging or not hedging does not have a linear relationship with the variability of the firm, contrary to theoretical predictions. Additionally, different from previous empirical studies, we also used the factor analytical results to estimate our logistic regression. As discussed by Géczy et al. (1997) and Aretz and Bartram (2010), the traditional paradigm of using logit test has limitations. The endogeneity of variables measuring potential incentives for hedging is one of the empirical challenges and potential shortcomings, which may limit the conclusions drawn from existing hedging evidence. Though we recognise that it is almost impossible to eliminate all the endogeneity problems, using the factor analysis approach can alleviate the problems. The approach has the advantage of including variables that are uncorrelated in the analysis, as this will provide more reliable results compared to including several variables that are highly correlated. Our findings provide clearer guidance on the motives for the corporate hedging strategies of firms in the different countries.

Third, the study adds to the limited empirical evidence on the relationship between the manager-shareholder agency problems and corporate hedging policies. Our evidence shows that both the US and UK firms hedge to reduce the agency costs arising from overinvestment problems. To our knowledge, this is the first study to find strong evidence for the overinvestment costs explanation for hedging in the UK. Most UK empirical studies examining agency costs hypothesis focus on the underinvestment explanation for hedging (e.g. Joseph and Hewins, 1997; Judge 2006; Panaretou, 2014).

Purnanandam (2008), extending the financial distress hypothesis for hedging predicted by Smith and Stulz (1985), finds a non-monotonic relation between leverage and hedging with the data for the 1996-1997 periods for the US firms. We extend this work and show that such a non-monotonic relation exists over time and outside the US. Lel (2012) finds that firms with high distress costs are prevented from accessing derivatives for FX hedging because of their high credit and counter-party risks. We extend the analysis of Lel (2012) by examining a broader arrays of financial characteristics and broader types of hedging with a larger sample. Our results find that the likelihood of hedging among firms below investment grade increases as the likelihood of bankruptcy decreases.

Prior literature poses an empirical puzzle for the effect of firm size on hedging. While theories of hedging suggest smaller firms are more likely to hedge because of their higher riskiness, empirical results show that large firms hedge more than small firms. Our finding that credit rating is positively related with hedging in the US is consistent with the economies of scale and may be able to explain the puzzle. Additionally, the evidence also suggest that, when hedging is costly, the dynamics associated with the costs of hedging alters the optimal hedging policy of a firm. Firms have different hedging policies in response to the same hedging motivation. These results have theoretical and practical implications.

The other contributing factor is the evidence for the taxation hypothesis. Aretz and Bartram (2010) suggest that the weak empirical evidence for the tax hypothesis may be because the tax incentives to

hedge is small compared to other hedging factors. Compared with prior empirical works, this research provides new evidence from the tax liabilities and cash flows perspectives. The results from the factor analyses show that tax liabilities explain a large portion of variation in US firms, while having much smaller explanatory power in the UK, which is consistent with Joseph's (2000) prediction that tax measures for UK hedgers should have a lower degree of variability. Thus, the argument that the tax incentives to hedge is relatively small cannot completely explain the weak results regarding tax variables. The results from our research also suggest that firms place more emphasis on tax benefit from increased debt capacity by hedging than tax function convexity, consistent with the argument of Graham and Rogers (2002). Furthermore, we extend this work and show that the tax incentives to hedge are different in terms of different types of hedging. The tax function convexity affects firms' incentives to hedge FX exposures, whereas the tax benefit on debt affects firms' incentives to hedge interest rate exposure. This finding is in line with MacKay and Moeller's (2007). Firms selectively hedge concave revenues but leave concave costs unhedged.

8.4 Implications and Recommendations for Future Research

Derivatives provide firms with a way to reduce risks and an opportunity for risk-taking, thus complicating the task of overseeing financial activities within the firm (Bodnar et al, 1995). The 2008 financial crisis raised new concerns and debates about the use of financial derivatives. Among those debates, Bartram et al (2011) argue that, while most harm during this global economic downturn have been caused by those financial instruments held by financial firms, the use of derivatives at non-financial firms reduces both total risk and systemic risk, particularly with regard to reducing the risk of down markets.

The outcomes and contributions of this study will benefit both investors and financial managers. The findings provide additional information to researchers who are interested in foreign exchange risk premium and stock return. The conclusions from this doctoral research will allow owners, shareholders and bondholders who have the ability to hold diversified portfolios of securities and other stakeholders to understand the logic of corporate hedging policies. The new understanding of corporate hedging will be helpful to financial managers when making risk management decisions and policy makers who regulate financial instruments. The study shows that the volatility of stock price significantly affects firms' FX hedging policies in the US, but has no significant effect in the UK. It therefore raises a further question as to, compared to the US firms, whether or not the volatility of FX movements have smaller risk premium in the UK markets. In addition, our findings underscore the importance of incorporating industry-specific and country-level factors in cross-country studies

Although the research is well designed, it still faces challenge with the research going on. Secondary empirical research is easier to carry through, but there are also shortcomings at the same time. Some hypotheses such as managerial risk aversion cannot be tested directly. Information for manager

remuneration packs of some companies may not be available. We used more than one applicable variable to test the hypotheses to minimise the negative impact caused by this challenge.

There are some potential ways to extend our work. In our study, we do not investigate the effects of hedging on firm value (see Panaretou, 2014). Given the findings of significant influence of tax, leverage, agency costs and investment on hedging in the presence of costly market imperfections, corporate hedging should enhance value. It would be fruitful to examine the joint effect of corporate governance and hedging on firm value in the future (see Allayannis et al., 2012).

As observed in Panaretou et al. (2014) and Lins et al. (2011), hedge accounting treatment and fair value reporting for derivatives impact on scope of corporate risk management. Further research may focus on the effect of change of derivatives reporting and hedge accounting for corporate financing and investment.

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