Are Firms Using Derivatives for Hedging or Speculation? The Effects of Derivative use on the Probability of Financial Distress

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The question of whether firms are using derivatives for hedging or speculation is important in light of attempts by regulators to curb the use of OTC derivatives as a response to the 2008 financial crisis and concerns about systemic risk in the financial sector. This paper examines the effects of derivative use on the probability of financial distress using a sample of UK non-financial firms during the period 1999-2010. By employing a market-based measure of default probability we extend previous studies that rely heavily on measures such as leverage or accounting based proxies for the probability of financial distress. As a result these studies present mixed and rather unclear evidence on the link between derivative use and the likelihood of financial distress. After controlling for firm characteristics, endogeneity between hedging, leverage and the probability of default this study finds that hedging is associated with a lower probability of default. This result is important as it indicates that firms are using derivatives for hedging purposes rather than speculative ones. We also find that interest rate hedging has a greater impact on the probability of default than foreign currency hedging. Our results are robust to the use of alternative measures of hedging, methods of estimation and instrumenting for the possible endogeneity of hedging, leverage and default probability.

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1 Introduction

"I have never bought into the argument that corporate users of derivatives give rise to systemic risk – that's a completely misguided view of the significance of corporate transactions," Richard Raeburn, chairman of the European Association of Corporate Treasurers in London, Risk Magazine, 15 June 2010[2]

In October 2008, a month after the collapse of Lehman Brothers, financial market regulators in the European Union began an investigation into the global derivatives market looking at ways of reducing systemic risk within the financial sector. The concern for European regulators is that when a derivatives trade goes "bad", an outcome that is more likely when derivatives are used for speculation, they have the potential to spread the negative consequences of defaults to all corners of the global financial market.

Regulators in both the US and Europe are primarily concerned about the systemic risks arising from positions in the "Over the Counter" (OTC) derivatives market. Establishing central clearing houses or central counterparties (CCPs) is considered a way of reducing systemic risk related to derivatives transactions. Instead of being exchanged privately via the OTC market, they could be processed through an intermediary, a move which is expected to improve transparency and reduce risk. However, non-financial firms using derivatives to hedge their risks would be required to keep large amounts of extra financing available for the purposes of putting up margin dependent on daily mark to market valuations. Capital and undrawn lines of credit will need to be held against potential margin for significant price changes in the price of the asset underlying the derivative transaction.

Companies will be required to be able to pay margin to their contracted counterparty for negative positions during the life of a derivative contract although the offsetting, hedged, underlying cash flows will not materialize until the maturity of the underlying exposure. While margin payments would be received for derivatives positions showing a gain, they could not be used in the business prior to maturity as this cash could flow out again just as quickly as underlying prices moved in the opposite direction.

One of the advantages of OTC derivates is that they usually require no cash flows prior to maturity. But if the move to CCPs will require non-financial firms to provide

[2] http://www.risk.net/risk-magazine/news/1685735/ec-derivatives-consultation-stops-short-corporate-exemptions

collateral to their counterparty daily during the life of the derivative hedge, the hedge cash flows become immediate and companies would have to finance them up to maturity. This could be a significant financial burden for many companies particularly at a time when the flow of bank credit to the corporate sector is running at historically low levels. The net result could be an increase in liquidity risk for firms. Another problem with enforcing clearing on non-financial firms is that it could stop them meeting hedge accounting requirements, as standardized, exchange-traded contracts would not match the financial exposures on their balance sheet.

Many voices from the corporate sector are arguing that there is a strong possibility that compulsory clearing will hamper firms' ability to hedge because they would have to post initial and variation margin, utilizing a firm's scarce working capital. For example, Richard Raeburn, chairman of the European Association of Corporate Treasurers in London, is lobbying hard for non-financial firms to be exempt from being required to post margin. Speaking to Risk Magazine Christopher Whittall[3] says,

> *"Forcing corporates into central clearing creates an unmanageable liquidity risk challenge. You can also argue that incremental systemic risk is created because of the hazards corporates will face if they are required to set aside almost unlimited liquidity to meet uncertain future margin calls. I would argue that faced with the volatility of currency and interest rate markets, corporates are left with a very large contingent exposure to post collateral if the mark to market goes against them…If corporates don't get some kind of exemption from central clearing, they'll basically just see prices go up, as banks will have to pass prices on. That's the biggest issue at the moment."*

Christopher Whittall from Risk Magazine points out that many corporate treasurers have previously told Risk of their opposition to central clearing. He provides the following quote from a treasurer of a major airline,

> *"When fuel prices spiked prior to the financial crisis and then dropped significantly, the mark-to-market impact was huge. Margin calls would have tied up a good few $100 million at the very time we needed the money.*

[3] 16 June 2010 - Corporates should be forced onto central counterparties – BIS, http://www.risk.net/risk-magazine/news/1686244/corporates-forced-central-counterparties-bis

Clearing would be a disaster: all it will do is stop people hedging as they can't afford it." [4]

Corporate end-users are lobbying hard to be exempt from any clearing obligations, arguing that their use of derivatives doesn't impose any systemic risk and that any mandatory clearing requirement would require them to eat into vital working capital to meet margin calls by CCPs. Derivative end–users are concerned that the requirement to centrally clear all OTC derivatives trades will force them to put aside large amounts of cash for margin calls and consequently increase their costs of hedging. This will lower the net benefits of hedging and hence decrease firm value. The tying up of cash in this way has the potential to adversely affect firm value in another way, (as firms may be forced to forego valuable investment opportunities) as that cash could otherwise be deployed in the firm, such as for investment purposes. For practitioners it seems that there are clear economic and financial implications to the proposed clearing rules. Firstly, increased costs of hedging leading to less hedging and therefore firms subjected to greater financial price exposure. It follows that this could result in greater credit risk for firms' financial counterparties (such as the banks that lend to corporates) which could increase systemic risk within the financial sector. This outcome would be opposite to that envisaged by regulators. Secondly, firms cash resources being diverted away from productive use, such as funding value increasing investment, for the purposes of meeting margin and collateral requirements on their derivative transactions. The implications of this would be a likely reduction in corporate economic activity with obvious consequences for employment, growth and the real economy. Given the strong possibility tat the proposed clearing and margin obligations could significantly hinder firms' ability to hedge their financial price exposures an important question is whether the proposed move to central clearing is really necessary. It will be necessary only if corporate users of derivative instruments give rise to systematic risk. We should therefore attempt to establish if the corporate use of derivatives pose a systemic threat? We would argue that it will only do so if non-financial firms are using derivatives for speculation.

In this study we examine the link between the use of derivatives by UK non-financial firms and their likelihood of default measured using expected default frequencies. A key advantage of our indicator of firm risk is that it is a direct measure of firm's credit risk. The limited numbers of previous studies that investigate this issue rely on financial risk indicators that take no account of a firm's level of indebtedness (see Batram et al. (2011)). In order to

[4] 16 June 2010 - Corporates should be forced onto central counterparties – BIS, http://www.risk.net/risk-magazine/news/1686244/corporates-forced-central-counterparties-bis

gauge whether the use of derivatives by non-financial firms generates systemic risk we require a measure of firm credit risk which our measure provides.

The focus of this paper is to examine whether firms are using derivatives for hedging or speculative purposes. We do this by investigating the effect of hedging on the firm's financial risk and more specifically on the probability of financial distress. This paper studies UK firms from 1999 to 2010 to test the relationship between hedging and the likelihood financial distress. For the overwhelming majority of our firms disclosures in annual reports indicated that firms are using financial derivatives for risk management. Our empirical results show that hedging firms have a significantly lower probability of default. This result is consistent with the notion that firms are using derivatives for hedging rather than speculation. Furthermore, we find that interest rate hedging lowers the probability of default more than foreign currency hedging. We use an instrumental variable approach to control for endogeneity of hedging and leverage on probability of default and find that hedging firms have significantly lower probability of default than non-hedging firms.

This paper is organized as follow. Section 2 reviews the related empirical literature. Section 3 describes our methodology, sample and the data employed in the study. Section 4 presents the empirical results and section 5 draws some conclusions.

2 Literature Review

"Firms speculate because they believe doing so is a profitable activity and not simply a risk taking activity that provides upside potential" (Geczy, Minton and Schrand (2007), page 15).

2.1 Introduction

According to Modigliani and Miller [M&M] (1958) in a world of perfect capital markets, investors, where they have easy access to the capital markets, can obtain the same results that the firm could achieve through corporate hedging, by self-hedging. Thus, according to the M&M (1958) irrelevance propositions a firm managed by profit maximizing managers should not employ in financial hedging activities since investors can carry out their own hedging. However, if there are capital market imperfections then there may be valid reasons for the firm to hedge. Based on the work of M&M (1958) Smith and Stulz (1985) develop a theory of

corporate hedging. By relaxing the M&M (1958) assumptions, Smith and Stulz (1985) provide a rationale for why firms may decide to hedge and therefore use derivatives as a means for hedging. According to Smith and Stulz (1985) (and subsequently others) the reasons why firms might hedge are:

1. Minimize corporate tax liability.

Smith et al., (1985) argue that by reducing the variability of taxable income, hedging can reduce a firm's expected tax liabilities given that it has a convex tax function.

2. Reduce the expected cost of financial distress

Smith et al., (1985) argue that hedging can reduce the expected cost of financial distress. Ross (1997) and Leland (1998) show that by reducing the likelihood of bankruptcy hedging may increase a firm's debt capacity, which in turn will increase firm value through debt interest tax shields

3. Improve conflicts of interest between bondholders and shareholders

Bessembinder (1991) shows that conflicts between shareholder and bondholders can lead to the problem of underinvestment in future positive net present value projects and that hedging can help the firm reduce this conflict.

4. Improve the co-ordination between financing and investment policy

Froot, Scharfstein and Stein (1993) argue that firms facing costly external finance may use hedging to reduce the probability that internally generated cash flows are insufficient to cover the cost of planned investments.

5. Maximise the value of managers wealth portfolio

Stulz (1984) states that there are greater benefits for managers to hedge when managerial compensation leaves the managers holding a large portfolio of idiosyncratic firm risk.

Over the last seventeen years several studies have examined the aforementioned theories of corporate hedging (for example, Nance, Smith and Smithson (1993); Mian (1996); Gay and Nam (1998); Geczy, Minton and Schrand (1997); Guay (1999); Graham and Rogers (2002); Judge (2006); Spano (2006); Purnanandam (2006); Magee (2008); Bartram, Brown and Conrad (2010)). All of these studies incorporate the use of financial derivatives into their hedging definitions. One problem with this approach is that they have classified derivative

users as hedgers; however, firms could potentially be using derivatives for speculating in financial markets and not for hedging. It follows from this that one of the critical basic assumptions of these studies is that risk management activities (such as the use of derivatives) are conducted for hedging (that is, risk reduction) rather than speculative purposes. However, firms' use of derivatives may be motivated by reasons other than those related to hedging, such as increasing the value of the managers wealth portfolio, firms attempting to profit from taking speculative positions and firms matching the risk management strategies of competitors.

2.2 Managers taking a view on future financial price movements and selective hedging

Outright speculation may be a rare activity for non-financial firms but there is evidence that manager's future market views affect firms' financial policy decisions. Stulz (1996) calls the practice of managers' attempt to time the financial markets with their risk management policy decisions as "selective hedging". He says that selective hedging will increase shareholders wealth if managers have private information about the market than the other market participants. However, if financial managers don't have this advantage then this type of financial strategy of hedging will merely result in an increase in the variability of cash flow (relative to a fully hedged position) and will potentially reduce shareholders value.

Stulz (1996) provides three reasons for selective hedging. First, he notes that it is a rationale approach for managers of firms that are likely to go bankrupt to take speculative positions as they have very little to lose. Since the firm is in financial distress it is likely to fail anyway and the additional downside risk due to speculation will be negligible, however, the firm's upside potential will be enhanced leading to an increase in the probability of survival. Second, he suggests that risk managers could engage in selective hedging when their compensation is structured in a way that encourages risk taking. Finally, he states that some managers may engage in selective hedging because they erroneously believe that they have a comparative advantage in hedging selectively, which in turn might lead them to overestimate their ability to beat the market.

Stulz (1996) suggest that firms that can afford to be wrong are more likely to selectively hedge. Firms are in better position to absorb losses from wrong market calls when they are less financially constrained or have fewer growth opportunities. Stulz (1996) also argues that only firms with an informational advantage should selectively hedge.

2.3 Empirical Evidence on Selective Hedging

Several studies have presented evidence, which suggests that non-financial firms engage in selective hedging activities where they incorporate their views of future market price movements in deciding their hedging positions. (Bodnar, Hayt and Marston (1996); Bodnar, Hayt and Marston (1998); Bodnar & Gebhardt (1999); Glaum (2002); Guay and Kothari (2003); Adam and Fernando (2006); Brown, Crabb and Haushalter (2006) and Adam and Fernando (2008)).

Using a survey data of 244 firms, Dolde (1993) reported that almost 90% of the responded firms said that at least some times they changed the size of their derivatives contract based on the future market views. (Dolde (1993) cited by Adam and Fernando (2008) pg no.2). Bodnar et al., (1996) provide evidence that US treasurers time to time allow their view of future financial price movements to influence their hedging decisions. However, this study suggests that firms use financial derivatives generally to reduce the firm's cash flow variation. In a survey of 399 US non-financial firms Bodnar et al., (1998) find half of the sample firms' indicate that based on market view they sometimes change the amount and/or the maturity of their hedges.

Bodnar et al., (1998) ask non-financial firms if their market views of future interest rates and exchange rates cause them to actively take positions. Thirteen firms indicated that they frequently take positions, 66 firms mentioned that they time to time took active positions and for 290 firms the response was they never speculated. Geczy et al (2007) find that speculators are larger than firms that do not take views. Firms that frequently speculate on exchange rates have more foreign currency revenue and costs relative to firms that do not, which is consistent with theories that firms speculate to generate more profit based on what they believe is private information.

In a comparative study of the responses to the 1995 Wharton School Survey of derivative usage among US non-financial firms and 1997 companion survey on German non-financial firms Bodnar and Gebhardt (1999) find firms in US and Germany are different particularity on issue such as the key objective of hedging, the selection of hedging instruments and the influence of their market view when taking derivatives positions. German firms' show considerably less concerned regarding issues related to financial derivatives use than the US firms. This could be due to that financial accounting standards of Germany have greater importance than the US and German firms have strict corporate policies of control over risk management activities of German firms. Bodnar et al. (1999) find compare to US firms German firms are more likely to allow their own market view on future price movements when taking positions with financial derivatives. Almost 25% of German firms responded that they often change the maturity or the amount of their derivatives positions based upon their future market view. In addition to this 50.6% of German firms mentioned that considering their future market view they at least sometimes take active positions on their underlying derivatives contracts compared to 41.2% of US firms.

Using a survey data of 74 non-financial German firms on financial risk management practices Glaum (2002) finds similar results to those of Bodnar et al. (1999) in that the most of the sample German firms pursue forecast based, profit oriented financial derivative strategies. However, Glaum (2002) suggests that the benefits arising to shareholders from managers allowing their future market views into firms hedging strategy decision is not clear. Therefore, according to Glaum (2002) the question then arises as to why there is a widespread use of risk management strategies based on future market views of managers. Glaum (2002) provides three potential explanations for this. Firstly, managers' thinks that their forecast of future exchange rates are of a value and based on it firms are able to outperform the financial market, which helps them to make profit on their gambles. Secondly, managers' thinks that their forecasts of future exchange rates are of a value but they are unaware that the firms are not able to outperform the financial market. He argues firms managers themselves think that they can successfully forecast future market prices and able to outperform the financial market with the information. Lastly, managers are not aware that they are not able to outperform the financial market but they nonetheless take the bets in the market. Using a data of 234 large non-financial firms Guay and Kothari (2003) show that firms' hedge only a small fraction of their exposure with the help of financial derivatives. This indicates that firms

might be leaving some of their exposures unhedged and therefore selectively hedging their financial price exposure.

Beber and Fabbri (2006) analyse the time series variation of foreign currency derivatives for a sample of S&P 500 non-financial firms and find selective hedging is a reason for considerable time series variation they find in currency derivatives holdings in excess of what can be explained by changes in currency exposure.

There seems to be strong evidence of selective hedging in the gold mining industry (Adam (2005); Adam and Fernando (2006) and Brown, Crabb and Haushalter (2006)). Adam (2005) notes that 62% of surveyed firms mentioned when taking decisions on how much exposure to hedge, their expectations about movements in future metal prices are very important or fairly important. For three firms out of 13 surveyed firms the primary risk management objective was to increase sales revenues (Adam (2005) cited by Adam and Fernando (2006) pg no. 6). Using a sample of 92 North American gold mining firms from 1989 to 1999 Adam and Fernando (2006) find evidence of selective hedging but find no economically significant cash flow gains on average from selective hedging. In an attempt to time the market their sample firms' do not yield any positive cash flows gains on average and this kind of speculation creates no value for shareholders.

Brown et al., (2006) also find that risk management strategies in gold mining industry affected by the risk managers' view of future movement of gold prices. In line with Adam and Fernando (2006), they report that the potential economic benefit arising because of selective hedging in their sample is fairly small even before allowing for the marginal transaction costs of such hedging. They find no evidence of superior operating or financial performance based on selective hedging activities by managers.

Faulkender (2005) shows that speculation or market timing drives interest rate risk profile. He does not find evidence that firms are hedging, as when he investigated firms issue of debt he find no link between interest rate exposure and the choice of debt instrument. Measures of interest rate sensitivity are not predictive of firms' choices of their interest rate exposure (that is, how much of the firm's debt is fixed). This analysis builds on the belief that the final interest rate exposure of a new debt issue best reflects the implementation of firms' interest

rate risk management program. Using a firm's fixed-floating debt mix profile as the dependent variable this study finds strong evidence that the shape of the yield curve is a key determinant of whether a firm's newly issued debt instruments is fixed or floating. As the yield curve steepens, firms are more likely to have floating- rate debt, reducing their short-term interest payment relative to locking in at a higher fixed rate. As yield curve flattens, firms are more likely to raise debt funds that have a fixed final interest rate exposure. Faulkender suggests that firms are trying to lower their short-term cost of capital. These findings are consistent with both short-term earnings management and speculation. In order to reduce their short-term debt service payments, which generates higher quarterly earnings, firms might swap the interest rate profile of their debt into floating when there is a large difference between fixed and floating rates. On the other hand, firms may be speculating by incorporating their view of anticipated interest rate movements into their interest rate exposure decision, resulting in a significant sensitivity to the yield spread, if such views are on average correlated with the shape of the yield curve. A recent study by Faulkender and Chernenko (2007) further investigates the reasons for the interest rate timing behavior noted by Faulkender (2005) and finds that to meet consensus earnings estimate and to increase managerial compensation firms primarily use interest rate swap and the choice of interest rate exposure.

Interestingly, in a study of selective hedging in airline industry Sturm (2009) finds that the crude oil futures markets may be a vehicle by which the domestic airline industry can create value via selectively cross hedging their exposure to jet fuel price.

2.4 Firm Characteristics that Might Influence Corporate Speculation

Ljungqvist (1994) argues that firms with certain characteristics may have an incentive to speculate on future financial price movements. Geczy, Minton and Schrand (1997) mention that they are observing derivatives use by sample firms and not the motive of using derivatives and considering this they mention that their dependent variable might be used for speculation rather than hedging. They incorporate firms' motives in using currency derivatives to speculate and the implications of Ljungqvist (1994) arguments for speculation on the results of their study. They mention that some of firms' characteristic variables such as firm size are significant determinants of both optimal speculation and optimal hedging, while

other proxy variables such as those related with underinvestment costs are unrelated to optimal speculative motives. However, they find no support for the speculative uses of derivatives. They point out that although currency derivatives is not direct measure of hedging their results suggest that on an average, their sample firms are not speculating with currency derivatives instruments.

Adam, Fernando and Salas (2007) uses a sample of 97 north American gold mining firms data that enables them to identify speculating firms and their extent of speculation. They find that compare to larger firms smaller firms speculate more. This result is surprising as it is normally believed that small firms are less likely than larger firms to possess the information and financial advantages necessary to beat the market through speculation. Their results also show that firms with the highest likelihood of bankruptcy speculate more. This is in line with the opinion expressed by Stulz (1996) that at the cost of bondholders, firms close to bankruptcy may have incentives to speculate for the benefit of shareholders. However, Adam et al., (2007) also provides evidence that firms that have the lowest possible chances of bankruptcy also speculate more. This can be justified as financially stronger firms can take on additional risk exposure associated with speculation. This would seem to suggest that there is a U-shaped relationship between extent of speculation and the likelihood of bankruptcy. However, more importantly, their results indicate that speculative activities of firm reduce firm value.

If the firm characteristics suggested by Ljungqvist (1994) also motivate the decision to hedge then there are chances that financial derivative users could be using them for other purposes than hedging, such as speculation, if they are presented with these incentives. Therefore, it would seem that the only way to differentiate between hedging and speculation is to compare the financial risk characteristics of derivative users and non-users. If derivative using firms display lower levels of financial risk then it could be argued that firms are using financial derivatives for hedging purposes and not to speculate.

2.5 The link between the use of derivatives and firm financial risk characteristics

To better understand whether firms speculate or hedge we need to measure firms risk and then examine the effect of derivative use on this risk. Several studies have investigated the relationship between derivatives use and firm financial risk (Nance, Smith and Smithson (1993); Tufano (1996); Guay (1999); Peterson and Thlagarajan (2000); Allayannis and Ofek (2001); and Hentschel and Kothari (2001)). The majority employs samples of US firms.

One of the earliest studies to look at the question of whether derivatives were being used to reduce risk was Nance, Smith and Smithson (1993). Using survey data to gather data on US firms derivative use they find, using Non-parametric tests, no difference between the volatilities of derivative users and non-derivative users. Based on this finding they conclude that their firms are using derivatives for hedging.
Tufano (1996) using a sample of 48 North American gold mining firms for the period 1990 to 1994 finds that as US gold producers increase their use of derivatives to the sensitivity of equity value to gold price falls, which is consistent with the theories of hedging that derivatives are used for hedging purposes. Peterson and Thiagarajan (2002) also find evidence, which suggests that firms are not speculating as they find that a gold price hedger possesses gold price exposure that is only slightly greater than that for a gold price non-hedger.

Using a sample of 254 non-financial US firms that started using derivatives Guay (1999) provides evidence that firms risk (total risk, market risk, idiosyncratic risk, interest rate exposure and exchange rate exposure) declines in the period following the initiation of a derivatives program. These results are consistent with the theories that firms are using derivatives to hedge and not to increase financial price risk. Hentschel and Kothari (2001) also look at firm risk characteristics by investigating whether firms' use of derivatives is significantly related to their overall stock return risk. Using data from annual reports of 425 large US firms and after focusing not only on firms with an average level of derivative usage but also intensive users of derivatives they do not detect any economical or statistically significant relationship between firms' risk characteristics and the extent of their participation in derivatives market. They also do not find evidence consistent with the hypothesis that firms use derivatives to speculate on a large scale. However, their results do not provide any evidence suggesting that firms' use of financial derivatives helps in reducing firm risk. They

get a similar result when they control for endogeneity using an instrumental variable methodology.

There are many studies that look at the relationship between foreign currency derivatives use and firms' exchange rate exposure (Allayannis and Ofek (2001); Allayannis, Ihrig and Weston (2001); Carter, Pantzalis and Simkins (2004) and Kim, Mathur and Nam (2006)).

Allayannis and Ofek (2001) using a data of 378 US non-financial firms find evidence that firm's use of currency derivatives significantly reduces the exchange rate exposure firms face and derivative user firms have lower estimated values of firm risk, which suggest that firms use derivatives for hedging financial risk and not to speculate in the foreign exchange market. Allayannis et al., (2001) also provide evidence that firms' exposure through foreign sales and foreign trade is a very important factor in deciding what exposure to hedge, the size of hedge and the maturity of contract. This suggests that firms are not taking decisions on hedging using market views but instead looking at from where their exposure is coming and hedging that exposure.

Using a sample of US non-financial firms for the period 1996 to 1998 Allayannis, Ihrig and Weston (2001) shows firms' financial risk management strategies are related to lower financial price risk. They also find that multinational firms probably use more financial hedging instruments to protect from exchange rate exposure. A study by Carter, Pantzalis and Simkins (2004) uses a dataset of 208 MNCs from the US provide evidence that both operational hedging, such as production in other country, and financial hedging such as derivatives lowers the firms foreign exchange exposure. Studying a sample of 424 US MNCs Kim, Mathur and Nam (2006) find both operational and financial hedging strategies are effective in reducing foreign exchange risk exposure.

Muller and Verschoor (2005) using a sample of 471 European non-financial firms look at the effect of derivatives use on firms' exchange rate exposure. Consistent with Allayannis and Ofek (2001) they find a firm's decision to use foreign currency derivatives is negatively related to exchange rate sensitivity. This evidence suggests that non-financial firms use foreign currency derivatives primarily for hedging purpose and not for speculation.

In a study of hedging activities of 119 US oil and gas producers for the period 1998 to 2001 Jin and Jorion (2006) find that risk management activities of oil and gas producers decreases with sensitivity of equity returns to oil and gas prices. These results suggest that there is a negative relation between financial derivative instruments and the level of firm risk, which is consistent with firms using derivatives to hedge rather than speculate.

A recent study conducted by Magee (2008) looks at the relationship between foreign currency hedging and the probability of financial distress for US firms. This study finds that firms with a more extensive use of foreign currency derivatives exhibit a lower probability of financial distress, which is consistent with foreign currency derivatives being used for hedging rather than speculation. It is not clear why Magee (2008) focuses on foreign currency derivatives and not interest rate derivatives since the latter would be expected to have a stronger impact on the risk of financial distress. Furthermore, there is evidence (Faulkender (2005)) that US firms are timing the market with respect to their use of interest rate swaps.

Bartram et al.,(2010) using a large dataset of non-financial firms from 47 countries with a sample of 6,888 non-financial firms find significant evidence that the use of financial derivatives reduces both total risk and systematic risk. They also find hedging with derivatives is associated with significantly higher value, abnormal returns and larger profits suggesting firms are hedging downside risk. Their results suggest that with the help of financial risk management with the help of derivatives significantly reduces firm's cash flow risk, total risk and systematic risk. This suggests that non-financial firms use derivatives instruments for the purpose of reducing firm risk.

2.6 Asymmetric Information

Theoretical studies on speculation usually look at the role of asymmetric information as a factor, which might motivate such activity. Kyle (1989) examines the information aggregation in an imperfectly competitive model to show how traders speculate based on costly private information. Froot, Scharfstein and Stein (1992) study the speculators trading horizon and show that speculators can reap profit by focusing on information that bears no relation at all to fundamental information of long-term firm values. Madrigal (1996) and Brunermeier and

Pedersen (2005) illustrate that speculators trade profitably by obtaining superior knowledge about market environment or exploiting the need of other investors.

Standard models of informed speculation suggest that traders in the financial markets try to learn information that others do not have. Similarly, corporate speculation can be done using derivatives if managers hold private information that other market participants do not have. DeMarzo and Duffie (1995) shows that when managers hold private information on the firms expected payoff then corporate hedging is optimal despite shareholders ability to hedge their own exposures. Guay and Kothari (2003) finds that although derivative users have private information about the direction of future movements in interest rates, exchange rates and commodity prices, majority of the derivative positions appear much too small to increase firm value. We can interpret this in one of two ways, either this implies that corporate speculation with derivatives is not likely to be widespread or that firms are leaving much of their financial price exposures unhedged. Geczy, Minton and Schrand (2007) find that speculators perceived private information and cost advantages lead them to take active positions. They say "*Several individual pieces of evidence taken together suggest that speculators are more likely to believe they have comparative information advantage relative to the market, and hence to view speculation as a positive net present value (NPV), that is, profitable, activity.*" (Geczy, Minton and Schrand 2007, Pg no. 2). Adam, Fernando and Salas (2007) state that when firm has private information, which is not available to other participants of the market, selective hedging increases firm value. They find that smaller firms speculate more than larger firms, although they are less likely to possess the information and financial advantages necessary to outperform the market through speculation compared to larger firms. Stulz (1996) concludes that firms should also possess financial strength besides having a genuine information advantage, to support the extra risk that selective hedging involves, to increase shareholders value using selective hedging.

2.7 Speculation and Managerial Compensation

The relation between managerial risk taking and compensation is complex. Previous studies in the field consider managers portfolio structure as a determinant of the corporate risk management choice. Smith and Stulz (1985) state the usually the holder of the holder of the

executive stock options have disadvantage to hedge firm risk. Tufano (1996) suggest that corporate risk management policy is mainly determined by managerial risk aversion.

Using a sample of North America gold mining industry Tufano (1996) find that firms whose managers hold more options manage less gold price risk, and firms whose managers hold more stock manages more gold price risk which suggest that managerial risk aversion may affect corporate risk management policy. He finds no evidence of use of derivatives for speculation among these firms. However, these studies are carried out on firms in gold mining industry only.

There is a positive relationship among option-based compensation policy and incentives for managers to take risk because stock price volatility increases call option values (Smith and Stulz (1985)). Firms are also more likely to use derivatives for speculative purposes when the stock price sensitivity of the CFO's firm related compensation is higher but the convexity of his options is not associated with speculation. Managers might have an incentive to engage in speculation if their remuneration is linked to the profits such strategies produce.

Smith et al., (1985) demonstrates that when a risk-averse manager owns a large number of firm's shares, his expected utility of wealth is significantly affected by the variance of the firm's expected profits. The manager will direct the firm to hedge when he believes that it is less costly for the firm to hedge the share price risk than it is for him to hedge the risk on his own account. Consequently, Smith et al. (1985) predict a positive relation between managerial wealth invested in the firm and the use of derivatives. A study by Beber et al., (2006) using a sample of large US non-financial firms with currency exposure finds no significant link between CEO stock price sensitivity (delta) and selective hedging. However, they find a decrease in hedging activity when the sensitivity CEO Vega increases. This study also finds that CEO education; age, gender and experience can explain speculative behavior.

Using response to a well-known survey Geczy, Minton and Schrand (2007) find that CFO's delta is positively associated with the probability of actively taking positions. However, the equity-based compensation of the CEO's has the negative association with speculation. These results also suggest that the speculating firms have compensation related incentives that encourage speculation, but only if it is expected to be profitable. Their findings also suggest

that firms engage in active trading once the total costs of initiating a derivatives strategy are in place. "*Firms are motivated to use derivative instruments to hedge. Once the fixed costs of derivatives operation in place, however, some firms extend these operations to include active trading based on market view"* (Geczy et al., 2007; Pg No. 2). Geczy et al. (2007) also suggest that managers of derivative using firms are more likely to speculate when derivatives function is benchmarked against profits rather than the effect of risk management on firm. Adam, Fernando and Salas (2007) find that selective hedging is negatively correlated with the notion that convexity in managerial compensation is motive for managers to speculate.

Table 2-1: Summary of Key Previous Studies that has looked at whether firms use derivatives for hedging or speculation

Author(s)	Area of Study	Country	Period	Sample Size(# of firms)	Type of firms	Dependent Variable	Methodology	Source of Data
Nance, Smith and Smithson	All Hedging	US	1993	169	Non-Financial	Binary	Logit	Survey
Bodnar, Hayt And Marston	All derivatives	US	1996	350	Non-Financial	-	-	Survey
Geczy, Minton and Schrand	Foreign Currency derivatives	US	1997	372	non-financial	Binary	Logit/Simultaneous equation	10-k filings, Compustat
Gay and Nam	All derivatives	US	1998	486	Non-Financial	Binary	tobit	Compustat
Bodnar and Gebhardt	All derivatives	US and Germany	1999	-	Non-Financial	-	Comparative study	Survey
Guay	All derivatives	US	1999	254	non-financial	Total Risk, Market Risk, Exchange rate exposure, Idiosyncratic Risk, Interest rate exposure	logit, OLS	Compustat, CRSP
Allayannis and Ofek	foreign currency derivatives	US	2001	378	Non-Financial	Exchange rate exposure	Logit, Probit, Weighted Least square	Annual Reports
Hentschel and	All derivatives	US	2001	425	Non-	Total Risk	IV regression	Annual Reports, CRSP

kothari					Financial			
Glaum	All derivatives	Germany	2002	154	Non-Financial	Binary	Logit	Survey
Carter, Pantzalis and Simkins	foreign currency derivatives	US	2004	208	Non-Financial	Capital expenditure scaled by lagged assets.	Three stage least square	Compustat, CRSP, SWAPS database
Faulkender	Interest rate exposure	US	2005	133	Non-Financial-Chemical	Binary	Probit,	SDC platinum, Deal scan, Compustat, EDGAR
Brown, Crabb and Haushalter	All derivatives	North America	2006	44	Non-Financial	Std. deviation of quarterly hedge ratios	Pooled Regression, Quadric regression	Collected from financial analyst (Private firm), Compustat
Judge	All Hedging	UK	2006	400	Non-Financial	Binary	Logit	Annual reports, Survey
Kim, Mathur and Nam	Operational and financial Hedging	US	2006	424	Non-Financial	Binary and continuous, Tobin's q	Logit, Probit	Compustat, EDGAR
Purnanandam	Foreign Exchange and Comm.	US	2006	More than 2000	Non-Financial	Binary and continuous	2SLS logit and Probit, IV model,	10-k Filing, Compustat, CRSP
Geczy, Minton and Schrand	All derivatives	Us	2007	341	Non-Financial	Categorical Variable, Never, Sometimes, and Frequent	Logit	Survey data
Adam,	All derivatives	North	2007	92	Non-	Hedge Ratios	OLS, Heckman	Gold and silver hedge outlook,

Fernando and Salas		America			financial Gold Mining		Two step regressions	Compustat and annual reports, CRSP and Data Stream
Adam and Fernando	All derivatives	North America	2008	92	Non-Financial-Gold mining	Hedge Ratios	Cragg Model Regression	Survey and market data
Magee	Foreign Currency Hedging	US	2008	401	Non-Financial	One year Distance to default using Merton's option pricing model.	2SLS, IV, GMM	Compustat, EDGAR
Bartram, Brown and Conrad	All derivatives	47 countries	2010	6788	Non-Financial	Cash flow volatility, Sta. deviation of returns and market risk.	Propensity score matching	Annual Reports, DataStream, Thomson analytical database

3 Sample, Data and Methodology

3.1 Sample Selection and Data

In this study ~~We~~we examine our model using the foreign currency, interest rate and commodity derivatives holdings of a large cross section of firms during the fiscal year 1999-2010. We remove financial firms from the sample as they use derivatives for trading and speculative purposes and they are not necessarily comparable to non-financial firms that use derivatives for reducing risk. For the remaining firms we collected data from annual reports. Firms listed on the London Stock Exchange are subject to UK accounting rules. Accounting standards on derivatives use have been mandatory in the UK since September 1998 when financial reporting standard (FRS) 13 was published. According to FRS 13, non-financial firms are required to provide both narrative and numerical disclosure on their derivative activities in their financial statements. These narrative disclosures should describe the role that financial derivatives have in creating or changing the risk that the firm faces, including its objectives and policies in using financial derivatives to manage these risks. The numerical disclosures in annual reports should explain how these objectives and policies are implemented and provide supplementary information for evaluating significant financial exposures. These disclosures should provide a broad overview of the firm's financial instruments and of the risk positions created by them. Firms also have to specify whether the derivatives they use are regarded as hedges or as for speculative purposes[5].

In the first step we collected annual reports for all the firms in our sample during the sample period. We search annual reports for following text strings: "foreign exchange contract," "interest rate swap," "commodity price," "hedge," "derivative," "risk management." If a reference is made to any of these keywords, we read the surrounding text to obtain the data on a firm's hedging activities. We obtain the data on notional amounts of foreign currency, interest rate and commodity derivative contracts used for hedging purposes. If we couldn't find any reference to the searched

[5] Accounting Standard Board, September 1998

keywords, we classified the firm as a non-hedging firm. We use DATASTREAM software to collect the firm level financial data.

The dataset is created in panel data format which provides scope for both cross-section and time series analysis. The dataset is an unbalanced panel dataset that means that for some firms data is not available for the whole period. One of the key problems with firm level data is unobserved heterogeneity. Panel data allows the analysis to control for unobserved individual effect by estimating the model in fixed or random effects and for controlling for unobserved heterogeneity across companies by comparing the same firm overtime.

We employ univariate and multivariate analysis to present the empirical results. The univariate analysis examines the differences in probability of default and other firm-level characteristics between hedging and non-hedging firms. As univariate analysis does not account for changes in other variables, we also analyze multivariate analysis. The multivariate analysis shows the impact of hedging on probability of default while controlling for other firm characteristics. For the multivariate analysis we are using following Model.

3.2 Model Development

This study examines the effects of hedging on the probability of default. This study uses a firms probability of default as a proxy for its probability of financial distress and uses the following regression specification to estimate the effect of hedging on the probability of default.

$$\textit{Probability of default}_{it} = \beta_0 + \beta_1(\textit{Hedging}) + \beta_2 \textit{Leverage}_{it} + x'_{it}\beta + \varepsilon_{it.} \qquad (1)$$

x'it includes control variables which are discussed below. We also include year dummies to control for aggregate time effects and industry dummies for industry effects in the model.

There are some important challenges in empirically testing the above model. The first challenge is that the data on a firm's hedging decision is very limited. The second challenge is that the independent variables, leverage and hedging are likely to be defined jointly by firms that creates the problem of endogeneity. Theories based on ex-ante incentives show that by actively using hedging strategies, firms could increase their debt capacity as a result of a reduction in risk. This creates a reverse causation problem between these variables.

3.3 Variable Description

3.3.1 Measures of Firm Risk

We classify measure of firm risk into pre and post hedging measures. Our pre-hedging measures are foreign sales, Z score, qui score and interest coverage. Our post-hedging measures are Probability of default one and five year, equity volatility, cash-flow volatility, equity volatility to market volatility and idiosyncratic risk.

3.3.1.1 Pre hedging Measures

In this section we discuss how we have calculate pre-hedging measures.

- **Foreign Sales**: We calculate foreign sales as international sales / net sales or revenues. This is a measure of exposure with regards to foreign exchange rate risk.
- **Z score**: Altman (1968) originally developed the Z score. The Z score is a proxy for likelihood of risk of financial distress and is the transformation into a single measure of a number of financial ratios, weighted and added together (Agarwal and Taffler, 2007). . This study uses the following formula to calculate Z score for UK firms;[6]

  Z Score = 3.20 + 12.18 PROF + 2.50 WCAP – 10.68 FRISK + 0.029 LIQUID

  ∴Where

  PROF = profit before tax/current liabilities

  WCAP = Current assets/Total liabilities

[6] (Agarwal and Taffler, 2007, pg no 3(287))

FRISK = Current liabilities/Total assets

LIQUID = Quick assets - current liabilities/ (Sales- profit before tax – depreciation)/365 days

- **Qui-Score**[7]: The Qui Score is a measure of the likelihood of company failure in the twelve months following the date of calculation. It is given as a number in the range

  a) 0 to 100. This range is divided into five distinct bands.

     a. 81-100 The Secure Band

        Includes large and successful companies. Failure of company is very unusual and occurs only as a result of exceptional market or company changes.

     b. 61-80 The Stable Band

        There are very less chances of failure of companies in this range. Market wide factors could results in company failure.

     c. 41-60 The Normal Band

        In this band few of the companies are likely to fail

     d. 21-40 The Unstable Band

        If a firm has qui score in this range then there are four times more changes of failure than that of the normal band.

     e. 0-20 The High Risk Band

        Companies in the High Risk sector may have difficulties in continuing trading unless significant remedial action is undertaken, there is support from a parent company, or special circumstances apply. A low score does not mean that failure is inevitable.

- **Interest Coverage:** we measure interest coverage as earnings before interest and taxes / interest expenses on debt.

3.3.1.2 Post-Hedging Measures

[7] Qui Credit Assessment Limited (1999).

A firm's post-hedging exposure is the result of its off-balance sheet activities such as derivatives and the assets and liabilities characteristics. Our measures of post-hedging exposures are Probability of default one and five year, equity volatility, cash flow volatility and ratio of equity volatility to market volatility.

- **Probability of default:** We use firm's one-year and five year probability of default as a measure for probability of financial distress, which is sourced from Moody's. The probability of default measurers the probability that the market value of firm's assets will be less than the book value of the firm's liabilities by the time the debt matures. Probability of Default is one step ahead of distance to default, which is also a measure of financial distress estimated using Merton's (1974) option pricing model.

  Alternative proxies for probability of financial distress include distance to default, which is estimated using Merton's (1974) model. The probability of default is extended version of distance to default. Other proxies for probability of financial distress are Altman's (1968) Z-score and Ohlson's (1980) O-score. These measures are calculated using accounting data and as accounting models use information that derived from financial statements. These information is backward looking, since this information is designed to measure firms past performance and this is not useful to know the future of the organization. The probability of default is calculated using threes steps. First step include estimation of asset value and volatility, which is estimated using market value and volatility of equity and the book value of liabilities. Second step includes calculations of the distance to default by calculating asset value and asset volatility (which is done in first step) and the book value of liabilities. Step three, which is probability of default, is determined directly from distance to default (second step) and the default rate for given levels of distance to default. This calculation uses the market value of firm's equity and assets. These measures reflect expectations about firm's future prospects. These variables contain forward-looking information that is better suited to estimating the likelihood that a firm might default in future.

It is difficult to breakdown the factors affecting the risk of assets and liabilities as there are many of these factors. However, the assumption of efficient capital market suggests that the post-hedging can be estimated using the information available from the companies share prices as share prices reflects all the information related to the company. Following this, we employ different risk measures constructed using stock prices.

- **Equity Volatility :** We calculate the standard deviation of stock return for each firm. We calculate equity volatility for each firm as daily local currency stock return standard deviation over the entire fiscal year
- **Standardised Firm Volatility :** Ratio of the daily local currency stock return standard deviation ( ) and the local currency market index standard deviation (.[8]
- **Cash Flow Volatility** : we define cash flow volatility as five-year standard deviation of operating cash flow/sales[9]. Bartram et al., (2011) suggests that this measure may not be a good measure of post-hedging for several reasons. They argue that the variable is calculated using accounting data and managers can systematically manipulate these data. They also argue that operating cash flow may not account for the use of all derivatives for all firms. *"if exchange rate and commodity price derivative transactions do not utilize (i.e., qualify for) "hedge accounting" they will not be reflected in operating cash flow. Similarly, the effects of most interest rate derivatives will not be reflected in operating cash flow" (Bartram et al (2011), pg no: 979).* However, they also argue that cash flow volatility captures the effect of natural hedging, important tool for foreign exchange hedging.

3.3.2 Derivatives as a proxy for hedging

This study uses two definitions of hedging based on use of derivatives. The first definition is based on the firm's decision to use derivatives for hedging purpose. This specification uses three types of derivative contracts – Foreign exchange contract, interest rate contract and commodity contract where we assign 1 if a firm uses

[8] Bartram et al., 2011

[9] Bartram et al., 2011

derivatives and 0 otherwise. However, the problem with definition is that one cannot differentiate between firms with different extent of hedging. To differentiate between firms with different hedging intensities, this study uses the TOTAL NOTIONAL amounts of Foreign exchange contract, interest rate contract and commodity contract. The second definition based on notional amount of derivatives captures the firm's total ownership of risk-management instruments and thus able to distinguish between firms with different hedging intensities.

There is an important concerns associated with the use of derivatives as a proxy for hedging activities. Thought this study-collected data on derivatives from firms' annual reports where firms classify them under risk-management tools, there may still be concern about how firms might use these risk-management instruments. There is always a question- whether firms use these instruments for hedging purpose or for speculation? However, earlier empirical studies which examined the motives after the use of derivatives find enough evidence to suggest that the majority of firms use financial derivatives or hedging purposes and not for speculation. Guay (1999) find that firms that started using derivatives experience decline in stock price volatility after the initiation of the derivatives program. Allayannis and Ofek (2001) show that hedging helps firms in reducing their currency exposure.

3.3.3 Control Variables

This study relies on the existing empirical literature to help determine the control variables employed in the multivariate analysis. Probability of default is related to the following firm characteristics:

a) **Leverage**: This study uses the ratio of total debt to market value of assets as a measure for leverage. Shumway (1999) finds significant positive relationship between leverage and probability of financial distress. We expect a positive sign on this variable.
b) **Firm size**: We use natural log of total debt plus market value of equity to control for firm size. Larger firms have diversified products and operate in many geographical markets.

c) **Excess return**: we calculate excess return as annual return on the firm minus the value weighted FTSE all shares index annual return over the entire fiscal year. We expect a negative coefficient for this variable.

d) **Quick ratio**: We measure quick ratio as ratio of total current assets minus total stock and work in progress over total current liabilities. We expect quick ratio to be negatively related to probability of default, as firms with more cash have lower likelihood of default.

e) **Profitability**: It is expected that profitable firms are more likely to have a lower probability of default than less profitable firms. We use return on invested capital as a measure for profitability. It is expected that more profitable firms have lower likelihood of default. We expect negative coefficient for this variable.

f) **Equity volatility**: It is expected that firms with greater equity volatility should have higher probability of default. We calculate equity volatility as standard deviation of each firm's daily stock return over the entire fiscal year. We expect positive coefficient for this variable.

3.4 Methodology

In order to find out the effects of hedging on probability of default, we employ both Univariate and Multivariate regressions. Univariate analysis is examined in order to find the mean difference between hedgers and non-hedgers.

We use Multivariate regressions to find out the relationship between probability of default and hedging. We use different definition of hedging and run pooled OLS regression with clustering effects where probability of default is regressed on dummy variables for hedging and on different control variables. We also use fixed effects and random effects model. We use industry and time dummy variables to control for industry and time effects.

We use instrumental variable approach to control endogeneity between hedging and leverage. We use different econometric models to control for the endogeneity problem. We specifically use two stage least square and Generalized Methods of Moments methods.

4 Empirical Analysis

4.1 Time-Series profile of Probability of default

In this section we discuss empirical analyses by plotting the time-series of mean probability of default data for all-hedgers, FX hedgers and IR hedgers and compare this with that of non-hedgers from 1999 to 2010. These figures are indicative of our results but its important to note that we are not controlling the firms for firm-level difference between users and non-users. Figure 4-1 shows that all hedger and non-hedgers have similar probability of default at the start of sample year 1999 and as we move towards year 2002 the figure shows that hedging firms have lower probability of default for both 1 and 5 year than non-hedging firms. This is the period of financial crisis and its clear from the figure that hedging firms have lower probability of default than non-hedging firms in the same time period. After 2002 the probability of default is reducing for both the types of firm. However, it is clear that hedging firms have lower probability of default than non-hedging firms for all the years after 2001. The probability of default is again increases around year 2008, second period of financial crisis, but the increase is much faster for non-hedging firms than hedging firms. The difference for probability of default between all-hedgers and non-hedgers is also highest in mid of 2008. This figure clearly shows that our data covers two period of global crisis i.e. 2002 and 2008. From the figure its also clearly evident that the difference between default level is highest during the period of crisis and this suggests that hedging adds more value to the firm during the period of financial crisis or market uncertainty.

Figure 4-2 and Figure 4-3 show the time series variability in probability of default for FX hedgers and IR hedgers respectively. Both of these figures have similar characteristics as figure 4-1. For both of the figures hedging firms have lower probability of default than non-hedging firms. These figures also suggest that firms get the best results of hedging in the time of financial crisis as indicated by lower probability of default.

We also calculate the probability of default difference for one and five year between hedges & non-hedges, foreign currency hedgers & non-hedgers and interest rate hedgers and non-hedgers. We plot these differences in figure 4-4 and 4-6. Figure 4-4 shows the difference for hedgers and non-hedgers. For the first four years hedging firms have higher probability of default but after that hedgers have lower probability of default. Hedging firms have 1 to 2 percent lower probability of default starting from year 2002 to the end of year 2005. The difference decreases during year 2006. The difference increased rapidly from 2007 to 2009, a period of recent financial crisis. In the beginning of the year 2009t there is a 4 percent difference between the default probability of hedgers and non-hedgers. The difference figure for FX hedging in figure 4-5 also suggests that the highest difference between FX hedgers and non-FX hedgers is in beginning of year 2009. The difference figure for interest rate hedging is very different from foreign exchange hedging. Before year 2001 interest hedging firms have higher probability of default but after that they have lower probability of default. After year 2001 there is a sharp increase in the difference of probability of default until the start of 2003. The difference again sharply increases during the recent financial crisis of 2008-09. This figure clearly indicates that interest rate hedging firms have lowest probability of default during the financial crisis of 2002-03 and 2008-09.

Figure 4-1: Time-Series plot of Mean Probability of default (EDF 1 & 5 Year) of All-Hedgers and Non-Hedgers Between 1999-2010

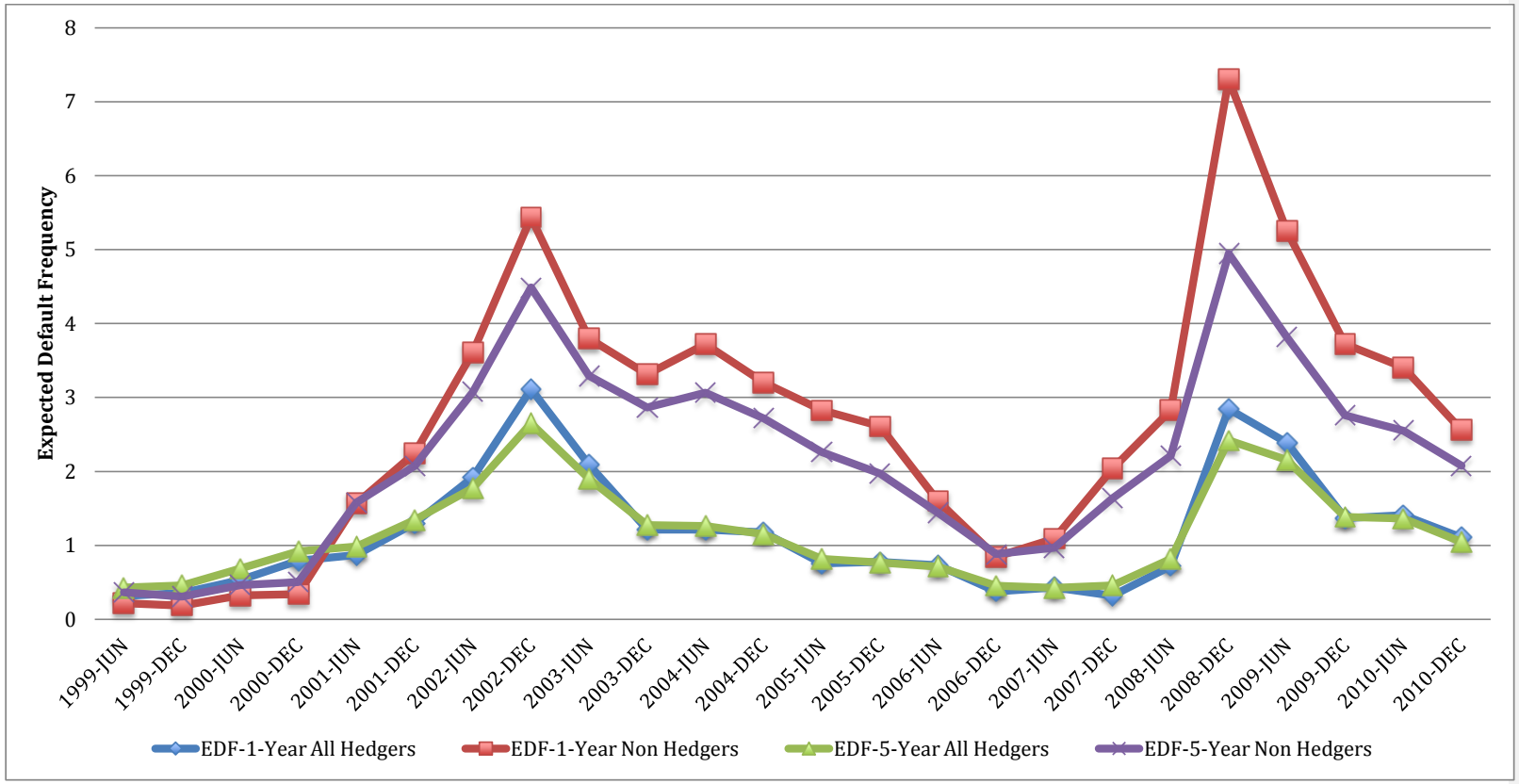


Figure 4-2: Time-Series plot of Probability of default (EDF 1 & 5 Year) of FX-Hedgers and Non-FX Hedgers Between 1999-2010

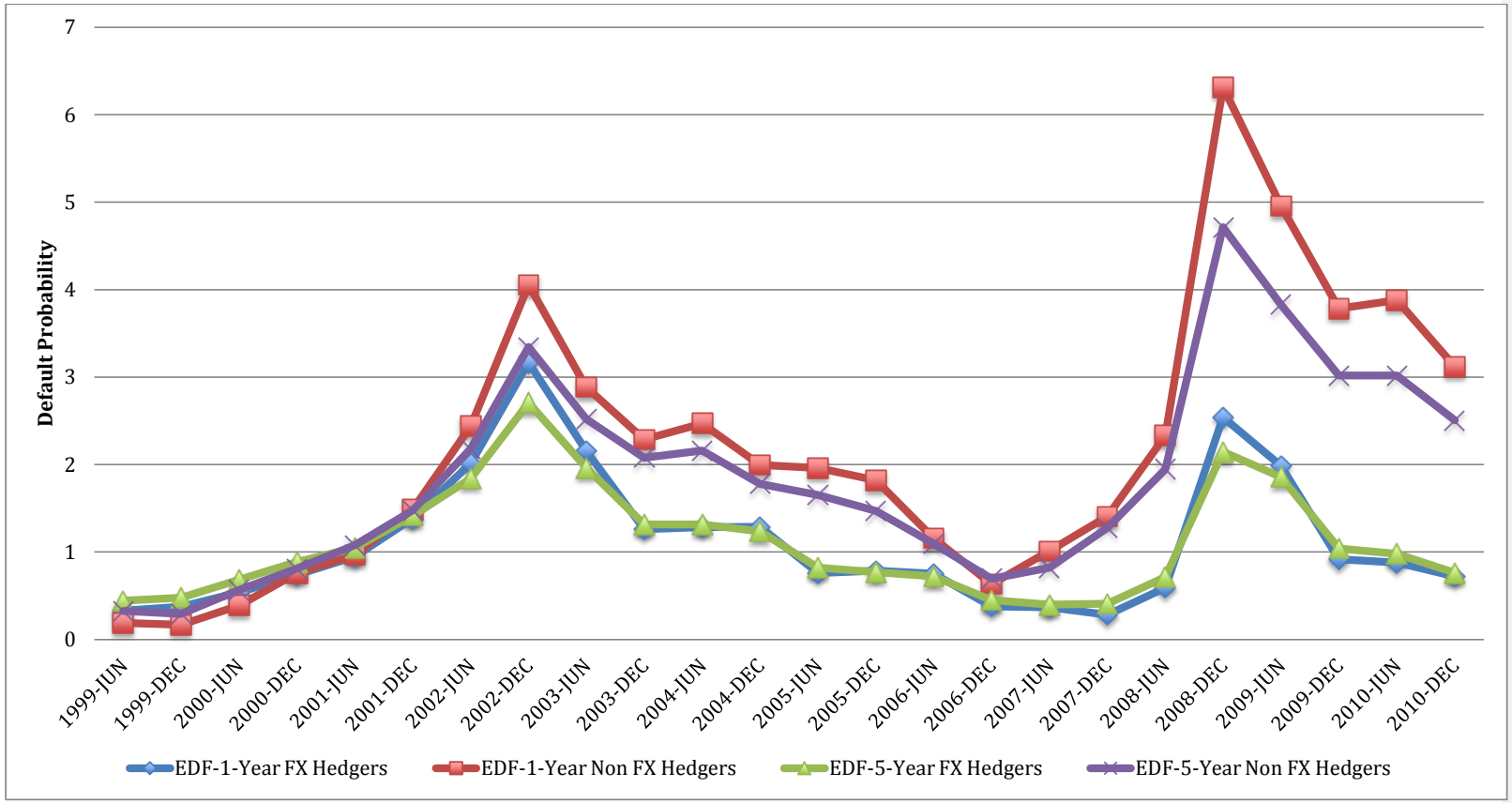


Figure 4-3: Time-Series plot of Probability of default (EDF 1 & 5 Year) of IR-Hedgers and Non-IR Hedgers Between 1999-2010

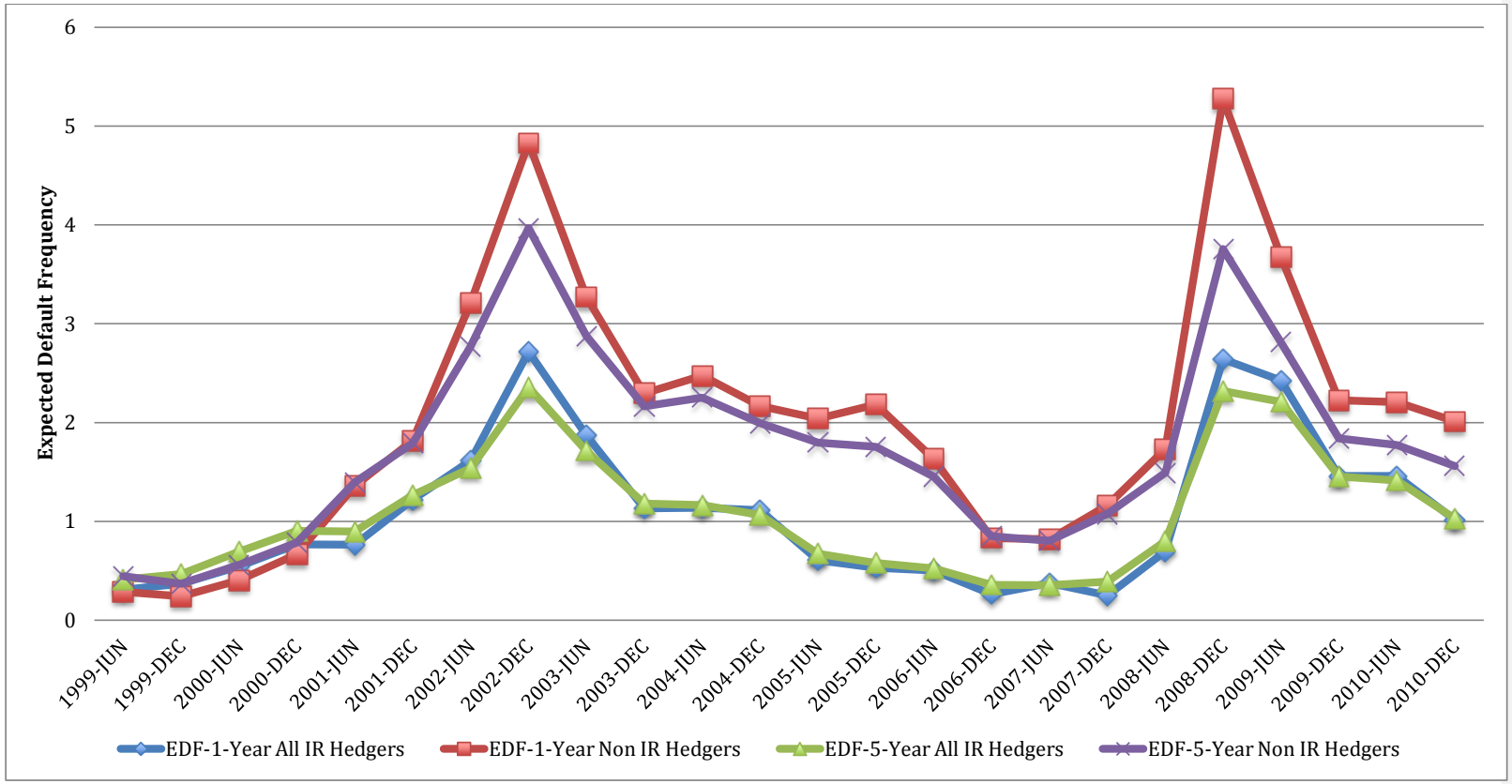


Figure 4-4: Time-Series plot of Probability of default difference (EDF 1 & 5 Year) of All-Hedgers and Non-Hedgers Between 1999-2010

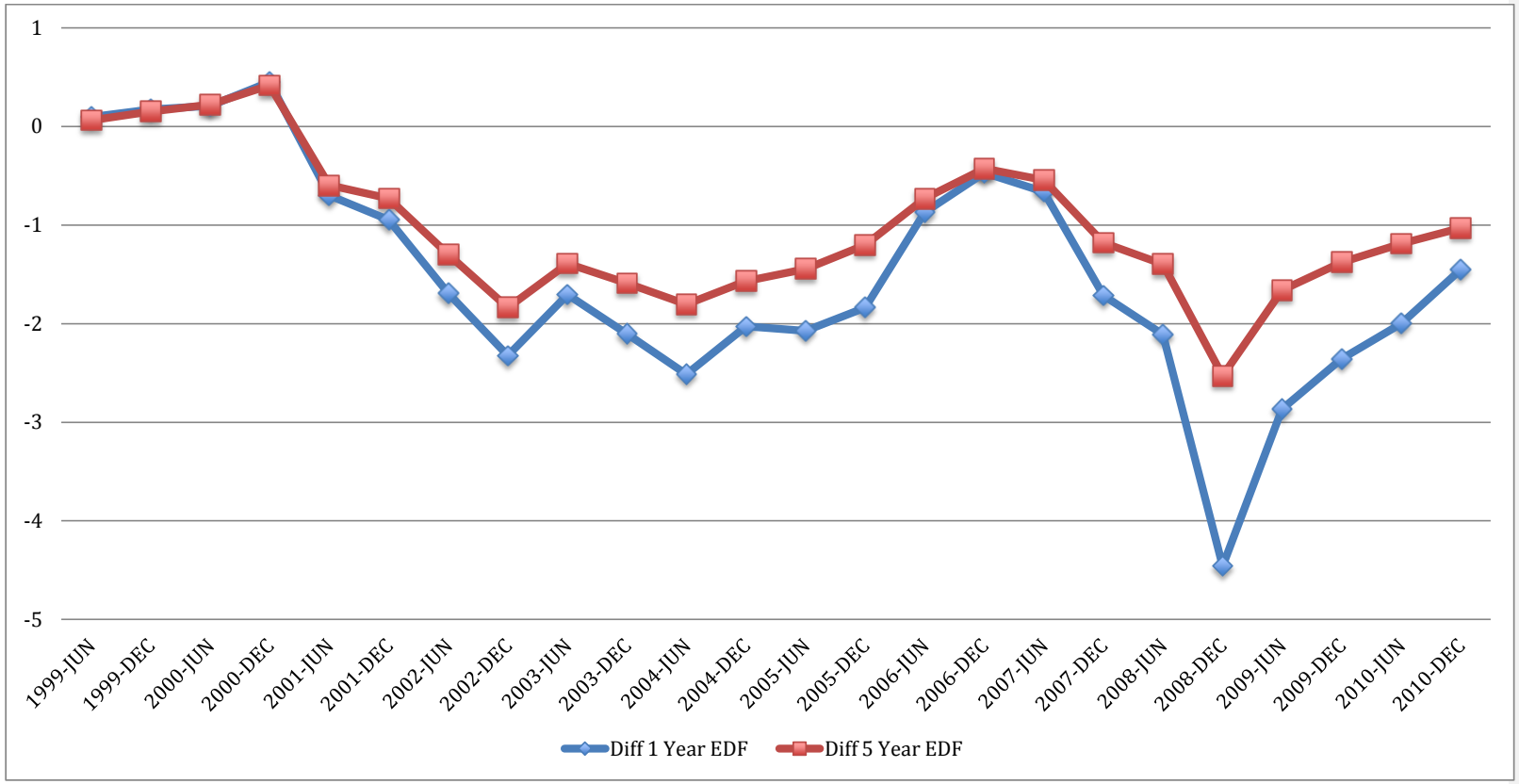


Figure 4-5: Time-Series plot of Probability of default difference (EDF 1 & 5 Year) of FX-Hedgers and Non-FX Hedgers Between 1999-2010

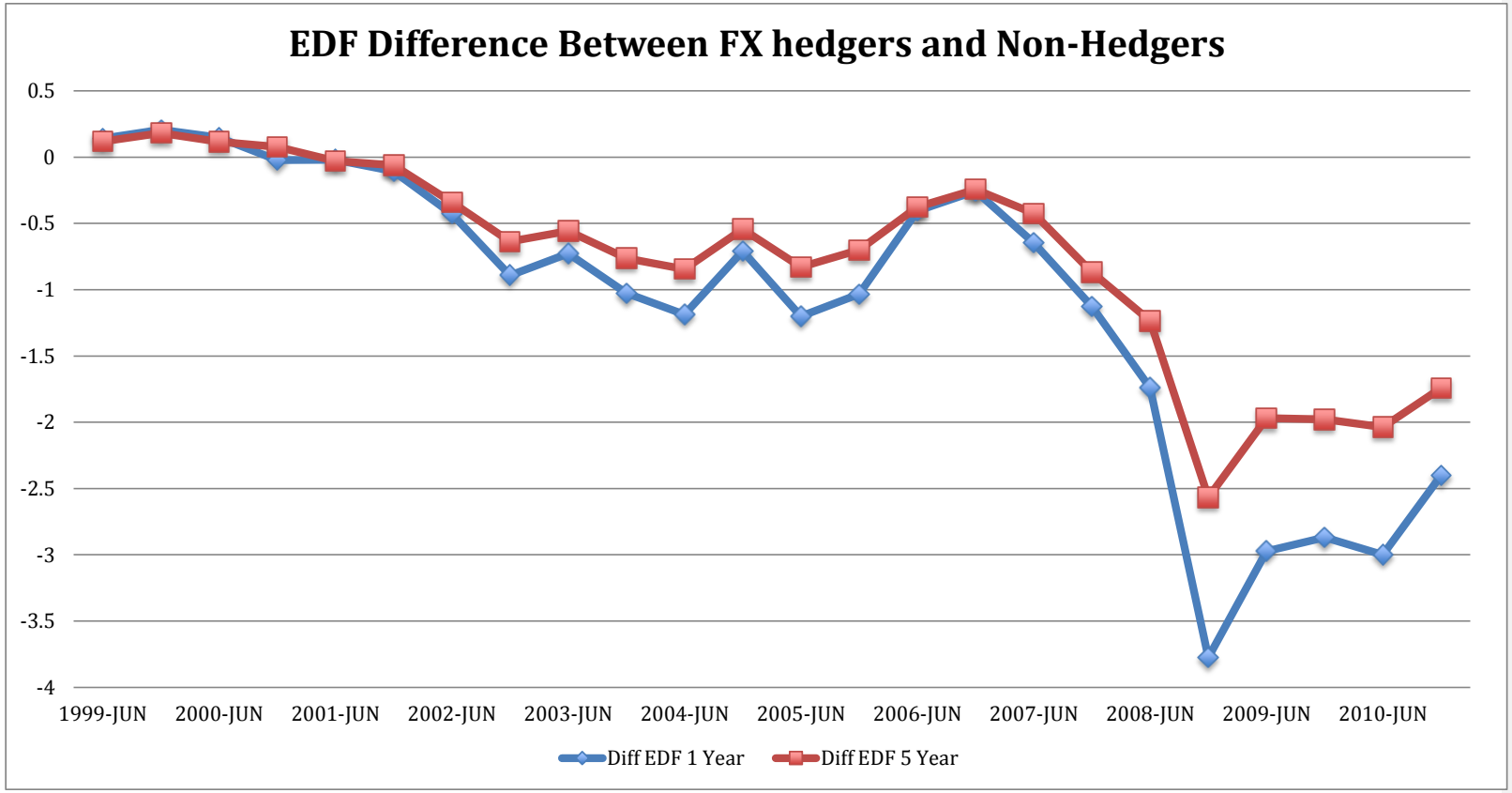
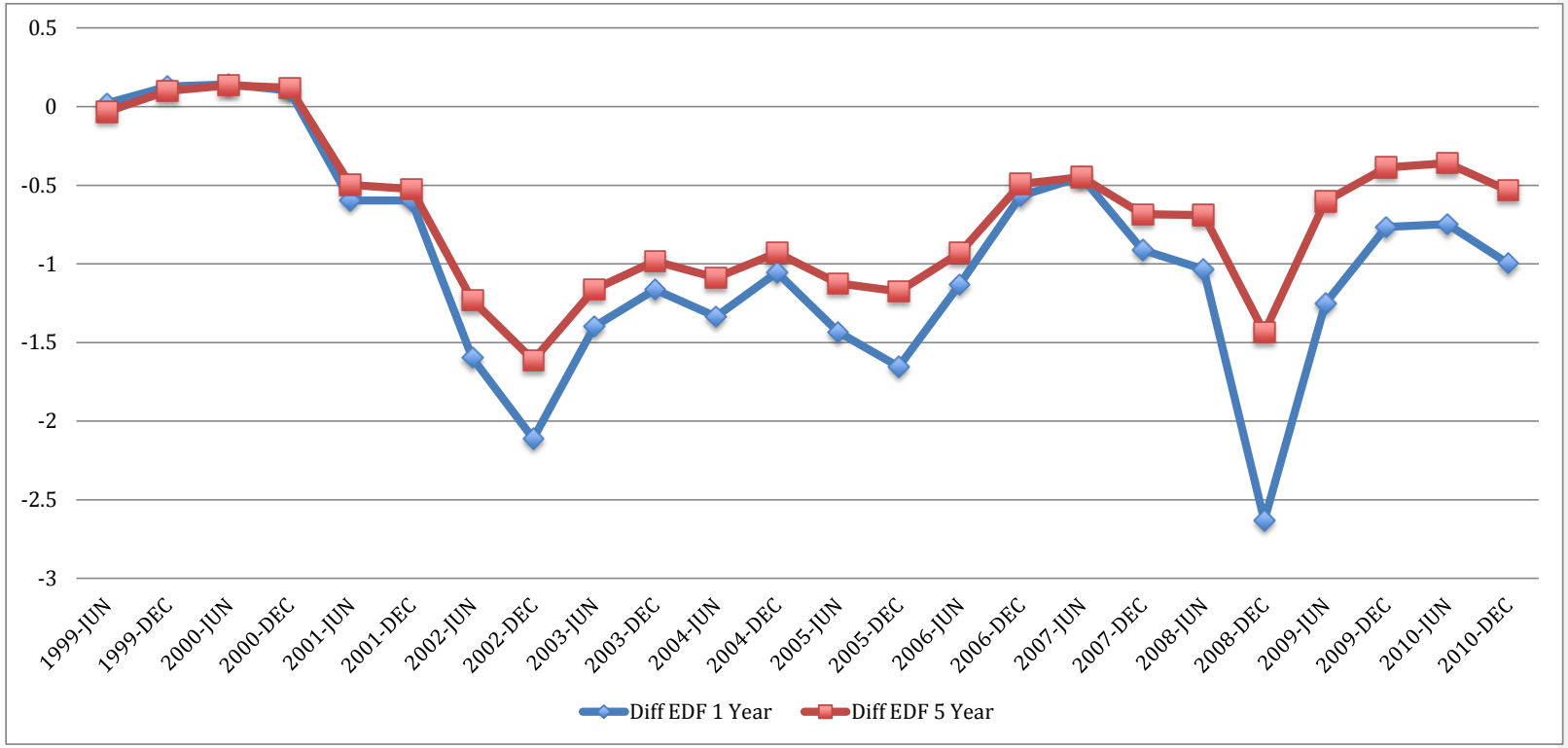


Figure 4-6: Time-Series plot of Probability of default difference (EDF 1 & 5 Year) of IR-Hedgers and Non-IR Hedgers Between 1999-2010



4.2 Summary Statistics, Correlation and Frequency Distribution of data

Table 4-1 presents descriptive statistics for pre-hedging, post-hedging, derivative continuous variables and control variables used in the analysis. The average foreign sale for our sample firms is 49.50%. The minimum and maximum values for foreign sales are respectively 0 and 100 percent. The average foreign debt, foreign income and foreign assets for our sample firms are 46.69, 34.80 and 24.91 percent respectively. From this information it's clear that there are many firms in our sample that are exposed to foreign exchange risk due to their operations. The mean Z score for our sample firm is 3.6609 that suggest that average firm in our sample is financially healthy. However, the minimum value for Z score is -47.4732 suggesting that there are some firms in our sample that are in financial distress position suggested by very low Z score. Qui score is also an accounting based risk measure. The mean qui score for our sample is 75.64. The minimum and maximum values for qui score is 19 and 96 respectively. The mean interest coverage for our sample firm is 10.70%. This suggests that the average firm is earning ten times of its debt expenses. However, the minimum value for interest coverage is 0.00 suggesting there are firms in sample that have trouble managing their interest rate obligations. For the sample firms the range for probability of default for one year is 0.0100 to 28.5977. The mean for one-year probability of default is 1.3115 that suggests that most of the sample firms are financially healthy. The range for probability of default for five years is 0.0132 to 18.5866. The mean for probability of default in five years time is 1.2436. It appears that there are more chances of default in five-year time than in one-year time. 1110 firms in the sample have disclosed the notional amount of their derivatives use. 76% of these firms reports the use of either foreign currency, interest rate or commodity price derivatives. There is a wide variation in the use of derivatives by sample firms. The range of notional total derivatives as a percentage of total assets is zero to .7421. The mean total notional value of total derivatives, as a percentage of total assets, is 19.43%. 845 sample firms have disclosed the notional amounts of foreign currency derivatives. The range of total notional foreign currency derivatives is zero to 0.5005. The mean total value of total foreign currency derivatives, as a percentage of total assets, is 10.77%. 942 of the sample firms disclose the use of interest rate derivatives. The range of notional total interest rate derivatives as a percentage of total assets is zero to 0.4630. The mean total value of total interest rate derivatives, as a percentage of total assets, is

12.45%. It appears that more firms are using interest rate derivatives than foreign exchange derivatives. The mean (Median) value for leverage is 22.41% (18.31%). The minimum value of leverage is 0.00% and the maximum value is 89.20% for our sample firms. This suggests that there are some firms in our sample that do not use debt. The mean (median) liquidity for the sample firms is 1.07%(0.81%). The mean (median) equity volatility for the sample firms is 39% (33%). The mean (median) excess return is -0.032 (0.0179). The mean (median) profitability for sample firms is 7.36% (8.82%). The minimum value for profitability is -101.88% and the maximum is 75.35%. This suggests that in the sample firms there are firms with negative profitability (loss).

Table 4-1: Summary Statistics

The table presents the summary statistics for the variables used in this analysis. In particular, it presents the number of firms, mean, median, minimum values, maximum values and standard deviation.

Variables	N	Mean	Median	Minimum	Maximum	Standard Deviation
Pre-Hedging Measures						
Foreign Sales	4418	49.6843	50.2250	0.0000	100.00	37.0156
Foreign Debt	2845	46.6987	47.0100	0.0000	100.00	38.8546
Foreign Income	2881	34.8091	19.8200	0.0000	100.00	37.0501
Foreign Assets	3374	24.9195	18.4200	0.0000	91.9500	25.2696
Z Score	4069	3.6609	3.2848	-47.4732	48.6113	11.4397
Qui Score	3321	75.6417	84.0000	19.0000	96.0000	20.2446
Interest Coverage	4706	10.7070	4.4700	0.0000	77.4700	16.0530
Post-Hedging Measure						
EDF1YEAR	3948	1.3115	0.1637	0.0100	28.5977	4.0235
EDF5YEAR	3948	1.2436	0.3528	0.0132	18.5866	2.7540
Equity Volatility	4538	0.3929	0.3396	0.0061	1.2699	0.2151
Cash Flow Volatility	4135	14.7438	2.6653	0.2899	468.3105	57.7926
Idiosyncratic Risk	4525	0.0230	0.0195	0.0061	0.0780	0.0130
Standardized Firm Volatility	4528	2.3103	2.0537	0.5396	7.2625	1.2027
Extent of Derivatives Hedging (Notional Values of outstanding Derivatives/ Total Assets)						
Total Derivatives	1110	0.1943	0.1280	0.0000	0.7421	0.2043
FX Derivatives	845	0.1077	0.0536	0.0000	0.5005	0.1390
IR Derivatives	942	0.1245	0.0789	0.0000	0.4630	0.1338
Control Variables						
Leverage	4644	0.2241	0.1813	0.0000	0.8920	0.2085
Firm Size	4674	13.4954	13.3581	9.0881	17.9283	1.7497
Liquidity	4303	1.0707	0.8100	0.0000	8.8000	1.2551
Excess Return	4639	-0.0320	0.0179	-1.9106	1.3488	0.4977
Profitability	4445	0.0736	0.0882	-1.0188	0.7535	0.2213

Table 4-2: Pearson Correlation Coefficients

This table presents the correlation coefficients for the main variables used in this analysis. EDF 1 and 5 year are a proxy for probability of financial distress sourced from Moody's. All Hedgers is dummy variables set equal to 1 if a firm is hedging and 0 otherwise. **FX hedgers** is a dummy variable set equal to 1 if a firms is hedging foreign exchange exposure and 0 otherwise. **IR hedgers** is a dummy variable set equal to 1 if a firms is hedging interest rate exposure and 0 otherwise. **Leverage** is the ratio of total debt to market value assets. **Profitability** is measured as return on capital invested. **Excess Return** is the annual return on the firm minus the value weighted FTSE all shares index annual return over the entire fiscal year. **Equity volatility** is calculated as standard deviation of each firm's daily stock return over the entire fiscal year. **Firm size** is a natural logarithm of Market value of assets. **Liquidity** is the ratio of total current assets minus total stock & work in progress over total current liabilities.

	EDF1DEC	**EDF5DEC**	**All-hedgers**	**FX Hedgers**	**IR Hedgers**	**Leverage**	**Firm Size**	**Profitability**	**Liquidity**	**Equity Volatility**	**Excess Return**
EDF1Year	1.0000										
EDF5Year	0.9854***	1.0000									
All-hedgers	-0.1234***	-0.1243***	1.0000								
FX Hedgers	-0.1127***	-0.1169***	0.6653***	1.0000							
IR Hedgers	-0.1128***	-0.1195***	0.6111***	0.2968***	1.0000						
Leverage	0.4115***	0.4443***	0.1894***	0.0086	0.3153***	1.0000					
Firm Size	-0.2884***	-0.3325***	0.3191***	0.2641***	0.4348***	0.1444***	1.0000				
Profitability	-0.3618***	-0.3930***	0.1374***	0.1151***	0.1299***	-0.1446***	0.2781***	1.0000			
Liquidity	-0.0314***	-0.0225***	-0.2116***	-0.0619***	-0.3005***	-0.2777***	-0.2700***	-0.2085***	1.0000		
Equity Volatility	0.5507***	0.5953***	-0.0860***	-0.0230	-0.1241***	0.1535***	-0.2498***	-0.4059***	0.2319***	1.0000	
Excess Return	-0.4460***	-0.4705***	0.0405***	0.0222	0.0232	-0.2531***	0.1965***	0.2268***	-0.0663***	-0.3469***	1.0000

The table presents the Pearson correlation coefficients for probability of default, hedging and several independent variables. We find a negative correlation between expected default frequencies and our hedging variables. This suggests that hedging firms have lower probability of default As expected leverage and equity volatility are positively correlated and firm size, profitability, liquidity and excess return are negatively correlated with firms' probability of default.

Table 4-3: Frequency Distribution of Hedging Data

Hedging Categories~~Particular~~	**Frequency**	**Percentage**
Panel A		
Hedgers	3694	86.60
Non-Hedgers	572	13.40
Total	4266	100
Panel B		
Foreign Exchange Hedgers	3157	74.00
Interest Rate Hedgers Only	508	11.90
Other-Hedgers	29	0.67
Non-Hedgers	572	13.40
Total	4266	100
Panel C		
Interest Rate Hedgers	3012	70.60
Foreign Exchange Only Hedgers	646	15.14
Other-Hedgers	36	0.84
Non-Hedgers	572	13.40
Total	4266	100

Above table provides the hedging discloser of our sample firms. Panel A provides the over all information of hedging disclosure for our sample firms. 13.40% of sample firms do not hedge any exposure. 86.60% of our sample firms hedges at least one type of exposure. In panel B we break down hedgers into different categories while focusing on foreign exchange hedgers. 74% of our sample firms hedge foreign exchange exposure. These include all the firms which hedge foreign exchange only and also those firms that use foreign exchange along with other exposures. There are 11.90% of firms in our sample that hedges only interest rate exposure. 0.67% of firms hedges either commodity price or commodity price with interest rate hedging. In panel B we also break up hedgers but this time focusing on interest rate hedging.

There are 70.60% of firms in our sample that hedges interest rate exposure. These include all the firms that hedge interest rate exposure only and firms that hedge interest rate exposure with other exposures. In our sample majority of the firms are foreign exchange hedgers. There are 15.14% of the firms that hedges foreign exchange exposures only. 0.67% of firms hedges either commodity price or commodity price with foreign exchange hedging.

4.3 Univariate Tests

Table 4-4 to table 4-8 shows the results of comparison between different types of hedgers and non-hedgers using both parametric (t-test) and non-parametric (Wilcoxon rank sum test) tests. The number of observations may differ for the various comparisons due to data availability.

The results in table 4-4 are groped in three panels. Panel A shows the mean difference for pre-hedging variables. The results show that hedging firms are more exposed to foreign exchange risk on pre-hedging basis. Hedging firms have significantly higher foreign sales, income and assets. This is consistent with the notion that firms use derivatives for hedging. Hedging firms have significantly higher Z score than non-hedging firms. Our result suggests that hedging firms have lower qui score than non-hedging firms. Panel B shows the results of post hedging measures of financial risk. The results show that hedging firms have significantly lower Probability of default for one year and five year, equity volatility, cash-flow volatility and standardized firm risk. These results provide some support to the argument that firms are using derivatives for hedging rather than speculating with derivatives. Since the probability of default is directly related to the equity volatility and cash flow volatility, the firm would be more likely to hedge, the more volatile its equity and cash-flow.

Panel C show that hedging firms are significantly larger and are more indebted companies than non-hedging firms, consistent with the economies of scale and the financial distress hypothesis[10]. Hedging firms are more profitable than non-hedging firms. Similar to Nance, Smith and Smithson (1993) we find that hedging firms have significantly lower level of liquidity. Hedging firms provide excess return than non-hedging firms.

As well as looking at all hedging we also examine differences between foreign exchange (FX) hedgers against non-hedgers and interest rate (IR) hedgers against non-hedgers.

[10]Spano (2004) finds similar results.

In table 4-5 we have calculated mean difference test between FX hedger and non-FX hedgers and between FX hedgers and non-hedgers. Similar to table 4-4, table 4-5 shows similar characteristics. FX hedging firms have more foreign sales, income, debt and assets and their mean difference is significantly different from that of non-FX hedgers As non-FX hedging firms includes those firms that are hedging their IR exposure, the mean difference between FX hedging and non-FX hedging firms is smaller than the mean difference between FX hedging and non-hedging firms where we have removed IR hedging firms. Also, the mean difference for leverage and volatility is not significant for FX hedging and non-FX hedging firms but it is significant for FX hedging and non-hedging firms. These differences in results indicates that there is a bias when non hedging sample includes firms that are hedging their IR exposure and should be deal properly to remove the effects of this bias.

In the same table we have changed the definitions from FX hedging to FX only hedgers and analyzed mean difference tests. We have removed all the firms that are hedging IR exposure. By doing this, we are comparing FX only hedgers with non-FX hedgers and non-hedgers. We find similar results as for FX hedging for variables proxying for probability of default. The results are very different for other control variables. The mean difference between FX only hedgers and non-FX hedgers shows that hedging firms are smaller and less indebted than non-FX hedging firms. FX only hedgers have significantly more liquidity and higher equity volatility than non-FX hedgers. These results suggest that FX hedging has less effect on probability of default than IR only hedgers. When we control for the bias by removing the IR hedging firms from the non-hedging sample we find that now FX only hedging firms are larger than non-hedging firms but they still have less debt. As expected, FX only hedgers have low liquidity and low volatility, however not significant.

Table 4-7 presents the mean difference results between IR hedgers and non-IR hedges and all-IR hedgers and on hedgers. As expected, the mean for probability of default is lower for IR hedgers for both time horizons than non-IR hedgers and non-hedgers. For other control variables, the mean difference for IR hedgers is consistent with earlier results. IR hedging firms are significantly larger and more indebted firms than non-IR hedging firms. IR hedging firms have more profitability than non-IR hedging

firms. We find that IR hedging firms have significantly low level of liquidity. We find that IR hedging firms have significantly lower equity volatility. When we control for the bias by removing firms that hedge only FX exposure, we find that the mean difference between IR hedgers and non-hedgers is now larger than before for all the default variables and for all the control variables except for leverage and volatility.

In the same table, we have changed the definitions from IR hedging to IR only hedgers by removing all the firms that are hedging FX exposure. In this section, we are comparing the mean difference results of IR only hedgers with non-IR hedgers and non-hedgers. As expected, we find that the mean difference on probability of default is lower for IR only hedgers for both one-year default and five-year default. Consistent with economies of scale and financial distress hypothesis, we find that IR only hedging firms are bigger and more indebted than non-IR hedging firms. IR only hedging firms are more profitable and have more excess return. Leverage, hedging substitute, is significantly lower for IR only hedging firms. As suggested by financial distress hypothesis, IR only hedgers have significantly lower equity volatility. When we removed the bias from the non-IR hedging sample, the mean difference between IR only hedgers and non-hedgers is larger for variables proxying for probability of default and also for control variables except for leverage and volatility.

Overall, our univariate results show that hedging firms are statistically different from non-hedging firms with respect to probability of default indicated by EDF for one and five year. We also find that hedging firms have larger Z score than non-hedging firms. However, when there is a problem of bias, non-hedging firms include firms that are hedging only one type of risk i.e. either FX or IR, hedging firms have lower z score than non-hedging firms (this is true for IR hedging firms where non-hedging firms included FX only hedgers). Overall, our results suggest that hedging firms are bigger in size, more indebted, more profitable, hold less cash, provide more return and have less equity volatility.

Table 4-4: Mean Difference Test of All Hedgers VS Non-Hedgers

This table presents the results of tests of Mean differences across a range of pre-hedging measures, post-hedging measures and other control variables between hedging firms and non-hedging firms. (*** Indicates significance at 1%, ** at 5% and * at 10% level).

	All-Hedgers		**Non-Hedgers**		**Test Stat**			**Wilcoxon Rank Sum Test**		
	N	Mean	N	Mean	Mean Diff	T - Stat	Sig	H&NH	Z Stat	Sig
Panel A: Pre-Hedging Measures										
Foreign Sales	3456	51.0661	522	47.8283	3.2378*	-1.87	0.060	H>NH	-2.01**	0.043
Foreign Debt	2578	48.57	267	28.5775	19.9980***	-8.10	0.000	H>NH	-8.295***	0.000
Foreign Income	2224	36.1553	327	32.4187	3.7365	-1.162	0.108	H>NH	-3.15**	0.013
Foreign Assets	2687	27.2949	361	17.7695	9.5254***	-6.851	0.000	H>NH	-8.63***	0.000
Z Score	3218	3.8295	459	2.1988	1.6306***	-2.81	0.004	H>NH	0.075	0.940
Qui Score	2744	75.8305	398	77.4196	-1.5890	1.464	0.143	H>NH	0.569	0.569
Interest Coverage	3157	10.2995	572	13.3768	3.0772***	3.50	0.000	H>NH	-3.87***	0.000
Panel B: Post-Hedging Measures										
EDF 1 YEAR	3143	1.2051	444	2.7757	-1.5706***	5.01	0.000	H<NH	-7.14***	0.000
EDF 5 YEAR	3143	1.1789	444	2.2588	-1.0799***	5.27	0.000	H<NH	-6.53***	0.000
Equity Volatility	3664	0.3796	559	0.4368	-0.0572***	4.60	0.000	H<NH	-4.75***	0.000
Cash Flow Volatility	3576	9.7666	558	46.6635	-36.8969***	14.36	0.000	H<NH	10.37***	0.000
Idiosyncratic Risk	3694	0.0225	520	0.0281	-0.0057***	7.73	0.000	H<NH	-8.47	0.000
Standardized Firm Risk	3593	2.2788	520	2.8120	-0.5339***	9.39	0.000	H<NH	7.61***	0.000
Panel C: Other Firm Characteristics										
Firm Size	3676	13.7439	565	12.0926	1.6513***	-23.55	0.000	H>NH	-20.28***	0.000
Profitability	3490	0.0786	518	-0.011	0.0896***	-5.95	0.000	H>NH	-6.12***	0.000
Liquidity	3419	0.9716	493	1.7794	-0.8078***	8.03	0.000	H<NH	-7.39***	0.000
Excess Return	3664	-0.0118	559	-0.0713	0.0595**	-2.19	0.029	H>NH	-2.63***	0.009
Leverage	3657	0.2414	550	0.12387	0.1176***	-12.70	0.000	H>NH	-16.16***	0.000

Table 4-5: Mean Difference Test of FX hedgers and Non-FX hedgers & Non-hedgers

This table presents the results of tests of Mean differences across a range of pre-hedging measures, post-hedging measures and other control variables between FX hedging firms and non-FX hedging and non-hedging firms (*** indicates significance at 1%, ** at 5% and * at 10% level).

	All-FX Hedgers		FX-Only Hedgers		Non-FX Hedgers						Non Hedgers					
Variables	N	Mean (1)	N	Mean (2)	N	Mean (3)	Mean-Diff (1-3)	Sig	Mean-Diff (2-3)	Sig	N	Mean (4)	Mean-Diff (1-4)	Sig	Mean-Diff (2-4)	Sig
Panel A: Pre Hedging Measures																
Foreign Sales	2953	52.7552	608	53.0492	1025	44.5511	8.2041***	0.000	8.4980***	0.000	522	47.8283	4.9269***	0.009	5.2208**	0.210
Foreign Debt	2230	52.2026	400	52.6395	615	26.7413	25.4613***	0.000	25.8982***	0.000	267	28.5775	23.6250***	0.000	24.0620***	0.000
Foreign Income	1887	39.9431	347	32.1222	664	23.5507	16.2932***	0.000	8.5714***	0.000	327	32.4187	7.5243***	0.001	-0.29653	0.918
Foreign Assets	2336	29.2999	419	23.2316	712	15.8873	13.4125***	0.000	7.3443***	0.000	361	17.7695	11.5303***	0.000	5.4620***	0.000
Z Score	2846	3.8232	621	6.6934	831	2.9504	0.8728*	0.091	3.7430***	0.000	466	2.2084	1.6148**	0.041	4.4850***	0.000
Qui Score	2348	75.93	508	77.59	794	78.1900	-2.2600***	0.003	-0.6000	0.564	403	77.7000	-1.7700**	0.068	-0.1100	0.925
Interest Coverage	3157	10.2995	646	16.6010	1109	11.0680	-0.7684	0.194	5.5330***	0.000	572	13.3768	-3.0772***	0.000	3.2242***	0.007
Panel B: Post-Hedging Measures																
EDF 1 YEAR	2763	1.1414	607	1.6756	824	2.2650	-1.1236***	0.000	-0.5894**	0.025	449	2.7479	-1.6065***	0.000	-1.0723***	0.002
EDF 5 YEAR	2763	1.1298	607	1.5484	824	1.9252	-0.7954***	0.000	-0.3768**	0.034	449	2.2389	-1.1091***	0.000	-0.6905***	0.003
Equity Volatility	3129	0.3841	668	0.4265	1094	0.3960	-0.0119	0.180	0.0305**	0.012	564	0.4358	-0.0517***	0.000	-0.0093	0.535
Cash Flow Volatility	3056	9.8473	622	21.5547	1078	28.6368	-18.7894***	0.000	-7.0820*	0.068	558	46.6636	-36.8162***	0.000	-25.1088***	0.000
Idiosyncratic Risk	3061	0.0227	628	0.0261	1049	0.02456	-0.0018***	0.000	0.0015**	0.042	520	0.02819	-0.0054***	0.000	-0.0020**	0.022
Standardized Firm Risk	3064	2.3129	628	2.6073	1049	2.4440	-0.1311***	0.007	0.1632**	0.021	520	2.8128	-0.4999***	0.000	-0.2055**	0.019
Panel C: Other Firm Characteristics																
Firm Size	3144	13.7982	669	12.5294	1097	12.7376	1.0606***	0.000	-0.2082***	0.003	569	12.1018	1.6964***	0.000	0.4276***	0.000
Profitability	2985	0.0817	636	0.0492	1023	0.0240	0.0577***	0.000	0.0252*	0.052	522	-0.0102	0.0919***	0.000	0.0594***	0.001
Liquidity	2965	1.0291	639	1.5913	947	1.2121	-0.1830***	0.003	0.3792***	0.000	497	1.7680	-0.7389***	0.000	-0.1767	0.130
Excess Return	3129	-0.0132	668	-0.0114	1094	-0.0384	0.0252	0.178	0.0270	0.326	564	-0.0688	0.0556**	0.041	0.0574*	0.089
Leverage	3127	0.2271	665	0.1217	1080	0.2230	0.0041	0.609	-0.1013***	0.000	554	0.1240	0.1031***	0.000	-0.0023	0.831

Table 4-6: Median Difference Test of FX hedgers and Non-FX hedgers & Non-hedgers

This table presents the results of Wilcoxon Rank Sum test across a range of pre-hedging measures, post-hedging measures and other control variables on FX hedging firms and non-FX hedging and non-hedging firms. (*** indicates significance at 1%, ** at 5% and * at 10% level).

	FX Hedgers VS Non- FX Hedgers			**FX Hedgers VS Non Hedgers**			**FX-only Hedgers VS Non-FX Hedgers**			**FX only Hedgers VS Non Hedgers**		
Variables	H&NH	Z Stat	Sig	H&NH	Z Stat	Sig	H&NH	Z Stat	Sig	H&NH	Z Stat	Sig
Panel A: Pre Hedging Measures												
Foreign Sales	H>NH	-6.49***	0.000	H>NH	-2.98***	0.000	H>NH	-4.67***	0.000	H>NH	-2.39**	0.000
Foreign Debt	H>NH	-15.26***	0.000	H>NH	-9.47***	0.000	H>NH	-10.90***	0.000	H>NH	-7.92***	0.000
Foreign Income	H>NH	-12.18***	0.000	H>NH	-4.89***	0.000	H>NH	-5.65***	0.000	H>NH	-1.43***	0.000
Foreign Assets	H>NH	-16.10***	0.000	H>NH	-10.39***	0.000	H>NH	-8.30***	0.000	H>NH	-5.37***	0.000
Z Score	H<NH	-1.03	0.305	H<NH	-0.16	0.872	H>NH	-3.76***	0.000	H>NH	-3.53***	0.000
Qui Score	H<NH	-1.54	0.124	H<NH	-0.64	0.522	H>NH	-0.53	0.596	H>NH	-0.94	0.348
Interest Coverage	H>NH	-4.44***	0.000	H>NH	-3.93***	0.000	H>NH	-3.92***	0.000	H>NH	-3.73***	0.000
Panel B: Post-Hedging Measures												
EDF 1 YEAR	H<NH	-6.17***	0.000	H<NH	-7.25***	0.000	H<NH	-0.03	0.978	H<NH	-2.06**	0.039
EDF 5 YEAR	H<NH	-5.90***	0.000	H<NH	-6.66***	0.000	H<NH	-0.13	0.896	H<NH	-1.85*	0.064
Equity Volatility	H>NH	-1.39	0.165	H<NH	-3.85***	0.000	H>NH	-4.24***	0.000	H<NH	-0.20	0.841
Cash Flow Volatility	H<NH	-11.24***	0.000	H<NH	-10.95***	0.000	H<NH	-3.67***	0.000	H<NH	-5.28***	0.000
Idiosyncratic Risk	H<NH	-1.18	0.237	H<NH	-7.72***	0.000	H>NH	-4.04***	0.000	H<NH	-1.91*	0.056
Standardized Firm Risk	H<NH	-0.73	0.462	H<NH	-6.86***	0.000	H>NH	-3.23***	0.001	H<NH	-2.02**	0.043
Panel C: Other Firm Characteristics												
Firm Size	H>NH	-16.37***	0.000	H>NH	-20.11***	0.000	H<NH	-4.03***	0.000	H>NH	-4.60***	0.000
Profitability	H>NH	-7.21***	0.000	H>NH	-6.39***	0.000	H>NH	-2.91***	0.004	H>NH	-3.37***	0.001
Liquidity	H>NH	-4.45***	0.000	H<NH	-5.78***	0.000	H>NH	-11.32***	0.000	H>NH	-2.53**	0.011
Excess Return	H>NH	-0.54	0.588	H>NH	-2.27**	0.023	H>NH	-0.93	0.351	H>NH	-2.07**	0.039
Leverage	H>NH	-3.85***	0.000	H>NH	-15.03***	0.000	H>NH	-8.47***	0.000	H>NH	-2.09**	0.037

Table 4-7: Mean Diff Test of IR hedgers and Non-IR hedgers & Non-hedgers

This table presents the results of tests of Mean differences across a range of pre-hedging measures, post-hedging measures and other control variables between IR hedging firms and non-IR hedging and non-hedging firms. (*** indicates significance at 1%, ** at 5% and * at 10% level).

	All-IR Hedgers		**IR only Hedgers**		~~1.1.1.1.1.1.1.1~~ **Non-IR Hedgers** ~~**Test Sta**~~						**Non Hedgers**					
Variables	N	Mean (1)	N	Mean (2)	N	Mean (3)	Mean Diff (1-3)	Sig	Mean Diff (2-3)	Sig	N	Mean (4)	Mean Diff (1-4)	Sig	Mean Diff (2-4)	
Panel A: Pre-Hedging Measures																
Foreign Debt	2151	47.7220	330	24.2661	694	43.5270	4.1949**	0.016	-19.2609***	0.000	267	28.5775	19.1445***	0.000	-4.3113	0.160
Z Score	2590	3.1455	365	3.8977	1087	4.7707	-1.6252***	0.002	-0.8730	0.192	466	2.2084	0.9371	0.232	1.6893*	0.059
Qui Score	2231	76.04	391	78.69	911	77.6400	-1.6000**	0.028	1.0500	0.339	403	77.7000	-1.6600*	0.087	0.9900	0.438
Interest Coverage	3012	8.5777	508	8.3571	1254	15.1149	-6.5372***	0.000	-6.7572***	0.000	572	13.3768	-4.7991***	0.000	-5.0196***	0.000
Panel B: Post-Hedging Measures																
EDF 1 YEAR	2531	1.0940	375	1.6868	1056	2.1315	-1.0375***	0.000	-0.4447	0.125	449	2.7479	-1.6539***	0.000	-1.0611***	0.006
EDF 5 YEAR	2531	1.0916	375	1.5495	1056	1.8420	-0.7504***	0.000	-0.2925	0.159	449	2.2389	-1.1473***	0.000	-0.6894***	0.008
Equity Volatility	2991	0.3693	530	0.3536	1232	0.4307	-0.0614***	0.000	-0.0771***	0.000	564	0.4358	-0.0665***	0.000	-0.0822***	0.000
Cash Flow Volatility	2919	7.3116	492	9.6412	1215	32.6099	-25.2982***	0.000	-22.9687***	0.000	558	111.9991	-39.3519***	0.000	-37.0223***	0.000
Idiosyncratic Risk	2927	0.0216	501	0.0210	1183	0.0268	-0.0051***	0.000	-0.0057***	0.000	520	0.0161	-0.0065***	0.000	-0.0070***	0.000
Standardized Firm Risk	2930	2.2103	501	2.0836	1183	2.6832	-0.4728***	0.000	-0.5995***	0.000	520	1.5494	-0.6024***	0.000	-0.72917***	0.000
Panel C: Other Firm Characteristics																
Firm Size	3003	14.0149	528	13.4229	1238	12.3328	1.6821***	0.000	1.0901***	0.000	569	12.1018	1.9131***	0.000	1.3211***	0.000
Profitability	2850	0.0851	501	0.0596	1158	0.0224	0.0627***	0.000	0.0372***	0.001	522	-0.0102	0.0953***	0.000	0.0698***	0.000
Liquidity	2776	0.8298	450	0.5982	1136	1.6686	-0.8388***	0.003	-1.0704***	0.000	497	1.7680	-0.9382***	0.000	-1.1698***	0.000
Excess Return	2991	-0.0123	530	-0.0061	1232	-0.0377	0.0254	0.178	0.0316	0.237	564	-0.0688	0.0565**	0.037	0.0627*	0.058
Leverage	2988	0.2682	526	0.3272	1219	0.1228	0.1454***	0.000	0.2045***	0.000	554	0.1240	0.1442***	0.000	0.2032***	0.000

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Table 4-8: Median Difference Test of IR hedgers and Non-IR hedgers & Non-hedgers

This table presents the results of Wilcoxon Rank Sum test across a range of pre-hedging measures, post-hedging measures and other control variables on IR hedging firms and non-IR hedging and non-hedging firms. (*** indicates significance at 1%, ** at 5% and * at 10% level).

	IR Hedgers VS Non-IR Hedgers			**IR Hedgers VS Non Hedgers**			**IR Only Hedgers VS Non-IR Hedgers**			**IR Only Hedgers VS Non Hedgers**		
Variables	H&NH	Z Stat	Sig	H&NH	Z Stat	Sig	H&NH	Z Stat	Sig	H&NH	Z Stat	Sig
Panel A: Pre-Hedging Measures												
Foreign Debt	H>NH	-2.38**	0.017	H>NH	-7.93***	0.000	H<NH	-8.03***	0.000	H<NH	-1.79*	0.074
Z Score	H<NH	-5.07***	0.000	H<NH	-1.07	0.286	H<NH	-1.33	0.183	H<NH	-0.72	0.474
Qui Score	H<NH	-1.79*	0.073	H<NH	-0.71	0.478	H>NH	-0.54	0.588	H>NH	-0.98	0.326
Interest Coverage	H<NH	-0.65	0.516	H>NH	-3.56***	0.000	H<NH	-1.21	0.224	H>NH	-2.03**	0.042
Panel B: Post-Hedging Measures												
EDF 1 YEAR	H<NH	-9.40***	0.000	H<NH	-8.07***	0.000	H<NH	-3.41***	0.001	H<NH	-3.97***	0.000
EDF 5 YEAR	H<NH	-8.63***	0.000	H<NH	-7.36***	0.000	H<NH	-2.85***	0.004	H<NH	-3.38***	0.001
Equity Volatility	H<NH	-7.66***	0.000	H<NH	-5.49***	0.000	H<NH	-8.11***	0.000	H<NH	-6.56***	0.000
Cash Flow Volatility	H<NH	-9.85***	0.000	H<NH	-10.99***	0.000	H<NH	-1.22	0.220	H>NH	-4.05***	0.000
Idiosyncratic Risk	H<NH	-11.60***	0.000	H<NH	-9.66***	0.000	H<NH	-10.15***	0.000	H>NH	-9.37***	0.000
Standardized Firm Risk	H<NH	-9.58***	0.000	H<NH	-8.54***	0.000	H<NH	-8.87***	0.000	H>NH	-8.59***	0.000
Panel C: Other Firm Characteristics												
Firm Size	H>NH	-28.86***	0.000	H>NH	-23.08***	0.000	H>NH	-15.01***	0.000	H>NH	-14.58***	0.000
Profitability	H>NH	-5.07***	0.000	H>NH	-6.38***	0.000	H>NH	-0.53	0.598	H>NH	-2.81***	0.005
Liquidity	H<NH	-17.86***	0.000	H<NH	-9.39***	0.000	H<NH	-16.61***	0.000	H<NH	-11.71***	0.000
Excess Return	H>NH	-1.08	0.281	H>NH	-2.39**	0.017	H>NH	-1.69*	0.091	H>NH	-2.56**	0.011
Leverage	H>NH	-25.06***	0.000	H>NH	-18.88***	0.000	H>NH	-18.98***	0.000	H>NH	-16.38***	0.000

4.4 Multivariate Tests

4.4.1 Impact of Hedging on Probability of default

The previous section describes the results of tests of differences in means between hedgers and non-hedgers for various default measures and firm-level characteristics. However, the problem with univariate tests is that they do not control for the correlations between different firm characteristics and hence, cannot show differences in these characteristics, holding other firm level attributes constant. Therefore, in this section we use multivariate tests to control the correlation between different firm characteristic variables while holding other firm level attributes constant. We have used a binary measure of hedging in multivariate tests. We have assigned the value 1 to the variable if firms indicate in their annual report that they hedge otherwise zero. As discussed earlier, we have created different definitions of hedging based on the exposures hedged by the firms.

In particular, (1), we control for leverage by using ratio of total debt over market value assets; (2) we control for profitability by using return on invested capital; (3) we control for size by using the log of market value of assets; (4) we control for volatility by using equity volatility; (5) we control for excess return by using firm's excess return minus FTSE all firms' return; and finally (6) we control for liquidity by using current ratio.

Table 4-9, regression 1 in Panel A, presents the results of a pooled OLS regression. The main variable we used to examine our hypothesis is the all-hedging dummy that equals 1 if a firm hedges any exposure (i.e. FX, IR, Commodity) and 0 otherwise. The dependent variable is probability of default in one year's time. Consistent Magee (2008), we find a negative and significant association between hedging variable and probability of default, suggesting that hedging affects firm's probability of default. The hedging coefficient in the OLS model suggests that hedging lowers the probability of default by 1.04 percent. The result suggests that hedging firms have lower probability of default than non-hedging firms. For Panel B, we also find that hedging firms have lower probability of default and that hedging lowers the probability of default by 0.61 percent.

All of the control variables are significant and with the expected sign. For example, as expected, we find that leverage has positive and significant impact on probability of default, which is consistent with the theories that more debt increases financial risk. It is expected that firms with more profits have lower probability of default; similarly we find that profitable firms have lower probability of default. As expected by the study that large firms have lower probability of default, we find that size has negative and significant relation with probability of default. We find that equity volatility has positive and significant association with probability of default, a finding suggested by the financial distress literature. We find that a firm that has excess return has lower probability of default. Finally, firms with more liquidity also have lower probability of default.

Table 4-9: Impact of Hedging on ~~Default p~~Probability~~ies~~ of Default

This table presents the results of OLS, RE and FE regressions of ***All Hedging*** on the ***probability of default***. In Panel A we use one year Probability of default and in Panel B we use five year Probability of Default. ***Probability of Default is*** from Moody's. ***All Hedgers*** is dummy variables set equal to 1 if a firm is hedging and 0 otherwise. ***Leverage*** is the ratio of total debt to market value assets. ***Profitability*** *is measured as return on capital invested.* ***Excess Return*** is the annual return on the firm minus the value weighted FTSE all shares index annual return over the entire fiscal year. ***Equity volatility*** is calculated as standard deviation of each firm's daily stock return over the entire fiscal year. ***Firm size*** is a natural logarithm of Market value of assets. ***Liquidity*** is the ratio of total current assets minus total stock & work in progress over total current liabilities. In parentheses are standard errors adjusted for heteroskedasticity (White (1980)) and ~~firm~~ clustering at the firm level. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively. The regressions also include year and industry dummies.

	Panel A: Dependent Variable: EDF 1 Year			Panel B: Dependent Variable: EDF 5 Year		
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	OLS	RE	FE	OLS	RE	FE
All Hedgers	-1.0394***	-0.9567***	-0.8713**	-0.6171***	-0.5744***	-0.5188**
	(0.322)	(0.315)	(0.359)	(0.189)	(0.180)	(0.201)
Leverage	6.8945***	8.6352***	9.9803***	5.1878***	6.3599***	7.2344***
	(1.062)	(1.080)	(1.225)	(0.600)	(0.615)	(0.714)
Profitability	-1.0577*	-1.0759*	-1.1338*	-0.6663*	-0.6992*	-0.7645*
	(0.575)	(0.582)	(0.634)	(0.361)	(0.362)	(0.390)
Firm Size	-0.4022***	-0.5905***	-1.0948***	-0.3440***	-0.4806***	-0.8517***
	(0.059)	(0.074)	(0.159)	(0.038)	(0.048)	(0.102)
Volatility	6.3502***	5.4766***	4.8607***	4.6774***	4.0395***	3.6280***
	(0.632)	(0.590)	(0.610)	(0.379)	(0.356)	(0.373)
Excess Return	-1.6555***	-1.3651***	-1.0743***	-1.0914***	-0.9017***	-0.7014***
	(0.183)	(0.161)	(0.161)	(0.109)	(0.095)	(0.098)
Liquidity	-0.3688***	-0.2651***	-0.1462*	-0.2481***	-0.1788***	-0.1001*
	(0.069)	(0.062)	(0.078)	(0.046)	(0.042)	(0.056)
Constant	4.1875***	6.5583***	13.1678***	3.7531***	5.5312***	10.3880***
	(0.965)	(1.162)	(2.233)	(0.614)	(0.730)	(1.407)
Observations	3,422	3,422	3,422	3,422	3,422	3,422
R-squared	0.5362	0.5279	0.5081	0.6213	0.6127	0.5931
F-Test	13.2138		21.1553	21.7450		35.9784
Chi2 test		382.2178			634.3710	

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To control for individual effects that might affect the regression, we examine a random effects model. In a random effects model, we assume that the individual effects are orthogonal to the regressors we include in the model. Regression 2 in table 4-9 shows the results of random effects model. Similarly to the results in pooled OLS regression, we find a negative and significant relationship between hedgers and probability of default. The hedging coefficient in random effects model is -0.94 percent suggesting that hedging lowers the probability of default by 0.94 percent. This suggests that the hedgers have lower probability of default than non-hedgers. The signs of the coefficient of our control variables are the same as in the pooled OLS regression. The coefficient of determination is 0.5279 suggesting that the model can explain the 52.79% of variability in probability of default. We find similar results for five-year probability of default. Hedging firms also have lower probability of five year.

To control for unobservable firm characteristics that may affect probability of default, we examine a fixed effects model. In fixed-effects model each firm is assigned a different intercept. Regression 3 in table 4-09 shows the results of fixed effects model. Similar to the results in the pooled OLS regression, we find a negative and significant relationship between hedgers and probability of default. The hedging coefficient in the Fixed Effects model suggests that hedging lowers the probability of default by 0.87 percent. The signs of the coefficient of our control variables are the same as in the random effects regression. The hedging coefficient for five-year probability of default is -0.5188 percent suggesting that hedging firms have lower probability of default. When results of one year probability of default is compared with five year probability of default, we find that hedging has greater impact on one year probability of default than on five-year probability of default.

4.4.2 Impact of FX hedging on the probability of default

In this study we also look at separately the impact of FX and IR hedging on the probability of default. We begin by looking at the impact of FX hedging on the probability of default.

Table 4-10 shows the regression results of foreign exchange (FX) hedging on probability of default. The main variable of interest in panel A regressions is FX hedging dummy, which is set equal to 1 if a firm hedges foreign exchange risk (also includes firms which are hedging foreign exchange and interest rate exposure) and 0 for non-foreign exchange hedgers (includes those firms which hedges interest rate and/or commodity price exposure only). We argue that the inclusion of these firms, referred to as "other" hedging firms, in the non-hedging firms sample might potentially bias the results against finding particular hypothesized relationships. Since majority of other hedgers are interest rate hedgers this might make it difficult to detect a relationship between foreign currency hedging and probability of default as probability of default might have greater relevance with interest rate hedging. The results for model 1 to 3 in table 4-10 shows this bias to some extent.

Regression 1, presents the results of pooled OLS model. Consistence with the expectations of this study, we find a negative and significant association between the use of FX hedging and probability of default. The coefficient is significant at 1% level. The coefficient value for FX hedging is -0.5498 percent suggesting that FX hedging lowers probability of default by 0.5498 percent Most of the control variables appear to be significant and with expected sign. To control for individual effects and unobservable firm characteristics that may affect probability of default, we examined a random effects (regression 2) and fixed effects (regression 3) model, respectively. The coefficient value for FX hedging is -0.54 and -0.49 percent respectively for Random and Fixed Effects model. These suggest that FX hedging lowers probability of default of user firms. Both the models have expected sign for the FX hedging variable and are significant. Other control variables have expected sign and majority of them are significant.

Table 4-10: Impact of FX Hedging on Probability of default

This table presents the results of OLS, RE and FE regressions of ***FX Hedging*** *on* the ***probability of default***. ***Probability of Default is*** from Moody's. ***FX Hedgers*** is dummy variables set equal to 1 if a firm is hedging *FX Exposure* and 0 otherwise. ***Leverage*** is the ratio of total debt to market value assets. ***Profitability*** *is measured as return on capital invested.* ***Excess Return*** is the annual return on the firm minus the value weighted FTSE all shares index annual return over the entire fiscal year. ***Equity volatility*** is calculated as standard deviation of each firm's daily stock return over the entire fiscal year. ***Firm size*** is a natural logarithm of Market value of assets. ***Liquidity*** is the ratio of total current assets minus total stock & work in progress over total current liabilities. In parentheses are standard errors adjusted for heteroskedasticity (White (1980)) and firm clustering. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively. The regressions also include year and industry dummies.

	Dependent Variable: EDF 1 Year						**Dependent Variable: EDF 5 Year**					
	Panel: A (FX hedgers VS Non-FX Hedgers)			Panel: B (FX hedgers VS Non- Hedgers)			Panel: A (FX hedgers VS Non-FX Hedgers)			Panel: B (FX hedgers VS Non- Hedgers)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	OLS	RE	FE	OLS	RE	FE	OLS	RE	FE	OLS	RE	FE
FX Hedgers	-0.5498***	-0.5485***	-0.4906**	-	-	-	-0.3271***	-0.3448***	-0.3213**			
	(0.188)	(0.190)	(0.237)				(0.114)	(0.114)	(0.141)			
FX Hedgers				-1.0404***	-1.0141***	-0.9842**				-0.6101***	-0.5973***	-0.5687**
				(0.329)	(0.336)	(0.425)				(0.194)	(0.195)	(0.243)
Leverage	6.6324***	8.4434***	9.8428***	6.6650***	8.2077***	9.0351***	5.0323***	6.2473***	7.1521***	4.9299***	5.9904***	6.5971***
	(1.040)	(1.067)	(1.215)	(1.203)	(1.179)	(1.340)	(0.590)	(0.609)	(0.709)	(0.682)	(0.679)	(0.793)
Profitability	-1.0860*	-1.0858*	-1.1333*	-1.0448*	-1.1029*	-1.2140*	-0.6830*	-0.7040*	-0.7635*	-0.7190*	-0.7772**	-0.8718**
	(0.580)	(0.585)	(0.637)	(0.606)	(0.623)	(0.682)	(0.364)	(0.364)	(0.392)	(0.382)	(0.388)	(0.420)
Firm Size	-0.4159***	-0.6031***	-1.1070***	-0.3930***	-0.5741***	-0.9970***	-0.3521***	-0.4874***	-0.8567***	-0.3389***	-0.4698***	-0.7947***
	(0.061)	(0.077)	(0.161)	(0.061)	(0.075)	(0.156)	(0.039)	(0.049)	(0.102)	(0.040)	(0.048)	(0.100)
Equity Volatility	6.4651***	5.5517***	4.9049***	6.4223***	5.4344***	4.8515***	4.7456***	4.0833***	3.6550***	4.6394***	3.9388***	3.5378***
	(0.655)	(0.595)	(0.609)	(0.713)	(0.663)	(0.679)	(0.393)	(0.359)	(0.372)	(0.429)	(0.401)	(0.417)
Excess Return	-1.6718***	-1.3752***	-1.0801***	-1.5978***	-1.3310***	-1.1053***	-1.1010***	-0.9078***	-0.7055***	-1.0659***	-0.8881***	-0.7215***
	(0.186)	(0.162)	(0.161)	(0.205)	(0.173)	(0.169)	(0.111)	(0.096)	(0.098)	(0.120)	(0.101)	(0.102)
Liquidity	-0.3475***	-0.2514***	-0.1403*	-0.3861***	-0.2685***	-0.1419*	-0.2354***	-0.1708***	-0.0967*	-0.2623***	-0.1845***	-0.1017*
	(0.065)	(0.059)	(0.077)	(0.071)	(0.064)	(0.081)	(0.044)	(0.041)	(0.056)	(0.047)	(0.044)	(0.059)
Constant	3.8829***	6.3324***	12.9494***	4.0323***	6.4561***	12.1836***	3.5724***	5.3983***	10.2504***	3.7272***	5.5114***	9.8701***
	(0.940)	(1.141)	(2.220)	(0.994)	(1.188)	(2.222)	(0.605)	(0.721)	(1.398)	(0.636)	(0.741)	(1.389)
Observations	3,422	3,422	3,422	3,063	3,063	3,063	3,422	3,422	3,422	3,063	3,063	3,063
R-squared	0.5332	0.5247	0.5066	0.5282	0.5196	0.4819	0.6190	0.6102	0.5921	0.6123	0.6034	0.5683
F-Test	12.7565		20.9550	.		15.7100	20.8756		35.7009	.		27.0028
Chi2 test		372.9827			326.9140			619.1779			529.7866	

In pane B, we repeat the regression but remove IR only hedgers from the sample of non-FX hedgers leaving us with a sample of non-hedgers and by doing this we remove the bias from the non-hedging sample.

When we compare the results of Panel A with results of Panel B, we detect the effect of bias. The coefficient for hedging variable is now bigger than what we find earlier. The FX hedging coefficient for OLS model increases to 1.04 percent after we remove the bias. This result now suggests that FX hedging lowers probability of default by 1.04 percent almost double when compared to the same model when results are biased. The coefficient value for random effects and fixed effects model are also larger than earlier. The only difference between these two sets of regression is the sample of non-hedgers and from the results it's clear that the results are biased when "other" hedgers are included in non-hedging sample. The results show similar trend for random effects and fixed effects model.

4.4.3 Impact of IR Hedging on Probability of default

In the previous sections we examined the relationship between foreign exchange hedging and probability of default. The results are highly significant and as per the expectations of the study when hedging group includes IR hedging firms. However, when we removed IR hedging firms from hedging firms sample, the results are no longer significant and in some cases they have opposite sign. These results have highlighted the importance of interest rate hedging on probability of default. To explicitly check the relationship between interest rate hedging and probability of default, in this section we are analyzing same models but by changing hedging variables in favor of interest rate hedging.

Table 4-12 shows the regression results of interest rate (IR) hedging on probability of default. The main variable of interest in panel A regressions is IR hedging dummy, which is set equal to 1 if a firm hedges interest rate risk (also includes firms which are hedging interest rate exposure and foreign exchange) and 0 for non-foreign exchange hedgers (includes those firms which hedges foreign exchange and/or commodity price exposure only). As discussed earlier, non-hedging group includes "other" hedging firms and might bias the results. Panel A shows the results of IR hedgers versus non-

IR hedgers. The coefficient on IR hedging is negative and highly significant for all the models. The coefficient value of the IR hedging suggest that IR hedging lowers probability of default by 0.76, 0.60 and 0.51 percent respectively for OLS, random effects and fixed effects model. These coefficient values are bigger than the one that we find for the same model for FX hedgers. When we removed the bias from the non-hedging sample the results improved significantly. IR hedging lowers probability of default by more than 1 percent under each model. We find bigger coefficients under OLS, random and fixed effects model and with the same level of significance. All of the control variables have expected sign and majority of them are significant. we find similar results for five year probability of default.

When table 4-12 is compared with table 4-10, we find that the coefficients are larger for all interest rate-hedging firms. This also suggests that interest rate hedging has more impact on probability of default than foreign exchange hedging.

Table 4-11: Impact of IR hedging on Probability of Financial Distress

This table presents the results of OLS, RE and FE regressions of ***IR Hedging*** *on* the ***probability of default***. ***Probability of Default is*** from Moody's. ***IR Hedgers*** is dummy variables set equal to 1 if a firm is hedging *IR Exposure* and 0 otherwise. **Leverage** is the ratio of total debt to market value assets. **Profitability** is measured as return on capital invested. **Excess Return** is the annual return on the firm minus the value weighted FTSE all shares index annual return over the entire fiscal year. **Equity volatility** is calculated as standard deviation of each firm's daily stock return over the entire fiscal year. **Firm size** is a natural logarithm of Market value of assets. **Liquidity** is the ratio of total current assets minus total stock & work in progress over total current liabilities. In parentheses are standard errors adjusted for heteroskedasticity (White (1980)) and firm clustering. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively. The regressions also include year and industry dummies.

	Dependent Variable: EDF 1 Year						**Dependent Variable: EDF 5 Year**					
	Panel: A (IR hedgers VS Non-IR Hedgers)			Panel: B (IR hedgers VS Non- Hedgers)			Panel: A (IR hedgers VS Non-IR Hedgers)			Panel: B (IR hedgers VS Non- Hedgers)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	OLS	RE	FE	OLS	RE	FE	OLS	RE	FE	OLS	RE	FE
IR Hedgers	-0.7674***	-0.6057***	-0.5189**				-0.4667***	-0.3660***	-0.3166**			
	(0.195)	(0.206)	(0.244)				(0.119)	(0.126)	(0.149)			
IR Hedgers				-1.2250***	-1.0744***	-1.0466**				-0.7301***	-0.6473***	-0.6485**
				(0.340)	(0.357)	(0.452)				(0.200)	(0.207)	(0.260)
Leverage	6.9867***	8.6569***	9.9866***	6.8426***	8.5130***	9.3528***	5.2486***	6.3722***	7.2402***	5.1399***	6.2195***	6.7801***
	(1.061)	(1.094)	(1.234)	(1.153)	(1.187)	(1.378)	(0.602)	(0.624)	(0.720)	(0.645)	(0.673)	(0.800)
Profitability	-1.1370*	-1.1357*	-1.1760*	-1.1138*	-1.0476	-1.0388	-0.7133*	-0.7349**	-0.7901**	-0.6441*	-0.6441	-0.6902
	(0.581)	(0.583)	(0.633)	(0.630)	(0.642)	(0.701)	(0.364)	(0.363)	(0.389)	(0.389)	(0.392)	(0.423)
Firm Size	-0.3797***	-0.5843***	-1.1133***	-0.3604***	-0.6017***	-1.1660***	-0.3296***	-0.4764***	-0.8622***	-0.3132***	-0.4813***	-0.9235***
	(0.061)	(0.078)	(0.162)	(0.062)	(0.083)	(0.206)	(0.039)	(0.050)	(0.103)	(0.039)	(0.052)	(0.134)
Equity Volatility	6.3819***	5.4885***	4.8411***	6.7136***	5.5917***	4.9765***	4.6946***	4.0469***	3.6156***	4.9286***	4.1724***	3.7569***
	(0.646)	(0.593)	(0.610)	(0.752)	(0.710)	(0.762)	(0.387)	(0.359)	(0.373)	(0.442)	(0.422)	(0.460)
Excess Return	-1.6724***	-1.3758***	-1.0758***	-1.7184***	-1.3910***	-1.0859***	-1.1015***	-0.9084***	-0.7023***	-1.1393***	-0.9337***	-0.7119***
	(0.185)	(0.161)	(0.161)	(0.204)	(0.174)	(0.183)	(0.110)	(0.096)	(0.098)	(0.124)	(0.106)	(0.114)
Liquidity	-0.3702***	-0.2637***	-0.1459*	-0.4248***	-0.2960***	-0.1255	-0.2493***	-0.1781***	-0.1001*	-0.2687***	-0.1775***	-0.0493
	(0.065)	(0.059)	(0.077)	(0.088)	(0.083)	(0.110)	(0.044)	(0.041)	(0.056)	(0.058)	(0.055)	(0.074)
Constant	3.4696***	6.0410***	13.0295***	3.7228***	6.7547***	14.2422***	3.3218***	5.2156***	10.3050***	3.3560***	5.5556***	11.4132***
	(0.923)	(1.133)	(2.231)	(1.057)	(1.298)	(2.913)	(0.593)	(0.718)	(1.403)	(0.650)	(0.799)	(1.872)
Observations	3,422	3,422	3,422	2,836	2,836	2,836	3,422	3,422	3,422	2,836	2,836	2,836
R-squared	0.5354	0.5266	0.5071	0.5394	0.5279	0.4991	0.6208	0.6118	0.5923	0.6246	0.6135	0.5863
F-Test	12.7732		21.1518	10.8565		17.4327	21.2302		36.2166	18.4208		30.5471
Chi2 test		374.4171			315.5205			629.9130			537.8093	

4.4.4 Impact of IR only Hedging on Probability of default

The tests in the previous section examined the relationship between IR hedgers and probability of default using sample of all interest rate hedgers (includes firms hedging both IR and FX) versus non-IR hedgers (include firms hedging FX only) and non-hedgers (controlled for bias). To examine the relationship between interest rate hedging and probability of default we have created new variable by removing firms that are using both IR and FX. By removing this firms from the hedging sample, we now have firms that are hedging only interest rate in our hedging sample. Similar to table 4-12, we have to Panels: A & B. Panel A shows the results of IR only hedging where non-hedgers include "other" hedging firms and Panel B presents the results of IR only hedging and non-hedgers (controlled for bias by removing FX only hedging firms from sample)

The results of these regressions are presented in table 4-13. Panel A regressions result show that the coefficient on IR only hedgers is still have expected negative sign and highly significant under all model. The coefficient in the OLS, random effects and fixed effects model suggests that hedging lowers the probability of default by more than 1 percent. In Panel B, where we have controlled for bias by removing "other" hedging firms from non-hedging sample, we find that the coefficient on IR only hedging is now increased by approximately 35-40 percent for OLS and random effects model than the results in Panel A.

These findings suggest that the inclusion of other hedgers in the non-IR hedging sample of this study adversely affect the ability to detect a relationship between interest rate hedging and probability of default. However, the bias is not strong compare to the bias when non-FX hedging sample consist of IR only hedging firms. This finding also shows the important of interest hedging on probability of default.

Table 4-12: Impact of IR Only Hedging on Probability of default

This table presents the results of OLS, RE and FE regressions of ***IR Only Hedging*** *on* **the *probability of default*. *Probability of Default is*** from Moody's. ***IR Only Hedgers*** is dummy variables set equal to 1 if a firm is hedging ***IR Exposure Only*** and 0 otherwise. **Leverage** is the ratio of total debt to market value assets. **Profitability** is measured as return on capital invested. **Excess Return** is the annual return on the firm minus the value weighted FTSE all shares index annual return over the entire fiscal year. **Equity volatility** is calculated as standard deviation of each firm's daily stock return over the entire fiscal year. **Firm size** is a natural logarithm of Market value of assets. **Liquidity** is the ratio of total current assets minus total stock & work in progress over total current liabilities. In parentheses are standard errors adjusted for heteroskedasticity (White (1980)) and firm clustering. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively. The regressions also include year and industry dummies.

	Dependent Variable: EDF 1 YEAR						**Dependent Variable: EDF 5 YEAR**					
	Panel: A (IR Only hedgers VS Non-IR Hedgers)			Panel: B (IR Only hedgers VS Non-Hedgers)			Panel: A (IR Only hedgers VS Non-IR Hedgers)			Panel: B (IR Only hedgers VS Non-Hedgers)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	OLS	RE	FE	OLS	RE	FE	OLS	RE	FE	OLS	RE	FE
IR Only Hedgers	-1.0250***	-1.0361***	-1.3845***				-0.6223***	-0.6423***	-0.8447***			
	(0.313)	(0.293)	(0.397)				(0.187)	(0.174)	(0.224)			
IR Only Hedgers				-1.3986***	-1.3564***	-1.4015***				-0.8343***	-0.8256***	-0.8447***
				(0.419)	(0.374)	(0.459)				(0.246)	(0.218)	(0.262)
Leverage	11.3139***	13.1452***	16.1564***	13.1349***	14.8009***	16.4242***	7.9207***	9.0587***	10.6862***	8.9232***	9.8322***	10.7462***
	(1.616)	(1.608)	(1.798)	(2.024)	(1.974)	(2.346)	(0.891)	(0.887)	(1.029)	(1.067)	(1.073)	(1.332)
Profitability	-0.7575	-1.0338	-1.2768	-0.9508	-1.2370	-1.6474	-0.5001	-0.7268	-0.9539*	-0.5360	-0.7825	-1.1467
	(0.795)	(0.807)	(0.957)	(0.987)	(1.039)	(1.239)	(0.487)	(0.493)	(0.577)	(0.593)	(0.615)	(0.729)
Firm Size	-0.8354***	-1.0234***	-1.5309***	-1.0707***	-1.2326***	-1.6887***	-0.6185***	-0.7480***	-1.1034***	-0.7413***	-0.8444***	-1.2488***
	(0.130)	(0.138)	(0.250)	(0.182)	(0.186)	(0.435)	(0.078)	(0.084)	(0.157)	(0.103)	(0.110)	(0.285)
Equity Volatility	5.9791***	5.0658***	3.9500***	5.7832***	4.7941***	3.9254***	4.4265***	3.7650***	3.0624***	4.3649***	3.7233***	3.1435***
	(0.783)	(0.806)	(0.975)	(1.074)	(1.130)	(1.403)	(0.485)	(0.506)	(0.616)	(0.637)	(0.675)	(0.865)
Excess Return	-1.4724***	-1.1490***	-0.7858***	-1.4619***	-1.1180***	-0.8362**	-0.9413***	-0.7407***	-0.5092***	-0.9426***	-0.7513***	-0.5375**
	(0.310)	(0.261)	(0.249)	(0.435)	(0.356)	(0.361)	(0.183)	(0.154)	(0.152)	(0.266)	(0.223)	(0.233)
Liquidity	-0.3386***	-0.2332***	-0.1387	-0.4563***	-0.3470**	-0.2398	-0.2433***	-0.1697***	-0.0998	-0.3051***	-0.2264***	-0.1213
	(0.075)	(0.071)	(0.102)	(0.135)	(0.137)	(0.174)	(0.048)	(0.048)	(0.071)	(0.082)	(0.088)	(0.121)
Constant	8.0944***	10.5866***	17.8333***	11.3462***	13.2928***	19.9058***	6.2657***	7.9940***	13.0070***	7.8137***	9.0969***	14.8121***
	(1.739)	(1.858)	(3.198)	(2.297)	(2.346)	(5.494)	(1.088)	(1.160)	(2.001)	(1.305)	(1.408)	(3.605)
Observations	1,333	1,333	1,333	747	747	747	1,333	1,333	1,333	747	747	747
R-squared	0.6101	0.6042	0.5985	0.6562	0.6498	0.6273	0.6798	0.6740	0.6624	0.7176	0.7127	0.6869
F-Test	12.9904		18.2401	13.4678		14.3864	19.0099		30.7514	26.4307		23.4581
Chi2 test		397.2551			429.6500			592.2239			658.0945	

For the regressions in table 4-14, we have created new variables using the data on how many exposures firms hedge. We have created three variables: Hedging 1 exposure, Hedging 2 exposures and hedging 3 exposures where hedging 1 exposure variable is set equal to 1 if a firm is hedging only one type of exposure i.e. either FX only hedging or IR only hedging or Commodity Price only Hedging and 0 otherwise, hedging 2 exposure variable is set equal to 1 if a firm hedges two types of exposure i.e. FX & IR or FX & CP or IR & CP and 0 otherwise and hedging 3 exposure variable is set equal to 1 if a firm is hedges all three exposures i.e. FX & IR & CP and 0 otherwise. Majority of the firms in our sample are FX and IR hedgers and there are very few firms that hedges FX, IR and CP together.

The regression in table 4-14 is analyzed using the new variables. The result of the model 1 to 3 shows that all three types of hedging have negative and significant relationship with probability of default. The hedging coefficient on hedging 1 exposure, hedging 2 exposures and hedging 3 exposures in OLS model suggest that hedging reduces probability of default by 0.38, 0.32 and 0.28 percent respectively. The coefficients are smaller when we use five-year probability of default. When we compare hedging 1 exposure coefficient with hedging 2 and hedging 3 exposures, we find that the coefficient on hedging 1 exposure is smaller than others. The coefficient on hedging 2 exposures is larger than hedging 1 exposure and hedging 3 exposures. This result is surprising as we expect that if a firm hedges more exposure they should have lower probability of default. So, when a firm is hedging three exposures, we expect that a coefficient on hedging 3 exposures should be larger than the coefficient on hedging 2 exposures. One explanation for this unexpected result could be that, the number of observations for hedging 3 exposures variable is very few compare to hedging 2 exposures. All control variables have expected sign and are significant. Overall, our results suggest that if a firm hedges more exposures than it has lower probability of default.

In table 4-15, we break up hedging 1 exposure into its three components: 1) FX only hedging, 2) IR only hedging and 3) Commodity price only hedging. We also break up two types of hedging into three components: 1) FX&IR, 2) FX&CP and 3) IR&CP. The result for one types of hedging is negative and significant for FX hedgers and IR

hedgers and significant. The coefficient sing on CP only is negative but not significant under any model. Under the hedging 2 exposures breakup, FX&IR and IR&CP have negative sign and are significant. The coefficient on FX&CP is negative but not significant. Among FX&IR and IR&CP, the coefficient on FX&IR is larger. The coefficient on hedging 3 exposures is still negative and significant. All other control variables have expected sign and are significant. Overall, our results suggest that IR hedging firms have lower probability of default than other types of hedging firms and firms that are hedging both FX&IR have lowest probability of default.

Table 4-13: Impact of Different Hedging Variables on Probability of default

This table presents the results of OLS, RE and FE regressions of ***Different Hedging Variables*** *on* **the *probability of default*. *Probability of Default is*** from Moody's. ***Hedging 1 Exposure*** is dummy variables set equal to 1 if a firm is hedging FX only or IR only or CP only and 0 otherwise. ***Hedging 2 Exposure*** is a dummy variable set equal to 1 if a firm is hedging FX&IR or FX&CP or IR&CP and 0 otherwise. ***Hedging 3 Exposure*** is a dummy variable set equal to 1 if a firm is hedging FX and IR and CP and 0 otherwise. **Leverage** is the ratio of total debt to market value assets. **Profitability** is measured as return on capital invested. **Excess Return** is the annual return on the firm minus the value weighted FTSE all shares index annual return over the entire fiscal year. **Equity volatility** is calculated as standard deviation of each firm's daily stock return over the entire fiscal year. **Firm size** is a natural logarithm of Market value of assets. **Liquidity** is the ratio of total current assets minus total stock & work in progress over total current liabilities. . In parentheses are standard errors adjusted for heteroskedasticity (White (1980)) and firm clustering. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively. The regressions also include year and industry dummies.

	Dependent Variable: EDF1 YEAR			Dependent Variable: EDF5 YEAR		
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	OLS	RE	FE	OLS	RE	FE
Hedging 1 Exposure	-0.3860**	-0.3279**	-0.2889*	-0.2255**	-0.1844**	-0.1541
	(0.170)	(0.158)	(0.167)	(0.100)	(0.092)	(0.095)
Hedging 2 Exposures	-0.7995***	-0.6425***	-0.5259**	-0.4843***	-0.3896***	-0.3222**
	(0.236)	(0.224)	(0.242)	(0.141)	(0.134)	(0.145)
Hedging 3 Exposures	-0.6921**	-0.5171*	-0.4843	-0.3705*	-0.2750	-0.2787
	(0.308)	(0.298)	(0.334)	(0.194)	(0.185)	(0.203)
Leverage	6.8679***	8.6027***	9.9671***	5.1750***	6.3385***	7.2251***
	(1.061)	(1.087)	(1.230)	(0.600)	(0.620)	(0.717)
Profitability	-1.0923*	-1.1067*	-1.1540*	-0.6822*	-0.7160**	-0.7773**
	(0.579)	(0.583)	(0.635)	(0.363)	(0.363)	(0.390)
Firm Size	-0.3999***	-0.5992***	-1.1144***	-0.3441***	-0.4859***	-0.8622***
	(0.064)	(0.079)	(0.163)	(0.040)	(0.050)	(0.104)
Volatility	6.3778***	5.4865***	4.8435***	4.6933***	4.0472***	3.6179***
	(0.639)	(0.592)	(0.611)	(0.383)	(0.358)	(0.374)
Excess Return	-1.6646***	-1.3689***	-1.0720***	-1.0969***	-0.9048***	-0.7009***
	(0.184)	(0.161)	(0.161)	(0.109)	(0.096)	(0.097)
Liquidity	-0.3678***	-0.2626***	-0.1461*	-0.2479***	-0.1774***	-0.1001*
	(0.066)	(0.060)	(0.077)	(0.045)	(0.041)	(0.056)
Constant	3.8982***	6.3585***	13.1050***	3.5956***	5.4038***	10.3347***
	(0.973)	(1.179)	(2.261)	(0.618)	(0.740)	(1.420)
Observations	3,422	3,422	3,422	3,422	3,422	3,422
R-squared	0.5352	0.5265	0.5070	0.6207	0.6119	0.5923
F-Test	12.5307		19.3380	20.9144		32.8241
Chi2 test		391.4871			655.5540	

Table 4-14: Impact of Different Hedging Variables on Probability of default

This table presents the results of OLS, RE and FE regressions of ***Different Hedging Variables*** *on* **the *probability of default*. *Probability of Default is*** from Moody's. **Commodity Price (CP) only hedging** is a dummy variable set equal to 1 if a firm is hedging commodity price exposure only and 0 otherwise. **FX Only hedging** is a dummy variable set equal to 1 if a firm is hedging foreign currency exposure only and 0 otherwise. **IR Only hedging** is a dummy variable set equal to 1 if a firm is hedging interest rate exposure only and 0 otherwise. **FX & IR** is a dummy variable set equal to 1 if a firm is hedging FX & IR exposure and 0 otherwise. **FX & CP** is a dummy variable set equal to 1 if a firm is hedging FX & CP exposure and 0 otherwise. **IR & CP** is a dummy variable set equal to 1 if a firm is hedging IR & CP and 0 otherwise. **Hedging 3 Exposure** is a dummy variable set equal to 1 if a firm is hedging FX and IR and CP and 0 otherwise. **Leverage** is the ratio of total debt to market value assets. **Profitability** is measured as return on capital invested. **Excess Return** is the annual return on the firm minus the value weighted FTSE all shares index annual return over the entire fiscal year. **Equity volatility** is calculated as standard deviation of each firm's daily stock return over the entire fiscal year. **Firm size** is a natural logarithm of Market value of assets. **Liquidity** is the ratio of total current assets minus total stock & work in progress over total current liabilities. In parentheses are standard errors adjusted for heteroskedasticity (White (1980)) and firm clustering. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively. The regressions also include year and industry dummies.

	Dependent variable: EDF1 Year			Dependent variable: EDF5 Year		
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	OLS	RE	FE	OLS	RE	FE
CP Only Hedging	-0.4928	-0.3325	-0.4055	-0.1018	-0.0512	-0.1474
	(0.697)	(0.768)	(0.811)	(0.349)	(0.425)	(0.473)
FX Only Hedging	-0.7583**	-0.7980**	-0.7670**	-0.4431**	-0.4841***	-0.4637**
	(0.332)	(0.315)	(0.369)	(0.197)	(0.180)	(0.207)
IR Only Hedging	-1.1088***	-0.9201**	-0.8241**	-0.6561***	-0.5285**	-0.4542**
	(0.387)	(0.371)	(0.407)	(0.226)	(0.213)	(0.230)
FX & IR	-1.2574***	-1.1146***	-1.0032**	-0.7541***	-0.6785***	-0.6171***
	(0.337)	(0.339)	(0.397)	(0.199)	(0.198)	(0.230)
FX & CP	-0.4908	-0.2619	-0.1238	-0.2574	-0.1217	-0.0481
	(0.534)	(0.423)	(0.497)	(0.340)	(0.259)	(0.317)
IR & CP	-1.2205***	-1.1493***	-1.1303**	-0.7940***	-0.7475***	-0.7397**
	(0.371)	(0.376)	(0.451)	(0.241)	(0.250)	(0.307)
FX & IR & CP	-1.0649***	-0.8658**	-0.8197*	-0.5898**	-0.4890**	-0.4870*
	(0.373)	(0.372)	(0.435)	(0.231)	(0.224)	(0.257)
Leverage	7.0523***	8.7113***	10.0166***	5.2860***	6.4032***	7.2534***
	(1.069)	(1.093)	(1.231)	(0.604)	(0.623)	(0.717)
Profitability	-1.0565*	-1.0737*	-1.1422*	-0.6610*	-0.6950*	-0.7688**
	(0.575)	(0.579)	(0.631)	(0.361)	(0.361)	(0.389)
Firm Size	-0.3783***	-0.5789***	-1.0879***	-0.3313***	-0.4741***	-0.8457***
	(0.062)	(0.078)	(0.160)	(0.040)	(0.050)	(0.102)
Volatility	6.3274***	5.4650***	4.8549***	4.6635***	4.0345***	3.6262***
	(0.631)	(0.590)	(0.610)	(0.378)	(0.357)	(0.373)
Excess Return	-1.6659***	-1.3732***	-1.0801***	-1.0980***	-0.9075***	-0.7061***
	(0.183)	(0.161)	(0.160)	(0.109)	(0.095)	(0.097)
Liquidity	-0.3802***	-0.2712***	-0.1491*	-0.2553***	-0.1826***	-0.1021*
	(0.069)	(0.062)	(0.078)	(0.046)	(0.042)	(0.057)
Constant	3.9090***	6.4093***	13.1298***	3.5988***	5.4437***	10.3487***
	(0.987)	(1.191)	(2.242)	(0.624)	(0.746)	(1.409)
Observations	3,422	3,422	3,422	3,422	3,422	3,422
R-squared	0.5381	0.5295	0.5088	0.6229	0.6141	0.5938
F-Test	11.1421		16.0582	18.4796		27.3245
Chi2 test		391.0593			653.6147	

4.5 Two Stage Least Square and Generalized Method of Moments Regressions

4.5.1 Endogenous modeling of probability of default, leverage and hedging

In our model endogeneity arises because of simultaneous causality. This occurs when the causality runs in both directions, that is, from the regressor(s) to the dependent variable and from the dependent variable to the regressor(s). In our case, the hedging–probability of financial distress relationship is affected by a feedback loop such that hedging affects the probability of default but the probability of default also affects the decision to hedge. In effect, hedging lowers the probability of default but it is also the case that firms with a high probability of default are more likely to hedge. However, we also need to recognize the role of leverage in this circular relationship. By reducing the likelihood of default, hedging increases a firm's debt capacity (Stulz, (1996), Ross (1997) Leland, 1998). It follows from this that any initial reduction in the probability of default could be offset by a return to the pre-hedging probability of default as firms take advantage of the additional debt capacity by increasing their holdings of debt. In effect we have a circular relationship that creates an endogeneity problem between probability of default, leverage and hedging. When there is simultaneous causality, the endogenous variables and the error term are correlated and OLS estimation picks up both forwards and backwards effects, thereby leading to bias and inconsistent coefficients.

We control for endogeneity by using a two stage least square model (2SLS). In the first stage we model our endogenous variables using instrumental variables.[11] The instruments capture the variation as to which firms decide to hedge or the extent of hedging. In the second stage regression, the probability of default is estimated using the predicted values of hedging and leverage from the first stage regression and the exogenous variables. We also employ the generalized method of moment's instrumental variables approach, as 2SLS is suboptimal in the presence of hetroskedasticity.

[11] The first stage in instrumental variables estimation is to estimate the endogenous variables as a function of the exogenous variables in the second stage plus additional instruments.

4.5.2 Instrumental Variables

This section describes the instrumental variables used for hedging and leverage. A good instrumental variable is one that affects the probability of default only through its impact on hedging and leverage and not directly by itself which suggest that a valid instrumental variable must be correlated with hedging and leverage but uncorrelated with error term, ε_{it}, in equation (1).

4.5.2.1 Instruments for hedging and Leverage

For selecting instrumental variables for hedging we followed Geczy et. al. (1997), Allayannis and Ofek (2001) and Graham and Rogers (2002), Magee (2008). The first instrumental variable is the ratio of research and development expenditure to sales. Geczy et. al. (1997) and Allayannis and Ofek (2001) find a positive and significant relationship between this variable and hedging, which is consistent with the theory that firms hedge to reduce underinvestment costs. The second instrumental variable is an IR and FX hedging where 1 indicates firms use IR and FX hedging and 0 otherwise. This variable measures economies of scale in hedging. The third instrumental variable that we used is depreciation and amortization scaled by the total assets of the firm as a measure of firms non-debt tax shield (Purnanandam, 2006). The fourth instrumental variable we use is interest coverage ratio. We also use market to book value variable which is calculated as market value of equity divided by book value of equity, where the book value of equity is measure as equity capital and reserves less goodwill and other intangibles. This variable is proxying for growth, which is one of the motives for hedging. Finally, We use Property, Plant and Equipment scaled by total assets to control for the collateral available for borrowing (Purnanandam, 2006).

Table 4-15: The Effect of All Hedging on Probability of Financial Distress

This table presents the results of OLS, 2SLS and GMM-IV regressions of the probability of default on the Extent of All Hedging. **Probability of Default is** a proxy for financial distress sourced from Moody's. Extent of Hedging is calculated as sum of notional value of foreign exchange derivatives, interest rate derivative and commodity derivatives divided by total assets. **Leverage** is the ratio of total debt to market value of equity plus total debt. **Profitability** is measured as return on capital invested. **Excess Return** is the annual return on the firm minus the value weighted FTSE all shares index annual return over the entire fiscal year. **Equity Volatility** is calculated as standard deviation of each firm's daily stock return over the entire fiscal year. **Firm size** is a natural logarithm of total assets. **Liquidity** is the ratio of total current assets minus total stock & work in progress over total current liabilities. In parentheses are standard errors adjusted for heteroskedasticity (White (1980)) and firm clustering. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively. The regressions also include year and industry dummies.

VARIABLES	(1) OLS	(2) 2SLS-IV	(3) GMM-IV
Extent of Hedging	-0.2241	-1.7898**	-1.5298*
	(0.158)	(0.724)	(0.873)
Leverage	3.8063***	4.4074***	4.4201***
	(0.345)	(0.818)	(0.889)
Profitability	-2.6964***	-1.3721**	-1.4105*
	(0.788)	(0.612)	(0.828)
Excess Return	-0.9143***	-0.8226***	-0.7891***
	(0.113)	(0.127)	(0.165)
Equity Volatility	2.3430***	1.3878***	1.3855***
	(0.349)	(0.336)	(0.369)
Firm Size	-0.1811***	-0.4827***	-0.4840***
	(0.038)	(0.119)	(0.126)
Liquidity	-0.0215	-0.0094	0.0044
	(0.054)	(0.068)	(0.067)
Constant	2.1537***		
	(0.617)		
Observations	1,038	979	979
R-squared	0.5776	0.4482	0.4677
F-Test	13.2612	15.1795	9.3652
Hausman Test		10.7179	6.8713
Hausman		0.0047	0.0322
Under-identification Test		51.1611	27.1643
Under-identification Test (*p*-value)		0.0000	0.0000
Sargan-Hansen J-Stat		3.3009	2.7591
Sargan-Hansen J-Stat (*p*-value)		0.1920	0.2517
Crag-Donald F-Stat		13.1652	13.1652

4.5.3 Instrumental Variable Regression Analysis

In the above table, Column 1 presents the results of OLS regression. The estimated co-efficient on the extent of hedging is negative as per the expectation of this study but insignificant, suggesting that the extent of a firm's foreign currency, interest rate and commodity hedging together dose not affect its probability of default. However, due to the problem of simultaneity between hedging, leverage and probability of default these results are not surprising. If firms employ more leverage in their capital structure then firm will face high probability of financial distress and this will motivate firm to hedge. With the help of hedging firm can lower its financial distress. This will help firm in borrowing more debt from the market. This relationship between hedging and leverage suggest that they are endogenous and positively related. Due to this relationship it's difficult to observe a significant relationship between the probability of default and the extent of hedging. Other results indicate that firms with more leverage in capital structure and firms with high asset volatility are more likely to default. There is a strong relation between profitability and probability of default and firm size as measured by total assets and probability of default. These findings are consistent with the theoretical prediction and earlier empirical studies. This study finds negative relation between excess return and probability of default. The results suggest that probability of default is associated with the scale of the firm: the bigger the firm the lower probability that the firm will default. Similarly, more profitable firms have less probability of default. Firm with higher equity volatility have more chances of default.

To control for the above-discussed issue of endogeneity this study uses Instrumental variable regression using 2SLS and GMM approach. A Hausman (1978) test is performed to determine whether extent of hedging and leverage are jointly endogenous. This test is based on the difference between OLS estimator and instrumental variables estimator. The null hypothesis for the test states that an OLS estimator for the same equation would yield consistent estimates. This means that any endogeneity among the regressors would not have adverse effects on OLS estimates. A rejection of null hypothesis indicates that regressors' effects on the estimates are meaningful, and instrumental variables techniques are required. This study rejects the null hypothesis of no endogeneity at the 1% level. Therefore, OLS regression

generates inconsistent estimates and ignores the endogeneity of extent of hedging and leverage with respect to probability of default and due to that potentially misleading.

Columns 2 and 3 present the 2SLS and GMM-IV results respectively. For the 2SLS regression, the extent of hedging is positively and significantly related to the probability of default at 5% level (*p*-value is 0.013). For the GMM-IV regression, the estimated coefficient on the extent of hedging is positive but weakly related to the probability of default with a *p*-value of 0.080. The higher *p*-value is expected, as GMM-IV is more efficient than 2SLS. The magnitude impact of the coefficients for extent of hedging is also larger for 2SLS and GMM-IV than OLS. The co-efficient on leverage is also larger for 2SLS ad GMM-IV regression. This suggest that due to the problem of endogeneity the co-efficient on extend of hedging and leverage are reflecting their exact effect on probability of default. The same is case with profitability, excess return, equity volatility, firm size and liquidity. These results suggest that after controlling for endogenous hedging and leverage, the extent of foreign currency hedging is associated with a lower probability of default.

4.5.3.1 Validity of Instrumental Variables

In this section, the validity of instrumental variables is discussed. A valid instrument must be uncorrelated with error term in the regression equation and it must be correlated with the endogenous explanatory variables in regression. That is, a valid instrumental variable is one that affects the probability of default through its impact on extent of hedging and leverage and not directly by itself.

To test the first condition, that is instrument must be uncorrelated with error term, this study conducts Sargan-Hansen Test of over identifying restrictions. Under this test the joint null hypothesis is that the instruments are valid instruments, that is uncorrelated with error term and that the excluded instruments are correctly excluded from the estimated equation. The Sargan-Hansen statistics are small with a *p*-value of 0.1920 and 0.2517 respectively for 2SLS and GMM-IV regressions. Therefore, this study cannot reject the null hypothesis that the instrumental variables are uncorrelated with the error term.

To test the second condition, that is instrument must be correlated with the endogenous explanatory variables, this study employs Under-Identification test (Kleibergen-Paap rk LM statistic). Under this test that null hypothesis is that the equation is under-identified, that is excluded instruments are "irrelevant", meaning uncorrelated with endogenous regressors. The *p*-value of under-identification tests for both 2SLS and GMM-IV is 0.0000. Therefore, this study rejects the null hypothesis that the instrumental variables are uncorrelated with the endogenous variables. This suggests that that equation is identified and excluded instruments are correlated with endogenous regressors.

5 Conclusion

This paper examines the effects of hedging on probability of default using one and five year probability of default data for a large cross section of UK non-financial firms. We use univariate and multivariate analysis to answer the research question. We use two definitions of hedging. The first is continuous variable that captures the extent of hedging. The second is dummy variable that is based on the firm's decision to hedge.

The univariate results show that hedging firms have lower probability of default across all the hedging definitions we use. In multivariate analysis we find that firms that hedges interest rate exposure have lower probability of default than those firms that hedges other types of exposures. We also find that FX and IR hedging firms have lowest level of probability of default. Firms that are hedging only FX exposure have very less effect on their probability of default. We also find that when non-hedging group includes "other" hedgers the results are biased and do not reflect the actual effect of hedging on probability of default. We also find that a firm has lower probability of default if it hedges more exposure. Our results also suggest that firms use commodity derivatives for speculation.

To control for endogeneity problem between hedging and leverage, we use 2SLS and GMMIV approach. After controlling for the endogeneity problem we find that hedging firms have lower probability of default compare to non-hedging firms. In 2SLS and GMMIV approach we have used continuous variable for hedging. The results are consistent with our hypothesis and theoretical literature. Magee (2008) also finds the similar results. However, Magee (2008) uses only foreign currency hedging while we use foreign currency and interest rate hedging. Theoretically, financial distress is a direct result of firms inability to payoff interest on debt and by hedging interest rate exposure firms can manage their interest rate payments and can directly reduce their probability of default. Overall, all of our results provide evidence consistent with the theory that a firm hedges to reduce its probability of default.

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