THE ECONOMIC DETERMINANTS OF CORPORATE HEDGING: AN EMPIRICAL ANALYSIS OF UK NON-FINANCIAL FIRMS

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ABSTRACT

This thesis attempts to differentiate among the theories of corporate hedging by using UK corporate level data for the first time. The UK provides a particularly valuable focus for empirical investigation since it has a large and sophisticated corporate sector. Additionally UK firms have become more exposed to financial risk because of the increasing level of debt type commitments, expanding international operations and the growth in price volatility in the world's commodities markets. Lack of a consensus on the economic effects of corporate hedging as well as the limited research on this issue in the UK intrigued the author and led to this research into whether the UK evidence supports theories that imply risk management enhances shareholder wealth.

In this way the thesis contributes to an ongoing debate in the literature and provides a valuable additional case study. It provides a further contribution by giving insights into the determinants of hedging across exposure categories. One of the main contributions of this study is that the evidence presented suggests that the conflicts between the results of this study and those of previous studies focusing on the hedging of specific exposures can be explained by the treatment of other hedgers in non-hedging samples.

In undertaking this analysis, a systematic empirical approach is taken which employs essentially four different econometric methodologies: a logit analysis, a multinomial logit analysis, a tobit analysis and a two step estimation process incorporating probit and truncated regression analysis.

The results indicate that firms with tax loss carryforwards, higher gearing, lower liquidity, higher foreign exchange exposure and larger firms are more likely to hedge and that firms with higher gearing, higher foreign exchange exposure and smaller firms hedge more of their exposures. Overall, the evidence supports theories that imply risk management enhances shareholder wealth.

CONTENTS

Page

CHAPTER 7

An Empirical Analysis of Interest Rate Hedging Practices of UK firms

Page

CHAPTER 8

An Empirical Analysis of Foreign Currency Hedging Practices of UK firms

CHAPTER 9

Summary and Conclusions

LIST OF TABLES

LIST OF TABLES

LIST OF TABLES

LIST OF TABLES

LIST OF TABLES

LIST OF TABLES

LIST OF TABLES

LIST OF TABLES

Introduction

"Financial price volatility can put even well-run firms out of business. Changes in exchange rates can create strong new competitors. Similarly, fluctuations in commodity prices can drive input prices to the point that substitute products - products made from different inputs - become more affordable to end consumers. Changes in interest rates can put pressure on the firm's debt service costs: firms who have relatively higher levels of debt may find themselves in financial distress as borrowing costs rise." **Charles Smithson, pg 1, Managing Financial Risk, 3rd edition, 1998.**

Over the past twenty-five years foreign exchange rates, interest rates and commodity prices have become more volatile.[1] In 1991 the Gulf war offered many companies an object lesson not only on currency exposure, but also on exposure to energy and commodity prices. For UK treasury managers whose companies trade overseas, the world in the latter half of 1992 became a more uncertain place. Until the autumn of that year, corporate treasuries with a large exposure to foreign currencies could afford to be relatively relaxed about the pound's exchange rate against the deutschemark and the US dollar. Importers, for example, knew that sterling's membership of the exchange rate mechanism meant that the pound could not fall below DM2.7780 against the deutschemark. Europe's moves towards economic and monetary union also reduced exchange rate volatility as the continent's economies appeared set on convergence. And then there was Black Wednesday. Sterling's suspension from the ERM on September 16 1992 was the climax of the worst currency crisis for many years, and was followed by a 19 percent devaluation against the deutschemark. A 2 or 3 pfennig fluctuation in the sterling-deutschemark rate, which would have been deemed unusual a few months earlier, was now seen as normal. Les Halpin of NP Record Treasury Management commented:

[1] See Marshall and Bansal (1992).

"The floating pound is a hazard for companies which trade overseas. People are suddenly much more aware of the risks. The dealings and profits which a company has at any moment can be wiped out in hours, let alone days." **[James Blitz, Gut Feeling Guides Decisions, Corporate Treasury Management Survey, Financial Times, Wednesday November 11, 1992, pp. II]**

In 1994 the reversal in the interest rate cycle and the resulting turmoil in the bond markets hit corporate treasurers with rising funding costs and falling investment values. By definition, higher levels of financial price volatility subject any given exposure to a greater degree of risk. At the same time, expanding international operations and trade flows have generated larger exposures for firms in the 1990s. Many companies are becoming more exposed to global financial risks because of increased exports. But a greater number of companies are also reporting that their exposures are rising as they make direct overseas investments.

In response to the increased financial price volatility and to the rise in international financial transactions, the demand for hedging products, such as derivatives, to hedge risks associated with interest rate, foreign exchange rate and commodity price fluctuations have proliferated. Between 1986 and 1991 the volume of exchange-traded and over-the-counter (OTC) derivatives expanded from $1.4 trillion to approach $10 trillion[2] and as reported in the Financial Times "The growth of the exchange traded market in futures and options and the over the counter market in swaps and options shows no signs of abating."[3] Surveys have documented that risk management is considered by financial executives as one of their most important

[2]Eli M. Remolona, "The Recent Growth of Financial Derivative Markets," Federal Reserve Bank of New York Quarterly Review (Winter 1992-93), 28-43.

objectives. A survey of corporate treasurers undertaken by Euromoney[4] found that nearly 80 percent of respondents were hedging with derivatives. A study by the Group of Thirty[5] found that over 80% of firms considered derivatives either very important or imperative for controlling risk. A survey by the management consultants Touche Ross in 1992, showed that 85 percent of UK companies had selective hedging cover. Derek Ross, a Touche Ross partner, speaking to the Financial Times noted:

"We advise 25 of the FT-SE 100 companies, and quite a large number have increased their hedging activity since Black Wednesday," **[James Blitz, Gut Feeling Guides Decisions, Corporate Treasury Management Survey, Financial Times, Wednesday November 11, 1992, pp. II]**

Richard Lapper, writing in the Financial Times, reported that:

"Economic volatility has increased interest in many categories of products, including the simpler less complex products traded on futures and options exchanges. Exchange traded volume rose sharply in the first six months of the year... Europe's three largest exchanges saw volume increase by more than 40 per cent in the first half." **[Financial Times, Wednesday November 16, 1994]**

All this has rekindled the debate on whether or not companies should hedge their exposures and, depending on one's answer to this, which exposures should be hedged and how they should be hedged. Even if we accept that there is something which could be hedged, (and that this "something" has grown in magnitude) it does

[3]Financial Times Survey, "International Capital Markets," Thursday May 26 1994.
[4]Derivatives Survey 1993, Euromoney Publications PLC.

not necessarily follow that it should be hedged. The fact that many firms face the risk of changing financial prices is a necessary but not sufficient condition for hedging. The litmus test is whether hedging leads to an increase in the firm's expected value.

Clearly the level of hedging activity has increased in recent years and firms are devoting greater resources to the management of financial risk. Understanding the economic determinants of this corporate hedging activity provides the main motivation of this thesis. The thesis empirically examines the competing theories of hedging and tries to discriminate between them.

Models of hedging suggest that reducing volatility in cash flows is optimal, even though it is costly, when the firm faces even greater exogenous or endogenous costs associated with cash flow volatility. Each of the models assumes the existence of a capital market imperfection that makes cash flow volatility costly. The approach employed to test these models is to examine the cross-sectional variation in the characteristics of firms that hedge or use derivatives.[6] The explanatory variables represent firm characteristics that the thesis predicts are related to the proposed costs of volatility that the firm can reduce by hedging.

The empirical analysis in this thesis fits into the general category of studies that test theories of optimal hedging. Notwithstanding this the thesis makes several contributions to the existing empirical literature on corporate hedging. Firstly, the thesis tests the relevance of modern corporate hedging theory on a new and unique dataset. This dataset facilitates the testing of the theories of hedging employing a sample of UK firms for the first time. Thirteen empirical studies use US firm level

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[5] Derivatives: Practice and Principles, Group of Thirty, July 1993.

[6] Recent studies using US data examine the cross-sectional variation in the characteristics of firms that use more derivatives.

data, this is the first non US study to test the various motives for hedging using a large sample of non-financial firms.[7]

Secondly, this thesis is the first study to collect and use simultaneously both annual report and survey data on risk management practices. The resulting database is far better than that employed in previous studies. This enables the study to provide more detailed and accurate information on the determinants of corporate hedging activity.

Thirdly, by using the subsample of firms that provide both survey and annual report data and comparing responses from both data sources to the question whether firms hedge or not, this thesis is able to identify two groups of firms, those firms whose response to this question correspond (referred to as correctly classified firms) and those firms whose response does not correspond (referred to as incorrectly classified firms). The former group consists of both correctly classified non-hedgers and hedgers. The empirical tests in this thesis are the first to identify the existence of incorrectly classified firms and to test the effects of this. Furthermore, using this unique data we assume that incorrectly classified firms undertake a smaller amount of hedging relative to correctly classified hedging firms. In multinomial logit tests the thesis demonstrates empirically for the first time, with dummy dependent variables proxying for the extent of hedging, that firms considered to be undertaking more hedging exhibit significantly different characteristics compared to firms that carry out only a small amount of hedging.

The fourth major innovation in this study is that it is the first to recognise that the inclusion of other hedging firms in non-hedging samples in tests of the determinants of specific categories of hedging can bias the tests against their a priori

[7] Berkman and Bradbury (1996) use a sample of 116 firms listed on the New Zealand Stock Exchange. The sample falls to 104 when they use fair value of derivatives outstanding scaled by firm value as the

expectations. This study is the first to demonstrate empirically the effects of this sampling error. The evidence for both interest rate and foreign currency hedging samples suggests that the conflicts between the results of this study and the results of previous studies can be explained by the treatment of other hedgers in the non-hedging sample. Therefore, using our superior database makes the research results in this study better than those produced to date.

The fifth significant contribution of this study is the investigation into the determinants of foreign currency only hedging (i.e. firms that only hedge foreign currency exposure). The motivation behind this is the argument that finding a relationship between foreign currency hedging and say, gearing might be driven by the fact that the sample of foreign currency hedgers are also interest rate hedgers. The results show for the first time an unambiguous link between foreign currency hedging and the expected costs of financial distress.

This thesis, therefore, makes an important contribution to understanding a very significant but under-researched topic in the United Kingdom.

As usual, prior to any empirical investigation a consideration of what economic theory and previous empirical studies have to say about the economics of corporate hedging is necessary. Chapters 2 and 3 survey the theoretical and empirical literature on the topic while they discuss some methodological and hedging data issues. Chapter 2 reviews the theories of hedging and demonstrates that each provides a potential explanation for why firms might hedge. The discussion also recognises the importance of considering how a firm might hedge, drawing the distinction between cost reducing and risk reducing strategies. The chapter considers firms' motives for speculating and the extent to which they are correlated with the motives for hedging.

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dependent variable.

The review of the empirical literature in chapter 3 shows that there is mixed support for the various theories of hedging. It argues that several previous studies are subject to flaws in their sample design, which might explain their results and that some theories have not been adequately tested because of poor choice of proxies.

Chapter 4 presents a detailed discussion of the methods of collecting and cleaning the data on hedging activity. The chapter also describes the characteristics of the data obtained from annual reports and a survey to Corporate Treasurers. This includes an examination of the hedging activity disclosures of the annual report sample. The analysis focuses on the qualitative disclosures of firms not hedging and of those not providing any disclosure on hedging. This thesis is the first study to conduct a comprehensive evaluation of qualitative disclosures of these types of firms. The analysis reveals that all non-hedging firms and the majority of non-disclosing firms provide disclosures that suggest that they face low levels of financial price exposure. This evidence provides support for the assumption that an annual report not mentioning hedging can be treated as a non-hedger. Furthermore, the examination of the qualitative statements of firms with no disclosure on interest rate hedging provides very strong anecdotal evidence in support for the optimal theories of hedging.

Collecting data on hedging activity from two independent sources enables this chapter to check the data's reliability by comparing the information obtained from annual reports with data from the survey. This analysis reveals that overall there is a high degree of consistency between the two data sources.

Thereafter, the chapter defines both the endogenous and exogenous variables. Chapter 5 specifies the appropriate econometric models employed in the empirical tests. This is followed by chapters 6, 7 and 8 which investigate empirically the determinants of corporate hedging using three different empirical definitions of hedging.

Chapter 6 examines the characteristics of UK firms that hedge any type of exposure (or use any type of derivative) – interest rate, foreign currency, or commodity price. It begins by testing a theory's relative importance in determining which firms hedge using univariate regression methods to compare the characteristics of firms that hedge with those that do not. Given correlations among the different firm characteristics, these tests cannot reveal significant difference in firm traits, holding other firm attributes constant. Therefore the tests employ multivariate logistic regression techniques to examine conditional relations. Thereafter, the chapter employs a continuous dependent variable and tobit regression methodology to investigate the determinants of the extent of hedging.

This thesis augments existing empirical studies on corporate hedging by not only examining the determinants of hedging per se, but also investigating the cross-sectional variation in interest rate hedging and foreign currency hedging, recognising that different factors may be important for each type of hedging. The empirical tests in chapters 7 and 8 restrict the analysis to these categories of exposure.

Like chapter 7, there are many studies that specifically examine interest-rate risk management. However, most of the existing research in this area focuses on the financial services sector because industry regulators have required firms to provide information about the use of derivatives by financial institutions since the early 1990s. By examining the interest rate hedging practices of non-financial firms that face different interest rate risk problems than financial institutions, this chapter makes a contribution to the literature on the hedging of interest rate risk. The chapter employs logit, tobit and a two stage estimation model to investigate the determinants of interest rate hedging.

Chapter 8 empirically tests the determinants of foreign currency hedging applying the econometric models used in chapter 7. The chapter presents strong evidence of a relationship between factors that expose a firm to exchange rates and the decision to hedge and the extent of hedging. It also finds evidence of a relationship between expected financial distress costs and the foreign currency hedging decision and more significantly the foreign currency only hedging decision. The tests also document an association between hedging policies and a firm's ability to hedge, which has not been examined in other studies.

The empirical analysis in chapters 6, 7 and 8 seem robust under a variety of econometric specifications, sample sizes and using a number of alternative proxy variables. Consequently, they help provide a more complete understanding of the determinants of corporate hedging.

Finally, Chapter 9 discusses the main conclusions as well as the limitations of the study and it makes some suggestions for future research on the issue.

Chapter 1. Financial Risk and Hedging

1.1 Introduction

Firms face variability in a whole range of outcomes in all areas of their operations (i.e., investment side and financing side). For example, there is variability in production outcomes in terms of how much is produced and at what cost, there is variability in sales outcomes in terms of how much is sold and a what price and thus how much revenue is generated, there is also variability in financing outcomes in terms of how much finance is raised and at what cost. Variation in any of these outcomes will result in variation in a firm's financial outcomes and ultimately variation in the return to shareholders and other stakeholders.

This chapter briefly discusses concepts considered to be relevant to the thesis. These are the types of risks faced by firms, which of these risks they might wish to avoid, and definitions of risk management and hedging.

1.2 Types of Risks Faced by Firms

Firms generally face two kinds of risk in terms of their potential impact on the firm's financial outcomes. Firstly, there are those risks that can only damage the business, that is, result in financial outcomes lower than expected. For example, flood, war, fire, accident and theft etc. These risks are usually managed by purchasing insurance. Secondly, there are those risks that can either produce gains or losses, that is, result in financial outcomes that are better or worse than expected. This secondary category of risk can be subdivided into business risk and financial risk. The former includes risks associated with factors such as exit or entry of competitors, new technology and economic or government regulation whereas the latter includes risks due to changes in exchange rates, interest rate rates of commodity prices. Business and financial risks are two way risks in that they can be good or bad for a business.

In this thesis risk is defined as that which causes any variation in a firm's financial outcome which cannot be predicted with certainty. This is a valid definition in the context of this thesis in so much as it includes both desirable and undesirable outcomes.

1.3 Which Risks Might Firms Want to Avoid?

All firms are in business to take risks. The issue is which types of risks and whether they should adopt strategies to avoid certain categories of risks. The question is must firms expose their shareholders to all the risks inherent in its operations?

Business risks are those class of risks that must unavoidably be accepted as part of the decision to enter a particular line of business. These risks should not be avoided, since it is the purpose of the business to have exposure to this kind of risk, without which there would be no point to its existence. Risk avoidance in this case would eliminate the potential profit from the business as well. To avoid or eliminate these risks would be akin to exiting the business and depositing the firm's capital in a bank. The firm is in existence to face the challenges of business risk, to maximise the potential rewards from exposure to business risks.[1] Financial risks can be seen as being supplementary to the package of business risks. These risks might interfere with the firm's core activities and so are risks that it might not want to take, and therefore might be avoided. The downside of these risks could prevent the firm from implementing its strategic objectives.

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[1] The objective of a firm's hedging policy might be to prevent financial risks from inhibiting its ability to take business risks.

1.4 Risk Management and Hedging Defined

Risk management is the discipline of identifying risks in a firm's economic environment, assessing their potential impact on the critical performance measures, such as a firm's cash flows, earnings or market value, and employing means for either reducing the exposure of underlying economic activities to these risks or shifting some of the exposures to others or reducing the costs of the risks to the firm.

Traditionally, the term "risk management" has been used to refer to the management of one-way or insurable risks such as fire, theft or accident. In these situations the only possible outcomes are losses or no change in the status quo.[2] However, in recent times the term risk management has come to be applied to the management of a different set of risks affecting firms. These risks are referred to as two-way risks and include risks such as fluctuations in raw material prices, interest rates and foreign exchange rates.[3] The risk here is the possibility that the actual outcome will differ from the expected (i.e., be better or worse than the expected outcome).

Hedging is the process of reducing a firm's risks. In this thesis hedging is the process of reducing a firm's exposure to financial price risks. How hedging might achieve this can be examined by considering the payoff of a portfolio of equal short and long positions. In this situation no matter which way the asset price goes, the portfolio gains and loses nothing. Therefore, if a firm holds a long position, the natural hedge is an equal and opposite short position. The reverse applies for holding a short position. Therefore, by hedging a firm effectively holds assets that have payouts that "match" those promised on its contractual liabilities. Thus, hedging reduces risk by offsetting changes in the value of an asset with (approximately) equal

[2] The insurance literature refers to this type of risk as a "pure" risk.
[3] The insurance literature refers to this type of risk as a "speculative" risk.

but opposite changes in the value of another position. More generally, any activity with the effect of reducing a firm's financial risks can be defined as hedging. In this thesis a firm's hedging policy is defined as the set of management activities designed to reduce financial price risk.

Hedging leads to a reduction in some aspect of a firm's volatility, be it a reduction in the volatility of its cash flows, the volatility of its earnings, or the volatility in its market value. Which aspect of the firm's volatility is reduced depends on what the firm intends to accomplish from its risk management program. This thesis does not attempt to identify which categories of a firm's volatility are reduced by hedging.[4]

1.5 Conclusion

Firms have exposure to two types of risk that can produce either gains or losses, these are business risks and financial price risks. Business risks are those category of risks that must be accepted as part of the decision to enter a particular line of business. They are the key to being in that business. To hedge or eliminate these risks would be the same as deciding to leave the business. Financial price risks are the risks that come with a business along with a package of business risks. These are risks that the business might not want to take and therefore might be hedged to the extent this is practical. Hedging is defined as the set of management activities whose purpose is to lower or eliminate financial price risk.

[4] Bodnar, Hayt, and Marston (1996) survey nonfinancial firms in the United States and find that 49 percent of respondents indicate that reducing volatility in cash flow is their most important objective in using derivatives to hedge and a further 42 percent indicate that reducing volatility in earnings is their most important objective in using derivatives to hedge.

Chapter 2. Theories of Corporate Hedging: A Review of the Theoretical Literature

2.1 Introduction

The growing importance of hedging and in particular the use of derivatives for hedging was identified in the introduction to the thesis. Recent survey evidence shows that hedging takes place and for many firms forms a significant aspect of their financing policy.[1] An important question for finance theorists is whether this activity benefits a firm's shareholders, its debtholders or its managers. This chapter examines whether finance theory can explain corporate hedging activity. The objective of the chapter is to identify the firm-level attributes that theories of hedging suggest may affect the firm's hedging decision. This analysis will ultimately determine the focus of the research in this thesis. In particular, the findings of this chapter will be employed in the later empirical chapters to identify testable hypotheses explaining UK corporate hedging policy.

This chapter first argues that in a perfect market setting hedging at the corporate level does not add to firm value and because of hedging transaction costs may in fact reduce firm value. This argument hinges critically on the validity of the perfect markets assumption. The chapter then shows how relaxing the perfect markets assumption can lead to circumstances where hedging adds value. Here the chapter identifies the situations in which hedging might provide economic gains to either shareholders or managers. This is followed by an examination of whether the economic benefits of hedging can be obtained through alternative means and a discussion of the various methods a firm can employ to hedge its risks. The chapter concludes by assessing the impact a review of the theoretical literature has for the focus of the thesis.

2.2. Modern Finance Theory

Modern finance theory has its roots in the late 1950s and the early 1960s. Many developments in finance have been inspired by Modigliani and Miller's (1958) ideas on the theory of capital structure and work on the Capital Asset Pricing Model (CAPM) by Sharpe (1964) and Lintner (1965). These models make predictions about firm corporate financing policy in a world where markets are perfect. The major perfect market assumptions are as follows:

- There are no taxes.
- There are no transaction costs.
- There are no bankruptcy or financial distress costs.
- There are no informational differences among market participants.
- Individual market participants have no impact on markets.
- Markets have an unlimited capacity to supply fairly priced debt and equity to the capital markets.

2.2.1 Corporate Finance Policy

Modigliani and Miller (1958) (M&M) argued that in a perfect capital market corporate financing policy has no impact on the market value of the firm. More specifically, the value of any individual firm or the welfare of its security holders will be independent of the degree of financial gearing it employs. As long as investors can

[1] See, for example, Bodnar, Hayt, Marston and Smithson (1995) and Bodnar, Hayt and Marston (1996).

borrow or lend on their own account on the same terms as firms ("home-made gearing"), corporate borrowing will not allow investors to do anything that they could not do already, and so it will not increase value. Furthermore, in the M&M model a firm's financial policy merely determines how its income stream is distributed amongst its investor stakeholders (i.e., debt holders and shareholders)[2], whereas, the size of its income stream and hence its value is determined by its investment policy (i.e., a firm's investment and financing decisions are independent of each other).

A firm's hedging policy is a component of its financing policy. This is because it involves the issue of financial claim against a firm. Therefore, the M&M argument can be extended to the treatment of hedging. In the context of the hedging decision it is argued that if a shareholder can buy and sell risk on the same terms as firms, no service is provided to shareholders by corporate hedging. That is, a shareholder can obtain "home-made hedging" by hedging for his or her own account implying that the corporate hedging decision is irrelevant. Alternatively, since value creation takes place on the asset side of the balance sheet (namely through the realisation of positive NVP projects), hedging as part of the firm's financing policies cannot create value per se.[3]

2.2.2 Capital Market Theory

The CAPM divides the total risk of a security (where total risk is taken as the variation of returns) into two parts: the unsystematic risk and the systematic risk (also called market risk). Unsystematic risk is the proportion of total risk that can be eliminated ("washed away") simply by holding a security in conjunction with an

[2] Other stakeholders include employees, creditors and the government. These entities hold financial claims but they are not investors.

appropriate portfolio of other securities. Unsystematic risks are essentially random events and idiosyncratic, which at the time of occurrence are unique to a particular firm and perhaps its immediate competitors. Examples of firm-unique risk include exchange rate risk, commodity price risk and situations such as a trade union dispute leading to strike action, a company being sued for breach of contract or the cessation of patent protection. The systematic risk of a security is the proportion of total risk that cannot be avoided regardless of the level of diversification. Systematic risk is faced by all firms. All firms are affected to some degree by macroeconomic factors such as inflation, interest rates, taxation, economic growth, the market's willingness to accept risk and the general welfare of the economy. These factors tend to affect all firms simultaneously.

For CAPM the essential factor that matters is the level of systematic risk inherent in the security. If a firm hedges systematic risk and if hedging instruments are priced according to CAPM all that a firm does by purchasing these instruments is move along the security market line (i.e. a zero NPV transaction) and there is no addition to the value of the firm. While the cost of capital is reduced, the expected value of the flows generated are reduced by exactly the amount that leaves the expected market value of equity unchanged. In these circumstances, management decisions to hedge assets appear to have no effect on the value of the firm. At worst, such actions, to the extent they are costly, can be viewed as "irrational behaviour" leading to a diminution of firm value.

Capital market theory also demonstrates that a rational investor who holds shares in a diversified portfolio can effectively eliminate unsystematic or random portfolio shocks, and in so doing he or she eliminates precisely the kinds of risks that

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[3] The M&M argument implies that if a firm chooses to change its hedging policy, investors who hold claims issued by the firm can change their holdings of risky assets to offset any change in the firm's

are usually hedged by the firm. If these random events can be eliminated without the purchase of hedging instruments the value of such hedging to shareholders must be seriously questioned. By reducing or eliminating diversifiable risk, a firm does not reduce the markets perception of its required rate of return and therefore the capital markets do not reward companies for eliminating diversifiable risks.

It follows that the theory of risk, as embodied by the CAPM, seems to regard as irrelevant and possibly wasteful, a range of corporate hedging activities designed to reduce the total risk, or variability, of the firm's cash flows. However, while a firm's owners have the incentive and often the means to provide their own kind of hedging through portfolio diversification, this may not be always true. Privately and closely held firms (i.e. firms with concentrated ownership structures) will often have owners whose portfolios are relatively undiversified. This make the owners, and thus the firm, risk averse. These investors will not have removed the unsystematic risk from their portfolios and a hedging policy which accomplishes this would be worthwhile. In this setting shareholder risk aversion makes corporate hedging desirable because it increases the expected utility of the undiversified shareholder. However, hedgers and in particular those that hedge with derivatives are dominated by large corporations, not by individuals trading for their personal accounts or for that matter small businesses. Thus, risk aversion per se provides an inadequate explanation for the wide spread use of hedging instruments.

2.3 The Corporate Demand for Hedging

The survey findings cited in the thesis introduction indicate that many firms are in fact hedging and using financial derivative instruments for this purpose.

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hedging policy, leaving the distribution of their future wealth unchanged.

Therefore, the above view of hedging would seem to be at odds with reality. This observed relevance and importance of risk management to firms has led to the development of positive theories that try to explain this activity.

It was alluded to above that the foundation of our understanding of corporate financial policy is the Modigliani and Miller (1958) proposition. They demonstrated that given the firm's investment policy, with no taxes and no contracting costs, the firm's choice of financial policy does not affect the current market value of the firm. An equivalent statement of this proposition is that if financial policy in general - or hedging specifically[4] - is to affect firm value, then it must do so through changes in tax liabilities, through changes in stakeholder contracting costs, or through important interdependencies between the choice of financial policy and future real investment decisions. This implies that hedging can increase firm value by simultaneously reducing external claims to the cash flow stream flowing from the firm's assets. Such claims include taxes paid to government by the firm; bankruptcy costs (both direct and indirect) paid to accountants, lawyers and the firm's non-investor stakeholders; and/or agency costs to align managerial interests with the interests of capital suppliers. Each has the potential to provide a partial explanation for the corporate demand for hedging.

This section identifies five main categories of determinants of corporate hedging. These are the desire to

- minimise corporate tax liability,
- reduce the expected costs of financial distress,
- ameliorate conflicts of interest between shareholders and bondholders,

- co-ordinate financing and investment policy,
- maximise the value of the manager's wealth portfolio and protect his or her reputation.

These theories suggest that the decision to hedge depends on attributes that determine the benefits associated with hedging. These benefits of hedging are likely to differ across firms in ways that depend on their characteristics. These characteristics and their relation to the hedging decision are discussed in this section.

This section shows that although the above factors create incentives for firms to hedge and therefore are necessary, they are not sufficient motives in themselves. It is argued that given these incentives, the overriding factor determining the decision to hedge is the level cash flow volatility faced by the firm. Therefore, this section identifies two factors affecting a firm's hedging decision: the incentives to hedge due to capital market imperfections and the level of cash flow volatility.

2.3.1 Tax Liability

As the variability of operating profits increases, so does the probability that the firm will be unable to make full use of its tax credits and depreciation and interest expense tax deductions. Since tax credits are non-marketable an increase in total risk will lead to a reduction in expected corporate cash flows. If the tax credit or tax loss is carried forward, the relevant cost is the reduction in the present value of the tax benefit. By reducing its total risk, a firm can increase the expected value of its tax credits and tax write-offs and thereby increase its expected future cash flows. Firms

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[4]Smith and Stulz (1985) develop a positive theory of hedging by value-maximising firms in which hedging is part of overall corporate financing policy.

that generate substantial non-interest tax shields, such as investment tax credits, have a greater incentive to hedge, ceteris paribus.

Smith and Stulz (1985) point out that if a firm faces a convex corporate tax function (i.e., if the firm's effective tax function is convex) then the firm's expected tax liability can be reduced by hedging.[5] The more convex the effective tax function the greater is the reduction in the firm's expected tax liability from hedging.[6] This implies the greater the convexity the greater the incentive to hedge. The factors that cause convexity in the effective tax function are:

(1) Progressivity in the statutory tax code. Firms with more of the range of their income in the progressive region of the tax schedule have greater tax based incentives to hedge.

(2) Tax preference items such as tax loss carry-forwards, investment tax credits and foreign tax credits. To minimise its taxes, a firm needs to take full advantage of its tax preferences, and it maximises the likelihood of doing so by reducing the variability in its pre-tax income. For example, a firm has a £30 million tax preference due to expire in the current period and it knows that its pre-tax income will be either £20 million or £40 million, with a 50% probability of each. The firm's expected tax liability is £10 million × 0.33 × 0.5 = £1.65 million. If through hedging, the firm could earn £30 million with certainty, its expected tax liability would be £0.

The tax hypothesis suggests that the benefits of hedging should be greater

[5] If the corporate tax rate increases as income increases then the corporate tax function is convex. Alternatively, the tax function is convex if the marginal tax rate is increasing. Graham and Lemmon (1998) define the marginal tax rate as the present value of current plus future taxes to be paid on an additional dollar of current period income. (pg. 56) The average tax rate is current tax expense divided by current income.

[6] Hedging reduces the volatility of pre-tax income.

i) the higher the probability the firm's pre-tax income is in the progressive region of the tax schedule, and

ii) the greater the firm's tax preference items.

2.3.2 Costs Of Financial Distress

Financial distress costs can be categorised into direct and indirect costs. Direct costs consist of all the costs pertaining to the administration of bankruptcy, for example, legal fees, management's labour spent on the bankruptcy procedure and so on. Indirect costs include any kind of implicit loss due to the possibility of financial distress, such as lost market share. For indirect costs there is a continuum of costs that increases at an accelerating rate as the likelihood of financial distress increases.

Firms with greater variability of cash flows are more likely to find themselves in financial distress.[7] By reducing cash flow variability hedging lowers the probability of the firm encountering financial distress and in turn lowers the expected costs of financial distress. This decrease in expected costs increases the firm's expected cash flows and so benefits shareholders.[8] Nance et al. (1993) note that the extent to which hedging can reduce these transaction costs depends upon two factors:1) the probability of encountering financial distress if the firm does not hedge, and 2) the costs it will face if it does encounter financial distress. However, even if the firm does not actually experience bankruptcy, the possibility of financial distress can impose substantial indirect costs on the firm. These costs arrive in the form of higher contracting costs with managers, employees, suppliers and customers.[9] Indirect costs will be incurred as the probability of financial distress exceeds some threshold

[7]Financial distress occurs when a firm's income cannot cover the firm's fixed claims, i.e. interest payments on debt capital and other fixed contractual payments.
[8] This increase in value derives from the reduction in deadweight costs, and an increase in debt capacity, which benefits the firm through debt tax shields or reductions in agency costs of free cash flow.

value. Above this threshold value the level of indirect costs are an increasing function of the probability of financial distress. Firms with a higher probability of financial distress and higher financial distress costs, both direct and indirect, will generate larger benefits from hedging and so have greater incentives to hedge their risks.

Warner (1977) suggests that direct costs of bankruptcy are less than proportional to firm size.[10] Smith and Stulz (1985) argue that if hedging costs are proportional to firm size, the reduction in expected direct bankruptcy costs is greater for the small firm implying that small firms are more likely to hedge. However, Smith and Stulz ignore the effect of indirect bankruptcy costs, which could be much larger than the direct costs of bankruptcy and not scale related.[11]

The probability of financial distress is determined by two factors. Firstly, the larger the ratio of the firm's fixed claims relative to its cash inflows, the higher the probability of financial distress. Secondly, the more volatile the firm's cash flow, the more likely the firm is to experience financial distress.

2.3.3 Agency Costs And Inefficient Investment

Myers (1977) observes that when firms are likely to go bankrupt in the near future, shareholders may have no incentive to contribute new capital even to invest in positive NPV projects.[12] The reason is that shareholders bear the entire cost of the investment, but the returns from the investment accrue to the debtholders such that the

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[9]See Shapiro and Titman (1985) for a non-technical discussion on the costs of financial distress.
[10] Ang, Chua and McConnell (1982), Altman (1984), Guffey and Moore (1991) also observe this scale effect. However, Weiss (1990) does not find a similar effect.
[11] "Perhaps the most important cost of bankruptcy proceedings is the negative effect that financial embarrassment may have on the stream of net operating earnings of the business firm." (Baxter (1967), Pg. 399) See Altman (1984) and Cutler and Summers (1988).
[12]Myers (1977) argues that managers acting in the interests of shareholders have an incentive to forego positive NPV investments if (most of) the benefits accrue to debtholders (see also Bessembinder (1991)).

shareholders will be worse off than if the investment had not been made. A high probability of financial distress can induce shareholders to forgo investments that would be undertaken in a low probability environment.[13] Thus, a greater probability of financial distress results in the rejection of more value-increasing projects. With rational bondholders these incentive costs are borne by shareholders themselves, inasmuch the bonds are priced to reflect the costs of this 'underinvestment' at the time the bonds are issued. This bondholder-shareholder conflict can be mitigated by reducing the probability of financial distress (default on debt claims).

We know that the larger the ratio of the firm's fixed claims relative to its cash inflows and the more volatile the firm's cash flow, the more likely the firm is to experience financial distress. It follows that this problem can be ameliorated by either lowering the firm's fixed claim burden or by reducing the variability in the firm's cash flows. The former is achieved by reducing the level of debt in the capital structure, however, this can be unattractive because it reduces debt-related tax shields and increases the firms tax liability. The latter can be achieved by hedging. Hedging shifts individual future states from default to non-default outcomes. The number of future states in which shareholders are the residual claimants increases and consequently they are more willing to provide funds for investment. The hedging firm can effectively commit to meet obligations in states where it otherwise could not and so negotiate better contract terms in the form of lower borrowing costs. Therefore risk management effectively expands the firm's "debt capacity".[14]

The costs of underinvestment will be greater for those firms with more growth options in their investment opportunity set. Firms with more positive net present value

[13]Myers (1977) refers to the existence of risky debt giving rise to these adverse incentives. The debt is risky because the firm faces a high probability of financial distress.

[14]For a more detailed discussion of these issues, see Mayers and Smith (1987), Schnabel and Roumi (1989) and Bessembinder (1991).

investments will lose more value if these projects are forgone. The incentive to forego value enhancing projects increases as the probability of financial distress increases, which is determined by the level of debt and the variability of cash flows. Therefore, firms with high levels of debt and where growth opportunities constitute a larger proportion of firm value are more likely to undertake a hedging programme, because the reduction in agency costs will be larger for these firms.[15]

2.3.4 Co-ordinating Investment and Financing Policies

The relationship between investment policy and firm cash flows has been examined in the literature, for example, Fazzari, Hubbard, and Petersen (1988) and Hoshi, Kashyap, and Scharfstein (1991) find that corporate investment is influenced by the size of internal cash flows. Lessard (1990) suggests that the management of foreign exchange risk is a rational exercise if the firm is trying to stabilise cash flows in order to reduce the probability that they fall below a critical level. Lessard points out that hedging enables the firm to meet two vital categories of cash flow commitments. Firstly, ensuring the firm's ability to meet the exercise prices of their operating options reflected in their growth opportunities and secondly, their dividends. The importance of both of these commitments derives from specific information imperfections in capital markets. Facing a funding shortfall relative to the firm's investment opportunity set the firm will be forced to raise costly external finance. Lessard argues, because of asymmetric information capital providers are unable to establish whether the firm really faces profitable investment opportunities or is confronted with severe operational deficits and so the firm's market value falls.

[15] These agency costs are in effect financial distress costs because their severity is positively correlated with the likelihood of financial distress.

Froot, Scharfstein, and Stein (1993) present a similar analysis by suggesting that variability in internal cash flow will result in either: a) variability in the amount raised externally, or b) variability in the amount of investment. Variability in investment will be undesirable, to the extent that there are diminishing marginal returns to investment (i.e., the extent that output is a concave function of investment). In the presence of capital market imperfections, such as informational asymmetries, the marginal cost of funds increases with the amount raised externally. A shortfall in cash may be met with some increase in costly outside financing, but also some decrease in investment. Therefore cash flow variability now disturbs both investment and financing plans in a way that decreases firm value. This is because by decreasing planned investment the firm is foregoing positive net present value projects and also since it has insufficient internal funds the firm is forced to raise costly external finance. Since hedging can reduce cash flow variability, it enables the firm to avoid unnecessary fluctuations in either investment spending or external financing and so increases firm value. This explanation for hedging relies on the basic premise that, without hedging, firms may be forced to underinvest in some states of the world because it is costly or impossible to raise external finance. As noted above firms with more asymmetric information about the quality of new investment projects will incur higher costs of external finance. There is likely to be more asymmetric information about the quality of new projects for firms with high growth opportunities,[16] for firms

[16]There are at least two reasons why firms with growth opportunities are more likely to be associated with persistent informational asymmetries than firms consisting primarily of 'assets in place'. First, growth efforts are often targeted toward new products, while assets in place are used to produce/market existing products. It seems probable that managers are more likely to have superior information about new products than about products that are already in the market place. Second, growth opportunities often take years to develop. Hence it potentially takes a significant time period for informational asymmetries in growth firms to be resolved. Therefore firms that specialise in new products with long development cycles are most likely to have significant and persistent informational asymmetries. John (1993) suggests that R&D and advertising expenditure may contribute to building up of assets and resources characterised by asymmetric information between corporate insiders and outside investors in the market. In a similar setting, Myers and Majluf (1984) have argued that firms can optimally maintain

that are not in regulated industries and small firms.[17] Therefore, the Froot et al. model predicts that hedging is more likely for firms with higher expected growth, for firms that are not in a regulated utilities industry and for small firms. Taking this one step further, the model predicts that firms with high growth opportunities and low levels of internal finance have a greater incentive to hedge.[18] These types of firms are more likely to require costly external finance than those with high growth opportunities and high levels of internal funding.[19]

The preceding analysis assumes that the value of a firm's investment opportunities is independent of current cash flows.[20] However, this is not always the case. For example, a company engaged in oil exploration and refining will find that both its current cash flows and the marginal product of additional investments decline when the price of oil falls. In this environment the firm has less to gain from a hedge which transfers cash flow from high price states to low price states. Thus, the more sensitive are investment opportunities to the price of oil, the smaller is the optimal hedge ratio.[21] In other words, low cash flows might coincide with a reduction in

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financial slack which can be used to finance projects, avoiding the adverse selection costs of interacting with a less informed market. This would give rise to an increasing relationship between hedging and R&D. It is argued that managers of firms in regulated industries are likely to have less discretion in their choice of investment policies. Regulation also makes it easier for fixed claim holders to observe managerial action. Therefore firms in regulated industries face lower contracting costs and hence have less of an incentive to hedge.

[17] Atiase (1985), Collins, Kothari and Rayburn (1987), and Brennan and Hughes (1991) argue that large firms have less information asymmetry than small firms. Ritter (1987) finds evidence consistent with this lower information asymmetry, by finding that larger firms have lower costs of issuing securities. If smaller firms have greater information asymmetries implying costly external financing then we would expect an inverse relationship between firm size and hedging. Also the fixed transaction costs associated with external financing activities are likely to make financing more expensive for smaller firms, therefore, again leading to the prediction that smaller firms are more likely to hedge.

[18] In other words, firms with many positive NPV investments together with a strong possibility of not having sufficient internal resources to finance these projects have a strong incentive to hedge.

[19] Firms with high growth opportunities face costly external finance because of asymmetric information. However, if they have access to a high level of internal funds this lowers the likelihood of using external finance.

[20] In other words, a firm's investment opportunities are nonstochastic, and thus independent of the cash flows generated from its assets in place.

[21] If the generation of lower cash flows coincides with fewer growth options available to the firm, then the firm has less incentive to hedge, since in period with low cash flow, the firm will have access to fewer investment opportunities that require financing.

investment opportunities and more favourable investment opportunities will occur during high cash flow periods. If this happens, the firm has less incentive to hedge, since the demand for investment funds (positive NPV investment opportunities) is matched by the supply of funds (firms' cash flow).

2.3.5 Managerial Risk Aversion

Stulz (1984) argues that corporate hedging is an outgrowth of the risk aversion of managers. Managers can be made strictly better off by reducing the variance of total firm value. Stulz's model implicitly relies on the assumption that managers face significant costs when trading in hedging contracts for their own account, otherwise, they would be able to adjust the risks they face without having to involve the firm directly in any hedging activities. Moreover, under the assumption there are zero transaction costs to hedging, the Stulz model predicts that firms will hedge until the variance of share prices is minimised.

Smith and Stulz (1985) show that if a manager can alter the riskiness of his or her wealth only by changing the riskiness of firm value, then the incentive to do so depends on the shape of his or her utility as a direct function of firm value. For example, if the manager's wealth is a concave function of firm value (i.e., a concave pay function), the optimal strategy is to hedge the firm completely. This is because the expected value of a concave function of a random variable is less than the value of the function evaluated at the expected value of the random variable. When the manager's wealth is a convex function of firm value, but his or her expected utility is still a concave function of firm value, the optimal strategy will be to hedge some portion of the firm's risk. Under this compensation structure the manager's firm related income is a convex function of firm value and so his or her expected income is higher if the firm does not hedge. Despite this, because the manager is risk averse, he or she will want to give up some expected income to reduce risk. A sufficiently convex wealth function will cause the manager's utility to be convex in firm value, this implies that the manager's utility has a higher expected value if the firm is not hedged at all (i.e., motivates risk-seeking). If the manager's expected utility is a convex function of firm value, the manager will behave like a risk-seeker despite the fact that his or her expected utility function is a concave function of wealth (i.e., risk averse over wealth).[22] Bonus or share option provisions of compensation plans can make the manager's expected utility a convex function of firm value. Faced with this payment structure the manager may choose to reverse hedge, that is, make the value of the firm even more dependent on the realisation of some state variable.[23] However, if the manager owns a significant fraction of the firm (in the form of equity), then Smith and Stulz (1985) predict that the firm will hedge more, as the manager's end-of-period wealth is more a linear function of the value of the firm.

The preceding discussion argues that a manager's incentive to reduce a firm's cash flow variability may vary according to his or her wealth structure. Agrawal and Mandelker (1987) suggest a manager's wealth consists of his or her holdings of shares and share options, if any, of the firm for which he or she works, his or her human capital (which equals the present value of the stream of future of earnings from employment), and holdings of other income generating assets unrelated to the firm. If the firm hedges, the variance of the return on the firm's assets would be reduced. The value of shares and share options decrease with decreases in the variance because the Black and Scholes (1973) option pricing model says that the value of options would decrease if the variance of the return on the underlying assets decreases, which

[22] See Smith and Stulz (1985) for an example.

implies that, if the firm has risky debt, the value of equity decreases when asset variance decreases. Thus, hedging can have three effects on the manager's personal welfare: the value of his or her share and option holdings in the firm will decrease; the value of his or her human capital increases; and the variability of his or her wealth changes. When a manager has large share and option holdings in the firm, the first effect is likely to dominate.[24] Thus, large share and option holdings by a manager may induce him or her not to hedge.[25] This incentive may prevail when the probability of bankruptcy is virtually non-existent. However, if bankruptcy risk is high, the manager may have a strong incentive to hedge despite his or her holdings of shares and share options. The manager's incentive with respect to changes in the firm's variance is then an empirical issue.

2.4 Cash Flow Volatility

The theories of optimal hedging discussed above demonstrate that capital market imperfections create incentives for firms to hedge. While these imperfections might be necessary for optimal hedging, they are not sufficient conditions. Given these incentives, a firms' ultimate decision to hedge also depends on the level of its exposure to financial price risk. Smith and Stulz (1985) show that firms with greater variation in cash flows or accounting earnings resulting from exposure to financial price risks have greater potential benefits of hedging. For example, the probability of encountering financial distress is directly related to the firm's cash flow volatility.

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[23]Share options may cause managers to take on more risk (see Haugen and Senbet, 1981). The asymmetric payoffs of call options make it more attractive for managers to undertake risky projects.
[24] Although, Smith and Stulz's (1985) arguments imply that, all else equal, managers with more wealth invested in a firm's equity will have greater incentives to manage the firm's risks.
[25]Lambert and Larcker (1985) and DeFusco, Johnson, and Zorn (1990) find an increase in the variance of equity returns after the adoption of executive share option plans. Agrawal and Mandelker (1987) find that the managers of firms with riskier investment decisions have relatively larger holdings of shares and share options in the firm that employs them. This is consistent with the argument that these type of security holdings give managers an incentive to increase the firm's risk.

Furthermore, the costs of hedging are likely to be lower for firms with greater cash flow volatility. Therefore, firms with higher levels of cash flow volatility, ceteris paribus, are more likely to hedge and/or hedge a greater proportion of their exposure. Firms with greater cash flow variability are generally those with more exposure to financial price movements such as exchange rates, interest rates and commodity prices. This implies that firms with more exposure to financial price movements are more likely to hedge.

However, this analysis ignores the possibility that the firm might be naturally hedged. A firm is naturally hedged when cash inflow from its operations is positively correlated with its cash outflows. More specifically, a firm is naturally hedged when its ability to generate operating cash flow is positively correlated with its investment opportunities. The firm may have highly variable operating cash flows, but since its supply of cash flow is matched to its demand for cash flow, it is naturally hedged and therefore has no incentive to hedge via other methods, such as derivatives. Similarly, a firm with the majority of its debt service payments tied to a floating rate index is not necessarily significantly exposed to interest rate risk. To determine if it is or not requires consideration of the correlation between operating cash flows and interest rates. Thus, if operating income is positively correlated with short-term rates, the firm will have the incentive to use more short-term debt as a hedge against situations where operating income is low. Additionally, foreign denominated debt can also act as a natural hedge of foreign revenues, thereby decreasing a firm's foreign currency exposure. Foreign debt service payments represent a cash outflow in a foreign currency and therefore can be used as a hedge when a firm has foreign currency revenues either from foreign operations or from exports. Where a company has extensive overseas investments, borrowings will probably arise in the foreign subsidiaries, this is desirable; but borrowings in currencies other than those in which the assets are held and revenue is earned pose additional risk through mismatch of currencies. This implies that foreign debt can increase a firm's exposure to foreign exchange rate risk if debt related cash outflows and net foreign denominated cash inflows are negatively correlated.[26]

2.5 The Costs of Hedging and Economies of Scale Arguments

Notwithstanding the incentives to hedge identified above, firms may refrain from hedging due to the costs associated with implementing a risk management program. Start-up costs include employing qualified personnel and development of the internal control and IT systems necessary for participation in hedging. Carter and Sinkey (1998) point out that transaction costs can be explicit in the form of fees or margin requirements or implicit in the form of higher liquidity or capital standards. Geczy et al. (1997) suggest that the costs of implementing a risk management program exhibit economies of scale related to the amount of risk managed (the effective hedging costs per unit of exposure fall as the size of exposure being hedged increases). Given that larger firms have higher levels of absolute exposure they are more likely to reach the threshold where the benefits of hedging outweigh the costs. It follows then that if larger firms have the control (IT) systems, qualified personnel, scope of activities necessary for involvement in hedging activities, a positive relationship should exist between firm size and the likelihood of participation in hedging.

However, arguments presented in earlier sections identified competing arguments which suggested a negative relation between firm size and hedging. For

[26] The correlation between these opposing cash flows cannot be calculated from publicly available data and therefore the relationship between foreign currency debt and hedging cannot be predicted and

example, it was argued that small firms were more likely to hedge or would hedge more, ceteris paribus, because of the inverse relation between firm size and direct bankruptcy costs (Warner 1977). The Froot et al. (1993) model predicted firms for which external financing is more costly would be more likely to hedge. If smaller firms have greater information asymmetries implying costly external financing then we would expect an inverse relationship between firm size and hedging. Also the fixed transaction costs associated with external financing activities are likely to make financing more expensive for smaller firms, therefore, again leading to the prediction that smaller firms are more likely to hedge. Finally, it was argued that the owners of closely held firms tend to hold non-diversified portfolios with most of their wealth tied up in the fortunes of the one firm. The owners of this type of firm therefore have an incentive to hedge to protect their non-diversified personal wealth. Given that concentrated ownership is more likely to occur in smaller firms this suggests a negative relationship between firm size and hedging.

Given that there are competing arguments for either a positive or negative relation between firm size and hedging activity the predicted impact of firm size on hedging activity is indeterminant. Dolde (1993) finds that treasury staff's lack of familiarity with sophisticated hedging techniques is a significant barrier towards the hedging decision. Therefore, given that firms employing personnel with treasury experience and/or qualifications are more likely to have a better understanding of hedging techniques it is predicted these firms are more likely to undertake hedging activity.

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hence is an empirical question.

2.6 Who Should Hedge?

The previous section has reviewed the corporate finance literature and identified several motives for hedging financial price risks faced by firms. If we accept that hedging can benefit a firm the next question is "Who should hedge?" In section 2.2.1 it was argued that shareholders might be able to hedge on their own accounts making it unnecessary for firms to hedge. However, if hedging by shareholders is not as efficient as corporate hedging, then it will be in the interest of the shareholders to let the firm manage the financial price risk. Several obstacles to shareholder hedging can be identified. Firstly, to calculate the firm's exposure shareholders need detailed operational and financial information without which the optimal hedging decision cannot be attained. Secondly, even if this information is available some hedging techniques are available only to firms, not to individuals. For example, the choice of currency for invoicing and leading and lagging payments. Furthermore, the derivative markets are wholesale in nature and deal in minimum amounts that tend to be too large for individual investors and hence access to the derivative markets is limited. Thirdly, in order to plan and achieve efficient diversification the individual investor needs to know the level and timing of all financial price exposures for all the companies in the portfolio. As a result of these barriers and information gaps, the firm faces lower additional transaction costs for its hedging decisions and the individual shareholder has inadequate information to form an effective hedge. Given these advantages corporate hedging is preferable to investor hedging.

2.7 How Can Risks be Managed?

The previous sections contained a discussion of the benefits of hedging. The analysis identified the circumstances where hedging would provide economic gains to either shareholders or managers. The discussion also described the empirical relations between corporate hedging policy and firm level characteristics. However, this empirical framework is incomplete. This is because a firm's decision to hedge is also influenced by its decisions with respect to other financial policies that may achieve the objectives of hedging. Consequently, any empirical investigation into the determinants of corporate hedging must control for these other financial policies or "substitute forms of risk management". Therefore, in order to complete the empirical framework, this section examines whether the economic benefits of hedging can be obtained through alternative means. The discussion identifies the methods a firm can employ to reduce or hedge its risks.

2.7.1 Types of Risk Management Strategy

There are two generic types of risk management strategy. The firm can either reduce the risk or reduce the cost of given risk to the firm. Risk reduction strategies come in several guises. The firm can enter into insurance for hedging insurable risk. Financial risks can be hedged on the balance sheet via changes in the fixed-floating debt mix or the currency debt mix, geographical and product diversification[27], lowering operating gearing, and hybrid debt securities. Finally, financial derivatives

[27] To the extent that risks from various sources are less than perfectly correlated, they are sub additive. Thus, a totally passive strategy, in which no corporate risks are hedged, will achieve some degree of natural diversification.

can be used to hedge financial price risk such as foreign currency and interest rate risk.[28] These various hedges are generally specific to the risk exposures.

Reducing the cost of risk can be achieved in several ways. For example, a firm can lower gearing. In contrast to risk reducing strategies, these cost reducing strategies are not risk source specific. Both cost reducing and risk reducing strategies provide either actual or contingent capital. By issuing equity, a company transfers its business and financial risks to shareholders in exchange for some of the upside potential of the firm. The process of issuing debt transfers risk to the firm's bondholders in exchange for an agreement to pay a periodic coupon payment and repurchase the risk at a later date if it is financially able. Buying insurance, the company pays only the premium against a specific risk in exchange for the contingent capital supplied in the event of a specific loss. Buying foreign exchange options, the firm also exchanges premium for contingent capital, which becomes capital when the options expire in-the-money. In this framework risk-reducing strategies such as insurance and hedging create contingent capital when it is needed most. The debt and equity holders provide actual capital with an understanding of the contingent loss.[29]

This section has argued that cost reducing strategies provide a substitute for the comprehensive hedging strategy in which all sources of risk are hedged. If financial price risk is not hedged, then its costs can be reduced. The following

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[28] Merton (1993) makes a similar point by suggesting there are three ways to moderate risk: by diversifying it, selling (or hedging) it' or insuring against it. To define these three terms Merton gives the example of the owner of a ship. To manage the risk of loss, a ship owner can (1) diversify by buying a portfolio of ships to avoid a complete loss if one ship sinks; (2) sell (or hedge) the ship and have no economic exposure to its subsequent outcome; or (3) buy an insurance policy that pays off if the ships sinks, but allows the ship owner to profit if it does not. Merton uses the term hedging to mean entering into a position such that the payoff is the same regardless of the outcome, which could be accomplished through selling the ship today or entering into a binding forward contract to sell it at some point in the future.

[29] This section draws on Shimko (1996), also see Doherty (1995). The principal difference to the company between contingent capital and actual capital is credit risk (i.e., the risk that insurers and counterparties will not be able to pay). Also actual funds can be used from the date of issue in the case of bonds and share issues.

section looks at the ways in which the costs of risk can be reduced, it begins by looking at capital structure (financing policy) strategies.

2.7.2 Capital Structure

The management of risk has traditionally focused on actual capital. In particular actual capital in the form of equity provides a 'cushion' for absorbing a firm's risks.[30] The more equity greater the protection. This is because the providers of equity capital are residual or variable claim-holders and have a claim to the proceeds of investment after the firms' prior claims have been met. The size of these prior claims will vary, that is, be higher or lower than expected, due to circumstances unforeseen at the time the investment is initiated. Prior claims higher than those expected generally imply adverse outcomes giving rise to losses. Knowledge of the source of these losses is not required, since equity protects the firm against all forms of risk. It is in this sense an all-purpose cushion and so very attractive for managing risk. More specifically, a higher level of equity (or lower gearing) can reduce the costs of risk in several ways.

Decreasing gearing reduces the probability of bankruptcy and thereby reduces expected costs of bankruptcy. Since bankruptcy costs are borne ex post by creditors (or bondholders), then ex ante, the anticipated expected value will be netted out of the issue price of bonds. It follows that reducing risk or reducing gearing, will reduce the expected value of these transactions. A firm could lower the likelihood of bankruptcy by possessing more liquid assets (for example, cash balances or short-

[30] This is achieved by raising additional capital beyond that required for the funding of the physical investment and working capital needed to run the firm. This assurance capital typically takes the form of equity although debt that is subordinated to customer contractual claims can sometimes be used. (See Merton, (1995)).

term investments) ensuring that funds will be available to pay debt claims.[31] Similarly, lower dividend payments help to avoid financial distress.

Firms can also lower the probability of financial distress by issuing preference capital instead of debt (Nance et al.,1993). A dividend payment due on preference capital can be postponed without any threat of insolvency, whereas non-payment of interest on debt can trigger insolvency. An opposing view formed by Geczy et al. is that preference capital more closely mimics the properties of debt rather than equity. Therefore its use increases the firm's effective debt and consequently lowers the firm's borrowing capacity. This limits the availability of less costly external funds (i.e., debt) and implies a greater reliance on costly new equity issues. Thus, they predict a positive relationship between hedging and the existence of preference capital.

Decreasing gearing also lowers the potential conflict of interest between shareholders and bondholders in selecting investment projects. Limited liability creates a put option for the firm's shareholders, that is, the option to put the firm to the bondholders in the case of bankruptcy. In selecting projects, shareholders will tend to underestimate the NPV by the value of this put.[32] Additionally, since the shareholders have effectively a call position on the value of the firm they will tend to select high risk projects (negative NPV as well as positive NPV) ignoring the downside risk since this is borne by the bondholders. These distortions in project selection will lead to lower firm value. The loss in value increases with the level of gearing and with the risk of the firm's cash flows. It follows that a reduction in risk or reduction in gearing will lead to improved project selection and higher firm value.

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[31] The existence of liquid assets can be interpreted as negative debt. Therefore, in order to paint a more realistic picture of a firm's debt position its cash position should be accounted for. This is sometimes referred to as net gearing.

[32] The put will have value if the firm is bankrupt or has a high probability of financial distress.

Funding unhedged financial price losses either means that other investment opportunities are foregone or that new capital must be raised with its attendant issue costs. The "pecking order hypothesis" (Myers and Majluff (1984)) asserts that internal funds are less costly than external funds, and that external debt is less costly than external equity. When a financial price loss occurs, the firm is faced with the choice of diverting internal funds away from a new investment project[33] or raising new capital so that both the loss and the investment project can be funded. A study by Fazzarri, Hubbard and Petersen (1988) has shown that, for every dollar loss of earnings, firms reduce capital expenditures by about 35 cents. In section 2.3.4 we showed that hedging adds to firm value by stabilising the availability of internal funds and thus enabling the firm to avoid unnecessary fluctuations in either investment spending or external financing. However, a firm can protect its ability to undertake value enhancing investments by having low levels of gearing (i.e., a large equity "cushion"). This protects the borrowing capacity of the firm so that it can fund new investment projects and unhedged losses without having to resort to costly new equity issues. The firm's borrowing capacity will be utilised after a fall in cash flow. The firm will revert back to its desired gearing level through debt repurchase, dividend policy or other methods which are less costly than new equity issues.

It has been demonstrated above that one way to reduce the expected costs of financial distress and the conflict between shareholders and bondholders is for the firm to reduce the level of debt in the capital structure. However, Ross (1997) and Leland (1998) identify the tax deductibility of interest as the primary benefit of debt and show that lowering the firm's debt capacity reduces firm value.[34] Firms can achieve some of the tax benefits of debt and control the aforementioned agency

[33] This assumes that the financial viability of the project is invariant to financial price changes.
[34] Conversely, these models show that hedging which increases debt capacity enhances firm value.

problems by issuing convertible debt as opposed to straight debt.[35] The conversion option allows the bondholder to convert debt into a given number of shares. This option will be "in the money" when the share price rises such that the shares obtained on conversion have higher value than the debt. Green (1984) has shown that this conversion feature can reduce the distortions in project selection by "straightening out" the payout function such that payouts to different stakeholders are more nearly aligned. Convertible debt mitigates the incentive conflict because this debt is more sensitive to firm value changes than straight debt and therefore reduces the sensitivity of equity value to firm value changes. Thus, convertible debt reduces the incentive to hedge. However, Geczy et al. predict a positive relation between hedging and convertible debt on the assumption that convertible debt reflects additional gearing, which constrains a firm's access to external financing.

Convertible debt is deemed to mitigate the incentive conflict by partly ungearing, i.e., ungearing in those states in which the firm performs well. However, it would appear that the best time to ungear is not when the firm is performing well, but when debt becomes a burden, i.e., when a firm approaches financial distress. With conventional convertible debt this will not happen. It would seem that agency costs could be dealt with more efficiently by issuing convertible debt in which the option is granted to the firm, rather than to the bondholders. Doherty (1995) calls this "reversible convertible dent" (RCD).

The agency cost literature (for example, Myers (1977)) recognises that, in addition to reducing the level of debt, the firm can mitigate the costs of asset substitution and underinvestment by shortening the maturity of debt. Since short-term debt facilitates the repricing of debt, bondholders can quite easily respond to changes

[35] Since interest payments are lower with convertibles then so are the tax shields.

in the risk of the firm by adjusting the debt's risk premium. Therefore, firms have an incentive to follow a low risk investment strategy with short-term debt to minimise the risk premium on their debt. Furthermore, since issuers of short-term debt face less risk than if they had issued long-term debt a greater proportion of the benefits from incremental investment accrue to shareholders rather than bondholders. Thus, the incentive to underinvest is reduced. Wall (1989) suggests that a combination of short-term debt and an interest rate swap allows high risk firms to reduce their agency costs without incurring interest rate risk. The swap protects the firm from changes in market interest rates while allowing the credit risk component to fluctuate. Therefore, the firm faces the prospect of a hike in its risk premium for any shift toward higher risk investments.[36]

2.7.3 Hedging Methods

If a firm decides to reduce its risk, it can choose between several different methods. Financial price exposures can be eliminated, often at source, by internal hedging techniques, which do not require transactions or services from financial institutions. Examples of internal hedging methods are matching, netting, leading and lagging, inter-company foreign exchange contracts, price considerations and improved cashflow forecasting techniques.[37] In other instances firms may have the ability to hedge their exposures with on-balance-sheet operating and financial strategies, such as location of production facilities, currency sourcing of raw materials and components, and maturity and currency structure of debt. Alternatively, firms may employ off-balance sheet financial instruments. For example, financial

[36]Long and Malitz (1983) present evidence which suggests that firms make short-term borrowing decisions independent of long-term investment requirements and do not attempt to resolve agency problems by the substitution of short-term debt for long long-term debt.

[37] See Ross (1996) for a clear exposition of these techniques.

derivatives can be used to protect or insure against possible losses from exposed positions that have not been eliminated internally. These instruments are examples of external hedging techniques which are usually used to hedge net financial price exposure.

2.7.4 Asset/Liability Management

Asset - liability management is an effort to reduce exposure to financial price risk by holding the appropriate combination of assets and liabilities. The key to this form of risk management is holding the right combination of on-balance sheet assets and on-balance sheet liabilities. Asset - liability management strives to match the timing, amount and currency of cash inflows from assets with the cash outflows on liabilities. One form of asset – liability management is the structuring of a firm's debt profile. A firm's debt profile has essentially two components, its currency mix and its fixed-floating interest rate mix.[38] Both aspects of a firm's debt profile can be managed to reduce exposure to financial price risk

1. Foreign Currency Debt Mix

Companies have sought to protect themselves against the effect of currency fluctuations, both on their earnings (or cash flows) and on their balance sheets. Foreign denominated debt can act as a natural hedge of foreign revenues, thereby decreasing a firm's foreign currency exposure. Foreign debt service payments represents a cash outflow in a foreign currency and can be used as a hedge when a firm has foreign currency revenues either from foreign operations or from exports. For example, in a money market hedge a firm borrows the foreign currency, converts the amount immediately to local currency, and uses the eventual cash flow to redeem the debt. However, imports, which represent a cash outflow in a foreign currency, cannot be hedged through foreign debt. Here the firm would have to make an investment in an interest bearing asset in the foreign currency as soon as the commitment is known. The eventual cash payment would be made by liquidating the investments without further exchange risk.

Where a company has extensive overseas investments, it may borrow in foreign currencies to protect the balance sheet.[39] If the foreign subsidiary does the borrowing, the net equity investment in the subsidiary will be reduced. If the parent company borrows in the foreign currency and switches into sterling, it will have a gain (or loss) to offset against any loss (or gain) on translating the net equity investment of the foreign subsidiary.[40] The foreign currency debt protects shareholders' funds from the effect of currency movements on the net assets of the group. For example, a proportion of a UK firm's assets and cash flow are in US dollars. It would, therefore, be appropriate to have a proportion of the firm's finance in dollars. The restatement of the assets on translation into sterling would be matched with the dollar liability. Similarly, the cash income stream in dollars would be matched with the interest expense outflow in dollars. Once the financing has been set up in this way, a natural hedge has been created which requires little further management.

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[38] A third component is the debt's maturity profile, that is, short-versus long-term debt.

[39] SSAP 20 allows hedging of the net equity investment in an overseas operation by means of currency borrowing. Currency borrowings is the most usual method of financing an investment which gives rise to a translation exposure. While any individual borrowing will be of finite duration, roll-over of the borrowing will normally provide continuity of the hedge. This is important for a long-term investment. A borrowing hedge may suffer from two disadvantages: (1) The borrowing may be unnecessary from a cash viewpoint for a cash rich company; and (2) The gearing consequences may be unacceptable.

[40] Grand Metropolitan, 1993 - As fas as is reasonably possible, the group matches overseas capital employed with actual overseas borrowings and currency swaps, with the result that the majority of the group's net debt is in US dollars. This policy aims to protect the sterling value of shareholders' funds. See Holmes and Sugden (1994) page 127.

However, borrowings in currencies other than those in which the assets are held and revenue is earned pose additional risk through mismatch of currencies. In this situation a firm's foreign debt related cash outflows (foreign currency debt service payments) and net foreign denominated cash inflows are effectively negatively correlated leading to an increase in exposure to foreign exchange rate risk.[41]

2. Fixed-Floating Interest Rate Mix

For financial institutions the matching of floating rate assets to floating rate liabilities is crucial and a relatively easy decision to make. This might also be the case for a non-financial firm with large levels of cash and short-term investments, wishing to set up a natural hedge by matching the floating rates of return earned on these investments with floating rate interest paid on its debt. However, for a non-financial firm with few financial assets, determining the appropriate mix is usually more difficult.

In order to reduce risk the fixed floating decision will need to reflect a company's sensitivity to the volatility of interest rates and the resulting impact on the income statement and cash flow. A treasurer would like to avoid situations where his interest costs and revenues are negatively correlated. To achieve this the firm will need to assess the correlation of the level of interest rates to a company's cash flow (or profit). If the correlation is negative the treasurer will issue less floating-rate debt. However, if operating income is positively correlated with short-term rates, the treasurer will have the incentive to use more floating-rate debt as a natural hedge against situations where operating income is low. Firms can alter the characteristics

[41] The correlation between these opposing cash flows cannot be calculated from publicly available data and therefore the relationship between foreign currency debt and hedging cannot be predicted and

of their debt portfolio by issuing floating rate notes or commercial paper to increase exposure to floating rates or fixed rate notes to increase fixed rate exposure.

This analysis implies that firms with more short-term debt (or floating rate debt) are not necessarily exposed to greater cash flow volatility. If firm revenues and interest rates are positively correlated, then when revenues are low, contemporaneous interest payments on the debt will be low and vice versa. Therefore, by utilising some short-term debt a positive correlation between revenues and costs can be achieved lowering cash flow volatility. The converse of this logic suggests that using more long-term fixed rate debt than implied by matching would reduce variance in the case where operating profits and short-term interest rates are negatively correlated.

2.7.5 Firm Level Diversification

At a very general level diversifying means holding similar amounts of many different risky assets whose returns are not perfectly correlated. Diversification thereby limits exposure to the risk of any single asset. Firms diversify by expanding into unrelated types of business activity. Three types of diversification can be distinguished. Product-extension diversification broadens the product lines of firms. Existing and new products are in related business activities. Geographic market-extension diversification is where a firm expands its operations into new geographic areas. Pure diversification is where a firm expands into unrelated business activities. This would not qualify as either product-extension or market-extension diversification. Diversification can be achieved through either internal or external means. External methods are generally diversification through mergers or takeovers.

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hence is an empirical question.

Firms can reduce both their business and financial risks through diversification. Diversification will reduce risk because combining cash flows that are not perfectly correlated will, in general, reduce the overall variance of the combined firm cash flows. Amit and Livnat (1988) and Bettis and Mahajan (1985) have shown that unrelated diversification is associated with lower risk than related diversification. A reduction in cash flow variability will lead to a fall in the probability of bankruptcy. This will decrease the "lenders risk" and the debt capacity will be increased (Lewellen, (1971)). A more rigorous treatment of this proposition has been provided by Stapleton (1982) in the option pricing model framework, in which debt capacity is defined as the maximum amount of debt that can be raised at a given rate of interest. If bankruptcy costs are significant, the debt-capacity argument is reinforced. The decrease in bankruptcy probabilities will decrease the expected value of bankruptcy costs and increase the expected value of tax savings from interest payments for pre-diversification debts, and thus increase the value of the diversified firm by increasing its debt-tax shield. However, if the value of the firm is assumed to be unchanged, the increase in debt values as a result of the co-insurance effect is at the expense of equity values, as pointed out by Higgins and Schall (1975). But this shift can be offset by increasing leverage (Galai and Masulis, (1976) and Kim and McConnel, (1977)). A post diversification increase in debt will allow the firm to realise an incremental stream of tax savings from interest payments on new debt.[42]

The above discussion argues that firms diversified across lines of business may already have a low volatility in operating income, with only a small benefit from hedging with derivatives. Thus, a firm's derivative hedging activity should be negatively related to its level of unrelated diversification.

[42] Although the increased leverage might offset the probabilities of lower bankruptcy probabilities. Yagil (1989) shows that lower expected costs of bankruptcy can be a potential source of financial gain

2.7.6 Multinational Diversification

One type of diversification described above is where a firm expands its operations into new geographic areas. By operating in different countries a multinational firm can take advantage of international diversification to reduce the riskiness of its earnings. A Multinational whose assets and cash flows are broadly spread geographically and are hence linked to a wide variety of currencies is likely to have a natural diversity of exposure to these currencies providing some degree of protection against currency fluctuations.[43] Multinationals with operations spread across many countries are likely to have less exposure to currency risk whereas firms with more highly concentrated operations are likely to be more exposed. Logue (1995) suggests that multinational diversification may provide a natural on-balance sheet operational hedge against economic exposure when purchasing power parity and uncovered interest parity fail. In addition to this, having a geographical spread of businesses might also reduce a firm's exposure to the economic cycle and so protect it from fluctuating demand.

2.7.7 Change Operating Gearing

Cash flow variability can be reduced by adopting costs that vary with revenues. When a firm exchanges fixed costs for variable costs, it lowers its operating gearing. Empirical tests of the firm's decision of whether or how to reduce its operating gearing are rare. One example is Mayers and Smith (1990). They examine the purchase of reinsurance by insurance firms. They find that the riskier the firm's assets as measured by business and geographic concentration, the more likely

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from purely conglomerate mergers.

they are to purchase reinsurance. The role of operating gearing has also been examined by Peterson (1994) in the context of the firm's pension choice. Here he investigates the potential role of pensions in hedging a firm's cash flow risk. A firm may choose a defined benefit or defined contribution pension scheme. The contributions to defined contribution plans are more flexible than contributions to defined benefit plans.[44] Therefore, firms may reduce their operating gearing by selecting a defined contribution plan. Consistent with this assertion Petersen finds a significant relationship between the variability of a firm's cash flow, the costs of financial distress and the probability that it will choose to sponsor a defined contribution pension plan.

2.7.8 Operational Hedging Techniques

Financial markets provide only short-term tactical hedging tools while long-term and strategic hedging tools must be based on internal operating policies and corporate strategies (Aggarwal and Soenen (1989) and Shapiro and Rutenberg (1976)). The short-term maturity of traditional financial instruments available for hedging foreign exchange exposure make them unsuitable for dealing with long-term foreign exchange exposure (i.e. economic exposure). Therefore, hedging foreign exchange economic exposure requires the adoption of strategies related to marketing, production and financing.[45] The effectiveness of these hedges is directly related to the structure of the firm's operating network.

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[43] As a result of constraints which may exist in capital markets through exchange controls, a company may undertake international diversification that cannot be replicated by shareholders.

[44] As part of its regulation of defined benefit plans, the US federal government imposes minimum and maximum limits on the firm's annual contribution. However, for defined contribution plans, there are no equivalent restrictions on the annual contribution. Therefore, the firm may adjust its annual contribution to match fluctuations in its cash flow.

[45] See, for example, Srinivasulu (1981), Cornell and Shapiro (1983), Lessard and Lightstone (1986), Aggarwal and Soenen (1989), Grant and Soenen (1991), Pringle (1991), Logue (1995), and Chowdhry and Howe, (1996).

2.7.9 Financial Derivatives

Few firms can hedge all, or even most, of their financial risks naturally or for that matter via on-balance-sheet hedging techniques. It could be that these risks or the residual risks might then be hedged with financial derivatives. It was noted above that managing risk with equity capital is all purpose, however, hedging with financial derivatives is a form of risk control that is very targeted. For example, a treasurer of an airline can use futures, forwards, or contractual agreements to hedge the firm against unexpected changes in jet fuel prices. To hedge, the firm must not only specify what kind of risk it is hedging but also the exact quantity of that risk. This type of hedging involves the structuring of claims in ways that smooth income by shifting revenue or costs across different circumstances. For example, the treasurer of the airline uses derivatives to shift the burden of higher jet fuel costs from bad times to good.

Hedging with derivatives is a form of risk control that can be very efficient[46] as a substitute for equity capital but it carries with it the requirement that its users have a deep quantitative understanding of their business. They must understand much more about their structures than in the case of all-purpose equity capital.

It was shown above that firms can reduce their financial risk by setting the fixed float debt mix so that interest costs are closely matched by the firm's revenues. The desired interest rate characteristics could be achieved by issuing the requisite amount of fixed and floating debt from the outset. Alternatively, the desired proportion of fixed to floating debt can be arrived at by using interest rate swaps

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[46] For example, an advantage of an interest rate swap or currency swap is that they allow firms to adjust exposure profiles without having to undo the underlying transactions. The major advantages of swaps in restructuring corporate debt are lower costs, increased flexibility, and more rapid execution. They have also been used to create lower-cost synthetic debt issues.

without varying the underlying debt. Because of the flexibility in altering interest rate characteristics of a debt portfolio using the interest rate swap market, particularly in response to changing company circumstances (e.g., the generation of large levels of surplus cash) or changes in the economic environment, there is increasing preference in the use of fixed or floating rate notes in combination with swaps to achieve fixed-floating debt targets. Swaps facilitate the changing of the fixed-floating debt mix in a relatively low cost manner.

It has been stated previously that the hedging of a net equity investment in an overseas operation can be achieved by means of currency borrowing. Alternatively, a currency a swap can be undertaken to create a liability in the required currency. This is of particular use when the group does not need to borrow and also avoids any adverse gearing effects. However, as with the case when a firm borrows, the company must be able to finance any cash loss at the maturity date of the swap. Many companies borrow in overseas currencies to finance operations generally, rather than to finance operations in the country in which the money is raised. They then use a currency swap to create a liability in the appropriate currency.

2.7.10 Hybrid Debt

In some cases, risk management is "bundled" with financing, this is referred to as structured or hybrid debt. Hybrid debt effectively combines straight debt with one or more embedded derivatives contracts that often correspond to a corporate exposure to interest rate, currency, or commodity price risks. For example, a farmer borrowing money to pay the costs of planting a crop may have a choice of repaying a fixed sterling amount, a fixed amount of output, or a share of his crop. By denominating the obligation in terms of a fixed physical quantity, the farmer shifts the risk of price fluctuations to the lender. By denominating it as a share of output, he also shifts output risks. Some oil, copper, and gold producers have issued bonds with interest or principal tied to the prices of their principal products, combining straight debt with a commodity forward or option contract. Building such a derivatives position into the bonds can make a company's cash flow more stable than if it had issued conventional debt.[47]

Smithson and Chew (1992) suggest that part of the corporate preference for managing price risks with hybrids rather than derivative products stems from current restrictions on the use of hedge accounting for derivatives, as well as tax and regulatory arbitrage opportunities afforded by hybrids.

2.8 Speculation

Although the above discussion focuses on the use of derivatives for hedging purposes, derivatives can be used to either lower or raise a firm's financial price exposure (i.e., decrease or increase cash flow volatility). The latter is akin to speculation. Speculation is where a treasury takes positions in derivative instruments that create exposures over and above the firm's underlying financial price exposures with a view to generating a profit. Firms can also use derivatives to hedge selectively. This is where a firm uses its views of future financial price changes to determine the amount of exposure to hedge or the choice of hedging instrument. For example, a firm might only hedge 50% of its exposures if it anticipates favourable

[47] Hu (1995) writes, 'I believe that it generally makes sense to consider core derivatives and structured notes collectively as "derivatives." Because the cash flows associated with a structured note will vary with the market price of the pertinent asset, the value of the structured note bears a relationship to the value of its underlying asset identical to that of a core derivative. Because core derivatives and structured notes share this characteristic, it is not surprising that they are both useful for hedging, speculative, and arbitrage purposes.' (p. 998) A review of the Form 10-Ks filed by 500 firms by the staff of the SEC's Division of Corporate Finance found that very few disclosed the existence of structured notes. Derivatives Disclosure, Accounting Is Not Adequate, SEC Staff Contends, 27 Sec. Reg. & L. Rep. (BNA) 140 (Jan. 20, 1995). See Hu (1995) page 1035.

market movements, but 100% if it expects prices moving in an unfavourable direction. Alternatively, a firm might use a variety of upside hedge products such as options to bias its exposure positions in case rates move in its favour. In the case of speculation the size of the firm's post derivative exposure is greater than its pre-derivative underlying exposure, whereas with selective hedging the post derivative exposure is less than or equal to the firm's pre-derivative underlying exposure. This section is concerned with the incentives for increasing a firm's underlying financial price exposure.

Shareholders are likely to support the use of derivatives for speculation if speculation is a profit-making activity. For speculation to be a profit making activity in rational markets, either a firm must have an information advantage related to the prices of the instruments underlying the derivatives, or it must have economies of scale in transaction costs allowing for profitable arbitrage opportunities. This suggests that firm size might be a possible determinant of the use of derivatives for speculation.

Another rationale for corporate speculation stems from the fact that bond-holders hold fixed claims whereas shareholders hold claims equivalent to a European call option on the value of the firm. Option pricing theory shows that the value of an option is positively related to the variability of the underlying asset as measured by its variance. The debt contract provides that if an investment yields large returns, well above the face value of the debt, shareholders capture most of the gains. If, however, the investment fails, because of limited liability bondholders bear the consequences. Managers acting in the interests of shareholders will endeavour to take actions that increase the variability of the firm's cash flows by speculating or by undertaking riskier projects.[48] By increasing the variability of the firm's future cash flows, management will have increased the probability of both large gains and large losses. The effect of the increase in the probability of large gains benefits the shareholders (because bondholders have fixed income claims) and the effect of the increase in the probability of large losses falls mainly on bondholders (because shareholders are protected by limited liability). The incentives for speculation that increases firm volatility will be greater when the firm is close to or in financial distress so that the option is near-the money or out-of-the money.[49] This analysis and that on financial distress in section 2.3.2 implies that it may be difficult to distinguish between hedgers and speculators. Since, the finding that more highly levered firms are more likely to hedge (i.e., use derivatives) can be motivated by the argument that these firms are attempting to lower their expected costs of financial distress. Alternatively, we could argue that these highly levered firms speculate more (i.e., use derivatives) to increase the value of the call option implicit in the equity of a levered firm. This makes interpreting empirical results difficult. Therefore the only way to know whether a firm is hedging or speculating is to know the firm's underlying risk exposure and measure the impact derivatives use has on its magnitude.

In a signalling framework Ljungqvist (1994) argues that managers of firms have an incentive to speculate when they have private information regarding the value of the firm and seek to increase the share price. In this model corporate speculation can be in the best interest of shareholders when they are concerned about both profits and share prices. The market is said to make inferences about firms' productivity's from their profits. Since higher profits are more likely to have been generated by

[48]Note that while Jensen and Meckling (1976) model a lone individual manager of the firm, we view the corporate management team of officers and directors as the real-world counterpart to the individual manager.

[49] As noted in section 2.3.5 managerial option holdings provide similar incentives for speculation.

firms with higher productivity (or high output), equilibrium share prices will be an increasing function of profits. Managers acting on behalf of shareholders must take this positive relationship into account when deciding whether or not to engage in speculation in the form of fair gambles in profits. A successful gamble would increase a firm's reported profit and therefore its stock price, while an unsuccessful gamble would do the opposite. Even though such speculative transactions cannot affect the expected profit of a firm (since we have a fair gamble), the manager may be able to increase the expected share price through a fair gamble in profits. The expected outcome of such a gamble depends on the shape of the equilibrium mapping from profits to stock prices. If stock prices are concave in profits, speculation will necessarily decrease a firm's expected stock price. However, if any segment of the profit - share price relationship is convex the firm can increase its expected market value by exposing its profit to a fair gamble. The model suggests that a firm facing bankruptcy with a zero share price could undertake such a speculative gamble without any downward risk in the hopes of imitating a higher productivity firm and obtaining a positive share price. The model assumes that speculative transactions cannot be observed by the market and such activity is described as a form of "signal-jamming". This assumption is unnatural given increased monitoring by outside debtholders as firms near bankruptcy.

This section has shown that shareholders are likely to support the use of derivatives for speculation if speculation is a profit making activity, if shares are viewed as options on the value of a levered firm, or with unobservable risk management activities managers of poor performing firms want to create noise so they can be pooled with good performing firms. Finally, even though the disclosure of derivative use is generally preceded by the statement that their purpose is to hedge and not to speculate, distinguishing between the two is difficult without knowledge of the firm's underlying exposure.

2.9 Summary of Hypotheses

The theories of corporate hedging examined in this chapter generate the following hypotheses with respect to the determinants of corporate hedging:

1. Tax Hypothesis

The tax hypothesis predicts that in the presence of a convex tax schedule, firms would reduce expected taxes by hedging to fix the level of taxable earnings. Statutory progressivity and tax preference items make the effective tax schedule convex. Therefore, the benefits of hedging should be greater the higher the probability the firm's pre-tax income is in the progressive region of the tax schedule, and the greater the firm's tax preference items.

2. Financial Distress Cost Hypothesis

Financial distress arguments for hedging predict that by reducing the probability of financial distress, hedging reduces the expected costs of financial distress, and so hedging can increase the expected value of the firm. Therefore, firms with higher expected costs of financial distress are more likely to hedge or would prefer more hedging. The extent to which hedging can reduce these transaction costs is postively related to two factors:1) the probability of encountering financial distress if the firm does not hedge, and 2) the costs it will face if it does encounter financial distress.

3. Underinvestment Cost Hypothesis

Theory predicts that without hedging some firms will be forced to pursue suboptimal investment policies. This is because, firstly in financial distress or near financial distress states firms (i.e., shareholders) reject positive NPV investments because the benefits accrue disproportionately to bondholders relative to shareholders. Theory predicts that firms with a higher probability of financial distress and more growth options in their investment opportunity set are more likely to hedge or would hedge more in order to mitigate the agency costs of underinvestment.

Secondly, for some firms there is a strong link between its cash flow and investment due to capital market imperfections such as asymmetric information. Firms with more asymmetric information about the quality of new investments, such as those with more growth options in their investment opportunity set and smaller firms, are faced with higher costs of external finance. Theory predicts that firms with key planned investment programs and costly external financing are more likely to hedge or would would hedge more to avoid having to rely on costly external finance to continue these programs. Furthermore, when the firm's cash flows are low these firms will be induced to scale back positive NPV investments because obtaining additional financing is very costly. Therefore, firms with more growth options in their investment opportunity set and low levels of internal finance are more likely to hedge or would hedge more.

4. Managerial Risk Aversion Hypothesis

The managerial risk aversion hypothesis predicts that managers with greater share ownership would prefer more hedging or are more likely to hedge, while those with greater option holdings would prefer less hedging or are less likely to hedge, because shares provide linear payoffs as a function of share prices whereas options provide convex payoffs.

5. Cashflow Volatility Hypothesis

Firms with more volatile income/cashlows/earnings are more likely to hedge or would prefer more hedging.

6. Substitutes for Hedging Hypothesis

Instead of reducing risk through hedging firms can pursue alternative strategies that reduce the costs of risk. They could adopt conservative financial policies such as low gearing or hold high levels of cash. Therefore, firms reducing the costs of risk through substitute hedging activities are less likely to hedge or would prefer less hedging.

7. Information and Transaction Scale Economies Hypothesis

The informational and transactional scale economies argument predicts that larger firms are more likely to hedge. However, the predicted relationship between the extent of hedging and firm size is unclear because, once a firm reaches the "critical mass" necessary for participation in hedging, greater size may not necessarily imply further benefits.

Firms employing personnel with corporate treasury experience have a greater understanding of the techniques of hedging and hence a greater ability to hedge. Therefore, it is predicted that these firms are more likely to participate in hedging.

2.10 Conclusion

This chapter has presented the theoretical arguments for and against corporate hedging. These arguments showed that under perfect market assumptions, hedging did not add to shareholder wealth. Modigliani and Miller demonstrated that given the firm's investment policy, with no taxes and no contracting costs, the firm's choice of financial policy, of which hedging was one, could not affect the current market value of the firm. Also according to CAPM a rational investor who holds shares in a diversified portfolio could effectively eliminate unsystematic risks, and in so doing he or she eliminated precisely the kinds of risks that are usually hedged by the firm. If these random events could be eliminated without the purchase of hedging instruments the value of hedging to shareholders must be seriously questioned. However, the efficacy of these arguments hinged critically on the validity of the "perfect markets" assumption.

The theories of hedging questioned the validity of the perfect market assumptions and showed how their relaxation led to different conclusions about the value of hedging. The modern theories of hedging argue that, i) hedging reduces the expected corporate tax liability for a firm with a convex corporate tax schedule; ii) hedging lowers the probability of the firm encountering financial distress which in turn lowers the expected costs of financial distress; iii) hedging reduces the risk imposed on the firm's managers, employees, suppliers, and customers; iv) hedging can control the conflict of interest between bondholders and shareholders, thus reducing the agency costs of debt; and v) hedging enhances the ability of a firm to finance future potential investment opportunities. This chapter has demonstrated that each of these theories has the potential to provide a partial explanation for the corporate demand for hedging. More specifically, the theories identified relationships between the benefits of hedging and various firm level characteristics, which provide empirically testable implications.

The chapter then went onto argue that firms have available to them cost reducing and risk reducing risk management strategies. Cost reducing strategies make inconsequential the effect of cash flow volatility on firm value and risk reducing (or hedging) strategies lower the volatility of cash flows. It was shown that instead of managing risk with derivatives (a risk reducing or hedging strategy), a firm could pursue alternative hedging or cost reducing strategies that substitute for derivative hedging strategies. For example, firms could diversify and hence lower cash flow volatility or adopt conservative financial policies such as low gearing, high liquidity or low dividend yields leaving cash flow volatility unchanged. In either case the probability of financial distress falls. It followed that firms adopting these financial policies or substitute risk management activities would have a smaller incentive to engage in hedging with derivatives. These strategies are not so much explanations for financial risk management, but rather controls for substitute forms of risk management.

Finally, the chapter suggested that firms might possess motives for speculation rather than hedging. It was argued that if the motives for hedging and speculation were correlated it might not be possible to distinguish between these two activities. The discussion suggested that the only way to know whether a firm was hedging or speculating was to know the firm's underlying risk exposure and measure the impact the firm's risk management strategy had on its size.

Since the aforementioned theories can only point the ways and channels through which corporate hedging can enhance firm value, empirical analysis is the only way to test the theories. Chapter 3 provides a review of the empirical studies on the determinants of corporate hedging. It discusses the particular tests of the theories and examines the extent to which they support or refute them.

Chapter 3. Review of the Empirical Literature on Corporate Hedging

3.1 Introduction

Chapter two reviewed the academic debate on the merits of hedging and identified five main theoretical rationales for corporate hedging, these being the desire to:

- minimise corporate tax liability;
- reduce the expected costs of financial distress;
- ameliorate conflicts of interest between shareholders and bondholders;
- improve the co-ordination between financing and investment policy; and
- maximise the value of the manager's wealth portfolio.

The theories provided useful insights and predictions on the firm's hedging decision. In particular, the hedging theories implied that the benefits of hedging to shareholders or managers were likely to differ across firms in ways that depended on various firm-level financial and operating characteristics. The chapter described the characteristics of firms that theory would use to explain the cross-sectional variation in hedging choices.

The empirical literature has confronted this theoretical debate on the merits of hedging by investigating the relative importance of the corporate hedging theories. This has been achieved by operationalising the various theoretical predictions into empirically testable implications. Table 3.1 shows that this literature has grown considerably in the last seven years with fourteen empirical studies in total and twelve since 1995. Thirteen studies source data from the United States. This is largely due to the mandatory disclosure of information on hedging practices and, in particular, the use of derivatives in annual reports and other financial statements. The catalyst responsible for this has been the Financial Accounting Standards Board (FASB). The FASB has issued several "Statement of Financial Accounting Standards (SFAS)" requiring firms to disclose in their annual reports both qualitative and quantitative information on hedging and derivatives use.

This chapter examines the literature that has focused on testing the various theories of hedging and the extent to which it supports or refutes them. The findings of the chapter will help to determine how these theories have been assessed in the empirical literature and whether the theories underpin what is observed in practice. The chapter begins by looking at how the empirical literature has defined hedging and measured hedging. It then examines whether the definitions of hedging employed are appropriate indicators of hedging or are potential proxies for speculation. This is followed by a look at the choice of sample firms and then an examination of the various econometric methodologies employed. The chapter then evaluates the findings of the existing empirical literature examining separately the results of the various hypotheses tested. Finally, the chapter concludes by assessing the impact a review of the empirical literature has for the focus of the thesis.

Table 3.1 Empirical Evidence Relating to Non-Financial Firms Hedging Policy and the use of Derivatives (in chronological order)

Author(s) of Study	Date	Area of Study	Source of Data	Type of Firm	Sample	Dependent Variable	Methodology	Country
Francis & Stephan	1993	All hedgers	Annual Reports (1983-87)	Financial & non-financial	434	Binary	Logit	USA
Nance, Smith & Smithson	1993	All hedgers	Survey (1986)	Non-financial	535 (169 respondents = 31.6%)	Binary	Logit	USA
Dolde	1995	All hedgers	Survey (1992)	Non-financial	476 Fortune 500 (244 respondents=51.3%)	Binary	Logit/OLS	USA
Wysocki	1996	All hedgers and foreign exchange hedgers	Annual Reports (1993 & 1994)	Non-financial	403 (215 derivative users) and 807 (234 currency derivative users)	Binary	Logit/OLS	USA/Canada
Mian	1996	All hedgers & foreign exchange & interest rate hedgers	Annual Reports (1992)	Non-financial	771 hedgers and 2251 non-hedgers	Binary	Logit	USA
Allayannis & Ofek	1996	Foreign exchange hedgers	Annual Reports (1992-93)	Non-financial	724 firm years (S&P500)	Binary/ Continuous	Logit/Tobit/ OLS	USA
Berkman & Bradbury	1996	All hedgers	Annual Reports (1994)	Non-financial	116 firms on NZ stock exchange	Continuous	Tobit	New Zealand
Tufano	1996	Commodity price hedging:Gold price hedging	Survey (1991-93)	Gold mining	48	Continuous	Tobit	USA
Fok, Carroll & Chiou	1997	All hedgers	Annual Reports (1990-92)	Non-financial	331	Binary	Logit	USA
Geczy, Minton & Schrand	1997	Foreign exchange hedgers	Annual Reports (1991)	Non-financial	372 Fortune 500	Binary	Logit	USA
Gay & Nam	1998	All hedgers and interest rate hedgers	Proxy statement (1995)	Non-financial	486	Continuous	Tobit	USA
Howton & Perfect	1998	All hedgers & foreign exchange & interest rate hedgers	Annual Report (1994)	Non-financial	451 Fortune 500/S&P 500 & 461 random firms	Continuous	Tobit	USA
Haushalter	1998	Commodity price hedging:Oil and gas price hedging	Annual Report (1992-94) and Survey (1995)	Oil and gas producers	100	Continuous	Tobit/Cragg	USA
Graham & Rogers	1999	Foreign exchange and interest rate hedgers	10-K forms (1994-95)	Financial & non-financial	Population=3232, sample=531	Continuous	Tobit/Cragg	USA

Note(s):
Under the "Area of Study" column "All hedgers" indicates that firms hedging any category of exposure were defined as hedgers.

3.2 Hedging Defined and Measured

The ability to identify which firms hedge and don't hedge and for those that hedge the extent to which they hedge is vital if reliable tests of hedging theories are to be undertaken. The empirical examination of hedging theories has been hindered by the general unavailability of data on hedging activities. Until recently, a firm's exact position in hedging and its methods of hedging (for example, use of derivatives) was information closely guarded by the firm because it was deemed to be of strategic importance. It is only in the last few years that firms have been encouraged to disclose in their annual reports information on their hedging policies and their methods of hedging. In the absence of this information, most of the earlier empirical studies used survey data to examine the determinants of corporate hedging (Nance et al. (1993) and Dolde (1995)).[1] In these studies, authors surveyed firms, asking respondents whether their firm used derivative instruments. As disclosure of hedging practices in financial reports improved several studies searched these reports for qualitative disclosures and defined hedgers as firms whose reports included references to terms such as "hedging" or "risk management" or "derivatives" or to particular derivative instruments such as "interest rate swaps" or foreign currency derivatives" (Francis and Stephan (1993), Wysocki (1996), Mian (1996), Geczy et al. (1997) and Fok et al. (1997).[2] Further improvements in the quality of annual report disclosures have made it possible for recent studies to employ quantitative data on derivative usage to measure the "extent of hedging".[3]

[1] Other studies, see for example, Malindretos, Norton, and Tsanacas (1993), Batten, Mellor, and Wan (1993), Booth, Smith, and Stolz (1984), Block and Gallagher (1986), Houston and Mueller (1988), Jesswein, Kwok, and Folks (1995), and Hakkarainen, Kasanen, Puttonen (1997a, 1997b).

[2] Other studies, see for example, Wall and Pringle (1989) and Samant (1996).

[3] See, for example, Tufano (1996), Allayannis and Ofek (1996), Berkman and Bradbury (1996), Haushalter (1998), Gay and Nam (1998), Howton and Perfect (1998), Graham and Rogers (1999).

The question of how hedging is defined and measured is critical to any empirical examination of the determinants of corporate hedging. In their seminal paper formulating the economic rationale for hedging, Smith and Stulz (1985) point out that a "firm can hedge by trading in a particular futures, forward, swap or option market ..." (pg. 392). They also suggest that a firm can hedge by via its operating strategies, for example, a merger can generate similar effects to those of hedging through derivatives. Other operating strategies, also referred to as on-balance sheet strategies, include relocating production facilities abroad or funding in a foreign currency. Given the different methods a firm can employ to reduce its risks, how hedging is defined is crucial for the purposes of precisely classifying firms as "hedgers" and "non-hedgers". Several studies take firms' investment and on-balance-sheet financing strategies as predetermined and define hedging as the use of financial derivatives (Nance et al. (1993), Dolde (1995), Berkman and Bradbury (1996), Wysocki (1996), Mian (1996), Gay and Nam (1998), Howton and Perfect (1998), Graham and Rogers (1999)). Two studies (Francis and Stephan (1993) and Mian (1996)) employ keyword searches. Key words such as "hedging" or "derivatives" or references to specific types of derivatives are used to identify hedging firms. Firms not disclosing the use of derivatives are classified as non-hedgers.

The failure to allow for the fact that firms can and do use other techniques to manage risk is a major weakness in these studies.[4] This is because the methodologies employed in these studies do not directly distinguish between derivatives use and risk reduction. Chapter two mentioned that hedging could be pursued through changes in the firm's operating characteristics or other financial policies. For example, two firms may consciously manage their foreign currency exposure arising from foreign assets, one firm using a currency swap to create a liability in the required currency, and the other using foreign denominated debt to act as a natural hedge of foreign revenues. Therefore, by equating "hedger" with "derivative user," the former would be characterised as a "hedger" and the latter, while functionally equivalent, a "non-hedger". In addition some firms may be naturally hedged. A firm is naturally hedged when its ability to generate operating cashflow is positively correlated with its investment opportunities. The firm may have highly variable operating cash flows, but if its supply of cash flow is matched to its demand for cash flow, it is naturally hedged. Thus, precisely classifying firms as hedgers and non-hedgers may not be possible empirically. One way of alleviating this problem is to examine the use of derivatives rather than hedging in general and introduce variables that indicate the existence of other hedging methods. Therefore, firms that are naturally hedged will not be expected to use derivatives.[5] Some studies attempt to take account of hedging achieved through operational or financial policies (Tufano (1996), Allayannis and Ofek (1996), Fok et al. (1997), Geczy et al, (1997), Haushalter (1998)).

Tufano's (1996) investigation of risk management practices in the North American gold mining industry attempts to address this problem by recognising that

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[4] Firms can manage risk through diversification, hedging, and insurance (see Merton (1993)). See chapter 2 for a discussion of the various methods of risk reduction.

[5] For example, Rio Tinto says, "Rio Tinto's exposure to commodity prices is naturally diversified by virtue of its broad commodity spread, and the Group does not believe a commodity price hedging programme would provide long term benefit to shareholders." The firm also does not believe that currency hedging provides long term benefits, it says, "Rio Tinto's assets, earnings and cash flows are influenced by a wide variety of currencies, which provides a substantial degree of protection against changes in currency parities..." "Rio Tinto's operating costs are influenced not only by the US dollar but by currencies of other countries where its mines and processing plants are located, in particular the Australian dollar. In any particular year, currency fluctuations may have a significant impact on Rio Tinto's financial results. However, in the case of the Australian dollar there is a significant degree of natural protection against cyclical fluctuations, in that the currency tends to be weak (reducing costs in US dollar terms) when commodity prices are low." 1997 Annual report on Form 20-F, pg. 84-85.

risk management strategies can be implemented using explicit derivative transactions, such as in the forward sale of gold, or they can be combined with financing activities. For example, in borrowing via a gold or bullion loan, a mining firm combines dollar-based-financing with a forward sale of gold. Therefore, he attempts to identify both on- and off-balance sheet risk management activity so as to avoid what he refers to as "the inaccurate categorisation of functionally-equivalent financial positions" (pg. 1103).

Fok et al. (1997) use a measure for unrelated business line diversification and a dummy variable identifying multinational firms which proxies for production or operational hedging. Only the multinational dummy variable was significant, although the sign was opposite to that predicted. If this variable is a good proxy for operational hedging, then the Fok et al. results imply that operational hedging and derivatives hedging are more likely to be complements rather than substitutes.

In their study of the determinants of the use of currency derivatives Geczy et al, (1997) argue that the existence of foreign denominated debt can act as a natural hedge of foreign revenues, although they recognise that foreign debt can increase a firm's exposure to foreign currency risk if debt related cash outflows are negatively correlated with net foreign-denominated cash inflows. Since this correlation cannot be determined from publicly available data, they cannot predict the relation between foreign debt and derivatives use. They use both a dummy indicator and continuous measure of the use of foreign debt as an exogenous variable in their model. In two separate tests they find on the one hand foreign debt and currency derivatives may act as substitutes for hedging foreign operations and on the other derivatives use is positively associated with the use of foreign debt. Allayannis and Ofek (1996) also recognise that foreign debt can be another way to hedge foreign currency exposure but take a slightly different approach to that of Geczy et al. In particular, they explore the determinants of the use of foreign debt as a hedge against foreign exchange exposure and also investigate the overall foreign currency hedging decision of the firm by combining the use of foreign currency derivatives and foreign debt into one variable and examining its determinants. They find a significant positive relation between the level of foreign sales and firms' use of foreign debt, but an insignificant relation of export share to the use of foreign debt. Also, they do not find any significant evidence that firms with revenues from operations abroad (i.e., multinationals) prefer to use foreign currency derivatives or foreign debt to hedge currency exposure from foreign operations. This result implies that derivatives and foreign debt might be seen as alternatives for hedging currency exposure from foreign operations. Although, they find significant evidence that exporters prefer the use of foreign currency derivatives to the use of foreign currency debt. The Allayannis and Ofek evidence clearly demonstrates the need to allow for substitute forms of hedging in any analysis of the determinants of corporate hedging.

A second weakness with the approach used in most of the early studies is the way in which hedging is measured (Francis and Stephan (1993), Nance et al. (1993), Mian (1996), Wysocki (1996), Fok et al. (1996) and Geczy et al. (1997)). In these studies researchers measured "risk management" by using a dichotomous variable that equalled one if the firm indicated that it hedged or used derivatives and zero otherwise. Thus hedging in these early empirical papers is seen as a binary decision, the decision to hedge or not to hedge. Although, the theories examined in chapter two predict relationships between the extent of risk management and various firm level financial and operating characteristics. For example, ceteris paribus, a firm with a high proportion of export sales might be expected to hedge a greater proportion of its exposure than say a firm with a lower proportion of export sales.[6] Therefore, the approach employed by early empiricists is clearly a crude way to measure hedging since it does not discriminate between firms that fully hedge and those that part hedge. Consequently, firms that hedge 1 percent of their exposure will make up the population of hedging firms just the same as those that hedge 100 percent of their exposure. These types of hedging firms might differ significantly in terms of their exposure characteristics and other financial and operating traits. Therefore, it may not be possible to detect differences between hedgers and non-hedgers since a firm that hedges a small portion of its exposure might be closer to a non-hedging firm than to one that hedges most of its risk.[7] Dolde (1995) attempts to allow for the variation in the extent of hedging by asking firms to indicate what proportion of their exposures are hedged, firstly, when a firm holds no view on future financial price changes and secondly, when a firm holds a view on future financial price changes. He then uses a dichotomous variable to distinguish between firms lying above or below the median of all responses.

Because of the limitations of the data on hedging the above studies examine the determinants of the decision to hedge and cannot examine the determinants of the

[6] Allayannis and Ofek (1996) attempt to examine nonlinearities in foreign currency hedging by examining the hypothesis of whether a firm with a larger proportion of foreign sales hedges a larger proportion of its foreign sales than a firm with a smaller proportion of foreign sales. In this regression, the dependent variable is the ratio of foreign currency derivatives to foreign sales and the ratio of foreign sales to total sales is used to indicate the existence of nonlinearities. They find a negative coefficient which indicates that, as the percentage of foreign sales in total sales increases, firms increase the percentage of foreign sales that is covered by foreign currency derivatives, however, at a decreasing rate. A problem with the dependent variable is that it does not necessarily represent the size of the firm's underlying exposure. For example, foreign sales includes the sales of goods produced and sold in, say, Germany. Clearly, these sales do not generate transaction exposure. Only goods exported from Germany give rise to exposure. Furthermore, Geczy et al. argue that to the extent that costs are a natural hedge of foreign revenues, net profit represents the underlying exposure to foreign currency risk. For pure transaction exposure, the ideal measure is the proportion of export sales covered by foreign currency derivatives and the proportion of import costs covered by derivatives.

decision of how much to hedge. The former is concerned with the likelihood of hedging and the latter is concerned with the extent of hedging. However, as the disclosure of quantitative data on derivatives use has improved several recent studies have attempted to derive a continuous measure of hedging in order to provide more reliable tests of the determinants of hedging (Tufano (1996), Berkman and Bradbury (1996), Allayannis and Ofek (1996), Haushalter (1998), Gay and Nam (1998), Howton and Perfect (1998) and Graham and Rogers (1999)). Several of these studies employ total notional values of derivatives scaled by firm size to measure the level (or extent) of derivatives use (or hedging) (Berkman and Bradbury (1996), Allayannis and Ofek (1996), Gay and Nam (1998), Howton and Perfect (1998)).

A problem with the use of total notional values is that they are an aggregate of long and short positions and therefore, are an overestimation of the level of derivative use and so a biased measure of the extent of hedging. For example, in the case of swaps, the notional amount can be quite large, whereas the "net" position may be small. Where hedging is undertaken at a decentralised level, the reported notional value of derivatives may be larger than if hedging is undertaken at a group level. Yet the same net position may result. Graham and Rogers (1999) attempt to correct for this by restricting their sample of derivative users to those for which they can determine the net notional amount of derivatives. However, this factor will only be important if many firms enter into offsetting long and short positions.

Two studies also use fair values of derivatives scaled by firm size as an indicator of the extent of hedging (Berkman and Bradbury (1996) and Howton and Prefect (1998)). Although it is not clear what this variable is measuring. The fair value is the amount at which an instrument could be exchanged in a current transaction

[7] This problem biases the results of these studies against their a priori expectations.

between willing parties other than in a forced or liquidation sale. Fair values are estimated by discounting the future cash flows to net present value using appropriate market rates prevailing at the year-end. The fair value of a derivative contract at origination is zero even though the firm might be fully hedged. Clearly this variable provides no indication of the extent of risk management undertaken and therefore, its value in testing the theories of hedging is questionable.

Another problem is that the notional values employed in these studies do not take into account the risk characteristics of the derivative instrument such as the term, denomination and settlement price of the outstanding contracts. For example, suppose a swap's principal is £250 million and the debt with which it is associated is £500 million. Either the swap is covering only half the debt issue and its consequent interest expense, or the entire interest expense is being hedged in some other way, for example, through an amplified interest rate.[8] Also different firms can hold the same notional value of derivatives and still have very different hedging practices (Smith (1995)). For example, two firms may hold swaps with notional principal of £200 million, but for one the term is one year and the other the term is five years. What is important is which firm is hedging more extensively? It might seem that the latter is more extensively hedged. However, if the first firm is hedging debt that matures in one year and the other firm is hedging debt that matures in five years, then their hedging practices are similar. Therefore, no conclusions can be drawn from examining notional principal amounts, but relating them back to their underlying exposures prompts closer investigation into companies' risk management activities and philosophies. Existing financial reporting regimes do not require firms to disclose the underlying asset or liability that is associated with a derivative contract, so researchers are not able to determine the precise relationship between the item hedged and the hedging instrument.

A weakness in using gross or net notional amounts of derivatives scaled by firm size as the dependent variable is that it is not clear what this is actually measuring. For example, Allayannis and Ofek expect a relation between the value of foreign currency derivatives and factors that expose the firm to foreign currency risks (overseas operations, imports and exports). Unless firm size is correlated with these exposure characteristics, the exact relationship between their dependent variable, the ratio of notional value of currency derivatives to total assets, and the size of the exposures is unclear.

If the dependent variable in these studies is attempting to measure the degree of hedging then the fundamental problem with this measure is that it does not scale by the firm's underlying financial price exposure. All studies use firm size as their scaling variable. Unless this is a good proxy for the level of a firm's exposure it is not clear whether this is actually a measure of the extent of risk management undertaken. These studies fail to recognise that it is necessary to scale the firm's financial risk management activity against its natural exposure to understand its economic importance. Therefore, it is not clear from these studies what additional insights they provide relative to the studies employing a binary dependent variable to the question of the empirical determinants of hedging.

Two industry specific studies attempt to address this criticism (Tufano (1996) and Haushalter (1998)). Tufano calculates a measure of the degree of risk management undertaken by firms in the US gold mining industry. Tufano uses the delta of a firm's risk management portfolio divided by the amount of gold expected

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[8] For firms using only interest rate derivatives Gay and Nam (1998) calculate the ratio of the firm's notional amount of interest-rate derivatives to its total debt, and zero for non-users. They use total debt

to be produced over a three-year period as a measure of the extent of risk management activity. Tufano refers to this as the delta-percentage: the percentage of production accounted for by portfolio delta.[9] Haushalter (1998) examines the hedging policies of U.S. oil and gas producers for the period 1992 through 1994. Using both survey and financial statement data he measures the extent of hedging as the fraction of the firm's production for the year that is hedged against price fluctuations. The implicit assumption made by both of these studies is that the size of a firm's exposure is equal to its level of production rather than the level of its sales. Ultimately it is the amount sold in a given period that is exposed to price risk. The Tufano and Haushalter dependent variables are appropriate if production levels in a given period are similar to sales for that period otherwise these measures may over- or underestimate the level of hedging.

A potential weakness in these industry specific studies is that although variability in the commodity price is the exposure that dominates for firms in the oil, gas and gold mining industries these studies take no account of firms other hedging activities, such as interest rate and foreign currency hedging. This point is pertinent since shareholders in a commodity company might prefer a company to keep its commodity price exposure unhedged to preserve all of its upside to commodity price appreciation. Hedging commodity price exposure may limit the ability of the company to benefit fully from increases in the price of the commodity, something shareholders would have expected when buying the shares.

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to proxy for a firm's total interest rate exposure.

3.3 Speculation

The previous section shows that all fourteen empirical studies incorporate the use of derivatives into their hedging definition. Chapter two suggests that derivatives can be used for speculation as well as hedging and identifies incentives for speculation. Given these incentives it is possible that derivative users are speculating rather than hedging. Much of the recent debate on derivative use has focused on whether firms use these instruments for hedging or for speculation. Therefore, the issue is whether these studies are measuring hedging or speculation. If the motives for optimal hedging and speculation are correlated empirical results might not distinguish between these two activities.

This section examines whether the available empirical evidence supports the speculative motives for derivatives use. Most empirical studies examine how the use of derivatives for hedging purposes may increase shareholder wealth. However, these studies are in effect examining the determinants of derivatives use and not hedging per se. The implicit assumption is that derivatives are used for hedging. However, chapter 2 showed that derivative instruments can be used for speculation (as well as for hedging) and that firms might have incentives to use them for this purpose. It follows that evidence of the use of derivative instruments does not necessarily mean that these instruments are being used to hedge.[10] Therefore, this raises a question mark over how precisely derivatives use measures corporate hedging and whether it is

[9] The delta-percentage ignores operating risk management activities, including the real options to change the rate of production, exploration, and acquisition.

[10] The general consistency of empirical results with models of optimal hedging behaviour suggests that firms, on average, are using derivatives for hedging. Although, this assumes that the motives for optimal hedging and speculation are not correlated. If they are correlated then it may not be possible to distinguish between these two activities.

possible empirically to distinguish between hedgers and speculators. As noted above most studies examine derivatives use and not hedging specifically and therefore the dependent variable might measure speculation rather than hedging.

Five empirical studies ignore the possibility that firms may use derivatives to enhance rather than reduce their exposures (Nance et al. (1993), Wysocki (1996), Fok et al. (1997), Gay and Nam (1998) and Howton and Perfect (1998). Although, Nance et al. (1993) find, using contemporaneous and lagged data, no significant difference in the volatility of pretax income between hedgers (derivative users) and non-hedgers (non-users) ex post. Nance et al. point out that since hedging reduces cash flow volatility, there might not be significant differences in volatility ex post. This evidence would seem to imply that derivative users in the Nance et al. sample are hedging rather than speculating.

Two studies use keyword searches to identify hedging firms (Francis and Stephan (1993) and Mian (1996)). A potential weakness with using keyword searches to make inferences about hedging is that this method has the potential of misclassifying hedgers as non-hedgers (for example, hedging firms with no disclosure in their annual report) and speculators as hedgers. In an attempt to correct for this Mian (1996) draws the distinction between firms who explicitly disclose that they hedge their exposures and firms that disclose the use of derivatives but make no reference to hedging. Mian argues that this latter group could potentially be using derivative instruments for speculation and not hedging. Mian searches the NAARS database and classifies firms into hedgers and non-hedgers based on annual financial statements for 1992. Out of 3,022 firms, 543 firms explicitly state that they hedge and 228 firms disclose the use of derivatives but do not mention hedging. Mian's empirical tests are conducted using hedging firm samples that include and exclude the

228 firms using derivatives while not mentioning hedging in their annual reports. His results show that potential misclassifications resulting from inclusion of derivative users as hedgers do not materially affect his results.

Three studies (Francis and Stephan (1993), Berkman and Bradbury (1996) and Graham and Rogers (1999)) find no firms disclosing in their annual reports that they speculate with derivatives. To the contrary, they find that many firms provide statements such as "derivatives are used for risk management purposes only" or "derivatives are not used for speculative purposes."[11]

The discussion in chapter 2 also recognises that firms can incorporate their views of future price movements into determining the degree of hedging. Three surveys of corporate treasurers (Dolde (1995), Edelshain (1985) and Bodnar, Hayt and Marston (1996)) find evidence of this kind of selective hedging. Dolde's (1995) survey of large US firms indicates that most firm's hedge only a portion of their interest rate or foreign currency exposures. Edelshain's (1995) investigation into the currency risk management practices of 189 UK companies shows that 46 percent of firms selectively hedge their foreign currency exposure.[12] Bodnar, Hayt and Marston (1996) find that US treasurers sometimes allow their view of financial price movements to influence their hedging decisions. Some might argue this type of activity is tantamount to speculation, however, this kind of derivatives use appears more to be the conscious bearing of the firm's underlying exposures rather than

[11] Ciesielski (1996) reviews the annual reports of the top 30 companies in the Dow Jones Industrial Index. Of the 28 nonfinancial companies one firm states that "financial instruments held for trading purposes are insignificant". Ciesielski argues this implies that the firm may use derivatives for trading but it is not the same as explicitly declaring one's firm to be a derivative trader. For another it is suggested that accounting treatment of its derivative activities could label the firm as either a hedger or trader depending upon its interpretation. Of the remaining 26 companies 13 companies did not use derivatives for trading purposes whilst the other 13 did not make specifically address this issue.

[12] Edelshain (1995) found that 53 percent of respondents hedged all of their currency risk and 29 percent indicated that their policy on currency risk management was one of complete risk aversion.

speculative use of derivatives. A weakness in the aforementioned approaches to assessing whether firms are using derivatives for hedging or speculation is the reliance on qualitative data provided by firms regarding their reasons for using derivatives.

Geczy et al. (1997) consider firms' motives in using currency derivatives to speculate and the implications of speculation for their results. Some of their proxy variables, such as firm size, are important determinants of both optimal speculation and optimal hedging, while other firm characteristics, such as those associated with underinvestment costs, are unrelated to optimal speculative motives. They argue that while currency derivative use is not a direct measure of hedging, their results suggest that on average, their sample of firms are not speculating with currency derivative instruments.

Two studies have detailed data on the extent of risk management undertaken (Tufano (1996) and Haushalter (1998)). Tufano (1996) finds that there are no gold mining firms in any period with negative delta percentages. This, he suggests, indicates that firms are not using financial contracts to increase gold price exposure. This assumes that any speculative activity with derivatives can be observed. However, Haushalter (1998) argues that if managers anticipate that the price of oil and gas will increase and thus increase the exposure of the firm's cash flow to oil and gas prices, the fraction of production hedged will be censored at zero. Therefore negative observations for his dependent variable, constructed in a manner similar to that of Tufano, cannot be observed. Although, since Tufano has access to very detailed information on firm's risk management activities derivatives usage is far more transparent making it easier to detect speculative activity.

A far better approach to determining whether firms hedge or speculate is to measure a firm's risk exposure and then examine the effect derivatives use has on this exposure. Three studies attempt this by measuring the impact derivatives use has on firms risk characteristics (Hentschel and Kothari (1996), Allayannis and Ofek (1996) and Guay (1999). Hentschel and Kothari (1995) find that derivative users and non-users exhibit few measurable differences in risk characteristics. Allayannis and Ofek (1996) find that, controlling for the level of foreign sales, the higher the use of foreign currency derivatives by a firm, the lower its exchange rate exposure. Guay (1999) finds that initiation of corporate derivatives use is associated with declines in various measurements of firm risk. These findings are consistent with firms using derivatives to hedge rather than speculate.

The empirical evidence reviewed in this section provides strong support indicating that non-financial firms use derivatives mainly for hedging rather than for speculation.

3.4 Sample Composition

Most studies impose restrictions on the types of firms included in their sample. The majority of studies focus their work on the hedging practices of large firms.[13] This is because these firms are more likely to face the types and size of exposures that require hedging and also because information about their hedging practices is generally more readily available. Most of these studies restrict their analysis to the

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[13] Several US studies have investigated hedging and derivatives use of firms in the Fortune 500 and the S&P 500 lists. For example, Nance et al. (1993) survey Fortune 500 and the S&P 400 firms, Dolde (1993) and Jesswein, Kwok and Folks (1995) survey Fortune 500 firms, Geczy et al.'s (1997) sample is selected from the Fortune 500 list and Allayannis and Ofek (1996) and Visvanathan (1998) include firms from the S&P 500. Howton and Perfect (1998) use a sample of Fortune 500 and S&P 500 firms and a random sample of firms. Berkman and Bradbury (1996) include all non-financial firms listed on the New Zealand Stock Exchange (116 firms). The exceptions are Francis and Stephan (1993), Mian (1996) and Graham and Rogers (1999).

hedging practices of non-financial firms because financial firms are both users and providers of risk management products.[14]

A potential weakness in the sample selection process of these studies is that they fail to exclude firms that may have an incentive to reduce risk but do not have ex ante exposure. For example, a firm may have a high R&D ratio and a low liquidity ratio but no cash flow variability arising from exposure to financial price volatility and hence will have no requirement to hedge.[15] Restricting the sample to firms that face ex ante financial price risk reduces noise in the empirical tests by focusing on the major cross-sectional differences that affect the incentives for hedging. For samples constructed in this manner a non-hedger can be interpreted as a decision by a firm not to hedge its risks. This position is different from that of a non-hedger because of no exposure to financial risks.[16] Geczy et al. (1997) and Graham and Rogers (1999) employ this sample selection criteria. Graham and Rogers (1999) test the effectiveness of this selection process and find that their results are invariant to changes in the composition of their sample.

3.4.1 The Types of Exposures Hedged

The ways in which hedging theoretically increases firm value are not limited to a particular type of exposure hedged or type of hedging method, but relate to hedging activities the primary focus of which is to reduce income volatility.

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[14] The exceptions are Francis and Stephan (1993) and Graham and Rogers (1999).

[15] Potential cash flow variability arises from exposure to financial price changes. For a given level of financial price exposure the higher the R&D ratio and the lower the liquidity ratio the greater the incentive to hedge. Alternatively, for a given level of R&D ratio and liquidity ratio the higher the financial price exposure (the higher the potential cash flow variability) the greater the incentive to hedge.

[16] This approach implies that there are two types of non-hedgers, those that do not hedge because they have no exposure and those that do not hedge despite having some level of exposure. By focusing on firms that face ex ante risk (have some exposure), the absence of derivatives (or hedging) can be interpreted as a choice not to use derivatives (or hedge), rather than possibly indicating a lack of exposure to financial price risks.

Consequently, there is no need to arbitrarily restrict hedging activities to a particular category of exposure hedged or derivative instruments.

Table 3.2 shows that several studies follow this approach and focus on firms hedging any type of financial price exposure (Francis and Stephan (1993), Nance et al. (1993), Dolde (1995), Berkman and Bradbury (1996), Wysocki (1996), Fok et al. (1997), Gay and Nam (1998)). The sample of hedgers in these studies includes firms who use any type of derivative instrument (i.e., foreign currency, interest rate, commodity price or equity price derivative). The non-hedgers do not use any type of derivative.

Table 3.2 Categories of Hedging Investigated in Previous Empirical Studies

Author(s) of Study	Date	Area of Study
Francis & Stephan	1993	All hedgers
Nance, Smith & Smithson	1993	All hedgers
Dolde	1995	All hedgers
Wysocki	1995	Foreign exchange hedgers
Wysocki	1996	All hedgers
Mian	1996	All hedgers & foreign exchange & interest rate hedgers
Allayannis & Ofek	1996	Foreign exchange hedgers
Berkman & Bradbury	1996	All hedgers
Tufano	1996	Commodity price hedging: Gold price hedging
Fok, Carroll & Chiou	1997	All hedgers
Geczy, Minton & Schrand	1997	Foreign exchange hedgers
Gay & Nam	1998	All hedgers & interest rate hedgers
Howton & Perfect	1998	All hedgers & foreign exchange & interest rate hedgers
Haushalter	1998	Commodity price hedging: Oil and gas price hedging
Graham & Rogers	1999	Foreign exchange & interest rate hedgers

Notes: Under the "Area of Study" column "All hedgers" indicates that firms hedging any exposure category of were defined as hedgers.

The discussion in chapter 2 argued that capital market imperfections created an environment in which exposure to financial prices adversely affected shareholder wealth. The theories in chapter two that modelled how these imperfections provide an incentive to hedge did not specify the source of the volatility, nor which type of derivative should be used to hedge. Therefore, some studies focus on the type of exposure hedged, recognising that different factors may be important for each type of hedging. Two studies focus on the use of foreign currency hedging instruments

(Geczy et al. (1997) and Allayannis and Ofek (1996)). Three studies examine separately the determinants of interest rate and foreign currency hedging (Mian (1996), Howton and Perfect (1998) and Graham and Rogers (1999)). A further two investigate commodity price hedging in the gold mining, and the oil and gas industries, respectively (Tufano (1996) and Haushalter (1998)). Although, by construction, these industry specific studies diminish cross-sectional variation in firms' risk exposures, they do so at the expense of cross-sectional variation in the potential incentives to hedge.

As shown in Table 3.2 there has been a trend towards the examination of the determinants of hedging specific types of exposure. A hitherto unrecognised problem for these types of empirical studies is the inclusion of firms hedging other exposures in the sample of non-hedgers. This is a major weakness in these studies because the inclusion of hedging firms in the non-hedging sample might blur the distinction between the two groups and hence bias any empirical tests against the a priori expectations.

Table 3.3 shows that of the seven studies that have investigated the determinants of interest rate hedging, five included firms hedging other exposures in their sample of non-hedgers. For example, Mian's (1996) full sample includes 735 hedgers and 2064 non-hedgers and his interest rate sample includes 417 interest rate hedgers (318 less than the full sample) and 2382 non-hedgers (318 more than the full sample). These 318 are firms hedging exposures other than interest rate exposure and join the non-hedgers in the interest rate hedging tests. Samant (1996) studies the use of interest rate swaps and obtains control samples of firms that do not use interest rate swaps but might use other interest rate derivatives and/or other derivatives. Visvanathan (1997) also studies the use of interest rate swaps for interest rate hedging and other reasons and partitions his sample into firms that report the use of interest rate swaps and those that do not report interest rate swaps. The latter includes firms that use non-interest rate derivatives, such as foreign currency options. Graham and Rogers (1999) investigate the determinants of interest rate derivative use and foreign currency derivative use. In their interest rate sample 180 out of 404 firms use some type of derivative, and 142 use interest rate derivatives. In multivariate tests interest rate derivative non-users are sampled from the 262 firms which do not disclose the use of interest rate derivatives, of which 38 firms use other types of derivatives.

The two exceptions to these studies are the Gay and Nam (1998) study which looked at the differences in characteristics between a sample of interest-rate derivatives only users and a matching sample of firms that did not use any derivatives and the Li (1996) study of the use of interest rate swaps comparing users of interest rate swaps versus non-users of any derivative.[17]

Table 3.3 Composition of Non-hedging Samples in Previous Empirical Studies of Interest Rate Hedging/Swaps

Author(s) of Study	Date	Area of Study	Non-hedger sample includes hedgers
Mian	1996	All hedgers & foreign exchange & interest rate hedgers	Yes
Samant	1996	Interest rate swaps	Yes
Li	1996	Interest rate swaps & Interest rate hedging	No
Visvanathan	1997	Interest rate swaps & interest rate hedging	Yes
Gay and Nam	1998	Interest rate hedgers	No
Howton and Perfect	1998	All hedgers & foreign exchange & interest rate hedgers	Yes
Graham and Rogers	1999	Foreign exchange & interest rate hedgers	Yes

[17] Gay and Nam (1998) find that of their control variables (tax, interest cover, stock holdings, option holdings, convertible debt, preference capital, and size) only size is significantly (negatively) related to the level of interest rate derivative use. Although a negative coefficient contradicts the economies of scale explanation. This result supports the hypothesis that larger firms benefit less from hedging

Table 3.4 shows that all six previous studies investigating foreign currency hedging include in their sample of non-hedgers firms hedging other exposures. For example, Mian's (1996) foreign currency sample includes 426 foreign currency hedgers (309 less than the full sample) and 2373 non-hedgers (309 more than the full sample) the latter clearly includes 309 interest rate and/or commodity price hedging firms.[18] Geczy et al. (1997) investigate the use of foreign currency derivatives by 372 large US firms and report that 220 firms (59.1 percent) use any category of derivative of which 154 firms (41.4 percent) use currency derivatives. In their empirical tests the characteristics of the sample of currency derivative users (154 firms) are compared with those of the non-users of currency derivatives (218 firms) which include 66 firms (30 percent of the non-user sample) that use derivatives other than currency derivatives. In another study Graham and Rogers (1999) identify 242 firms with ex ante foreign currency exposure, 138 of these use some kind of derivative of which 105 use currency derivatives. Non users of currency derivatives total 137 firms of which 33 firms use derivatives other than currency derivatives.

Most surveys of derivative use tend to show that foreign currency and interest rate derivatives are the most popular categories of derivatives used whereas the use of commodity price derivatives lags far behind in third place. This is usually because only a small proportion of the sample surveyed face commodity price exposure.[19]

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because they have lower levels of information asymmetry (Demarzo and Duffie (1995)) or face lower expected costs of financial distress due to lower proportional bankruptcy costs (see Warner (1977)).

[18] Mian (1996) finds, using difference in means t-tests, that currency hedgers have lower gearing than non-foreign currency hedgers. The non-foreign currency hedgers include firms hedging interest rate and or commodity price exposure. An inspection of Table 5, page 435 in Mian's paper clearly demonstrates that the inclusion of these firms in the non-foreign currency hedging sample increases the mean value of gearing for this group. The inclusion of foreign currency hedgers in the non-interest rate hedging sample decreases the mean value of gearing for this group. Similar results are shown for the debt maturity variable.

[19] Phillips (1995) reports that of those firms with less than $250 million in sales, 86% face interest rate risk, 73% face foreign exchange risk, and 30% face commodity price risk. Among large firms, he reports that 97% face interest rate risk, 91% face foreign exchange rate risk and 63% face commodity price risk.

This suggests that the majority of "other" hedgers in the non-foreign currency hedging samples of the foreign currency studies cited above are likely to be interest rate hedgers. Therefore the existence of interest rate hedgers in both the hedging and non-hedging samples might explain why none of these studies have found statistically significant links between foreign currency hedging and indicators of debt levels and debt servicing ability. Since these variables usually act as proxies for the expected costs of financial distress this might also explain why none of the foreign currency studies find evidence in support of this hypothesis.

Another weakness in these studies is that they fail to recognise that a sample of foreign currency hedgers that includes firms also hedging interest rate exposure engenders bias. This is because tests that investigate links between foreign currency hedging and factors that are potentially more relevant to interest rate hedgers, such as gearing, might be driven by the sample of foreign currency hedgers that also hedge interest rate exposure. This bias could be avoided by excluding these firms as well as those that also hedge commodity price exposure leaving a sample of foreign currency only hedgers.

Tufano (1996) recognises that some of the firms in his sample of gold mining firms might also be managing interest rate and foreign currency exposures but does not account for this in his analysis. Haushalter (1998) examines the extent to which oil and gas producers in the US hedge their commodity price exposures, again these firms may be hedging other exposures. For both the Tufano and Haushalter samples commodity price exposure was by far the larger of the exposures faced. This might mitigate any biases arising from ignoring the hedging of other exposures.

In summary, it seems that for some studies their research design might not have facilitated the collection of the appropriate data to permit them to control the inclusion of other hedgers in the non-hedger sample. However, other studies seem to have the necessary data to identify other hedgers in the non-hedger sample, but they clearly have not recognised this as being a potential problem.

Table 3.4 Composition of Non-hedging Samples in Previous Empirical Studies Investigating Foreign Currency Hedging

Author(s) of Study	Date	Area of Study	Non-hedger sample includes hedgers
Wysocki	1995	Foreign exchange hedgers	Yes
Mian	1996	All hedgers & foreign exchange & interest rate hedgers	Yes
Allayannis and Ofek	1996	Foreign exchange hedgers	Yes
Geczy, Minton & Schrand	1997	Foreign exchange hedgers	Yes
Howton and Perfect	1998	All hedgers & foreign exchange & interest rate hedgers	Yes
Graham and Rogers	1999	Foreign exchange & interest rate hedgers	Yes

3.5 Econometric Methodologies Employed In The Empirical Literature

Section 3.2 contained a discussion and evaluation of the various empirical measures of hedging. These have ranged from a simple binary variable distinguishing between hedging and non-hedging firms to a continuous measure reporting the delta of a firm's risk management portfolio.

The choice of econometric methodology employed in an empirical investigation of corporate hedging is determined largely by the type of data used to measure hedging. The early empirical studies used a dichotomous dependent variable that equalled one if the firm used derivatives or indicated that it hedged and zero otherwise (Francis and Stephan (1993), Nance et al. (1993), Dolde (1995), Wysocki (1996), Mian (1996), Geczy et al. (1997), Fok et al. (1997)). These studies employed logistic regression analyses to determine the likelihood that a firm will hedge given a number of financial and operating characteristics. Effectively these studies examine the determinants of the decision to hedge.

Recent studies have employed a continuous measure of hedging in an attempt to examine the determinants of the decision of how much to hedge (Berkman and Bradbury (1996), Tufano (1996), Allayannis and Ofek (1998), Haushalter (1998), Gay and Nam (1998), Howton and Perfect (1998), Graham and Rogers (1999)). All these studies use Tobit methodology.[20] This methodology effectively sees these two decisions, the decision to hedge and the decision how much to hedge, as being linked. However, the influence of a specific variable on the decision by a firm to hedge could differ from the influence of the same variable on the level of hedging by those firms that have decided to hedge. Therefore, a limitation of the tobit model is that it does not allow the possibility that the relation between characteristics of a firm and the probability it decides to hedge is different from their relation to the extent a firm decides to hedge, if it is hedging. Haushalter (1998), Allayannis and Ofek (1998) and Graham and Rogers (1999) attempt to overcome this limitation by using a variant of the tobit model suggested by Cragg (1971). The Cragg model applies when the probability of a non-limit outcome (e.g., the decision to hedge) is determined separately from the level of the non-limit outcome (e.g., the fraction of exposure to hedge). This model is a combination of a binomial probit (i.e., the decision equation) and a truncated regression (i.e., the regression equation for non-zero outcomes).

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20 Allayannis and Ofek (1996) employ OLS, logit and tobit methodology to estimate the relation between foreign currency derivatives and its determinants. They find that their results are qualitatively similar.

3.6 What Types of Firms are Hedging?

3.6.1 Corporate Tax Liability

Chapter two showed that if a firm faces a convex corporate tax function then the firm's expected tax liability can be reduced by hedging. The tax benefits from hedging will be generally greater as the convexity of the tax function increases. Statutory progressivity and tax preference items make the effective tax schedule convex. Furthermore, firms with more of the range of their pretax income in the progressive region of the tax schedule have greater tax based incentives to hedge.

The existing empirical literature has had difficulty in identifying an appropriate method of measuring the extent of convexity in the corporate tax schedule. Several measures of the firm's effective tax function have been used to test the tax hypothesis such as, tax loss carry forwards, investment tax credits, foreign tax credits and the likelihood of pretax income falling in the progressive region of the tax code. The most popular variable, used in eleven studies, is based on reported tax loss carry forwards. However, there has been much variation (inconsistency) in the type of tax loss variable used. Three studies use actual values of reported tax loss carry forwards[21], four studies scale reported values by firm size, and four use a dummy variable to denote the existence of tax loss carry forwards. A problem with using these kinds of tax loss measures is that such variables imply that firms with existing tax losses have convex tax functions, whereas the Smith and Stulz (1985) argument is about losses that firms expect to experience in the future. Furthermore, Graham and Smith document that existing net operating losses provide a tax disincentive to hedge for firms with small expected losses (if a firm expects to lose money, hedging reduces "right tail" outcomes and the chance that the firm will use its existing net operating

[21] Dolde (1995) does not scale his tax variable because he argues that tax theories of hedging refer to the convexity of the tax system, which is not scale-free.

losses) but provide an incentive to hedge for firms that expect to be profitable. Thus, variables based on existing tax losses are too simple to capture incentives that result from the shape of the tax function, and may even work backwards for expected loss firms. In addition, existing tax losses may measure financial distress rather than a tax incentive to hedge.[22]

Four studies use a dummy variable to indicate that a firm's pre-tax income is expected to lie in the progressive region of the tax schedule (Nance et al. (1993), Mian (1996), Haushalter (1998), and Howton and Perfect (1998)). This variable suffers from the problem that the range of the firm's income in the progressive region may imply other effects, for example, firms with more of the range of their income in the progressive region are more likely to experience financial distress and are generally smaller (Nance et al. (1993). Another concern with the tax progressivity variable is that incomes are measured post-hedging implying that any results should be viewed with caution.

Four studies use investment tax credits as indicators of convexity in the corporate tax schedule (Nance et al. (1993), Allayannis and Ofek (1996), Wysocki (1996) and Fok et al. (1997)). Again there is variation in the type of indicator used. One study uses actual reported values of investment tax credits, another scales reported values by equity value and two use dummy variables. A potential weakness with the investment tax credit variable is that it may proxy for an aspect of the investment opportunity set since only certain types of assets give rise to investment tax credits. Furthermore, three studies use investment tax credits as proxies for tax incentives after the Tax Reform Act of 1986 repealed investment tax credits (Allayannis and Ofek (1996), Wysocki (1996) and Fok et al. (1997)). The samples

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[22] Graham and Rogers (1999) use net operating loss carryforwards to denote the occurrence of recent

investigated in these studies are dated after 1986 and therefore, investment tax credits are unlikely to be an important tax shield.

The aforementioned empirical problems make interpretation of any results more difficult and tests of specific hypotheses less powerful. Table 3.5 summarises the results relating to the tax incentives for hedging and shows that the existing body of empirical evidence provides little support for a tax-based explanation for hedging.[23] This is consistent with the findings of Brown (2001) who reports that corporate treasurers and tax experts indicate that reducing US taxes is not a motivation for currency hedging.

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or current financial distress.

[23] Mian says, "One reason for the weak results with respect to the tax loss carry forward variable is that it is probably a good proxy for a low marginal tax rate, but a poor proxy for the convexity of the tax schedule." Page 431 However, Haushalter claims otherwise. He assumes firms with lower marginal tax rates in the current period are more likely to face non-constant marginal tax rates in future years and, hence are expected to hedge more extensively.

Table 3.5 Summary of Empirical Studies Investigating the Relationship Between Corporate Tax Convexity and Hedging

Table 3.5 summarises the multivariate results of 14 papers that investigate the determinants of corporate hedging. The table identifies the variables used in each paper to test the tax convexity hypothesis. The table reports consistency of evidence for the hypothesis linking corporate hedging to convexity of the corporate tax function, where yes indicates evidence is consistent and no indicates either not consistent or no relationship.

Author(s) of Study	Date	Multivariate Results	Variables Employed ("√" indicates used in study)						
			ATR	TLCF	ITC	FTC	PR	MTR	CON
Francis & Stephan	1993	ATR (No);	√						
Nance, Smith & Smithson	1993	TLCF(No); ITC (No); PR (No);		√	√		√		
Dolde	1995	TLCF (No);		√					
Allayannis & Ofek	1996	TLCF (No); ITC (No);		√	√				
Berkman & Bradbury	1996	TLCF (Yes);		√					
Mian	1996	TLCF(No), PR(No), FTC(Yes);		√		√	√		
Tufano	1996	TLCF (No);		√					
Wysocki	1996	TLCF(No), ITC(No);		√	√				
Fok, Carroll & Chiou	1997	TLCF(No), ITC(No);		√	√				
Geczy, Minton & Schrand	1997	TLCF (No);		√					
Gay & Nam	1998	TLCF(No);		√					
Haushalter	1998	MTR(No), PR(No);					√	√	
Howton & Perfect	1998	TLCF(No), PR(No);		√			√		
Graham & Rogers	1999	CON (No);							√
Total			**1**	**11**	**4**	**1**	**4**	**1**	**1**

Other results:

Nance, Smith and Smithson (1993) find that only the investment tax credit variable is significantly related to the likelihood of hedging (p-values ranging between 5 and 7%). However, if the market value of equity is used to scale the tax preference variables they find no significant relation between hedging and investment tax credits or tax losses. Dolde (1995) finds a significantly positive coefficient (at the 10% level) on the tax loss carry forward variable for the model separating firms into greater and lesser hedgers when they held no view on future financial price changes. Mian (1996) reports a significantly positive coefficient for the foreign tax credit variable. In Haushalter's (1998) truncated model the progressive region dummy variable is significantly positive in several regressions, which is consistent with theory. Howton and Perfect (1998) find that derivatives use (both notional and fair value) is significantly positively related to their tax progressivity dummy.

Key:

ATR = Average Tax Rate; TLCF = Tax loss carry forwards; ITC = Investment tax credits; FTC = Foreign tax credits; PR = Progressive region; MTR = Marginal tax rate; CON = Convexity.

3.6.2 Costs of Financial Distress

The transaction costs of financial distress can induce firms to hedge financial price risks since the probability of incurring the costs is reduced. The savings in expected costs will vary directly with the probability of financial distress if the firm does not hedge and with the costs of financial distress.

Most empirical studies test this hypothesis using measures only for the probability of encountering financial distress (Francis and Stephan (1993), Nance et al. (1993), Allayannis and Ofek (1996), Berkman and Bradbury (1996), Mian (1996), Tufano (1996), Wysocki (1996), Fok et al. (1997), Gay and Nam (1998) and Haushalter (1998)). The two preferred proxies for the pre-hedging probability of financial distress are gearing, which is a measure of the quantity of debt in relation to the size of the business and the interest cover ratio, which is a measure of the firm's ability to service its debt. The lower a firm's interest coverage ratio and the higher its gearing ratio, the greater the probability of financial distress. Table 3.6 shows that two of these studies (Berkman and Bradbury (1996) and Fok et. al. (1997)) find the hypothesised negative association between hedging and interest cover and three studies find a positive relationship between gearing and hedging (Berkman and Bradbury (1996), Gay and Nam (1998) and Haushalter (1998)). The latter three studies employ a continuous measure of hedging and interpret this finding as evidence that greater expected financial distress costs cause more hedging.

When examining the relationship between the costs of financial distress and hedging these studies assume that the sum of ex ante (usually indirect costs such as deterioration in relationships with customers and suppliers) and ex post costs (direct transaction costs such as legal fees) are positively correlated with the probability that the firm enters into financial distress.[24] Therefore, the expected costs of financial distress are predicted to be greater for those firms with higher gearing and or lower interest cover ratios implying that these types of firms have a greater incentive to hedge. However, the use of these variables as proxies for expected financial distress costs does create some concern. These studies assume that exogenous bankruptcy costs are constant across firms and therefore fail to address the possibility that exogenous bankruptcy costs might influence the firm's capital structure choice. For example, a firm with high exogenous bankruptcy costs might choose a low level of debt or conversely, a firm with low exogenous bankruptcy costs might choose a high level of debt. Despite having a higher level of debt implying a higher probability of distress the latter firm may have a smaller incentive to hedge. Although, it is not inconceivable that these two firms might have similar expected costs of financial distress despite having different probabilities of distress.

Dolde (1996), Geczy et al. (1997), Howton and Perfect (1998) and Graham and Rogers (1999) attempt to address this issue. Dolde uses measures for product uniqueness as proxies for financial distress costs but finds statistically insignificant evidence. However, in both univariate and mulitivariate tests he controls for the level of primitive risk and finds statistically significant evidence in support of a positive relationship between gearing and hedging. With no controls in place, the relationship loses its statistical significance. As well as controlling for primitive risk Dolde adopts a second approach in an attempt to model correctly the relationship between hedging and gearing. He designs a direct measure of expected financial distress costs, based on differential credit risk premium corresponding to bond ratings. Dolde calculates for each rating class the spread between its bond yield and 10 year Treasury notes.

[24] The results in Opler and Titman (1994) suggest that leverage is associated with the indirect costs

This spread is referred to as the credit risk spread. Using the spreads on a firm's actual debt issues would obscure credit risk differences with differences in maturity, callability, and covenants. In OLS regressions Dolde finds that gearing has a significant positive effect on his measure of expected financial distress costs[25] and that hedging variables mitigate the effects of gearing on expected financial distress. Howton and Perfect (1998) use the ratio of tangible assets to total assets as a proxy for the direct costs of financial distress but find statistically insignificant evidence. However, they find a strong positive relationship between gearing and hedging Graham and Rogers (1999) also attempt to directly measure expected distress costs by creating a variable that incorporates the probability of financial distress and the indirect costs if distress occurs. They do so by multiplying gearing, which proxies for the probability of financial distress, by the equity market-to-book ratio which proxies for the costs of distress if encountered.[26] They find some evidence showing that the extent of hedging is positively related to this variable.[27] However, they find much stronger evidence in support of a positive relationship between gearing and the extent of hedging.

Geczy et al. conduct additional estimations of their regressions to address the problem of endogeneity of a firm's capital structure, as measured by the long-term debt ratio. They use a firm's S&P credit rating in place of its long-term debt ratio as a measure of expected distress costs. In another robustness check, they assume that firms within specific industries have a common exposure to distress and replace long-term debt ratios with industry adjusted ratios. Their logit results are unchanged by

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of bankruptcy.

[25] This finding seems to suggest that it might not, after all, be inappropriate to use gearing as a proxy for the expected costs of financial distress.

[26] Geczy et al. (1997) use the product of the gearing ratio and the market-to-book ratio as a proxy for underinvestment costs and find a significantly positive relationship between the decision to hedge with foreign currency derivatives and this variable (at the 10% level).

these substitutions, and the coefficient estimates for the credit ratings and the industry-adjusted debt ratio are insignificant. To control for the simultaneity of the capital structure and currency derivatives use decisions, Geczy et al. estimate the determinants of these decisions simultaneously with a two-stage estimation technique. The debt choice equation includes firm characteristics that control for cross-sectional variation in exogenous financial distress costs. Their results suggest that there is no clear association between the decision to use currency derivatives and capital structure choice. Graham and Rogers (1999) also investigate the link between hedging and debt choice using a procedure similar to that used by Geczy et al. However, unlike Geczy et al., they find evidence indicating that high-debt ratios contribute to the incentive to hedge. In their second-stage debt choice regression they find that the predicted extent of hedging is positively related to the debt ratio. They interpret this evidence to imply that hedging increases the debt ratio and consequently increases value through the debt interest tax shield.

The empirical evidence reviewed in this section highlights weaknesses in the variables chosen to test the financial distress hypothesis. Recent studies have attempted to incorporate indicators of financial distress costs although with mixed results. The relationship between hedging and the interest coverage ratio is uniformly weak. An examination of extant empirical research shows that of the 6 studies finding evidence in support of the financial distress cost hypothesis, five employ a continuous measure of hedging. These results might imply that the ability to discriminate between those that hedge a little and those that hedge a lot rather than simply those that hedge and don't hedge is an important factor in detecting a relationship between measures for expected financial distress costs and hedging.

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[27] They find statistically significant findings for their interest rate hedging sample only.

Table 3.6 Summary of Empirical Studies Investigating the Relationship Between Financial Distress Costs and Hedging

Table 3.6 summarises the multivariate results of 14 papers that investigate the determinants of corporate hedging. The table identifies the variables used in each paper to test the expected costs of financial distress hypothesis. The table reports consistency of evidence for the hypothesis linking corporate hedging to financial distress costs, where yes indicates evidence is consistent and no indicates either not consistent or no relationship.

Author(s) of Study	Date	Multivariate Results	Variables Employed ("√" indicates used in study)													
			G	IAG	IC	Z	PU	PE	CRS	CR	ROA	CC	TA	NOL	GMB	PC
Francis & Stephan	1993	G (No);IC (No); Z (No);	√		√	√										
Nance,Smith & Smithson	1993	G (No); IC (No);	√		√											
Dolde	1995	G (Yes); PU (No);	√				√	√	√	√						
Allayannis & Ofek	1996	G (No); ROA (No); Z (No); LIQ (No);	√			√					√					
Berkman & Bradbury	1996	G (Yes); IC (Yes);	√		√											
Mian	1996	FS (No);	√													
Tufano	1996	G (No); CC (No);	√									√				
Wysocki	1996	G (No); IC (No);	√		√											
Fok, Carroll & Chiou	1997	G (No); IC (Yes);	√		√											
Geczy, Minton & Schrand	1997	G (No); IAG (No); CR (No);	√	√	√					√						
Gay & Nam	1998	G (Yes); IC (No);	√		√											
Haushalter	1998	G (Yes); CR (Yes); PC (No);	√							√		√				√
Howton & Perfect	1998	G (Yes); IC (No); TA (No);	√		√								√			
Graham & Rogers	1999	G (Yes); GMB (Weak Yes); ROA (Weak Yes); NOL(No); CR (No);	√							√	√			√	√	
Total			**14**	**1**	**8**	**2**	**1**	**1**	**1**	**4**	**2**	**2**	**1**	**1**	**1**	**1**

Notes:
Dolde (1995) measures product uniqueness using ratios of advertising to sales and selling, general, and administrative costs to sales. Tufano (1996) finds evidence indicating that highly geared firms undertake more risk management, although, this relationship prevails in only one of three years. Graham and Rogers (1999) attempt to directly measure the expected costs of financial distress by interacting multiplicatively gearing which proxies for the probability of financial distress and the equity market-to-book ratio which proxies for the costs of distress if encountered.

Key:
G = Gearing; IAG = Industry adjusted gearing; IC = Interest cover; Z = Z-score; PU = Product uniqueness; ROA = Return on assets; LIQ = Liquidity; FS = Firm size; CC = Cash costs; PC = Production costs; CRS = Credit risk spread; CR = Credit rating; TA = Tangible assets; NOL = Net operating losses; GMB = Gearing-Market-to-book interactive term;

3.6.3 Underinvestment Costs

Chapter two described the circumstances in which a firm might reject positive net present value projects. Myers (1997) refers to this as the underinvestment problem. Several papers have identified hedging as way of mitigating the underinvestment problem (Mayers and Smith (1987), Bessembinder (1991), Dobson and Soenen (1993), and Froot, Scharfstein and Stein (1993)).

Table 3.7 shows that thirteen of the fourteen empirical studies test the underinvestment hypothesis. The two most commonly used proxies have been a firm's market-to-book ratio and R&D expenditures scaled by some measure of firm size, both used in eight studies. Using the market to book ratio to proxy for firm's growth opportunities does not generate support for the underinvestment hypothesis. The only exception is the result in Gay and Nam (1998). All studies using the R&D variable find that these expenditures are positively related to either the decision to hedge or the level of hedging. However, a problem with using R&D is that it can also capture effects other than firm growth. For example, Froot et al. (1993) point out that R&D outlays can also be viewed either as a measure of a firm's intangible assets or of asymmetric information about the quality of new projects. Froot et al. suggest that it might be more difficult for R&D intensive firms to raise external financing (such as borrowings). This is because lenders do not view these firms' assets as quality collateral, or because there is likely to be greater asymmetric information about the quality of the new projects. Also, borrowing constraints that result from this asymmetric information might increase the probability of financial distress. Therefore, in addition to capturing a firm's growth opportunities, R&D expenditure could also be proxying for costly external financing or financial distress costs.

Another problem with the R&D variable according to Allayannis and Ofek (1996) is that in their model the R&D variable loses its explanatory power when they control for factors of foreign currency exposure. They argue that this result supports the notion that R&D expenditures can proxy for multinationality rather than growth options in the firm's investment opportunity set and therefore theories of optimal hedging should be tested while controlling for factors of exposure.[28]

The discussion of hedging theory in chapter 2 predicted more hedging by firms with high gearing and growth options, because these firms are more likely to incur financial distress and that their costs of underinvestment in financial distress will be greater. Furthermore, using the Froot et al. (1993) framework it was argued that the variability of future cash flows had a negative impact on firm value to the extent that it could unexpectedly reduce the amount of internally generated funds, thereby compromising the firm's ability to make value enhancing investments. These arguments suggest that it is not the existence of growth options per se that is the determinant of corporate hedging, but the risk of not undertaking (due to adverse incentives), or not being able to undertake (due to reliance on costly external financing), these investment opportunities drives the hedging decision. The discussion in chapter 2 argued that empirical models should include proxies for both the value of the firm's investment opportunities and its incentives or ability to exploit these investment opportunities. A weakness in several studies in testing the underinvestment hypothesis is their failure to consider the interaction between a firm's investment opportunities and its probability of financial distress or its ability to finance projects from internally generated cash flows. Two recent studies (Geczy et al. (1997) and Gay and Nam (1998)) attempt to address this weakness by designing

[28] Several studies have shown that there is a positive relationship between multinationality and R&D

variables that attempt to specifically examine whether firms with greater investment opportunities and greater financial constraints (for example, higher levels of debt or lower levels of cash) have a greater incentive to hedge, since such firms are more likely to experience financial distress or require costly external finance. Geczy et al. (1997) interact multiplicatively proxies for firm growth opportunities with a firm's long-term debt ratio which proxies for costly external financing.[29] They find that the interaction of the market-to-book ratio and a firm's gearing is significantly positively related to the hedging decision.[30]

Gay and Nam (1998) identify firms facing financial constraints by incorporating cash holdings into their interactive term. They use a dummy variable to identify those firms which they argue are expected to incur the highest costs of underinvestment, namely, those that have high growth opportunities and low levels of cash. Low (high) cash firms are those with cash holdings[31] less (greater) than the Compustat global mean and high (low) growth firms are those with growth higher (less) than the Compustat global mean. Their dummy variable has a value of one if the firm has both low cash and high growth opportunities concurrently. Their evidence shows that firms with enhanced investment opportunities use derivatives more when they also have relatively lower levels of cash. However, a problem with both the Geczy et al. and Gay and Nam interactive variables is that they are incomplete measures of a firm's financial constraint. Pulvino (1997) points out that a large cash balance offsets the debt capacity problem for firms with high gearing since positive NPV investments can be financed from the firm's surplus cash. This implies

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expenditures or other proxies for growth opportunities (see, for example, Pugel (1978)).

[29] Although, Geczy et al. also use the long-term debt ratio to proxy for the probability of financial distress.

[30] Geczy et al. also use the product of gearing and R&D expenditure to test this hypothesis but find no supporting evidence.

that a firm faces the greatest degree of capital constraints when it is both highly geared and it has low cash balances. Therefore, the use of the long-term debt ratio by Geczy et al. is an inappropriate measure for the possibility of not having sufficient internal resources to finance positive NPV investments because some companies might have highly liquid positions at the same time as high levels of debt. It is, therefore, more appropriate to take account of a firm's cash position to avoid an unnecessarily pessimistic view of debt being taken. In the case of Gay and Nam their financial constraint measure ignores gearing and considers cash holdings only, although gearing is included as a separate variable in their model. A potentially more reliable measure of the financial constraint facing a firm is the ratio of net debt to firm value to give a net debt ratio where net debt is defined as total debt minus cash.[32]

Overall, nine studies find some evidence in support of the underinvestment cost hypothesis. The results reviewed in this section indicate that there is evidence which is consistent with the proposition that firms with high underinvestment costs have a greater incentive to hedge.

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[31] Cash holdings are measured as the ratio of cash and short-term investments to total assets as of year end.

[32] Haushalter (1998) uses an indicator of a firm's financial constraint similar to that suggested here. He uses a binary variable that is set equal to one if a firm's gearing ratio is above the sample median and its current ratio is below the sample median. Although, this variable is not interacted with any growth measure.

Table 3.7 Summary of Empirical Studies Investigating the Relationship Between Underinvestment Costs and Hedging

Table 3.7 summarises the multivariate results of 14 papers that investigate the determinants of corporate hedging. The table identifies the variables used in each paper to test the underinvestment hypothesis. The table reports consistency of evidence for the hypothesis linking corporate hedging to underinvestment costs, where yes indicates evidence is consistent and no indicates either not consistent or no relationship.

Author(s) of Study	Date	Multivariate Results	Variables Employed ("√" indicates used in study)															
			R&D	G[R&D]	MTB	G[MTB]	DY	PE	AG	REG	CAPEX	TQ	CAR	DP	CR	DC	FS	CF
Francis & Stephan	1993	Hypothesis not examined																
Nance,Smith & Smithson	1993	R&D (Weak yes); BTM (No);	√		√													
Dolde	1995	R&D (Yes);	√															
Allayannis & Ofek	1996	R&D (Yes); MTB (No); DY (No);	√		√		√											
Berkman & Bradbury	1996	EP (No); AG (No);						√	√									
Mian	1996	MTB (No); REG (Yes);			√					√								
Tufano	1996	CAPEX (No);									√							
Wysocki	1996	BTM (No);			√													
Fok, Carroll & Chiou	1997	R&D (Yes); MTB (No);	√		√													
Geczy, Minton & Schrand	1997	R&D (Yes); G[R&D] (No); MTB (No); G[MTB] (Yes);	√	√	√	√					√							
Gay & Nam	1998	R&D (Yes); CAR (Yes); TQ (Yes); PE (Yes); MTB (Yes);	√		√			√				√	√					
Haushalter	1998	CAPEX(Weak yes);DC(Weak yes);CR(Yes);DP(Weak yes);FS (No)									√			√	√	√	√	
Howton & Perfect	1998	R&D (Yes); CF (Yes);	√															√
Graham & Rogers	1999	R&D (Yes); MTB (No); CAPEX (No); G[MTB] (Weak yes);	√		√	√					√							
Total			8	1	8	2	1	2	1	1	4	1	1	1	1	1	1	1

Key:

R&D = Research & development expenditure ratio; G[R&D] = Gearing and R&D interaction term; MTB = Market-to-book ratio; G[MTB] = Gearing and MTB interaction term; DY = Dividend yield; PE = Price-earnings ratio; AG = Asset growth; REG = Regulated industry; CAPEX = Capital expenditure; TQ = Tobins Q; CAR = Cumulative abnormal return; DP = Dividend payout; CR = Credit rating; DC = Debt constraint; FS = Firm size; CF = Cash flow.

3.6.4 Managerial Risk Aversion

Chapter 2 argues that risk aversion among managers can provide an incentive to hedge.[33] The firm's managers are unable to diversify risks specific to their claims on the firm. For example, their human capital claim is not so divisible and diversifiable as financial claims. Since managers are risk averse they attach higher discount rates to their cash flow claims and therefore, require extra compensation when faced with the nondiversifiable risk of their claims. Hedging reduces the risk exposure of the manager and therefore can lead to lower equilibrium managerial compensation. As long as the reduction in the required compensation exceeds the cost of hedging, it can be value maximising for the firm to hedge.

The Smith and Stulz (1985) model predicts that managers with greater share ownership are likely to hedge more since the shares provide linear payoffs as a function of share price. Managers with a concentration of share option holdings prefer less risk management because options introduce convexity between managerial wealth and share value, which offsets the concavity in the manager's utility function. This lowers the degree of the manager's risk aversion and reduces his or her incentive to hedge.

Table 3.8 shows that eight studies investigate whether managerial risk aversion influences hedging activity. To analyse whether the level and form of managerial equity stakes affect the hedging decision most studies use data on the number of shares and the number of options owned by the firms senior management. For equity ownership three types of variables have been employed. Two studies use the value of shares held by directors (Wyoscki (1996) and Fok et al. (1997)), two studies use the fraction of shares outstanding held by directors (Berkman and Bradbury (1996), and

[33] See, for example, Amihud and Lev (1981), Stulz (1984), and Smith and Stulz (1985).

Haushalter (1998)), and five studies use the log of the dollar value of shares owned (Tufano (1996), Geczy et al. (1997), Gay and Nam (1998), Haushalter (1998), and Graham and Rogers (1999)). The log specification is superior to the other measures because it reflects the notion that risk aversion should decline as wealth increases. However, a weakness in this proxy is that it assumes total managerial wealth is constant across managers in all firms and that the size of the management team is constant across all firms. A more appropriate proxy would be one that measures the percentage of total managerial wealth invested in the firm. Of the eight studies assessing whether shares owned by managers influences their hedging activity only Tufano (1996) and Graham and Rogers (1999) find that hedging increases with managerial shareholdings.

To test the affect of managerial option ownership on the hedging decision four studies use the number of options outstanding to measure the extent of option ownership (Tufano (1996), Gay and Nam (1998), Haushalter (1998) Graham and Rogers (1999)). Geczy et al. (1997) use the log of the market value of shares obtainable by outstanding options. Tufano (1996) and Haushalter (1998) find evidence that hedging decreases with managerial option ownership. However, the measures employed in these studies represent a crude proxy for convexity of the compensation function created by share options, since it is incorrectly assumed that all share options held by managers provide the same incentive effects. The disincentives related to hedging are greatest when the options are out of the money.[34]

For options, the ideal measure is the delta of a manager's exercisable options (i.e., their sensitivity to a change in the price of the underlying share) or these options' vega (i.e., their sensitivity to a change in the standard deviation of the underlying share). These sensitivities determine the effect share options will have on the convexity of the relation between the managers' wealth and a firm's value. For example, all else equal, the wealth of a manager whose option holdings are deep in the money will not be as sensitive to a change in the underlying risk of a firm's equity as one whose options holdings are slightly out of the money. Smith and Stulz's (1985) prediction that the existence of managerial share option schemes reduce managers' incentives to reduce a company's risk is based on the degree of convexity in the managers' incentive scheme provided by share options.

Overall, the empirical evidence provides only weak support for the managerial risk aversion hypotheses. The might be due in part because the variables employed may not measure precisely the incentive effects of share and option holdings.[35]

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[34] In some of these studies it is documented that firms do not consistently publish information on exercise prices and expiration dates of executive options making it impossible to determine if the options are in or out of the money.

[35] Graham and Rogers (1999) attempt to correct for this by calculating the more sophisticated delta and vega variables, which measure the change in a manager's wealth as share price and volatility change, respectively, given his or her share and option holdings. However, they find that these variables are not significantly related to the hedging decision.

Table 3.8 Summary of Empirical Studies Investigating the Relationship Between Managerial Risk Aversion and Hedging

Table 3.8 summarises the multivariate results of 14 papers that investigate the determinants of corporate hedging. The table identifies the variables used in each paper to test the managerial risk aversion hypothesis. The table reports consistency of evidence for the hypothesis linking corporate hedging to managerial risk aversion, where yes indicates evidence is consistent and no indicates either not consistent or no relationship.

Author(s) of Study	Date	Multivariate Results	Variables Employed ("√" indicates used in study)				
			S	OP	BL	BN	AGE
Francis & Stephan	1993	Hypothesis not examined.					
Nance,Smith & Smithson	1993	Hypothesis not examined.					
Dolde	1995	Hypothesis not examined.					
Allayannis & Ofek	1996	Hypothesis not examined.					
Berkman & Bradbury	1996	S(No); BN (No); AGE (No);	√			√	√
Mian	1996	Hypothesis not examined.					
Tufano	1996	S(No);	√				
Wysocki	1996	S(Yes); OP (Yes); BL (Yes);	√	√	√		
Fok, Carroll & Chiou	1997	S (No);	√				
Geczy, Minton & Schrand	1997	S(No); OP (No);	√	√			
Gay & Nam	1998	S(No); OP (No);	√	√			
Haushalter	1998	S(No); OP (Yes & No); BL (Weak yes);	√	√	√		
Howton & Perfect	1998	Hypothesis not examined.					
Graham & Rogers	1999	S (IR sample yes); OP (No);	√	√			
Total			**8**	**5**	**2**	**1**	**1**

Key:
S = Share holdings; OP = Option holdings; BL = Outside blockholders; BN = Bonus compensation; AGE = Age of CEO;

3.6.5 Cash Flow Volatility

The likelihood of hedging or the level of hedging activity should be positively related to the need to reduce risk. Chapter two identifies the need to reduce risk by highlighting which factors make cash flow or income volatility costly. Furthermore, the analysis recognises that the more volatile cash flows are the more costly these factors become. It follows from this that the need to reduce risk also depends on the level of cash flow volatility faced by the firm. Therefore, firms with more volatile operating income are more likely to hedge to reduce risk. The results of the 1995 Wharton/CIBC Wood Gundy Survey of Derivatives Usage indicate that 91% of derivative users cite volatility in cash flows or earnings as the most important reasons for using derivatives.

Clearly then it is important to control for the size of a firm's cash flow variability when assessing the determinants of corporate hedging. However, Table 3.9 shows that four studies make no attempt to capture the effect of cash flow volatility on the firm's hedging decision (see Francis and Stephan (1993), Nance et al. (1993), Mian (1996) and Gay and Nam (1998)).

Several studies address this weakness by attempting to control for the level of cash flow volatility across firms. Three approaches have been followed by the literature. The first approach is to use a measure of cash flow volatility (Titman and Wessels (1988) and Dolde (1995)). This measure of risk should be constructed in a manner that is independent of both gearing and hedging. Titman and Wessels (1988) use operating income to derive a volatility measure independent of financial policies in explaining gearing. Dolde (1995) uses the standard deviation of the ratio of past operating income before depreciation to book value of assets to measure the variability in operating income.[36] A problem with this is that it is an ex post measure of risk, while management's decision to hedge is based on expected risk exposure. Furthermore, Nance et al. (1993) point out that since hedging reduces cash flow volatility, there may not be any difference in volatilities between hedgers and non-hedgers ex post, which is what they find.[37] Another problem is that the relevant measure of operating income is pre-hedging earnings before interest and tax (EBIT). Under current hedge accounting rules, gains and losses from hedging activities are recorded in the consolidated statements of income as adjustments to revenue or the

36 Scaling by the book value of assets separates exposure effects from those of firm size.

37 Hentschel and Kothari (1994) analyse the risk characteristics of large US firms and find that there is little difference between users and non-users of foreign currency derivatives in their exchange rate

cost of the underlying physical transaction. However, for most firms, hedging gains or losses are not specifically identified as such. Instead, they are embedded in conventional measures of a firm's cash flow based on net profit or EBIT, and cannot be separated because of disclosure limitations. For example, for currency and commodity derivatives, the risk that is being hedged is typically associated with operations, so the gains or losses on these derivatives are reflected in EBIT.[38] But it is not possible in most cases to adjust this EBIT cash flow to a pre-risk management basis by adding (subtracting) back in derivatives losses (gains), since this information is not separately reported. Therefore, the consolidation of the effects of hedges with the corresponding operating cash flows makes the volatility of operating income an understatement of risk.[39]

Gay and Nam (1998) recognise this problem when testing the hypothesis that firms with greater correlation between cash flows and investment expenses will use derivatives less. They note that the risk hedged by interest rate derivatives is associated with interest expense. Interest expense items are reported after EBIT and therefore, EBIT provides a clean measure of pre-risk management cash flow for interest rate derivative users. Therefore in testing this hypothesis Gay and Nam construct a sample of user firms that use only interest rate derivatives. This restriction ensures a more accurate examination of the impact on the hedging decision of the correlation between internally generated cash flows (pre-risk management) and investment expenses.

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exposures. Similarly, Allayannis and Ofek (1996) find that, controlling for the level of foreign sales, the higher the use of foreign currency derivatives by a firm, the lower its exchange rate exposure.

[38] In the commodity based industries derivative contracts affect operating income in that sales revenue is a function of the delivered commodity price. Therefore, volatility of operating income would not be appropriate since it would understate the level of risk. See Tufano (1996), page 1117.

[39] Dolde (1995) notes that there is no standard practice among firms on whether hedging gains and losses appear with operating cash flows or with interest, investments and miscellaneous income. Therefore, in an attempt to exclude the effects of (derivatives) hedging from his volatility measure,

A second approach to control for cash flow volatility is to use regression analysis. Dolde (1995) derives separate measures for foreign exchange, interest rate, and commodity price risk as the absolute values of the coefficients from a regression of scaled operating income before depreciation on returns on corresponding indexes: the foreign exchange value of the dollar, the secondary market yield on 3 month Treasury bills, and the producers price index for crude materials for further processing. However, previous research (Jorion (1990), Amihud (1994) and Bodnar and Gentry (1993)) has found that U.S. firms with foreign operations or exports or imports were not significantly affected by exchange rate movements. Furthermore, Allayannis and Ofek (1996) find that, controlling for the level of foreign sales, the higher the use of foreign currency derivatives by a firm, the lower its exchange rate exposure. These findings suggest that firms make extensive use of foreign currency derivatives and other hedging instruments (e.g. foreign debt) to protect themselves from the unexpected movements of the exchange rates. Therefore, to the extent that firms fully cover their exposure to exchange rate movements, we should not expect to find any effect of exchange rate movements on firms' values.

Dolde (1995) measures a firm's economic exposure by capturing the sensitivity of a firm's operations to interest rate cycles such as those experienced by builders, construction companies, or manufacturers of durable goods. An inherent weakness in this is that it does not measure interest rate risk due to financing decisions, such as the interest rate profile or maturity structure of debt. This is important because interest rate hedging firms tend to hedge the latter exposure rather than the former. Fenn, Sharpe and Post (1996) find no evidence that firms hedge their economic exposure to interest rate risk. Additionally, firms responses to recent surveys (Bodnar et al. (1995)

Dolde uses operating income data for the period 1973 – 86, during which corporate use of derivatives was minimal.

and Phillips (1995)) indicate that firms mostly hedge certain commitments and/or anticipated commitments, and, to a lesser extent economic exposure.

The third approach to measuring the magnitude of a firm's cash flow volatility (and hence its need to hedge) is to use sources of potential cash flow volatility rather than measuring volatility directly.[40] The most common source of cash flow variability used in previous studies is some indicator of a firm's foreign currency exposure. Six studies employ at least one variable proxying for foreign currency exposure. Four of these use these variables exclusively to examine the determinants of foreign currency hedging (Wysocki (1996), Allayannis and Ofek (1996), Geczy et al. (1997) and Graham and Rogers (1999)). One study uses a foreign currency exposure variable in each of the models that separately examine the determinants of all hedging, interest rate hedging and foreign currency hedging (Howton and Perfect (1998)) and finally, one study includes a foreign currency exposure variable when testing the determinants of all hedging (Berkman and Bradbury(1996)).

Factors that could expose the firm to exchange rate movements are, for example, foreign income or sales from operations abroad, exports, imports and foreign competitors. Geczy et al. (1997) use the percentage of a firm's income from foreign operations to control for foreign exchange exposure. Income represents the net of foreign-denominated revenues, and also the direct and indirect expenses, which may be foreign denominated, related to foreign operations. This is their preferred measure, because to the extent that costs are a natural hedge of foreign revenues, net profit represents the underlying exposure to foreign currency risk. However, this is a transaction exposure if it is repatriated, otherwise it remains as a translation exposure. Also each of the foreign subsidiaries might have its own foreign exchange exposure

[40] That is, identify the factors that might give rise to cash flow volatility.

and its (i.e., the subsidiary) income would then be sensitive to changes in exchange rates. There is also the possibility that to some extent, the foreign exchange exposure of the foreign subsidiaries and of the parent may be offsetting.

Allayannis and Ofek (1996) employ a similar variable to that of Geczy et al. but find its explanatory power is eliminated when they use a foreign sales variable in their OLS regressions. Foreign sales might be a more appropriate factor of foreign exchange exposure because foreign income is a very noisy proxy for net foreign cash flows and exposure, given the effective use of transfer pricing by multinationals for tax allocation purposes. Allayannis and Ofek find strong support for the hypothesis that the factors that expose a firm to exchange rates are important determinants for the use of foreign currency derivatives. In particular, they find that the percentage of foreign sales is the most significant factor in explaining the use of foreign currency derivatives. Imports and exports in total sales are also an important factor.

Overall, these findings are consistent with the arguments that the benefits of hedging are greatest and the costs lowest for firms with extensive foreign exchange rate exposure.

Table 3.9 Summary of Empirical Studies Investigating the Relationship Between Measures of Cash Flow Volatility and Hedging

Table 3.9 summarises multivariate results for 14 papers that investigate the determinants of corporate hedging. The table identifies the variables used in each paper to test the cash flow volatility hypothesis. The table reports consistency of evidence for the hypothesis linking corporate hedging to measures of firm risk, where yes indicates evidence is consistent and no indicates either not consistent or no relationship.

Author(s) of Study	Date	Multivariate Results	Variables Employed ("√" indicates used in study)												
			FXS	FXA	FXI	FXT	FXD	IMP	TR	FXR	IRR	CPR	DIV	FLT	IES
Francis & Stephan	1993	Hypothesis not examined													
Nance, Smith & Smithson	1993	Hypothesis not examined													
Dolde	1995	TR (Yes); FXR (Weak yes); IRR (No); CPR (Weak yes);							√	√	√	√			
Mian	1996	Hypothesis not examined													
Wysocki	1996	FXS (Yes); FXT (Yes); IMP (No);	√			√		√							
Allayannis & Ofek	1996	FXS (Yes); FXI (No); IMP (Yes); IES (Yes);	√		√			√							√
Berkman & Bradbury	1996	FXA (No);	√	√											
Tufano	1996	All firms exposed to gold price volatility													
Fok, Carroll & Chiou	1997	DIV (No);											√		
Geczy, Minton & Schrand	1997	FXI (Yes); FXD (Yes); IMP (Yes);	√	√	√		√	√							
Gay & Nam	1998	Hypothesis not examined													
Haushalter	1998	All firms exposed to oil and/or gas price volatility.													
Howton & Perfect	1998	FXI (Yes);			√										
Graham & Rogers	1999	FXS (Weak yes); FLT (Yes);	√											√	
Total			**5**	**2**	**3**	**1**	**1**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Notes:
Wysocki (1996), Allayannis and Ofek (1996), Geczy et al. (1997) and Graham and Rogers (1999) use foreign currency exposure variables only when investigating foreign currency hedgers.Dolde (1995), Berkman and Bradbury (1996) and Howton and Perfect (1998) use foreign currency exposure variables across all samples investigated.

Key:
FXS = Foreign currency sales; FXA = Foreign currency assets; FXI = Foreign currency income; FXT = Foreign currency taxes; FXD = Foreign currency debt; IMP = Import share; TR = Total risk; FXR = Foreign currency risk; IRR = Interest rate risk; CPR = Commodity price risk; DIV = Diversification; FLT = Floating rate debt; IES = Industry export share;

3.6.6 Substitutes for Hedging

The analysis in chapter two identifies two types of risk management strategy. It shows that firms can pursue either risk reduction or cost reduction strategies. The discussion suggests that hedging via derivatives is one of several methods of lowering the volatility of cash flows and that alternative strategies can be considered as substitutes for derivative type strategies. Additionally, firms can adopt cost reduction strategies which effectively make inconsequential the effect of cash flow volatility on firm value. For example, a firm could diversify and thus lower cash flow volatility (a risk reduction strategy) or lower its gearing leaving cash flow volatility unchanged (a cost reduction strategy). In both cases the probability of financial distress would fall. Firms adopting these alternative financial policies or substitute risk management activities will have a smaller incentive to engage in risk management with derivatives (or hedging). Tufano (1996) points out that these policies "are not so much explanations for financial risk management, but rather controls for substitute forms of risk management" (pg. 1112).

Table 3.10 shows twelve studies consider the existence of alternative forms of risk management on the decision to hedge with derivatives. The most commonly used financial policy variable is a measure of a firm's liquidity, employed in ten studies. Nance et al. (1993) argue that firms can reduce the probability of financial distress by investing in more liquid assets since it helps to assure bondholders that funds will be available to pay fixed claims. Froot el al. (1993) also predict a negative association between liquidity and hedging. However, this prediction results from interpreting liquidity not as an offset for debt, but as a measure of the availability of internal funds.

Although most studies employ liquidity there is variation in how liquidity is measured. A few studies measure liquidity as current assets over current liabilities usually referred to as the current ratio (Nance et al. (1993), Mian (1996), and Fok et al. (1997)). However, this is not an effective measure for a firm's short-term liquidity because the numerator includes all short-term assets, such as inventory. The quick ratio is preferred in several studies because it measures a firm's ability to repay short-term operating liabilities with readily available cash (Berkman and Bradbury (1996), Tufano (1996), Geczy et al. (1997), Howton and Perfect (1998) and Graham and Rogers (1999)). The numerator of the quick ratio differs from that of the current ratio by including only cash and marketable securities, rather than all short-term assets. Table 3.10 shows that of the two studies using the current ratio in their multivariate tests the Fok et al. study finds weak evidence in support of a negative relationship between hedging and liquidity. Three of the four studies employing the quick ratio find supporting evidence for liquidity being interpreted as a substitute for risk management. These results seem to demonstrate that the quick ratio is a more effective measure of a firm's liquidity. However, converting some short-term assets, such as marketable securities can create information costs similar those related to debt financing, therefore a measure using only cash might capture the concept of internal wealth used in Froot et al. (1993) better than the quick assets ratio.

Other methods of reducing the probability of financial distress could include imposing dividend restrictions (Nance et al. (1993)). As argued in chapter 2 a lower dividend payout makes it more likely that funds will be available to service the firm's debt payments and therefore the lower the likelihood of the firm hedging. Although other arguments in chapter 2 suggest that companies facing liquidity constraints might pay little or no dividends (Haushalter (1998)). Therefore, low dividends might imply liquidity constraints and more hedging indicating a negative association between dividend payout and hedging.

It is interesting to note that although Nance et al. (1993) and Geczy et al (1997) discuss the issue of substitute financial policy in terms of the dividend payout ratio, they and three other studies use the dividend yield to test this hypothesis (Wysocki (1996), Fok et al (1997), and Graham and Rogers (1999). A problem with using the dividend yield is that it could be proxying for both growth opportunities (a price-earnings effect) and dividend restrictions (a dividend payout effect).[41] Berkman and Bradbury address this by using the dividend payout ratio in their multivariate tests. Haushalter also employs the dividend payout ratio but argues that it proxies for a liquidity constraint rather than a hedging substitute. Table 3.10 reveals that only two studies (Nance et al (1993) and Berkman and Bradbury (1996)) find support for the hypothesis that firms restrict dividends to make hedging unnecessary. Overall, the existing evidence implies a weak association between hedging and dividend policy.

The theoretical literature discussed in chapter 2 provides two competing hypotheses with respect to the relationship between hedging and the use of convertible debt and preference capital. Nance et al. (1993) argue that convertible debt helps control conflicts of interest between shareholders and bondholders and preference capital decreases the probability of financial distress and therefore they both reduce the incentive to hedge. In contrast, Froot et al.'s (1993) analysis suggests given that preference capital and convertible debt are interpreted as increasing the firm's level of debt they both act to limit the availability of external finance and potentially impose higher costs of underinvestment. This implies a positive association between hedging and these forms of capital. Table 3.10 shows that the existing empirical evidence provides no support for either of these hypotheses.

[41] Allayannis and Ofek (1996) use dividend yield to proxy for growth options in the firm's investment opportunity. Dividend yield is the product of the earnings-price ratio and the dividend payout ratio.

Table 3.10 Summary of Empirical Studies Investigating the Relationship Between Hedging Substitutes and Hedging

Table 3.10 summarises multivariate results for 14 papers that investigate the determinants of corporate hedging. The table identifies the variables used in each paper to test the substitutes for hedging hypothesis. The table reports consistency of evidence for the hypothesis linking corporate hedging to alternative risk management strategies, where yes indicates evidence is consistent and no indicates either not consistent or no relationship.

Author(s) of Study	Date	Multivariate Results	Variables Employed ("√" indicates used in study)							
			CD	PC	LIQ	DY	DP	DM	DIV	CFIC
Francis & Stephan	1993	Hypothesis not examined.								
Nance, Smith & Smithson	1993	CD (No); PC (No); LIQ (No); DY (Yes);	√	√	√	√				
Dolde	1995	Hypothesis not examined.								
Mian	1996	Univariate tests only.			√	√	√	√		
Wysocki	1996	CD (No); PC (No); DY (No);	√	√		√				
Allayannis & Ofek	1996	LIQ (No);			√					
Berkman & Bradbury	1996	CD & PC (No); LIQ (No); DP (Yes);	√	√	√		√			
Tufano	1996	LIQ (Yes); DIV (No);			√				√	
Fok, Carroll & Chiou	1997	CD (Weak yes); PC (No); LIQ (Weak yes); DY (No); DIV (No);	√	√	√	√			√	
Geczy, Minton & Schrand	1997	LIQ (Yes);			√		√			
Gay & Nam	1998	CD (No); PC (No); CFIC (Yes);	√	√						√
Haushalter	1998	LIQ (No); DP (No); DIV (No);			√		√		√	
Howton & Perfect	1998	CD & PC (No); LIQ (Yes);	√	√	√					
Graham & Rogers	1999	DY (No);				√				
Total			**6**	**6**	**9**	**5**	**4**	**1**	**3**	**1**

Notes:

Geczy et al. (1997) interpret liquidity as a measure of the availability of internal funds and not as a substitute for long-term debt. Gay and Nam (1998) use a cash stocks variable in their dummy interaction variable. This is defined as cash plus short-term investments over total assets. They do not use liquidity in their model. In univariate tests Mian (1996) finds that hedgers issue more longer term debt (currency hedgers issue less long-term debt), have lower liquidity, higher dividend yield, and higher dividend payout. In Graham and Rogers (1999) liquidity is used in the univariate tests only and dividend yield is used in the foreign currency model only.

Key:

CD = Convertible debt; PC = Preference capital; LIQ = Liquidity; DY = Dividend Yield; DP = Dividend Payout; DM = Debt maturity; DIV = Diversification; CFIC = Cash flow investment correlation;

3.6.7 Firm Size

Chapter two argues that the empirical relation between the hedging decision and firm value is indeterminant. Economies of scale in the costs of hedging might act as a barrier for small firms to engage in hedging activity, implying a positive empirical relationship between hedging and firm size. Conversely, the costs of raising capital or the direct costs associated with financial distress imply a negative empirical relation.

Table 3.11 shows that most prior studies find that the likelihood of using derivatives increases with firm size.[42] A positive size effect is consistent with firms not hedging with derivatives unless the benefits are larger than the fixed costs of establishing a hedging program. In contrast, Haushalter (1998) finds a negative relation between size and hedging, given that a firm hedges. Conditional on hedging, a negative relation is consistent with the extent of hedging increasing with informational asymmetry and financial distress costs.

Table 3.11 Summary of Empirical Studies Investigating the Relationship Between Firm Size and Hedging

Table 3.11 summarises the multivariate results of 14 papers that investigate the determinants of corporate hedging. The table identifies the variables used in each paper to test the relationship between firm size and hedging. The table reports consistency of evidence for the hypothesis linking corporate hedging to firm size, where yes indicates evidence is consistent and no indicates either not consistent or no relationship.

Author(s) of Study	Date	Multivariate Results	Variables Employed ("√" indicates used in study)				
			TA	MVE	TS	DE	RES
Francis & Stephan	1993	TS(Yes);	√	√	√		
Nance, Smith & Smithson	1993	DE (Yes);				√	
Dolde	1995	TS(No);			√		
Wysocki	1995	DE (Yes);				√	
Allayannis & Ofek	1996	TA (Yes);	√				
Berkman & Bradbury	1996	DE (Yes);				√	
Mian	1996	DE (Yes);				√	
Tufano	1996	DE (No); RES(No);				√	√
Wysocki	1996	DE (Yes);				√	
Fok, Carroll & Chiou	1997	DE (Yes); TA(Yes); TS(Yes);	√		√	√	
Geczy, Minton & Schrand	1997	DE (Yes);				√	
Gay & Nam	1998	DE (No) –ve;				√	
Haushalter	1998	TOBIT (No); PROBIT (Yes); TRUNC (Yes -ve);				√	
Howton & Perfect	1998	MVE (No);					
Graham & Rogers	1999	TOBIT (Yes); PROBIT (Yes); TRUNC (Yes -ve);	√				
Total			**4**	**1**	**3**	**10**	**1**

Notes:

Dolde (1995) finds that among hedgers larger firms tend to hedge less fully than do smaller firms when they have a view on market direction.

TOBIT=Tobit regression results, PROBIT=Probit regression results, TRUNC=Truncated regression results.

Key:

TA = Total assets; MVE = Market Value of Equity; TS = Total Sales; DE = Book Value of Debt plus Market Value of Equity; RES = Gold Reserves.

[42] In tests for difference in means or medians the majority of studies find that hedgers are larger than non-hedgers (significant at the 1 percent level). However, one study does find that more extensive hedgers are smaller than less extensive hedgers (significant at the 5 percent level).

3.7 Conclusion

This chapter has reviewed the extant empirical research on the determinants of corporate hedging. The review began by looking at how hedging has been defined in the empirical literature. Methodologies employed in several studies did not directly distinguish between derivatives use and risk reduction. So that by equating "hedger" with "derivative user," a derivative user would be classified as a hedger, while a functionally equivalent non-derivative user would be classified as a non-hedger. To avoid this incorrect distinction it was argued that tests should include both on and off-balance sheet risk management activity in the definition of hedging.

Several recent studies have employed a continuous measure of hedging activity using notional contract values of the derivatives outstanding at the year end scaled by some measure of firm size. This measure has been employed on the assumption that it gives an indication of the extent of risk management undertaken. However, this variable is at best a rough approximation of the extent of hedging since it fails to scale by the size of the firm's underlying financial price exposure. Notwithstanding this, given the non-availability of precise data in the public domain on the size of a firm's underlying exposure, there are still insights to be gained from using a measure that scales by firm size. Furthermore, despite the limitations, the evidence shows that this type of continuous dependent variable helps in identifying relationships between hedging and firm level characteristics.

The majority of empirical studies examine derivatives use and not hedging specifically and therefore the dependent variable might measure speculation rather than hedging. The evidence indicates that non-financial firms use derivatives mainly for hedging rather than for speculation.

The chapter identified a potential flaw in several studies that have examined the hedging of specific types of financial price exposure. This was the inclusion of firms hedging other exposures in the sample of non-hedgers in studies that examined the determinants of interest rate hedging, foreign currency hedging and commodity price hedging. The inclusion of other hedgers in the non-hedging sample might eliminate any differences between hedgers and non-hedgers and therefore bias the empirical tests. It was argued that the research design should facilitate the identification of the types of exposures hedged by firms in order to correct for the inclusion of other hedgers in the non-hedger sample.

The chapter also argued that tests examining the relationship between foreign currency hedging and factors such as gearing and interest cover, which are generally considered more relevant to interest rate hedging firms, might be biased. This is because results showing a significant relationship might be due to a sample of foreign currency hedging firms that also hedge interest rate exposure. It was suggested that employing a sample of foreign currency only hedgers could eliminate this bias.

This chapter has documented that the existing empirical evidence provides mixed support for the various hypotheses advanced to explain hedging activity. The chapter evaluates the current empirical research and finds support for hypothesis relating to the expected costs of financial distress, underinvestment and costly external finance, liquidity as a means of reducing the costs of risk, cash flow volatility and information and transaction cost scale economies.

Previous studies provide little support for the tax convexity hypothesis, the use of convertible debt, preference capital or dividend policy as alternative forms of risk management, and the managerial risk aversion hypothesis. In some instances the chapter has argued that the inconclusiveness of the results is possibly due to the inappropriate choice of proxy variables. For example, the variables employed to test the managerial risk aversion hypothesis may not measure precisely the incentive effects of share and option holdings. In other instances, where the findings provide mixed support, further consideration should be given to variable choice. For example, the review has established that it is important to use accurate proxies for a firm's expected costs of financial distress as well as indicators of its investment opportunities and the financial constraints faced by the firm. For example, several studies use indicators of the probability that a firm will enter into financial distress as a proxy for expected financial distress costs. In doing so these studies assume that exogenous bankruptcy costs are constant across firms and hence fail to address the possibility that exogenous bankruptcy costs might influence the firm's capital structure choice. Some studies use the level of debt as a measure of the financial constraint faced by a firm. However, it was suggested that a large cash balance offsets the debt capacity problem for firms with high gearing since investments can be financed from the firm's surplus cash. Therefore, it is argued that a firm faces the greatest degree of financial constraint when it is both highly geared and it has low cash balances.

This chapter has identified a number of additional research issues, expressed in the form of question, which require consideration in order for an empirical investigation to be undertaken. The questions are:

1. Where can data on hedging activities be sourced?
2. What methods of hedging data are available and are they adequate to provide a valid test of the various hypotheses on the determinants of hedging and the extent to which hedging takes place?

3. What types of exposure should be investigated (i.e., interest rate, foreign currency, commodity price)?
4. How is hedging measured?
5. Are firms hedging or speculating?
6. How is tax convexity measured?
7. How is managerial risk aversion measured?
8. How is the magnitude of a firm's cash flow volatility measured?
9. How is the use of alternative forms of risk management controlled for?

In summary, the review has demonstrated that there is a gap in the empirical literature since most of the empirical research on corporate hedging has been conducted using samples of United States firms. Currently, there is no study investigating the determinants of corporate hedging using UK firm level data. The review of the empirical literature has argued that the research designs of several studies are flawed because they include other hedgers in their non-hedging samples. The discussion has also suggested that the financial distress hypothesis and the underinvestment cost hypothesis have not been adequately tested. Chapter 4 examines how this thesis deals with these criticisms and how it attempts to answer the research questions identified above.

Chapter 4. Data Collection, Sample Characteristics and Description of Endogenous and Exogenous Variables

4.1 Introduction

The review of the empirical literature clearly demonstrated that several factors have been considered by the empirical literature as potential determinants of corporate hedging activity. The review also showed that many variables have been employed as proxies in testing the empirical validity of these factors, with varying degrees of success. The analysis in Chapter 3 also identified a number of criticisms and research questions on which the research reported in the thesis is focussed.

This chapter considers the methods employed to deal with the issues raised in chapter 3. The discussion is divided into four sections.

The first section describes how the firm sample was constructed. It then goes onto discuss where data on corporate hedging was sourced, explains how this data was collected and discusses the type of data collected.

The second section presents an analysis of the information on hedging activity sourced from annual reports and that obtained from a survey to Corporate Treasurers. This section begins by examining the disclosure of corporate hedging activity and derivatives use in annual reports. The discussion incorporates a detailed investigation of the qualitative disclosures of interest rate and foreign exchange hedging activity. This is followed by an analysis of the data obtained by the survey to corporate treasurers. This analysis also compares and contrasts the survey data with the annual report data.

The third section describes the two dependent variables employed in this study. The fourth section describes the independent variables. Finally, the chapter concludes by summarising the main findings and the impact they have for the focus of the thesis.

4.2 Method of Data Collection

This section discusses the construction of the database of risk management practices of UK non-financial firms. We explain the choice of sample firms and describe the data collection process.

4.2.1 Sample

In common with several of the studies reviewed in chapter 3, this thesis empirically investigates the determinants of corporate hedging using a sample of large UK firms. The sample is constructed from the Financial Times list of the United Kingdom FT500 which lists the 500 largest UK companies quoted on the London Stock Exchange, ranking a company by its market capitalisation. The sample is restricted to non-financial firms. Firms from the financial services sector are excluded from the sample because their risk management activities include both hedging and speculative transactions whereas non-financial firms are assumed to conduct only hedging transactions. By definition the FT500 excludes businesses which do not have a stock market quotation, that is privately-owned companies and wholly state-owned businesses. The final sample consists of 441 non-financial firms. This set of firms is chosen for two important reasons. First, this sample includes large firms which are more likely to have exposure to financial price risks. Because many firms are expected to have exposure to financial price risks, this sample potentially provides a rich cross-section of hedgers and non-hedgers. Second, firms within the UK FT500 are actively encouraged to report their hedging activities in their annual financial statements during the sample period. The distribution of firms within the FT500 is shown in Table 4.1.

Table 4.1 Size Distribution of Sample Firms

Market Capitalisation Ranking in FT500	No. of firms
1 – 100	83
101 – 200	86
201 – 300	92
301 – 400	92
401 - 500	88
TOTAL	**441**

4.2.2 Sources of Data/Information On Hedging Activity

The analysis in chapter 3 indicates that reliable data on hedging activity is of paramount importance in any empirical investigation of corporate hedging. It was also noted that the empirical examination of hedging theories has been hindered by the general unavailability of data on hedging activities. The chapter mentioned the difficulty in collecting publicly available data on corporate hedging and consequently showed that most of the earlier empirical studies used questionnaires sent to treasury officials to obtain information on hedging activity. However, as treasury disclosures have improved more recent studies have employed qualitative and quantitative disclosures on hedging activity contained in company annual reports.

The advantage annual reports have over surveys is that they provide data for a larger number of firms and are, perhaps, a more reliable source of information than surveys. Data collected from audited financial statements does not have the non-response bias inherent in survey designs. Furthermore, we can assume consistency of interpretation of information contained in the annual reports given that data is collected by a single researcher (or a small group of researchers). Their major drawback is that the information they contain is often limited in scope and varies greatly from firm to firm, although both the content and consistency of disclosure has improved as mandatory reporting requirements have evolved. In an attempt to overcome the deficiencies of either source of data, this study uses both treasury disclosures in an annual report and a questionnaire sent to corporate treasurers to collect data on corporate hedging activity. This study is unique in simultaneously using these dual sources for information on corporate hedging practices.

4.2.3 Annual Report Data

The majority of US studies on corporate hedging use annual reports to collect information on hedging activity. In the US financial statement information is filed electronically in various databases. This facilitates the use of electronic search engines to identify hedging firms and the collection of data on hedging practices. In the UK several databases such as Datastream and Fame store financial information about firms but do not collect details of firms other activities such as hedging and the use of derivatives. Therefore, information on hedging practices is collected by hand from annual reports published in 1995. The annual reports of 412 firms out of the initial sample of 441 firms were obtained. Table 4.2 shows the ranking distribution of these firms and illustrates the even spread of firms across the ranking categories. Annual reports were not available for some firms because they merged, were taken over or were delisted during 1995.

Table 4.2 Size Distribution of Annual Report Firms

FT500 Ranking	No. of firms	No. of reports	Percent
1 – 100	83	81	19.7
101 – 200	86	85	20.6
201 – 300	92	85	20.6
301 – 400	92	84	20.4
401 – 500	88	77	18.7
TOTAL	**441**	**412**	**100.0**

4.2.4 Method of Data Collection and Description of Data Collected

Unlike the case for US firms, information on hedging activity and the use of derivatives for UK firms was not available in electronic form. Consequently, this study collected this information manually from annual reports. The advantage this method has over electronic searches using keywords is that the researcher is able to read the context in which the keywords appear and can make a better assessment of the categories in which the firm belongs.

In order to facilitate data collection on hedging activity from annual reports a questionnaire was used. The questionnaire was structured to collect both qualitative and quantitative information. Qualitative disclosures were used to identify appropriate response categories to various questions, such as whether the firm hedged financial price exposures, what types of financial price exposures the firm hedged and how the firm hedged. Other questions were used to determine if the firm displayed certain characteristics, such as whether the firm had foreign operations or if it imported or exported. The majority of the categorical questions had three response options, yes, no and no mention/disclosure. For example, the response to the question whether the firm hedged its financial price exposures could be "yes" if it explicitly disclosed that it hedged, "no" if it explicitly disclosed that it did not hedge and "no mention" if the annual report contained no information on the firm's hedging practices. The same range of responses applied to the question whether the firm hedged interest rate exposure and foreign currency exposure. The responses to these types of questions enabled this study to classify firms as hedgers or non-hedgers and for those that were hedging whether they hedged interest rate and or foreign currency exposure. The questionnaire was designed to collect the following information from a firm's annual report:

1. The company's treasury objectives or a statement on treasury policy.

1.1 Hedging objectives: Hedge fully, hedge selectively or uses derivatives for speculative purposes.

2. The firm's hedging activity.

2.1 Interest rate hedging including fixed floating debt mix.

2.2 Foreign currency hedging: transaction, translation and economic exposure hedging.

2.3 The use of foreign currency debt for both hedging and funding purposes.

2.4 Commodity price hedging.

2.5 Equity price hedging.

3. The use of financial derivatives.

3.1 Whether the firm uses derivatives and the types of derivatives. For example, the latter includes forwards, futures, swaps and options.

3.2 The use of derivatives within exposure categories. For example, the types of foreign currency, interest rate, commodity price and equity derivatives used.

3.3 Notional amounts of interest rate, foreign currency and commodity derivatives outstanding at year-end or used during the financial year.

4. The use of structured debt.

5. The firm's exposure characteristics.

5.1 The existence of foreign operations.

5.2 Exporting or importing activity or the repatriation of dividends, profits or interest income.

5.3 The level of foreign sales by origin and destination.

6. The existence of tax loss carry forwards.

The exhaustive and careful reading of accounting disclosures in their original form produced highly accurate data. Notwithstanding this, two major concerns arose during the data collection stage. These were, firstly, the possibility of inconsistent interpretation of information and secondly, the misclassification of firms. The first concern was mitigated to some extent by ensuring that the questionnaires were completed by a single researcher and after the data had been entered each firm's data was checked. Furthermore, since the questionnaire collected the key qualitative information used to classify firms checks could be made to ensure that each firm's data was interpreted consistently by referring to this key information. The second concern was mitigated by using explicit definitions of hedging which were referred to in cases of potential misclassification.

The data cleaning process involved checking the data once it had been entered (effectively entering the data twice) and undertaking simple frequency analysis on each of the categorical variables. The latter would throw up whether 'illegal', or highly unlikely, codes had been entered. For example, a firm that is classified as a non-hedger should also be classified as a non-hedger of interest rate, foreign currency, commodity price and equity price exposure. The frequency analysis would highlight any inconsistency that could be checked and then corrected.

The complete database was created by combining data on hedging practices and exposure characteristics collected from annual reports[1] with data on firms' financial and operating characteristics constructed from various financial databases such as Datastream.

4.2.5 Information on Hedging Policies and Derivatives Use in UK Annual Reports

A discussion of corporate treasury policy will usually be found in the "Operating and Financial Review" (OFR) section of the annual report and accounts. A Statement on this section was issued by the Accounting Standards Board in July 1993. This Statement is not an accounting standard and its recommendations are not mandatory. The Statement says,

"The OFR should contain a discussion of the capital structure of the business, in terms of maturity profile of debt, type of capital instruments used, currency, and interest rate structure. This should include comments on relevant ratios such as interest cover and debt/equity ratios.

The discussion should state the capital funding and treasury policies and objectives. These will cover the management of interest rate risk, the maturity profile of

[1] As noted earlier this data is not available in electronic form and hence this part of the database is unique.

borrowings, and the management of exchange rate risk. The OFR should also discuss the implementation of these policies in the period under review, in terms of:

- *the manner in which treasury activities are controlled;*
- *the currencies in which borrowings are made and in which cash and cash equivalents are held;*
- *the extent to which borrowings are at fixed interest rates;*
- *the use of financial instruments for hedging purposes;*
- *the extent to which foreign currency net investments are hedged by currency borrowings and other hedging instruments.*

The purpose and effect of major financing transactions undertaken up to the date of approval of the financial statements should be explained.

The effect of interest costs on profits and the potential impact of interest rate changes should be discussed." (Accounting Standards, 1994/95, pg. 687, Institute of Chartered Accountants in England and Wales).

In this thesis information on hedging is mostly obtained by reading the OFR section of 412 annual reports for the financial year ended 1995. Disclosure about hedging and the firms' use of derivatives is also found in the Corporate Governance section under the heading Internal Control, in the Statement of Accounting Policies section of the report under the heading Foreign Currencies, in the footnotes to the notes to the accounts, in particular Creditors - amounts falling due after more than one year and in the Contingent Liabilities notes.

As indicated above it is recommended but not mandatory that the OFR section of the annual report contains a discussion of a firm's hedging practices. Therefore, because of the discretionary nature of the recommendations the reported information across the sample is inconsistent.[2] The process of data collection reveals that there is wide variation in the quality of risk management disclosure in UK annual reports. Many firms provided detailed information on the types of exposures faced and how they were hedged, which included the use of derivative instruments. In some instances firms provided data on the notional amounts of derivatives outstanding at the year-end. At the other extreme firms provided no disclosure on their hedging activities even though it seemed some had significant financial price exposures. Examples of the type of disclosure are as follows:[3]

Marks and Spencer Plc writes,

"Where overseas subsidiaries of Marks and Spencer import merchandise from the UK company, foreign exchange cover is arranged within agreed amounts and time spans to minimise the risks of exchange rate fluctuations. The Group also imports merchandise into the UK... These transactions are, in the majority of cases, sterling denominated, and the few exceptions are monitored and, where appropriate, covered by the Group's treasury department... Derivative contracts are only used to manage the Group's exposure to interest rate fluctuations and foreign exchange risk." (pg. 45)

[2] Several US studies face a similar problem (Francis and Stephan (1993), Mian (1996), Wysocki (1996), Geczy et al. (1997), Fok et al. (1997).

Devro International Plc writes,

"Formal written Treasury procedures are in operation covering ..., hedging instruments, ...," (pg. 16)

Devro Plc makes no reference to the use of hedging instruments elsewhere in the report.

Dixons Plc writes,

"Treasury operations are subject to policies and procedures manuals which are approved by the Board. These restrict Treasury activities to hedging underlying assets and liabilities and transactional exposures. No speculative use of derivatives, currency or other instruments is permitted. Treasury policy on investment restricts counterparties to those with an AA- long term credit rating or better." (pg. 29)

Life Sciences International Plc writes,

"The Group enters into forward exchange contracts and interest rate swap transactions to limit exposure to exchange and interest rate movements." (pg. 43)

4.2.6 Annual Report Disclosures and an Empirical Definition of Hedging

The discussion in chapter 2 identifies several ways in which firms can hedge their financial price exposures (i.e., reduce cash flow variability). Financial price risks can be hedged on the balance sheet, for example, via changes in the foreign currency or interest rate mix of its debt, or location of production facilities in foreign markets. Alternatively, hedging strategies can be implemented using off-balance sheet financial instruments, such as financial derivatives, or combinations of on and off-balance sheet

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All quotes are taken from Annual Reports for the 1995 financial year end unless stated otherwise.

instruments such as structured debt. Given the different techniques a firm can employ to lower its financial price risks, how hedging is defined is vital for the purposes of precisely classifying firms as "hedgers" and "non-hedgers". Chapter 3 shows that some studies take firms' investment and on-balance-sheet financing strategies as predetermined and define hedging as the use of financial derivatives. These studies fail to allow for the fact that firms can and do use other techniques to reduce financial price risks. For example, the non-use of derivatives (i.e., off-balance sheet hedging methods) does not necessarily mean that no hedging has taken place but could imply that a firm has managed its exposure through internal hedging techniques so that the residual exposure is immaterial.

This study employs qualitative disclosures contained in annual reports to determine which firms are hedging and which are not, the types of exposures hedged and how they are hedged. This study also uses quantitative disclosures on the total notional values of derivatives to determine the extent to which firms are hedging (or using derivatives). However, since disclosures on derivatives are not compulsory this study does not focus solely on the use of derivatives for the purposes of defining hedging firms. A manual search of annual reports is undertaken defining hedging firms as those that make any reference to hedging financial price risks.

The references to hedging found in annual reports might mean the use of operational hedges or on-balance-sheet financial hedges or derivatives. However, specifically including on-balance sheet production hedging activities is difficult. These activities include, for example, the decision to locate production facilities in major foreign markets to minimise foreign exchange exposure and choosing a technology to minimise exposure to commodity price risk. Two problems preclude a detailed analysis of this type of on-balance sheet hedging:

1. determining whether an on-balance sheet item is for hedging purposes, and
2. availability of data.

Production hedging activities appear in many different items on the balance sheet and are therefore categorised as on-balance sheet hedging, but it is difficult to identify which items from examining financial statements. Therefore this study does not include on-balance sheet production hedging in its definition of hedging.

Chapter 2 notes firms can reduce exposure to financial price risk by holding the appropriate combination of on balance sheet financial assets and liabilities. Firms can manage their financial price exposures by structuring their debt profiles in terms of currency mix and fixed-floating mix. For example, firms with a negative correlation between cash flows and short-term interest rates could issue long-term fixed rate debt to manage this exposure. Also firms with foreign currency assets could issue foreign currency debt to manage this exposure. The firm's optimal fixed-floating interest rate mix is not modelled explicitly in this study because information on a firm's cash flow exposure to interest rates is not publicly available. Some firms do provide information on their desired fixed-floating debt mix and whether this is achieved via on-balance sheet strategies or a combination of on- and off-balance sheet techniques. However, these disclosures only cover a small proportion of the sample and are not consistent and hence cannot be used in a meaningful way. Disclosures on the use of foreign currency debt, although qualitative, cover a much larger proportion of the sample. Furthermore, in the majority of cases it is possible to discern whether the foreign debt serves to hedge an exposure or is for funding purposes or some combination of the two. Therefore, this study specifically documents the use of foreign currency debt and assesses whether the borrowing is incurred for the purpose of hedging foreign assets and/or income or whether it gives rise to a foreign currency exposure. In this study the definition of hedging includes the use of foreign currency debt employed for hedging purposes.

In summary, this study classifies firms as hedgers as those that make any reference to hedging or managing their financial price exposures. This hedging might be achieved through the use of derivatives and/or on-balance sheet hedging methods. With reference to on-balance sheet hedging, firms using foreign currency debt for hedging purposes are also classified as hedging firms.

4.3 Analysis of Annual Report and Survey Data

This section examines the risk management characteristics of the firms in the annual report and survey samples. We begin by reporting on the hedging data sourced from the firm annual reports followed by a discussion of the survey data.

4.3.1 Hedging Data Found in Annual Reports

The statements on hedging activity disclosed in annual reports are initially employed to classify firms into three groups; those that disclose they hedge, those that disclose that they do not hedge and those with no disclosure on hedging. Table 4.3 shows that 77.9 percent of sample firms are classified as hedging financial price exposures.

Table 4.3 Hedging Activity Disclosures by UK Firms

Hedging Activity	No.	%
Firm hedges	321	77.9
Firm does not hedge	5	1.2
Firm provides no disclosure on hedging	86	20.9
TOTAL	**412**	**100**

Table 4.3 shows that five firms in the sample made it explicit that they did not hedge and/or use derivatives. For example, Blenhiem Plc writes,

"Other than in exceptional circumstances, it is not now the group's policy to hedge foreign exchange exposures as the directors believe investors should benefit from the exposure the group has to strong foreign currencies." (pg. 21)

The BSS Group writes,

"Because of the nature of the business we do not consider it necessary or desirable to attempt to anticipate interest rate movements by using treasury instruments... As over 97% of assets are held in sterling, there is no requirement to protect shareholder values by borrowing other than in sterling. (pg. 16)

Takare Plc writes,

"The Group does not currently utilise financial derivatives of any kind. Any change in this policy requires board approval... There are no off-balance-sheet financing arrangements." (pg. 13)

Shanks and Mcewan writes,

"The Group has no foreign exchange or interest rate hedging agreements and does not trade in derivatives." (pg. 33)

The Calor Group writes,

"Foreign currency exposures are restricted to meeting short-term business requirements and derivatives are not used." (pg. 37)

Eighty-six firms provided no references to hedging in their annual reports. Consistent with previous studies the non-hedging sample and the non-disclosing sample were merged to form the non-hedging sample in this study. The treating of non-disclosing firms as non-hedgers was justified on the grounds that many of the non-disclosing firms made statements implying they faced low levels of foreign exchange and/or interest rate exposure. For example, Beazer Homes writes,

"The Group has no foreign exchange exposure" and also writes, "Interest receivable has increased to £2.9m which reflects amounts earned on cash balances held on deposit." (pg 19)

DFS Furniture writes,

"Our furniture is sourced predominantly from UK manufacturers and all sales are made within the UK, so that foreign exchange risk is not an issue for the Group." (pg.31)

It also writes

"The Group ended the year with no gearing and thus no borrowings and cash balances of £29.2m. Interest receivable was higher than in 1993/94, reflecting higher average cash balances during the year and interest rate improvements." (pg. 31)

Table 4.4 shows that 41.9 and 77.9 percent of non-disclosing firms made statements that implied they had low levels of foreign exchange and interest rate exposure, respectively.

Table 4.4 Qualitative Disclosures Of Non-Hedging Firms (Excluding Firms With Explicit Statements On Not Hedging)

Level of Exposure	Foreign Exchange	Interest Rate
Low	36(41.9)	67(77.9)
High	10(11.6)	1(1.2)
No disclosure	40(46.5)	18(20.9)
TOTAL	**86(100)**	**86(100)**

Note: Figures in brackets are percentages.

Table 4.4 shows that 11.6 percent of firms made statements implying that foreign exchange exposure might be important. For example, General Electric Plc writes, *"Some 70% of sales were made to customers outside the UK and exports from the UK were maintained at the high level of £1.7bn."* (pg. 55)

The Micro Focus Group writes,

"The majority of revenue arises in US dollars (2/3 in 94) whereas costs are incurred approximately equally in dollars and other currencies, predominantly sterling. Thus fluctuations in exchange rates, mainly between the US dollar and sterling, may have a significant impact on operating results, when expressed in sterling." (pg. 29)

Halma Plc writes,

"Direct exports from the UK increased by 20% to £48.3m. Overseas sales as a proportion of total sales increased to 59%." (pg. 21)

These types of disclosure would suggest that these firms have levels of foreign exchange exposure that might warrant some form of hedging. A possible explanation is that these firms are in fact hedging but have deemed it not necessary to communicate this to their shareholders. Overall, this evaluation of qualitative disclosures of non-disclosing firms indicates that the majority of firms face low levels of either interest rate or foreign exchange exposure or both. This evidence provides support for the assumption that firms providing no disclosure on hedging can be treated as non-hedgers.

Moving onto hedgers, Table 4.5 shows the categories of exposures hedged by hedging firms. Over 90 percent of hedging firms report the hedging of foreign exchange exposure and 57 percent disclose the hedging of interest rate exposure.

Table 4.5 Type of Exposure Hedged By Hedging Firms

Type of Exposure Hedged	No.	%[a]
Foreign exchange	290	90.3
Interest rate	183	57.0
Commodity price	28	8.7

[a]This figure represents the percentage of all hedging firms.

Table 4.6 shows the combinations of exposures hedged. The most common combination of exposures hedged is foreign exchange and interest rate hedging, this is closely followed by foreign exchange only hedgers which make up nearly 40 percent of the hedging sample.

Table 4.6 Combination of Exposures Hedged by Hedging Firms

Combination of Exposures Hedged	No.	%
Foreign exchange only	128	39.9
Interest rate only	28	8.7
Commodity price only	3	0.9
Foreign exchange & Interest rate	137	42.7
Foreign exchange & Commodity price	7	2.2
Interest rate & Commodity price	0	0.0
Foreign exchange & Interest rate & Commodity price	18	5.6
TOTAL	**321**	**100**

4.3.2 Derivatives Use by Hedging Firms

Disclosures of hedging practices and derivative use are not compulsory in UK annual reports. As discussed previously hedging firms are those that indicate they engage in financial risk management activity. In this study derivative users are a subset of hedging firms, since not all of the hedging firms explicitly disclose the use of derivative instruments. Panel A of Table 4.7 shows that 67 percent of firms disclosed the use of derivatives. Panel B shows that 86 percent of hedging firms indicated the use of derivative instruments.

Table 4.7 Derivatives Activity Disclosures

Derivatives Activity Disclosures	Panel A: Full sample		Panel B: Hedging sample	
	No.	%	No.	%
Firm uses derivatives	277	67.2	277	86.3
Firm does not use derivatives	6	1.5		
Firm provides no disclosure on derivatives use	129	31.3	44	13.7
TOTAL	**412**	**100**	**321**	**100**

Table 4.8 presents details, where applicable, of the proportion of hedgers, foreign exchange hedgers and interest rate hedgers in 15 empirical studies. This Table shows that the level of derivatives usage reported in Table 4.7 is similar to that of several

studies that examine the use of derivatives by large non-financial firms. For example, Fok et al. (1997) report that 66.2 percent of their sample of Fortune 500 firms use derivatives, Gay and Nam (1998) find that 66.9 percent of their sample taken from the Business Week 1000 use derivatives, Howton and Perfect (1998) find that 61.4 percent of their sample of Fortune 500/S&P 500 firms use derivatives. Surveys of Fortune 500/S&P 400 firms by Nance et al. (1993) and Dolde (1995) find that 61.5 percent and 85.2 percent of firms use derivatives, respectively.[4]

Amongst firms using derivatives Table 4.9 shows that the most popular type of derivative is the forward contract followed by the swap contract.

Table 4.9 Types of Derivatives Used by Firms

	No.	%[a]
Forwards	181	65.3
Futures	8	2.9
Swaps	155	56.0
Options	58	20.9

[a]This figure represents the percentage of all derivative using firms.

[4] Bodnar et al (1995) survey a random sample of 2000 non-financial US firms in 1994 and find that 35 percent of the 530 respondents use derivatives. However, they find that 65 percent of large firms (defined as market value above $250 million) use derivatives while only 13 percent of small firms (market value below $50m) use them. In their 1995 survey 59 percent of large firms use derivatives. The sample of large firms is comparable with the sample of firms used in this study. The minimum market value in this study is £64.7m with over 75 percent of firms with a market value in excess of £215m. Phillips (1995) finds that 63.2 percent of respondents use derivatives for either managing financial risk, obtaining funding or investing. 70.8 percent of derivative users use them for managing financial risk, 66.7 percent use them in conjunction with obtaining funding and 21.4 percent use them for investment purposes.

Table 4.8 Proportion of Hedgers/Derivative Users in Samples of 15 Empirical Studies

Author(s) of Study	Date	Sample source	Sample size	No. of hedgers	No. of non-hedgers	% of hedgers	% of FX hedgers	% of IR hedgers
Francis & Stephan	1993	NAARS database - used matching sample of non-hedgers	434	434	434	50.0		
Nance, Smith & Smithson	1993	Fortune 500/S&P 400	535 (169 respondents = 31.6%)	104	65	61.5		
Dolde	1995	Fortune 500	476 Fortune 500 (244 respondents=51.3%)	208	36	85.2		
Wysocki	1995	NASDAQ, NYSE & AMEX exchanges - uses a sample selection criteria	807 (234 foreign currency derivative users)				29.0	
Wysocki	1996	NASDAQ, NYSE & AMEX exchanges - uses a sample selection criteria	403 (215 derivative users)	215	188	53.3		
Mian	1996	NAARS database	3022 firms, 771 hedgers and 2251 nonhedgers	771	2251	25.5	14.9	15.2
Allayannis & Ofek	1996	S&P 500	724 firm years (S&P500)				43.9	
Berkman & Bradbury	1996	Listed firms on NZ stock exchange	116	55	61	47.4		
Tufano	1996	Gold Hedge Survey	48			85.4		
Fok, Carroll & Chiou	1997	Fortune 500	331	262	134	66.2		
Geczy,Minton & Schrand	1997	Fortune 500 - firms that have foreign currency exposure	372 Fortune 500	154	218		41.4	
Gay & Nam	1998	Swaps monitor database & Business Week 1000	486	325	161	66.9		
Howton & Perfect	1998	Fortune 500/S&P 500 & 461 firms in a random sample	451 Fortune 500/S&P 500 & 461 random firms	277	174	61.4	45.0	45.4
Haushalter	1998	Oil & Gas Producers	100			51.0		
Graham & Rogers	1999	Random sample of 855 firms from EDGAR database, 531 firms satisfy selection criteria	Population=3232, sample=531			44.5/57.0	43.4	35.2

Notes:

In the Geczy et al. (1997) sample 59.1 percent use any category of derivative. In the Howton and Perfect Fortune/S&P 500 sample 61.69% use derivatives, 44.98% use currency derivatives and 45.43 use interest rate derivatives. In the Howton and Perfect random sample 36.4% use derivatives, 14.29% use currency derivatives and 26.62% use interest rate derivatives. Graham and Rogers (1999) have two samples, the first consists of 404 firms that face ex ante interest rate risk of which 180 use any derivative (44.55%) and 142 use interest rate derivatives (35.15%). The second sample consists of 242 firms that face ex ante foreign currency risk of which 138 use any type of derivative (57.02%) and 105 use currency derivatives (43.39%).

4.3.3 Annual Report Disclosures of Interest Rate Hedging Practices

The previous section examined the disclosure of hedging practices in general. This section presents evidence on the annual report disclosure of interest rate hedging practices of UK non-financial firms. As with the case for all hedgers, firms were placed into three categories; firms hedging interest rate exposure, firms not hedging interest rate exposure and firms providing no disclosure on interest rate hedging. Table 4.10 shows that 44.4 percent of firms disclose that they hedge interest rate exposure, 2.2 percent state that they do not hedge interest rate exposure and 53.4 percent have no discussion of interest rate hedging.[5]

Table 4.10 Interest Rate Hedging Activity Disclosures by UK Firms

Interest Rate Hedging Activity	No.	%
Firm hedges interest rate exposure	183	44.4
Firm does not hedge interest rate exposure	9	2.2
Firm provides no disclosure on interest rate hedging	220	53.4
Total	**412**	**100**

Interest rate hedging firms might also be hedging other exposures such as foreign currency and commodity price risks. Table 4.11 shows that 15.8 percent of interest rate hedgers only hedge this exposure whilst 84.2 percent hedge at least one other type of exposure. Amongst this latter group the most frequent combination is interest rate and foreign exchange hedging.

[5] Using a sample of 3022 firms Mian (1996) finds that 15.2 percent report the hedging of interest rate exposure.

Table 4.11 Interest Rate Hedgers Hedging Other Exposures

Interest Rate Hedgers Hedging Other Exposures	No.	(%)
Interest rate hedging only	29	15.8
Interest rate & foreign exchange hedging	136	74.3
Interest rate & commodity price hedging	0	0.0
Interest rate & foreign exchange & commodity price hedging	18	9.8
Total	**183**	**100**

The sample of interest rate non-hedgers consists of non-hedging firms and firms hedging other exposures. Chapter 3 shows that most previous empirical studies that have investigated the hedging of specific categories of exposure include firms hedging other exposures in their sample of non-hedgers. Table 4.12 shows that in this study 60.3 percent of interest rate non-hedgers hedge other exposures. This analysis has important implications for the empirical tests on the determinants of interest rate hedging. It is conceivable that hedging firms in the non-hedging sample have similar financial and operating characteristics to the interest rate hedging group. Therefore, the inclusion of these hedgers in the non-hedging sample potentially blurs the distinction between interest rate hedgers and so called non-hedgers and biases the empirical tests against the a priori expectations. To assess the effect "other hedgers" have on the empirical results tests should be conducted with and without these firms in the non-hedging sample.

Table 4.12 Firms Not Hedging Interest Rate Exposure

Firms Not Hedging Interest Rate Exposure	No.	%
Interest Rate Non-Hedgers	91	39.7
Interest Rate Non-Hedgers Hedging Other Exposures	138	60.3
Total	**229**	**100**

The breakdown of firms not hedging interest rate exposure but hedging other exposures is shown in Table 4.13. The overwhelming majority of this group of firms are hedging foreign exchange exposure only.

Table 4.13 Interest Rate Non-Hedgers Hedging Other Exposures

Interest Rate Non-Hedgers Hedging Other Exposures	No.	%
Foreign exchange only	128	92.8
Foreign exchange & commodity price	7	5.1
Commodity price only	3	2.2
Total	**138**	**100[a]**

[a]Percentages do not sum to 100 due to rounding.

4.3.4 The Use of Derivatives by Interest Rate Hedging Firms

For the sample period (i.e., 1995) employed in this thesis disclosures on hedging and derivatives use in UK annual reports were discretionary. Consequently, hedgers were defined as firms disclosing they hedged and/or used derivatives. Therefore, unlike previous studies it was not necessary for a firm to mention the use of derivatives in order for it to be classed as a hedger.[6] In this study interest rate hedgers were defined as firms disclosing they hedged interest rate exposure. The use of interest rate derivatives was in the majority of cases disclosed within the context of the firms' interest rate hedging activity. Not all interest rate hedging firms, however, disclosed the use of interest rate derivatives. Therefore, interest rate derivative users were deemed to be a subset of the population of interest rate hedgers. Panel A of Table 4.14 illustrates this by showing that 89 percent of interest rate hedging firms disclosed the use interest rate derivatives. Panel B of this table shows that interest rate derivative users accounted for 39.3 percent of the full sample. For a comparable sample of 451 large US firms drawn from the population of Fortune 500/S&P 500 firms Howton and Perfect (1998) report a slightly higher figure of 45.4 percent. Visvanathan (1997) collects data on interest rate swaps for

[6] Howton and Perfect (1998) and Graham and Rogers (1999) classify interest rate hedgers as firms that use interest rate derivatives. Francis and Stephan (1993) and Mian (1996) employ a similar approach to that used in this study.

410 non-financial firms in the S&P 500 and reports that 48 percent of firms use interest rate swaps.[7] Simkins (1999) generates a sample of 567 firms also using the Fortune 500 and S&P 500 and finds that 45.3 percent use interest rate derivatives. Additionally, Howton and Perfect (1998) investigate derivatives use for a random sample of 461 firms[8] and find that 26.6 percent use interest rate derivatives. Graham and Rogers also draw a random sample and find that 35.15 percent of 404 firms with ex ante interest rate exposure use interest rate derivatives.[9]

Table 4.14 Firms Using Interest Rate Derivatives

Panel A: Interest Rate Hedgers	**No.**	**%**	**Panel B: Full Sample**	**No.**	**%**
Yes	162	88.5	Yes	162	39.3
No disclosure	21	11.5	No disclosure	250	60.7
Total	**183**	**100**	**Total**	**412**	**100**

Consistent with previous evidence the most popular tool for interest rate hedging is the interest rate swap used by 76 percent of interest rate derivative using firms.[10] The interest rate option is the next most popular hedging instrument followed by the forward rate agreement. This latter finding is consistent with Phillip's (1995) survey findings.[11]

[7] Visvanathan reports that few firms in his sample use interest rate derivatives other than swaps. Given the insignificant number of these firms his study focuses only on interest rate swaps.
[8] Randomly select firms from the Compustat files that had data for 1994.
[9] Mian (1996) examines annual report disclosures of 3022 firms and classifies 15.2 percent as interest rate hedgers.
[10] Bodnar et al. (1995) and Phillips (1995) found that US firms use swaps more than any other interest rate derivative. Simkins (1999) reports that 88 percent of interest rate derivative users in the US use interest rate swaps, 12 percent use interest rate caps, 10 percent use interest rate swaptions and 4 percent forward rate agreements.

Table 4.15 Types of Interest Rate Derivative used by Firms

Type of Interest Rate Derivative	No.	% of interest rate derivative users
Swaps	140	76.0
Options	34	18.0
Forward rate agreements	29	15.8
Swaptions	3	1.6
Futures	3	1.6
Other	2	1.1

Of those firms using swaps to manage interest rate exposure 79.3 percent indicate the direction in which swaps are used to modify the exposure. As indicated in Table 4.16 for 41.7 percent of swap users their sole purpose was to convert floating rate debt into fixed and for 18 percent of swap users fixed rate debt was converted into floating rate. Phillips (1995) collected similar data in his survey to members of the Treasury Management Association. He found that 41.7 percent of issuers of floating rate debt swapped that debt into fixed-rate, and 31.5 percent of firms issuing fixed rate debt swapped it into floating.[12] Phillips also found that firm size plays a role in the tendency to swap with 70.4 percent of the largest firms raising funds swapped part or all of it.

Table 4.16 Types of Interest Rate Swap Used by Firms

	No.	% of swap users
Pay fixed only	59	41.7
Pay floating only	25	18.0
Pay fixed and floating	27	19.4
No disclosure	29	20.8
Total	**140**	**100**

[11] Phillips (1995) finds that after swaps caps, floors and collars are the next most frequently used tools, followed by forward rate agreements and finally interest rate futures.

4.3.5 Qualitative Disclosures on Interest Rate Hedging

In an attempt to ascertain the possible reasons why firms don't hedge interest rate exposure this section examines firms' qualitative disclosures on hedging practices contained in annual reports. Annual report disclosures are put into the following eight categories, the existence of fixed rate debt, high interest cover, low gearing, net cash balance[13], strong cash generation, capital expenditure financed by own cash flow, net interest receivable, surplus funds invested in deposits and other short term investments. A firm's qualitative disclosure usually referred to more than one of these categories when describing the firm's financial situation.

Nine firms indicated that they did not hedge interest rate exposure. These firms made the following disclosures;

Kwik Save Plc says,

"Cash resources and trading cashflows provided most of the finance to support capital expenditure... Underlying borrowings are not expected to exceed a gearing range of between 10% and 15% over the next 2 to 3 years... The Groups historical funding requirements have not required the use of derivatives." (pg. 18)

MFI Plc says,

"Policy is to manage exposure to changes in interest rates. The aim to fix rates at attractive levels and so increase the certainty of interest payments in the future. Due to

[12] Phillips (1995) reports that on average, firms swapped 45.8 percent of their fixed rate debt into floating and 44.7 percent of floating rate debt into fixed.

[13] A net cash balance indicates that the level of cash exceeds the level of borrowings so that net debt is negative. Many firms describe this as being in an ungeared position.

the current low gearing of the Group, no interest rate hedging has been arranged at present." (pg. 31)

Elsewhere in the report MFI says,

"The Group enjoys a strong financial position with high interest cover and low balance sheet gearing... Net interest payable is half last year's level. This reflects the strength of the Group's trading cash flow and tight cash control." (pg. 30)

Northern Foods Plc says,

"There were no material swaps or other derivatives in place at the year end. A sensible balance has been maintained between fixed rate long-term debt and floating rate debt, to reduce the risk from any future fluctuations in interest rates. The Group is confident of maintaining a satisfactory level of interest cover." (pg. 45)

Iceland Group Plc says,

"In view of the strength of cash generation, and the resulting long-term reduction in borrowings, the Group doesn't feel it is appropriate to enter into long-term or fixed rate debt commitments, nor does it consider it necessary to hedge its interest rate exposure... Interest cover remained very strong at 18 times... Unlike other food retailers operating superstores, Iceland is able to fund its continuing store opening programme from its own cash flow."[14] (pg. 41)

Stagecoach Plc says,

"Approximately 90 percent of group borrowings are at variable rates and the group has no exposure to any complex financial instruments or derivatives."[15] (pg. 28)

Takare Plc says,

"Of debt due after more than 1 year 99% is fixed until 2014. Surplus funds are only deposited with financial institutions rated AA or equivalent." (pg. 13)

Also says,

"Net interest expense increased because interest receivable declined as cash balance was used to fund capital expenditure... £50m 11.8% debenture stock is repayable at par in 2014... £0.5m long-term loan is with a bank and carries interest at 2.5% over 3 month libor subject to a minimum rate of 9.5%."[16] (pg. 13)

Menvier-Swain Group Plc says,

"The Group does not hedge the interest rate on borrowings, but the associated risks and costs are constantly reviewed. Gearing is 3% and interest cover is 27. The Groups strong performance and low levels of gearing means that operational investment needs can be met from internal cashflows." (pg. 25)

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[14] In its response to the survey this firm indicated that it hedged its interest rate exposure. The level of significance of interest rate exposure to the firm's performance was given as 3 on a scale where 1= low level of significance and 5 = high level of significance.

[15] In its response to the survey this firm indicated that it hedged its interest rate exposure. The level of significance of interest rate exposure to the firm's performance was given as 3 on a scale where 1= low level of significance and 5 = high level of significance.

[16] In its survey response this firm indicated that it had no interest rate exposure. This is consistent with its disclosure in the annual report where it indicates that 99 percent of debt due after one year is fixed until 2014.

Oxford Instruments Plc says,

"At present the Group has decided not to enter into any arrangements to hedge against future movements in interest rates. The Group ended the year with net cash and thus no net borrowings. Net interest receivable was £0.8m up £0.3m, reflecting higher average net cash balances." (pg. 43)

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Shanks and McEwan Group Plc says,

"All the Group's debt is denominated in sterling. Its long term debt is a ten year £20m fixed rate (8.9%) private placement... Any credit balances are lodged with its clearing bank or placed in the sterling money market...The group net debt has dramatically improved from £30.9m to £7.3m during the year. This reversed a four year trend of increased borrowings and has been achieved primarily by rigorous control of working capital, the collection of outstanding Construction Claims and constraints on capital expenditure... The interest expense is covered a healthy eight times by profits before exceptional items." (pg. 30)

A common feature for most of these firms is that they have low levels of debt and/or strong cash generation. Eight of the nine firms made some reference to at least one of the following financial characteristics; low gearing, high interest cover, net interest receivable, a large proportion of fixed rate debt and the ability to fund capital expenditure from its own cash flows. These characteristics would seem to suggest that these firms have a low probability of financial distress and also do not have to rely on external finance for funding purposes. Therefore, these firms not hedging interest rate exposure is consistent with the predictions of hedging theories which emphasise that hedging is desirable because it lowers the probability of financial distress, external financing costs associated with capital market imperfections and the costs of underinvestment.[17] However, this finding has to be tempered since no comparisons have been made with the qualitative disclosures of interest rate hedging firms

Two hundred and twenty firms provide no details of their interest rate hedging practices in their annual report. For these firms it is not known whether they hedge interest rate exposure or not. For some of these firms an assessment of the likelihood of them hedging interest rate exposure can be made by evaluating their qualitative disclosures.

Table 4.17 Qualitative Disclosures of Non Disclosing Firms

Financial Characteristic Disclosed	% of sample[a]
Firm has some fixed rate debt	14.1
Firm has high interest cover	13.2
Firm has low gearing	20.9
Firm has a net cash balance	16.4
Firm has strong cash generation	10.9
Firm funds capital expenditure from own cash flow	11.8
Firm has net interest receivable	29.1
Firm has invested surplus funds	16.4

[a]This sample represents the 220 firms with non-disclosure on interest rate hedging.

An examination of disclosures, the findings summarised in Table 4.17, reveals that the most frequent characteristic among firms not disclosing interest rate hedging is the existence of net interest receivable, with 29.1 percent of the sample displaying this characteristic. This is followed by 20.9 percent of the sample indicating that they have low gearing. The frequency of occurrence of the other characteristics ranges between 10.9 and 16.4 percent of the sample. Table 4.18 shows the frequency of occurrence of at

[17] These firms' pre-hedging probability of financial distress is too low to warrant any concern.

least one characteristic among a group of two or more characteristics. The existence of high interest cover and/or low gearing and/or net cash was indicated by 41.4 percent of the sample. Nearly three quarters of the sample (72.7 percent) exhibited at least one of the eight financial characteristics. Although, no comparisons have been made with the qualitative disclosures of interest rate hedging firms this evidence, based solely on statements provided by firms with no disclosure, seems to suggest that these firms possess characteristics which indicate low levels of interest rate exposure, such as low gearing, high interest cover and, for some, substantial amounts of cash earning interest. These findings suggest that these firms (like the non-hedgers) have lower financial contracting costs, low enough not to warrant any risk management activity. This provides some explanation for the lack of disclosure on interest rate hedging activity. This analysis of qualitative disclosures provides some justification for treating non-disclosing firms as non-interest rate hedging firms

Table 4.18 Qualitative Disclosures of Non Disclosing Firms

Content of Disclosure	% of sample[a]
High interest cover and/or low gearing	28.2
High interest cover and/or low gearing and/or net cash	41.4
Strong cash generation and/or fund capital expenditure from own cash flow	20.5
Net interest receivable and/or invested surplus funds	39.5
High interest cover and/or low gearing and/or net cash and/or strong cash generation and/or fund capital expenditure from own cash flow and/or net interest receivable and/or invested surplus funds	65.9
High interest cover and/or low gearing and/or net cash and/or strong cash generation and/or fund capital expenditure from own cash flow and/or net interest receivable and/or invested surplus funds and/or some fixed rate debt	72.7

[a]The sample is the 220 firms that provide no disclosure on interest rate hedging.

4.3.6 The Type of Interest Rate Exposure Hedged

Most non-financial firms are generally faced with three types of interest rate exposure. Interest rate changes can affect the firm's debt service costs and its interest income, the market value of its debt and investments, and its future cash flows. An important question is which of these risks should treasurers be concerned with? An increase in the market value of debt should result in a decrease in the market value of equity, all else being equal. Therefore the firm should protect against increases in the market value of debt. However, it could be argued that the market value does not matter from a liability management perspective, since the debt is intended to be outstanding until maturity, and therefore, even though the market value will fluctuate, the ultimate financial obligation remains unchanged. The third measure of interest rate exposure is an economic exposure[18] which captures the degree of sensitivity of the firm's cashflows to interest rate cycles such as those experienced by firms in the residential and commercial property sector, construction companies, or manufactures of consumer durables (e.g., white/brown goods).[19] An examination of disclosures in annual reports reveals that interest rate hedging firms hedge a firm's interest expense or income but take no measures to hedge the market value of their interest rate sensitive assets/liabilities or their future cash flows. This is consistent with the finding of Fenn et al. (1996), who find no evidence that firms hedge their economic exposure to interest rate risk. These results are also consistent with the responses to recent surveys in which firms report that they mostly

[18] Economic exposure is the risk implied by the correlation of operating earnings, or cash flow before interest cost, with interest rates.

[19] Dolde (1995) measures economic exposure to interest rates as the absolute value of the coefficient from a regression of scaled operating income before depreciation on the return on 3 month Treasury bills. Dolde's study also measures foreign exchange and commodity price exposure using as exogenous variables, the return on an index measuring the foreign exchange value of the dollar and the producers price index for crude materials for further processing, respectively.

hedge certain commitments and/or anticipated commitments, and, to a lesser extent economic exposure (Bodnar et al. (1995) and Phillips (1995). One possible explanation for this is that definite commitments can be quantified whereas economic exposure cannot be measured precisely.

4.3.7 Annual Report Disclosures of Foreign Currency Hedging Practices

This section presents an analysis of the annual report disclosures on the foreign currency hedging practices of UK non-financial firms. Foreign currency hedging firms were defined as those that provide a qualitative discussion of foreign currency hedging in their annual report. As discussed in section 4.2.6, in this study firms indicating they issue foreign currency borrowings to hedge foreign assets were included as part of the hedging definition.[20] Firms were placed into three categories; firms hedging foreign currency exposure, firms not hedging foreign currency exposure and firms providing no disclosure on foreign currency hedging. Table 4.19 shows 70.4 percent of firms disclosed that they hedged foreign currency exposure,[21] 1.5 percent stated that they did not hedge foreign currency exposure and 28.1 percent had no discussion of foreign currency hedging. In this study non-hedgers and firms with no discussion of hedging were combined to form one group of "non-hedgers of foreign currency exposure". Table 4.5 showed that 90 percent of all hedging firms were classified as foreign currency hedgers implying that the constituents of the all hedging and foreign currency hedging group are very similar.

[20] Wysocki (1995), Allayannis and Ofek (1996) and Geczy et al. (1997) examine the determinants of the use of foreign currency derivatives by non-financial firms in the US. Allayannis and Ofek and Geczy et al. take into consideration the use of foreign currency debt. Foreign currency debt can act as a natural hedge of foreign cash flows and therefore reduces foreign currency exposure. When debt is used in this way it is regarded as an on-balance sheet hedging technique. Conversely, foreign currency debt can increase a firm's exposure to foreign currency risk if the debt related cash outflow is not matched by a corresponding cash inflow.

Table 4.19 Foreign Exchange Hedging Activity Disclosures by UK Firms

	No.	(%)
Firm hedges foreign currency exposure	290	70.4
Firm does not hedge foreign currency exposure	6	1.5
Firm provides no disclosure on foreign currency hedging	116	28.1
Total	**412**	**100**

Foreign exchange hedging firms were also hedging other exposures such as interest rate and commodity price risks. Table 4.20 shows that 44.1 percent of foreign exchange hedgers only hedge this exposure whilst 55.9 percent hedge at least one other type of exposure. Amongst this latter group the most frequent combination is that of foreign exchange and interest rate hedging.

Table 4.20 Foreign Exchange Hedgers Hedging Other Exposures

	No.	(%)
Foreign exchange hedging only	128	44.1
Foreign exchange & interest rate hedging	137	47.2
Foreign exchange & commodity price hedging	7	2.4
Foreign exchange & interest rate & commodity price hedging	18	6.2
Total	**290**	**100**

Similar to the sample of interest rate non-hedgers the sample of foreign exchange non-hedgers also consists of both non-hedging firms and firms hedging other exposures. Table 4.21 shows that 25.5 percent of foreign exchange non-hedgers hedge either interest rate or commodity price exposure. Although this proportion is smaller than that for the sample of non-interest rate hedgers (i.e., 60.3%) the inclusion of these hedgers in the non-hedging sample might still bias the empirical results against the a priori expectations.Therefore, in line with the suggestion in section 4.3.3, empirical tests of the

[21] 17 of these firms were defined as foreign exchange hedgers based on disclosures in the accounting policies note.

determinants of foreign currency hedging should be conducted with and without these hedging firms in the non-hedging sample.

Table 4.21 Foreign Exchange Non-Hedgers Hedging Other Exposures

	No.	(%)
Not hedging any category of exposure	91	74.5
Interest rate hedging	28	23.0
Commodity price hedging	3	2.5
Interest rate & commodity price hedging	0	0.0
Total	122	100

4.3.8 Qualitative Disclosures on Foreign Exchange Hedging

In an attempt to establish the reasons why firms don't hedge various categories of foreign exchange exposure this section examines firms' qualitative disclosures on hedging practices contained in annual reports. Firms not hedging a particular category of foreign exchange exposure say the following:[22]

Boots Plc says,

"Modest sales and purchases are made in a range of currencies, but it is not considered that hedging them into sterling adds value." (pg. 52)

Forte Plc says,

"Approximately 75% of turnover and 85% of profits arise in the UK. The company's results are not significantly sensitive to currency fluctuations, it is the current policy not to hedge transactions exposure." (pg. 34)

RTZ Plc says,

"The US dollar is the currency of greatest significance in which most revenues are denominated as indeed is a large proportion of our costs. Natural diversity of exposure to currencies provides substantial degree of protection. RTZ-CRA does not believe an active short-term currency hedging programme would provide long-term benefit to shareholders."[23] (pg. 63)

Northern Foods Plc says,

"Currency translation and hedging are not material issues because the group has no significant interests outside the UK. Almost all our sales are made within the UK."[24] (pg. 45)

British Aerospace says,

"The company does not have any significant translation exposures arising from the need to translate into sterling the earnings, assets and liabilities of non-sterling business activities." (pg. 49)

Beazer Plc says,

"The group has no foreign currency exposure." (pg. 23)

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[22] These firms might be hedging other categories of foreign currency exposure.
[23] RTZ uses foreign currency debt for hedging purposes.

Calor Plc says,

"Foreign currency exposures are restricted to meeting short term business requirements and derivatives are not used." (pg. 34)

Meyer Plc says,

"The board regularly considers interest rates, foreign exchange and all other aspects of treasury policy and control... The Group imports significant quantities of timber and other building materials, and in general does not fix their price in local currency prior to arrival unless a matched sale has been arranged."[25] (pg. 40)

Wilson Bowden Plc says,

"We continue to have no direct exposure to currency movements and presently do not hedge our indirect exposures such as timber products." (pg. 28)

Blenheim Group Plc says,

"Other than in exceptional circumstances, it is not now the group's policy to hedge foreign exchange exposures as the directors believe investors should benefit from the exposure the group has to strong foreign currencies." (pg. 18)

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[24] Northern Foods uses foreign currency debt for hedging purposes.

National Express Group Plc says,

"As the majority of group's revenue and operating profit is generated within the UK at present, there is no significant foreign currency exposure."[26] (pg. 37)

Mayflower Corporation writes,

"The balance sheet is not hedged as no transaction exposure is foreseen. However, borrowings in local currencies, where possible, are used as a natural hedge from the volatility of exchange rates and to reduce the impact of translation exposure." (pg 33)

Redland writes,

"Transaction exposures are not generally significant... Exports are not material... More than 80% of profit is earned outside the UK."[27] (pg. 41)

Tibbett and Britten writes,

"The Group's subsidiaries mainly trade in their country of incorporation. There is no material cross-border transaction exposure within the Group. Approximately 45% of the Groups turnover in the year was generated outside the UK." (pg. 25)

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[25] However, the Group seeks to protect the value of its overseas investments from the swings in the value of sterling by borrowing in foreign debt and through foreign currency swaps.

[26] This firm is categorised as a foreign currency hedger on the grounds of its disclosure in the notes to the accounts.

[27] Redland's principal foreign exchange risks arise from the translation of the results and net assets of overseas activities into sterling. Group policy is to hedge part of the translation exposure to net assets by foreign borrowings. The Group also uses foreign currency swaps and forwards to change the currency profile of borrowings. Chubb Security Plc follows a similar approach, "Transaction exposures in total are not significant but for individually material transactions denominated in a currency other than that of the particular Group company involved, the foreign currency exposure is hedged by forwards." Furthermore it writes, "The principal foreign currency risks arise from the translation of the results and net assets of overseas activities into sterling." (pg. 38)

This anecdotal evidence shows that the primary reason why these firms are not hedging a particular category of foreign exchange exposure is because of their low level of exposure. Although, two firms (Boots Plc and RTZ Plc) argue that hedging provides no long-term benefits to shareholders and one of these takes a portfolio approach to managing this risk. Another firm declines to hedge because it wants its shareholders to benefit from exposure to strong currencies.[28] Finally, Associated British Ports, will manage foreign exchange risk if the need arises, it says,

"The Group has insignificant receipts or payments in foreign currency and it is the Group's policy to eliminate foreign currency risks by putting in place foreign exchange transactions as soon as the need arises... Turnover is derived almost entirely from operations within the UK." (pg. 26)

4.3.9 Type of Foreign Exchange Exposure Managed

The international finance literature identifies three categories of foreign currency exposure: transaction exposure, translation exposure and economic or competitive exposure. This study has relied on qualitative disclosures contained in annual reports to determine the category of foreign exchange exposure hedged.[29] However, not all companies provided sufficient or adequate disclosure to determine which category of exposure was hedged. For those that did it was possible to determine if the company hedged transaction exposure and the exposure arising from the assets, profits or cash flows of foreign operations (usually balance sheet translation exposure). Table 4.22 presents details of the types of foreign currency hedging activity.

[28] Blenheim Group Plc.

[29] "What you read in the Annual Report and Accounts can be misleading and rarely reflects the true currency exposure of a company." Julie Bower, Currency Hedging in the Drinks Sector, 1993.

Table 4.22 Categories of Foreign Exchange Hedging

	No.	(%)
Firm only mentions hedging foreign currency exposure	15	5.2
Firm only mentions hedging transaction exposure	38	13.1
Firm only mentions hedging the assets, profits or cash flows of overseas subsidiaries	87	30.0
Firm mentions hedging the assets, profits or cash flows of overseas subsidiaries and hedging transaction exposure	150	51.7
Total	**290**	**100**

Of the 290 firms classified as foreign exchange hedgers, 5.2 percent provided no indication of the type of foreign currency exposure hedged. A further 13.1 percent only discussed the hedging of transaction exposure and another 30 percent only mentioned the hedging of assets or profits or cash flows of overseas subsidiaries.[30] Another 51.7 percent disclosed the hedging of both transaction exposure and the exposure arising from overseas subsidiaries.[31] Eighty two percent of firms hedged the translation exposure arising from foreign operations. [32]

Six percent of the full sample[33] described situations that suggested they faced economic exposure. For example, Inchape Plc writes,

"Inchape Toyota Motors continued to be severely affected by the relative strength of the yen." (pg. 6)

[30] In most cases firms were hedging a balance sheet translation exposure.

[31] Edelshain (1995) finds that 61 percent of UK firms attempt to match assets and liabilities and or income and outgoings in the same currencies.

[32] Bodnar et al (1995) find that 80 percent of firms use derivatives to hedge firm commitments while only 44 percent use derivatives to hedge the balance sheet. Hakkarainen et al. (1997) find that approximately 50 percent of firms hedge the value of equity of a foreign subsidiary and the foreign exchange risk of financial assets. Belk and Glaum (1990) and Collier, Davis, Coates and Longden (1992) find that around three-quarters of UK firms manage translation exposure. Edelshain (1995) finds that 55 percent of large UK firms attempt to minimise balance sheet exposures in each foreign currency. Hedging the balance sheet refers broadly to activity intended to protect a specific account (equity) or the ratio of two accounts (debt as a percentage of total capital. One reason firms sometimes focus on balance sheet exposures rather than cash flows is to reduce the probability of violating a debt covenant.

Allders writes,

"Our US operation had a disappointing year with our operation at Las Vegas airport, traditionally dependent on Mexican traffic, suffering from the devaluation of the peso." (pg. 7)

Time Products writes,

"In March 1994, the Group acquired 78 percent of the company which distributes Audemars Piguet watches in Switzerland. Its performance so far has been affected by the strong Swiss franc which has had an impact on tourism." (pg. 2)

Avon Rubber writes,

"We believe that our factories will remain busy with the possible exception of France, where the strong currency is likely to affect exports." (pg 5)

Some firms described the effect of exchange rate changes on their competitive environment. For example, Norcros writes,

"The Australian housing industry grew rapidly in the first half, but higher interest rates and over supply resulted in lower activity at the end of the year; reduced import tariffs and a stronger currency also led to a higher level of tile imports and increased competition." (pg. 11)

[33] Full sample refers to 412 firms.

Ellis and Everard writes,

"Further progress has been achieved in the Food and Personal Care business despite severe pressure from competitors based in the Far East and unfavourable exchange rates." (pg. 9)

Hepworth writes,

"In a weaker German drainage markets, Hepworth Building products grew its clay market share with new products and benefited from favourable exchange rates." (pg. 11)

Harrisons and Crossfield writes,

"Businesses based in Germany and Holland were adversely affected by the strength of the currencies in those two countries..." (pg. 7)

Halstead writes,

"Despite competition from both the UK and Europe we have slightly improved our dominant share of the home market." (pg. 9)

RMC writes,

"The concrete market was less volatile during 1995 than in the previous year. However, uncertainty persisted due to the high level of imported cement." (pg. 14)

None of these firms, however, indicated they hedged this exposure with derivatives.[34] One firm suggested that the use of derivative instruments was ineffective against real changes in exchange rates, Huntliegh Technology, wrote

"Forward contracts are taken out, where appropriate, in the Group's principal trading currencies... However, such contracts cannot, of course, insulate the Group from any long-term fundamental shift in currency values." (pg. 21)[35]

Two firms provided examples of where operating solutions had reduced economic exposure.[36] For example, Powerscreen International acquired businesses in its main market, the US, in order to mitigate its foreign currency exposure, it writes,

"The purchase of two US based manufacturing facilities in Febuary 1994 improves the balance between dollar denominated revenues and costs." (pg. 15)

[34] Bodnar et al. (1995) report that economic exposure is frequently hedged (with derivatives) by only 16 percent of firms and a further 24 percent of firms sometimes use derivatives for this reason. Belk and Glaum (1990) find that economic exposure is given little attention in UK multinationals. An example of a firm using derivatives for hedging economic exposure is the Canadian forest products company Abitibi-Price. This company had purchased Canadian dollar call options to protect against a strengthening Canadian dollar and written Canadian currency puts to finance them. This strategy provided protection within a range of currency levels and was maintained on a rolling 12-month basis, with a new position out 12 months being taken every time a collar matured. When the Canadian dollar appreciated strongly in 1990 the call options were exercised and protected the company's margins (see Falloon (1995)).

[35] Financial hedging techniques might not be the way to deal with this kind of exposure. For example, Shapiro and Rutenberg (1976) write, "It is clear that firms cannot cover their economic exposure by traditional financial hedging. Here, instead of attempting to minimise the short-run balance sheet impact of an exchange rate change, managers should concentrate their efforts on the production and marketing adjustments and investment decisions necessary to ensure increases in profit in the long run." Aggarwal and Soenen (1989) present a similar argument suggesting that financial markets provide only short-term hedging tools while long-term and strategic hedging tools must be based on internal operating policies and corporate strategies. They point out that the lack of financial instruments to hedge long-term exposures to the risks of changing currency values means that multinational companies must consider alternative locations for production and investment as well as alternative pricing, sourcing and financing as a response to long-run changes in real exchange rates. (See also Grant and Soenen (1991))

Mersey Docks writes,

"Volumes handled at the (Liverpool) Terminal continue to suffer from the prevailing lethargy in the construction industry and the uncompetitive position of the Canadian softwood against Scandinavian timber." (pg. 9)

This suggests the firm was exposed to the relative position of the Canadian dollar and various Scandinavian currencies. Although the effect of this was mitigated because its other port Sheerness had recently become the focal point of UK distribution for two of the four largest Swedish forest product companies.[37]

One reason for finding very little evidence of firms hedging economic exposure might be because of the difficulty of quantifying economic exposure. For example, British Airways writes,

"...exchange rate movements can affect demand for services, especially from leisure travellers whose decision whether and where to travel may alter as a result of exchange rate movements. While it is not possible to quantify this effect, British Airways does monitor exchange rate movements in an attempt to anticipate likely changes in the pattern of demand." (pg. 36, Form 20-F, 1995)

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[36] Berkman, Bradbury and Magan (1997) find that 65 percent of hedgers indicate the use of foreign operations as a natural hedge.

[37] Bower (1993) examines the hedging of economic exposure by large firms in the UK drinks sector and also finds that these firms use operational techniques rather than derivative based solutions to manage this exposure. For example, Bower writes, "Allied's exposure in whisky is hedged to some degree by the 1% shareholding in the private group, Suntory (one of its competitors). The presence of a major cognac in the portfolio also provides a hedge against a weak franc induced boom in cognac sales and the impact it could have on Scotch. The ownership of a Canadian whisky equally partially hedges long-term exposure to the dollar." Pg. 12.

British Steel also has difficulty measuring economic exposure, it writes,

"Exchange rates are important to British steel's competitiveness and results. Sales in the EU are influenced by the deutschmark, reflecting the fact that Germany is both the EU's largest national market for steel and its largest steel producing nation. The balance of sales (20%) in other markets are influenced by the US dollar. Approximately one-quarter of British Steel's costs are related to the US dollar as most raw materials are purchased in markets where prices are set by reference to it. In general, a substantial strengthening of sterling against the deutschmark would have an adverse impact on sales, whereas changes in the sterling/US dollar rate would affect both sales and costs. The effects of fluctuations in the relationship between the three currencies are, however, complex. Variations in any particular direction do not have an identifiably consistent impact on results, which are also affected by related factors such as the pricing policies of British Steel and its competitors and shifts in underlying US dollar prices of raw materials. For these reasons the Company, in common with the steel industry generally, does not attempt to hedge long term strategic/economic risks." (pg. 24, Form 20-F, 1995)

4.3.10 The Use of Foreign Currency Debt by UK Firms

Nance, Smith and Smithson (1993) define corporate hedging as the use of off-balance-sheet instruments such as forwards, futures, swaps, and options to reduce the variability in firm value. They note that the firm could hedge via an on-balance-sheet strategy such as locating manufacturing facilities in close proximity to the geographical markets being served and/or financing operations using foreign currency debt.

However, in their study they "take the firm's investment and on-balance-sheet financing strategies as predetermined and focus on off-balance-sheet financial hedging". This approach is followed by the majority of studies conducting empirical tests of corporate hedging behaviour. Contrary to these studies this study includes the use of foreign debt employed for hedging purposes in the definition of hedging.[38]

Quantitative data on the corporate use of foreign currency debt is not disclosed universally in annual reports.[39] However, qualitative disclosure on foreign debt usage was found in various sections of the annual report, such as, the Operating and Financial Review, the Accounting Policies note[40], and the Creditors Due After More Than One Year note to the accounts.

Table 4.23 Foreign Currency Debt Usage by Full Sample

	No.	(%)
Firm uses foreign currency debt	272	66.0
Firm does not use foreign currency debt or no disclosure	140	34.0
Total	**412**	**100**

[38] Allayannis and Ofek (1996) find that 20% of the firms in their sample use foreign debt and 44% use foreign currency derivatives. They also note that the use of foreign debt is positively correlated with the percentage of foreign sales and that multinationals use foreign debt in conjunction with foreign currency derivatives for hedging, while exporters prefer to use derivatives. They also find that a firm's overall hedging position of foreign currency derivatives plus foreign debt is significantly positively related to the percentage of foreign sales and export share.

[39] In some instances where it is disclosed it is shown after the effect of the use of foreign currency swaps.

[40] SSAP 2 requires the accounting policies (the various bases on which the accounts have been prepared) to be disclosed. They are shown at the beginning of the notes to the accounts and amongst the items included is the basis of accounting for the translation of currencies. This policy note might include a reference to foreign currency debt. For example, Argyll Group writes, "Fixed asset investments in foreign currency are translated into sterling at current exchange rates except when financed by borrowings denominated in foreign currency when both investments and borrowings are retranslated at the exchange rates ruling at the end of the year." (pg. 23) Kenwood Appliances writes, "Differences on foreign currency borrowings, to the extent that they are used to finance or provide a hedge against foreign equity investment are taken direct to reserves." (pg. 15)

Table 4.24 Implied Effect of Foreign Currency Borrowings on Risk Profile

	No.	(%)
Reduce Currency Exposure	230	84.5
Increase Currency Exposure	10	3.7
Reduce and Increase Currency Exposure	8	2.9
Insufficient Disclosure to Determine Effect	24	8.8
Total	**272**	**100**

Table 4.23 shows that 66 percent of firms report the use of foreign currency debt[41] and it seems that in the majority of cases the maturity of the debt is long-term.[42] This figure is similar to that reported by Edelshain (1995) who found that 60 percent of his sample of 189 large UK-based companies used foreign currency denominated debt.

Thirty four percent of firms in our sample indicate they have no foreign borrowings or provide no disclosure. For example, Yorkshire Electricity writes, *"There are no long-term borrowings in foreign currencies."* (pg.20)

Anglian Water writes, *"The majority of treasury activities are carried out in the UK and there are no significant foreign currency borrowings."*[43] (pg. 30)

South West Water writes,

[41] Thirty-three of these firms were defined as foreign debt users based on information in the accounting policy note only. See footnote 39 for an example of the typical disclosure found in this note. If these firms are recoded as non-users of foreign currency debt the proportion of users falls to 58 percent of the full sample.

[42] In a few cases firms only used short-term foreign currency borrowings. For example, Associated British Foods writes, " No financial hedge is taken against the Group's long-term investments in overseas subsidiaries... Short-term borrowings of $50m were raised to part fund the US acquisition." (pg. 19) Electrocomponents Plc writes, "Borrowings are utilised to cover short-term cash flow requirements and are principally in overseas operations... It is not the policy of the Group to cover the balance sheet foreign currency translation risk." (pg. 16)

[43] In its 1996 annual report Anglian Water writes, "The Group borrowed US dollars, some of this was swapped to eliminate the risk of currency fluctuations." In its 1998 report, it writes, "Borrowings include £182.6 million denominated in foreign currencies. Of this amount £177.5 million has been swapped to eliminate the risk of currency fluctuations." (pg. 19)

"Loans and other borrowings are predominantly denominated in sterling." (pg. 38)

The BSS Group writes,

"As over 97% of assets are held in sterling, there is no requirement to protect shareholder values by borrowing other than in sterling." (pg. 29)

Northumbrian Water writes,

"The net assets of the Group are almost entirely situated in the UK." (pg. 21)

John Menzies writes,

"Overseas turnover was not significant." (pg. 10)

Of the 272 firms using foreign currency debt Table 4.24 shows that 84.5 percent used the debt solely for hedging purposes.[44] This debt usually hedged a balance sheet translation exposure.[45] Most companies with foreign operations organise their balance sheets such that foreign assets are matched by foreign debt, so that a change in exchange rates resulting in a change in the sterling value of foreign assets is matched by a corresponding change in the outstanding level of debt. For example Geest Plc writes,

"Balance sheet translation hedging is carried out in order to preserve the sterling value of shareholders funds by funding foreign currency assets with matching borrowings in the same currency." (pg. 33)

[44] Hakkarainen, Kasanen and Puttonen (1997b) find in a survey of 84 large Finnish firms that 65% use matching and foreign currency loans for hedging purposes often or continuously.

[45] SSAP 20 allows the hedging of the net equity investment in an overseas operation by means of currency borrowing by the investing company, the subsidiary/branch concerned or another subsidiary or branch of the investing company.

Yorkshire Chemical writes,

"Overseas debt partially funds the working capital requirements of the Group's subsidiary operations. Being denominated in the currency of the subsidiary, it acts as a partial hedge against currency translation differences on the Group's net investment in these subsidiaries." (pg. 46)

Rugby Plc writes,

"The Group seeks to mitigate the impact of extreme movements in foreign exchange rates on shareholders' funds by holding foreign currency borrowings to hedge certain of its assets overseas. As a consequence the Group incurs interest costs in the same currencies as those in which it generates operating profit, thereby also reducing the impact of foreign exchange movements on reported earnings." (pg. 19)

Field Group Plc writes,

"The assets, profits and cash flows of our European subsidiaries are in Belgian and French francs. To provide reasonable cover against the effect of currency movements, we have taken out loans in the same currencies. The acquisition of Bourgeot in the period was financed by new French franc borrowings, hedging the assets and goodwill acquired." (pg. 15)

EMAP Plc writes,

"The majority of the Group's debt is denominated in French francs and Deutschmarks so as to provide a natural hedge against the effects of exchange rate movements on the cash flows generated in those two countries." (pg. 23)

In addition to hedging a foreign currency exposure foreign currency debt might also be the source of the exposure. In 2.9 percent of cases firms borrowed in various foreign currencies some of which hedged an exposure and others which increased the firm's exposure.[46] For example, British Telecom Plc writes,

"The Group's foreign currency borrowings, which totalled £983 million at March 31, 1995, are used to finance its UK operations and to finance the Group's overseas investments, including MCI, in order to reduce the currency exposure on the underlying assets. Foreign currency swaps and foreign exchange contracts have been entered into to minimise the foreign currency exposure on the borrowings used to finance the Group's UK operations." (pg. 45, Form 20-F, 1995)

In 3.7 percent of cases firms' use of foreign currency debt increased their foreign currency exposure.[47] For example, British Aerospace Plc writes,

[46] These eight firms are included in the sample of 238 firms that use foreign currency debt for hedging purposes.

[47] In this situation firms may have been attempting to arbitrage borrowing rates. For example, Yorkshire Water, "Debt denominated in foreign currency is swapped into sterling where this achieves a lower cost of financing, and is otherwise only utilised to finance overseas assets." (pg. 28)

"The Group has entered into currency swaps to manage the foreign currency exposure associated with borrowings denominated in foreign currency. Borrowings have been swapped on a fully hedged basis into sterling." (pg. 39)

Lloyds Chemist writes,

"the Group raised a further $30 million from the private placement of a fixed rate loan note repayable in 1998, eliminating the foreign exchange exposure by the use of a forward foreign currency swap." (pg. 23)

Thames Water Plc writes,

"$150m 6^{3}/8% notes due 2004 of which $40m has been swapped into floating rate Deutschmarks to protect against adverse exchange rate fluctuations." (pg. 45)[48]

Finally, for 24 firms it was not possible to determine the precise impact of foreign currency borrowings on the firm's risk profile.[49]

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[48] Other examples are: Asda writes, "The group has entered into foreign currency swaps which have the effect of converting US dollar borrowings to sterling denominated interest." (pg. 26) HP Bulmer writes, "The Group issued $45m fixed coupon senior notes... The Group entered into foreign currency and interest rate swaps which removes all US dollar exposure, resulting in a sterling obligation." (pg. 15) Daily Mail writes, "$113m of the loan notes have been converted effectively into sterling liabilities using cross currency swaps and forward contracts." (pg. 23) Eurotunnel writes, "Borrowings of US$254m were converted to sterling for value 1 March 1996 leaving residual borrowings in US dollars of $316m." (pg. 67) McKechnie writes, "The US$15m loan note has been swapped into sterling and fixed at £10.1m." (pg. 28)

[49] Although, three of these firms indicated they did not hedge their long-term investment in overseas subsidiaries. For example, Farnell Electronics writes, "It is Farnell's policy not to hedge its long-term investment in overseas assets." (pg. 13) Lex Service writes, "The Group's exposure to overseas investments and profits is not material to the overall results of the Group and is therefore not hedged." (pg. 21) Associated British Foods writes, "No financial hedge is taken against the Group's long-term investments in overseas subsidiaries." (pg. 17)

4.3.11 The Use of Derivatives by Foreign Currency Hedging Firms

In addition to using foreign currency debt for hedging purposes foreign currency hedging firms might also employ derivatives.[50] Panel A of Table 4.25 shows that 86.9 percent of foreign exchange hedging firms disclose the use of any category of derivative instrument (i.e., interest rate, foreign exchange or commodity price). Panel B of this table shows that 73.8 percent of foreign currency hedging firms disclose the use foreign currency derivatives. These foreign currency derivative users make up 52.2 percent of the full sample. Table 4.26 shows that this figure is slightly higher than that reported in three US studies (Allayannis and Ofek (1996), Geczy et al. (1997) and Howton and Perfect (1998)) which also investigated foreign currency derivatives use by large firms (i.e., S&P/Fortune 500 firms). The other three studies (Wysocki (1995), Mian (1996) and Graham and Rogers (1999)) draw their sample of firms from a much larger population and hence include a larger proportion of smaller firms. This explains why both Wysocki and Mian report a lower level of derivatives use. Although drawing firms randomly from a large population, Graham and Rogers focus on firms with ex ante foreign currency exposure which explains their reported level of foreign currency derivatives use.

Table 4.25 Foreign Exchange Hedging Firms Using Derivatives

Panel A: All Derivatives	No.	(%)	Panel B: Foreign Currency Derivatives	No.	(%)
Yes	252	86.9	Yes	215	73.8
No & No disclosure	38	13.1	No disclosure	75	26.2
Total	**290**	**100**	**Total**	**290**	**100**

[50] British Gas writes, "... exposure to foreign exchange risk is minimised by the use of financial instruments and by raising overseas finance to hedge against overseas assets." (pg. 21)

Table 4.26 Proportion of Foreign Currency Hedgers/Derivative Users in Samples of 6 Empirical Studies

Author(s) of Study	Date	Sample size	No. of Hedgers	No. of Non-Hedgers	% of FX Hedgers
Wysocki	1995	807	234	573	29.0
Mian	1996	3022 firms	440	2582	14.9
Allayannis & Ofek	**1996**	**724 firm years (S&P500)**			**43.9**
Geczy et al.	**1997**	**372 Fortune 500**	**154**	**218**	**41.4**
Howton & Perfect	**1998**	**451 Fortune 500/S&P 500**			**45.0**
Graham & Rogers	1999	242 from 3232 firms	105	137	43.4

Note: In the Howton and Perfect random sample 14.29% use currency derivatives.

Panel B of Table 4.25 shows that 75 foreign currency hedging firms do not mention the use of derivatives. Table 4.27 classifies these firms into type of exposure hedged. Over three quarters were hedging foreign assets with foreign currency debt and 20 percent of firms referred to hedging transaction exposure.[51]

Table 4.27 Profile of Foreign Exchange Hedging Firms Not Using Foreign Currency Derivatives

	No.	(%)
Hedging foreign exchange exposure	3	4.0
Hedging assets, profits or cash flows of foreign operations	57	76.0
Hedging assets/profits/cash flows & hedging transaction exposure	14	18.7
Hedging transaction exposure	1	1.3
Total	**75**	**100**

Panel A of Table 4.28 shows that the most popular foreign currency hedging method is the use of foreign currency debt employed by 81.8 percent of foreign currency hedgers. This is slightly higher than Berkman, Bradbury and Magan (1997), who report

[51] Unreported tests show that these non derivative using foreign currency hedging firms have significantly higher levels of overseas sales (destination and origin) relative to non-foreign currency hedging firms. Derivative using hedging firms have significantly higher levels of foreign sales by destination relative to non-derivative using hedging firms but the level of foreign sales by origin are not significantly higher. These results can be explained by the fact that sales destined abroad include exports giving rise to a transaction exposure which is better hedged with derivatives, in particular forwards, futures or options. However, sales originating abroad imply foreign assets which can be hedged using either foreign debt or derivatives or some combination of the two.

that over 70 percent of New Zealand hedgers use foreign debt financing as a financial hedge.

Panel B shows that the forward contract is the most popular choice of foreign currency derivative. More than 77% of foreign currency derivative users indicate the use of forwards. Approximately a third indicate the use of swaps and 13.5 percent of foreign currency derivative users use options. Bodnar et al. (1995) also find that the foreign currency forwards are the preferred derivative for foreign currency hedging with nearly 50 percent of firms using them, followed by over-the-counter options and then swaps.[52] Phillips (1995) finds that forwards are used most by firms followed by swaps and then options.

Table 4.28 Method of Foreign Currency Hedging

Panel A: Foreign Currency Hedgers	No.	(%)[a]	Panel B: Foreign Currency Derivative Users	No.	(%)[b]
Foreign currency debt	238	81.8			
Forwards	166	57.0	Forwards	166	77.2
Swaps	74	25.4	Swaps	74	34.4
Options	29	10.0	Options	29	13.5

[a]Proportion of foreign currency hedgers (i.e., 290 firms).
[b]Proportion of foreign currency derivative users (i.e., 215 firms).

4.3.12 The Use of Foreign Currency Swaps

Panel B of Table 4.28 shows that 34 percent of foreign currency derivative users disclose using currency swaps. Table 4.24 shows that in 18 instances foreign debt increased exposure. Table 4.29 shows that in all of these cases firms always resorted to

[52] Bodnar et al. (1996) report similar findings.

foreign currency swaps to mitigate the exposure (see reasons 1 and 2).[53] Phillips (1995) found that 20.7 percent of firms issued foreign debt and swapped any part of the proceeds into US dollars.[54] Sixty three firms also reported the use of combinations of foreign currency debt and foreign currency swaps to hedge exposure arising from the existence of overseas assets.[55] In ten cases they also used foreign currency forwards.[56] Whilst in one instance a firm relied solely on swaps to hedge this exposure.[57]

In summary this analysis shows that foreign currency swaps were used to translate foreign debt into a domestic liability (for example, swap US dollars into sterling), translate foreign debt into a liability of another currency (for example, swap US dollars into deutschmarks) and lastly convert domestic debt into foreign debt (for example, swap

[53] In these cases it would seem that the swaps were used in conjunction with obtaining financing. For example, Thames Water Plc writes, "The Group has $150m notes due 2004 of which $40m has been swapped into floating rate deutschmarks to protect against adverse exchange rate fluctuations." (pg. 28) British Telecom also used foreign exchange forwards, "Foreign currency swaps and foreign exchange contracts have been entered into to minimize the foreign currency exposure on the borrowings used to finance the Group's UK operations." (pg. 45, Form 20-F) Hakkarainen et al. (1997b) find that 88 percent of Finnish firms with foreign debt hedge the exposure arising from the debt.

[54] In Phillips (1995) survey 46.9% of derivative users believed that derivatives were significant in increasing the flexibility of funding choice.

[55] For example, Adwest writes, "The Group hedges the effect of exchange rate movements on the translation of foreign currency net assets by using foreign currency borrowings and foreign currency swap contracts." (pg. 22) Smith and Nephew writes, "The group protects shareholders funds by matching, where practicable, foreign currency assets, including acquisition goodwill, with currency liabilities. These currency liabilities take the form of either borrowings or currency swaps." (pg. 27) BOC Group writes, "Usually foreign currency investments are hedged by borrowings in the same currency, either by means of direct borrowings or the use of foreign currency swaps." (pg. 37)

[56] For example, National Power writes, "It is the Company's policy to manage exposures in respect of overseas subsidiary and associated companies through related foreign currency borrowings, forward exchange contracts and foreign currency swaps. At 26 March 1995, approximately US$150 million of its 6¼ percent. Euro Dollar Bonds due 2003 was designated as a hedge against the net investment in ANP, and approximately US$100 million was designated as a hedge against the investment in the Hub power project. Also in place were approximately £42 million of foreign currency swaps and £9 million of forward exchange contracts that were designated to hedge against foreign currency risk in respect of investments in and loans to Tejo Energia."(Annual report on Form 20-F, pg. 48)

[57] For example, Tesco writes, "We have hedged our investment in Catteau by swapping the appropriate level of borrowings into French francs and so eliminating exposure to currency movements." (pg. 26)

sterling into French francs).[58] The main finding is that firms use foreign currency swaps to manage the currency composition of long-term borrowings and so hedge the exposure to exchange rate movements.[59]

Table 4.29 Reasons for Using Foreign Currency Swaps

Reason for swap usage	No.	(%)
1. Only Hedge exposure arising from foreign currency debt	10	13.5
2. Hedge exposure arising from foreign currency debt and hedge overseas assets with foreign borrowings and swaps	8	10.8
3. Hedge exposure arising from overseas assets with foreign borrowings and swaps[1]	55	74.3
4. Hedge exposure arising from overseas assets only with swaps	1	1.4
Total	**74**	**100**

[1]It is possible that for some of these firms foreign currency borrowings might have also resulted in an increase in foreign currency exposure in addition to being used to hedge overseas assets.

[58] Unreported tests show that within the group of foreign currency hedgers foreign currency swap users are significantly larger than other hedgers not using foreign currency swaps. Foreign currency swap users also had significantly higher levels of long-term debt than other hedgers not using currency swaps.

[59] Some firms borrow in currencies other than those in which their assets are held and revenue is earned. This poses additional risk through the mismatch of currencies. This risk can be hedged by matching foreign assets with foreign currency borrowings indirectly via foreign currency swaps. For example, BOC writes, "The Group has borrowings in a wide range of currencies... Usually, foreign currency investments are hedged by borrowing in the same currency, either by means of direct borrowing or the use of other hedging instruments such as currency swaps." (pg. 37) Cadbury Schweppes writes, "It is, however, important to relate the structure of borrowings to the trading cash flows that service them and the Group's policy is to maintain broadly similar fixed charge cover ratios for each currency block. This is achieved by raising funds in different currencies and through the use of hedging instruments such as swaps. Accordingly almost the whole of the funding for DPSU was made in, or converted into, US dollars." (pg. 49)

4.3.13 Derivatives Use and Speculation – Evidence From Annual Report Disclosures

Chapter 2 identifies the economic incentives for speculation and shows that derivatives can be used for this purpose. The analysis in chapter 3 shows that most studies examine derivative use and not hedging specifically, and therefore the dependent variable in these studies might measure speculation rather than hedging. Chapter three argues that the most appropriate way of determining whether firms are speculating with derivatives is to measure their underlying risk exposure prior to the use of derivatives and then examine the impact derivatives use has on the size of the firm's exposure. In this study it is not possible to undertake this kind of analysis because data on when firms first started to use derivatives is not publicly available.[60] Consequently, this study employs disclosures in annual reports to determine whether firms might be hedging or speculating with derivatives. A search of annual reports reveals that 27 percent of hedging firms specifically report that derivatives are not used for trading or speculative purposes.[61] These explicit disclosures about the absence of trading activities and/or leveraged derivatives constitute a very strong statement about the company's objectives.[62] Examples of the type of disclosures are as follows:

[60] Guay (1999) is able to determine when firms first use derivatives by looking at a sample of firms using derivatives for the first time. The risk characteristics of this sample are then examined to determine whether derivatives are used to lower or raise risk.

[61] Francis and Stephan (1993), Berkman and Bradbury (1996) and Graham and Rogers (1999) find similar statements made by firms in their studies.

[62] Although 73 percent provide no statement on this matter. One possible reason for non disclosure is that these companies might have considered it wiser from a legal point of view not to confirm or deny using derivatives for trading purposes. If the company suffered a derivatives loss after year -end that looked like

Tomkins writes,

"We do not seek speculative gain; indeed the controls in place are designed to preclude speculation but maximise certainty and safety." (pg. 30)

Cable and Wireless writes,

"The Group does not speculate in derivative financial instruments." (pg. 37)

Huntleigh Technology writes,

"No speculative positions are taken against future movements in foreign exchange rates or interest rates." (pg. 19)

Despite claims from corporate treasurers that their treasuries do not speculate or trade in derivatives, some treasuries follow a selective hedging policy designed to protect against adverse financial price movements and take advantage of anticipated favourable price changes.[63] The degree of exposure hedged or the type of hedging instrument used is based on views taken by treasury staff as to the likely direction of financial prices. The disclosures of 23 firms implied that they hedged selectively. Table

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a trading instrument was involved, a statement in the annual report that it did not engage in derivative trading activities might create legal problems.

[63] Searjeant (1994) reports the comments of Neil Record, a treasury consultant, who suggests that firms will say they hedge foreign cash flows, use interest rate swaps to make the best use of borrowing opportunities and insist that their treasury departments are highly conservative and never speculate. Record argues that this is the case up to a point and goes on to say, "No chief executive will admit that his treasury speculates with his company's money, and therefore a denial is valueless. But plenty of treasuries do in practice take bets on currency and interest rates. I would go further and say that practically all the treasuries I have ever come across have done this in one circumstance or another." Graham Searjeant, The Times, Monday August 15 1994, pg.32.

4.30 shows these selective hedgers are dominated by large firms, with over 50 percent ranked in the top 100 of UK firms.[64]

Table 4.30 Selective Hedgers Ranked By Firm Size

FT500 Ranking	No.	%
1-100	13	56.5
101-200	7	30.4
201-300	2	8.7
301-400	0	0
401-500	1	4.3
TOTAL	**23**	**100**

Examples of disclosures by firms selectively hedging their financial price exposures are:

SmithKline Beecham Plc writes,

"In view of the prevailing interest rate outlook, approximately 75 percent of forecast 1996 net interest payable is at floating, rather than fixed interest rates... All fixed rate Eurobonds and medium-term notes have been swapped to floating." (pg. 41)

Tesco had 73 percent of gross borrowings at floating rates at the year end. Tesco writes, *"In determining the mix, we have taken account of cost of fixed rate debt, the risk of interest rates rising significantly and the expected cash flows in the near term which should reduce the percentage of floating rate debt."* (pg. 49)

[64] Bodnar et al. (1995) report that 43 percent firm use derivatives for taking a view on the direction of financial prices, although only 9 percent do so frequently. However, their survey indicates that 34 percent of firms seldom use derivatives to take a view and 57 percent never do.

Christian Salvesen writes,

"At year end, 40 percent of our total borrowings was at floating rates, a policy which is regularly reviewed to take account of the predicted interest rate environment of the countries in which we operate." (pg. 23)

The Treasurer at Grand Metroplitan says,

"Any company which operates an interest rate hedging policy within a band will, at this moment, probably be nearing its maximum proportion of fixed-rate debt. We are at the top end of our fixed/floating band at the moment. This reflects our view that there is little downward potential for US interest rates." [65]

Morgan Crucible writes,

"All issues were made on a fixed rate basis, but some are swapped into a variable rate. The proportion depends on the Treasury's view of future interest rates." (pg. 33)

Other reported examples of a selective hedging policy are:

Mr Arthur Burgess, group treasurer at British Gas, says that British Gas aims to have three-quarters of its debt in fixed rate and one quarter in floating rate, but that the split can vary to half-and-half depending on the company's view on interest rates. "We use the swaps market to switch from fixed to floating," ...[66]

[65] See Nick Reed, Big Mac Attack, Risk, Vol. 7, No. 2, February 1994, pg. 19.
[66] Corporate Treasury Management Survey, Financial Times, 2/11/1993, pg. 36.

Reuters interest rate exposure arises from its investment of its large cash balances. It had net cash balances of £850 million at the 1995 year end. Most of the company's assets are held in sterling. This is designed to give investors the opportunity to hedge themselves out of sterling into another currency. Reuters argues that if it held its cash in a range of currencies rather than in sterling, it would be creating large accounting exposures and high volatility in its earnings. "What we then have to do is manage the yield curve," says the deputy finance director. This is done by entering floating-to-fixed swaps, often on a forward start basis. For the period 1992-94, the strategy generated a profit of £61 million over the yield that would have been achieved on three-month deposits.[67]

The Zeneca treasury describes itself as being risk averse, it sees its role as reducing risk in a cost-effective way and would therefore not contemplate taking speculative positions to maximise profits. However, the unit does not just roll over hedge positions, but uses its judgement to time trades or depart slightly from its benchmark when opportunities arise. The Zeneca treasury team has scope to deviate away from their benchmark for economic exposure, but only by a 10-20 percent margin. This enables them to exploit profit opportunities as they occur. "We can either vary amount of the hedge or vary the composition of the hedge between forwards and options to express a view on volatility."[68]

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[67] See Jules Stewart, Sterling Performance, Risk, Vol. 8, No. 8, August 1995, pg. 17.
[68] See Sarah Priestley, Risk, Vol. 7, No. 8, August 1994, pg. 30.

It would seem then that these firms are pursuing a strategy of selective risk management. However, there is no evidence to suggest that their hedge ratios lie outside the normal bounds of 0% and 100%. The rationale put forward by some firms for their selective approach to risk management is their belief that they can add some value by changing their hedging positions when they have a view about future developments in particular markets.

A search of annual reports reveals that only two firms disclose that they speculate with derivatives. One of these, British Petroleum (BP), seems to run its treasury department much like a bank and seeks to make a profit from financial price movements. BP writes,

"The Group maintains active trading positions in a variety of derivatives. This activity is undertaken as a secondary and limited activity, and in conjunction with risk management... For traded derivatives, most positions have been neutralised, with trading initiatives being concluded by taking opposite positions to fix a gain or loss, thereby achieving a zero net market risk." (pg. F-24, Form 20-F, 1995)

The other company, Shell, discloses that it uses derivatives for trading purposes but only in certain exposure categories.

Shell writes,

"Some Group companies operate as traders in crude oil and products. These companies use commodity swaps in managing their overall pricing risks... At December 31, 1994 the total notional value of commodity swaps used for trading purposes was £481 million... Gains and losses on trading derivatives are recognised in income as they arise

and reflected in sales and purchases... In addition some Group companies use commodity swaps from time to time to hedge their price risk. When designated as a hedge, the gains and losses are taken to income when the gains and losses on the underlying hedged transaction are recognised. The amount of outstanding swaps at December 31, 1994 was not material." (pg. G-39, Form 20-F, 1994)

Shell does not deal in foreign currency derivatives, it writes

"Foreign exchange derivatives, including forward exchange contracts and currency swaps and options, are used by some Group companies. Group companies do deal not in these derivatives, but rather use forward exchange contracts to maintain an appropriate currency balance for investments of a trading nature. Some Group Companies also use these instruments to hedge future transactions and cash flows." (pages G-38 and G-39, Form 20-F, 1994)

For British Petroleum the level of hedging and trading also seems to vary across the financial price risk categories. Table 4.31 shows that commodity derivatives used for hedging purposes accounted for on average only 12 percent of the total notional value of derivatives used for hedging outstanding each year.

Table 4.31 Use of Financial Derivatives for Hedging by British Petroleum 1993-97

Panel A: Notional values in £ millions

	1993	1994	1995	1996	1997	Total
Foreign currency	7130	5523	6018	5677	6173	30521
Interest rate	2690	3873	3969	3349	2879	16760
Commodity price	633	756	2212	2935	378	6914
TOTAL	10453	10152	12199	11961	9430	54195

Panel B: Percentage of total

	1993	1994	1995	1996	1997	Average %	Total %
Foreign currency	68.2	54.4	49.3	47.5	65.5	57.0	56.3
Interest rate	25.7	38.2	32.5	28.0	30.5	31.0	30.9
Commodity price	6.1	7.4	18.1	24.5	4.0	12.0	12.8
TOTAL	100	100	100	100	100	100	100

Source: British Petroleum Annual Report on Form 20-F, 1993 – 1997.

Table 4.32 shows that commodity derivatives used for trading accounted for, on average, approximately 32 percent of the total notional value of all derivatives used for trading outstanding at year end. The data in Tables 4.31 and 4.32 indicates that commodity price hedging makes up approximately one-tenth of BP's hedging activity whereas commodity price trading is about a third of its trading activity. British Petroleum seems to be making limited use of commodity derivatives for hedging and extensive use of commodity derivatives for trading. As noted above Shell is prepared to trade in derivatives where the underlying is a commodity price but not when it is an exchange rate.[69] The limited use of derivatives for hedging their commodity price exposures and the willingness to use commodity derivatives for trading purposes is consistent with the belief that shareholders expect these firms to not only take on the risks of the oil market but also expect

[69] Shell's commodity derivatives programme accounts for around 7 percent of its total derivatives activity (see 1995 Annual Report page 54-55).

management to exploit any comparative advantage they might have in forecasting future price movements.

Table 4.32 Use of Financial Derivatives for Trading by British Petroleum 1993-97

Panel A: Notional values in £ millions

	1993	1994	1995	1996	1997	Total (93-97)
Foreign currency	2686	4244	2156	2466	2852	**14404**
Interest rate	1329	429	413	450	130	**2751**
Commodity price	1470	635	1095	2835	1692	**7727**
TOTAL	**5485**	**5308**	**3664**	**5751**	**4674**	**24882**

Panel B: Percentage of total

	1993	1994	1995	1996	1997	Average %	Total %
Foreign currency	49.0	80.0	58.8	42.9	61.0	**58.3**	57.9
Interest rate	24.2	8.1	11.3	7.8	2.8	**10.8**	**11.1**
Commodity price	26.8	12.0	29.9	49.3	36.2	**30.8**	**31.1**
TOTAL	**100**	**100**	**100**	**100**	**100**	**100.0**	**100**

Source: British Petroleum Annual Report on Form 20-F, 1993 – 1997.

Other oil firms in the UK seem to have similar policies to that of BP and Shell, for example:

Lasmo writes,

"During 1995, LASMO entered into oil swaps up to three months forward in respect of some 13 percent of total group production for the year. At the year end, LASMO had oil swaps outstanding in respect of 2,525,000 barrels of first quarter 1996 production. In addition, a further 2,400,000 barrels... of second quarter 1996 production has been hedged. To reduce exposure to periods of price weakness, LASMO, may, from time to time, continue to hedge its near term oil and gas price realisations. The objective remains to stabilise the near term financial position whilst retaining shareholder exposure to oil and gas prices in the medium and longer term." (pg. 16-17)

Enterprise Oil writes,

"The oil hedging policy is designed to reduce the group's post tax exposure to periods of potential short-term weakness in crude oil markets." (pg. F-23, Form 20-F)

Oil producers in the US also seem to have a similar perspective on commodity hedging. For example, Hu (1995) writes,

"Mobil Oil apparently hedges against interest rate and foreign exchange risks, but does not hedge against petroleum prices. Mobil believes that shareholders expect it to take on the risks of the oil market. Exxon has noted that it makes "limited use" of commodity swap and futures contracts of short duration. At year-end 1994, the aggregate notional amount of Exxon's commodity swap and futures contracts was only $37 million, compared with notional amounts of $604 million and $2998 million for its interest rate swap agreements and currency exchange contracts." (pg. 1037)

In summary, this study finds only two firms disclosing in their annual reports that in addition to hedging with derivatives they also speculate with derivatives. However, qualitative disclosures in annual reports indicate that over a quarter of hedging firms do not use derivatives for speculative purposes. A small number of firms provide disclosures which suggest that they hedge selectively either by varying the amount hedged or the choice of hedging instrument. This type of hedging appears more to be the conscious bearing of the firm's underlying exposures rather than speculative use of derivatives. Therefore, evidence based on annual report disclosures provides very little support for the suggestion that firms are using derivatives for speculative purposes on a widespread scale. In view of this finding this study assumes that for the vast majority of derivative users derivatives are used for hedging and not speculation.

4.3.14 Analysis of Survey Data

Since disclosure of hedging practices and the use of derivatives is neither universal nor consistent across UK listed firms this study also used a questionnaire sent to Corporate Treasurers to source data on firms' hedging policies and their use of derivatives. The questionnaire and a glossary defining key terms contained in the questionnaire were sent to the treasury staff of 441 non-financial firms in the FT UK500 in January 1995.[70] A letter accompanying the survey explained its purpose and assured participants the confidentiality of their responses. The letter stated that the purpose of the study was to investigate the determinants of corporate hedging and encouraged non-hedging firms and/or non-derivative using firms to respond by stating that the information they would provide was as useful as that provided by hedging firms. The purpose of the glossary was to help avoid inconsistency of interpretation of the key terms in the questionnaire. The vast majority of questions in the survey were of the closed variety where a response was chosen from two or more fixed alternatives. The survey was designed in this way to maximise the response rate while eliciting the information of greatest interest. The main part of the questionnaire required firms to indicate whether they hedged and if so whether they used derivative instruments for hedging. There was also a section requiring firms to provide their motives for hedging.

[70] Appendices A4.1 and A4.2 contain the questionnaire and glossary, respectively.

Table 4.33 shows that 186 firms responded to the survey representing a response rate of 42 percent.[71] The Table also presents a classification of respondents according to their ranking in the FT UK500 list. The proportions of respondents within each size category are similar ranging from 39 percent to 47 percent. Therefore the survey respondent sample is not dominated by any one particular size category.

Table 4.33 shows a relatively even distribution of respondents across the firm size categories implying that there is not a response bias with reference to firm size. Table A4.1 in appendix A4.3 presents the results for additional checks for response bias by comparing the survey respondents to the non-respondents with respect to the characteristics that measure the firm's incentives to hedge. This comparison of means shows no statistically significant differences.

Table 4.33 Size Distribution of Survey Respondents

Market Capitalisation Ranking in FT UK500	No. of firms	No. of respondents	Response rate (%)	Percent of Total
1 – 100	83	33	39.8	17.7
101 – 200	86	39	45.3	20.9
201 – 300	92	43	46.7	23.1
301 – 400	92	36	39.1	19.4
401 - 500	88	35	39.8	18.8
TOTAL	**441**	**186**	**42.2**	**100**

4.3.15 Types of Financial Price Exposure Faced by Firms

Section II of the survey asked firms about the types of financial price risk they faced. Respondents were asked to indicate whether or not their firm was exposed to interest rate risk, foreign exchange risk, commodity price risk, or equity price risk. This information was useful because it facilitated the testing of consistency of responses to

[71] Nance et al. (1993) had a response rate of 31.6% and Dolde (1993) had a response rate of 51.3%.

questions that followed in the questionnaire. For example, firms with no financial price exposure would not be expected to be hedging.[72] Table 4.34 shows that over 97 percent of respondents indicated they faced some type of financial price exposure. Based on their perceptions 3 percent faced no financial price exposure, 95 percent of respondents were exposed to interest rate risk, 86 percent faced foreign exchange risk, 44 percent were exposed to commodity price risk, and 23 percent faced equity price risk.[73] Since many organisations faced multiple risks, the respondents were classified by the combination of risk exposures. In 42 percent of cases firms were exposed to the three major categories of financial price risk, foreign exchange, interest rate and commodity price.

Table 4.34 Types of Exposures Faced by Firms

	No. of Respondents	% of Respondents
No exposures	5	2.7
Foreign exchange only	5	2.7
Interest rate only	18	9.7
Commodity price only	0	0.0
Foreign exchange & Interest rate	77	41.4
Foreign exchange & Commodity price	0	0.0
Interest rate & Commodity	3	1.6
Foreign exchange, Interest rate & Commodity price	78	41.9
Total	**186**	**100**

4.3.16 Hedging Financial Price Risks

The previous section demonstrated that nearly all respondents had exposure to financial price risks. Firms were then questioned about their hedging practices, more specifically, whether they were hedging or not. In this study hedging firms are defined as those that explicitly state that they hedge their financial price exposures. The discussion in chapter 2 recognised that firms can hedge their exposures in various ways.

[72] The use of derivatives by these firms would give a strong indication of speculative activity.
[73] Data on equity price risk is not shown in the table.

The glossary sent to treasurers defined hedging as "the process of reducing exposure to financial price risk by using techniques such as netting, matching or forward contracts, etc." The glossary also noted that hedging might also mean the use of operational hedges such as plant location and issuing foreign currency debt.

Table 4.35 shows that of the 186 firms in sample, 86.5 percent of firms indicated that they hedged one or more financial price exposures, while 13.5 percent reported they did not hedge. The proportion of hedging firms in the survey sample is higher than the figure of 77.9 percent found for the annual report sample.

Table 4.35 Hedging Activity by Survey Respondents

	No.	%	%[a]
Firm hedges	159	86.5	77.9
Firm does not hedge	27	13.5	22.1
TOTAL	**186**	**100**	**100**

[a]Annual report data from Table 4.3.

4.3.17 Reasons For Not Hedging

Firms not hedging were asked to provide reasons for their decision not to hedge. Table 4.36 shows that twenty two firms or 81.5 percent of non-hedgers indicated that the level of the firm's financial price exposure did not warrant the need for hedging, 22.2 percent indicated they had insufficient knowledge of hedging methods and 14.8 percent of firms suggested that hedging was not cost effective. Since the latter were a subset of the firms that indicated they had low levels of exposure this suggests that hedging was too expensive for firms with low levels of exposure.

Table 4.36 Reasons for Not Hedging

	No.	%[a]
The level of exposure does not warrant positive action	22	81.5
Insufficient knowledge of hedging methods	6	22.2
Hedging not cost effective	4	14.8

[a]Some firms provided more than one reason and therefore percentages do not sum to 100.

Firms that perceived they had exposure to financial price risks were required to indicate how significant these exposures were to the current and future performance of their firm. A likert scale from 1 to 5 was used with 1 indicating a low level of significance and 5 a high level of significance. Table 4.37 presents the results of a t-test for the difference in the mean scores between hedgers and non-hedgers for the 3 main types of exposure. The results show that all three exposures were found to be of lower significance for non-hedgers relative to hedgers and for foreign currency and interest rate exposure the difference in the mean scores were statistically significant. This evidence provides support for results in Table 4.36 which indicate the primary reason for not hedging is the low level of financial price exposure. These results are also consistent with the analysis of qualitative disclosures in annual reports by non-disclosing firms in section 4.3.1 which finds that non-disclosing firms make statements in their annual reports suggesting they have low levels of financial price exposure.

Table 4.37 Difference in the Mean Scores Between Hedgers and Non-Hedgers For the Perceived level of Importance of Foreign Currency, Interest Rate and Commodity Price Exposures

	Hedgers		Non Hedgers		Mean	T-	P-value
	N	Mean	N	Mean	Difference	Statistic	
Foreign Exchange Exposure	142	3.06	17	2.00	1.06	3.01	0.003
Interest Rate Exposure	154	3.12	20	1.95	1.17	4.37	0.002
Commodity Price Exposure	77	2.82	4	2.00	0.82	1.3	0.200

4.3.18 Types of Exposure Hedged by Hedging Firms

The survey required hedging firms to specify the types of financial price exposures they were hedging. Foreign exchange exposure was hedged by 87.4 percent of hedging firms and interest rate exposure was hedged by 83.6 percent. The proportion of foreign currency hedgers in the survey sample was slightly lower than the proportion in the annual report sample, where as the proportion of interest rate hedgers in the survey sample was significantly higher than the annual report sample as shown in Table 4.38. The proportion of commodity price hedgers in the survey sample was nearly twice as much as the proportion in the annual report sample. The differences between the two samples could be due to the non-disclosure of interest rate and commodity price hedging practices.

Table 4.38 Type of Exposure Hedged by Survey Hedging firms

Type of Exposure Hedged	No.	%[a]	%[b]
Foreign exchange	139	87.4	90.3
Interest rate	133	83.6	57.0
Commodity price	26	16.4	8.7
Equity price	3	1.9	-

[a]This figure represents the percentage of all hedging firms. [b]This figure represents the corresponding percentage for the annual report sample.

Table 4.39 shows the combinations of exposures hedged. Consistent with the annual report sample the most common combination of exposures hedged is foreign exchange and interest rate hedging, this is followed by foreign exchange only hedgers and firms hedging all three exposures which each make up 15 percent of the sample.

Table 4.39 Combination of Exposures Hedged by Hedging Firms

Type of Exposure(s) Hedged	No.	%	No.[a]	%[a]
Foreign exchange only	24	15.1	128	39.9
Interest rate only	18	11.3	28	8.7
Commodity price only	0	0.0	3	0.9
Foreign exchange & Interest rate	90	56.6	137	42.7
Foreign exchange & Commodity price	1	0.6	7	2.2
Interest rate & Commodity price	1	0.6	0	0.0
Foreign exchange & Interest rate & Commodity price	24	15.1	18	5.6
No mention	1	0.6	-	-
TOTAL	**159**	**100**	**321**	**100**

[a]Annual report data from Table 4.6.

4.3.19 Derivatives Use by Hedging Firms

This section examines how firms hedge and in particular looks at the use of derivatives by hedging firms. Panel A Table 4.40 shows that 90 percent of hedging firms use derivatives. This figure is slightly higher than the 86 percent of hedging firms that disclosed the use of derivatives in their annual reports. The 10 percent of hedging firms that did not use derivatives indicated that they used other methods of managing financial price risks. All these firms indicated that they had no intention or expectation of using derivatives for hedging purposes in the near future. Panel B shows that 78 percent of respondents use derivatives. This figure is higher than Nance et. al (1993) who find 61.5 percent of firms use derivatives but lower than the 85.2 percent found by Dolde (1995) in his survey of large US firms. Panel B shows that the number of derivative users for the full sample is higher than for hedging firms only. This indicates that two non-hedgers are using derivatives. Closer inspection of these firms reveals that they use derivatives for funding purposes and not for hedging. Although the number of non-hedgers using derivatives is very small the evidence in panel B shows that derivative users are not necessarily hedgers. Furthermore, panel A shows that not all hedgers are derivative users. Therefore, focusing solely on derivative users for the purposes of defining hedging firms might exclude hedging firms and include non-hedging firms. Also t-tests examining the perceptions of Treasurers about the importance of financial price exposures to the firm revealed no significant differences in the perceptions between hedging firms that used derivatives and hedging firms that did not (see Table 4.41). Furthermore, t-tests that compared these two groups of hedgers with respect to characteristics that measure the firm's incentives to hedge revealed no statistically significant differences in all measures with the exception of firm size.[74] Overall, these findings provide justification for the arguments presented in this study that hedging firms should include hedgers that do not use derivatives in addition to those that do.

Table 4.40 Survey Firms Using Derivatives

Panel A:			**Panel B:**		
Hedging Firms	**No.**	**%**	**Full Sample**	**No.**	**%**
Uses derivatives	**143**	**89.9**	Uses derivatives	**145**	**78.0**
Does not use derivatives	**16**	**10.1**	Does not use derivatives	**41**	**22.0**
Total	**159**	**100**	**Total**	**186**	**100**

Table 4.41 Difference in the Mean Scores Between Hedgers that use Derivatives and Hedgers that do not for the Perceived level of Importance of Foreign Currency, Interest Rate and Commodity Price Exposures

	Hedgers		**Non Hedgers**		**Mean**	**T-**	**P-value**
	No.	**Mean**	**No.**	**Mean**	**Difference**	**Statistic**	
Foreign Exchange Exposure	126	3.11	16	2.63	0.48	1.323	0.188
Interest Rate Exposure	139	3.17	15	2.67	0.50	1.598	0.112
Commodity Price Exposure	71	2.86	6	2.33	0.53	1.012	0.315

[74] The results are not reported in this study.

4.3.20 Interest Rate Hedging Practices of Survey Firms

The previous section examined survey respondents hedging practices in general. This section presents evidence on the interest rate hedging practices of survey respondents. Table 4.42 shows that 71.5 percent of survey respondents say that they hedge interest rate exposure and 28.5 percent state that they do not hedge interest rate exposure. The Table also shows that the proportion of interest rate hedgers in the survey sample is significantly higher than in the annual report sample.

Table 4.42 Interest Rate Hedging Activity of Survey Respondents

	Survey Sample		Annual Report Sample	
	No.	%	No.	%
Firm hedges interest rate exposure	133	71.5	183	44.4
Firm does not hedge interest rate exposure	53	28.5	229	55.6
Total	**186**	**100**	**412**	**100**

Interest rate hedging firms might also be hedging other exposures such as foreign currency and commodity price risks. Table 4.43 shows that 13.5 percent of interest rate hedgers only hedge this exposure whilst 86.5 percent hedge at least one other type of exposure. Among this latter group the most frequent combination is interest rate and foreign exchange hedging.

Table 4.43 Interest Rate Hedgers Hedging Other Exposures

	No.	(%)
Interest rate hedging only	18	13.5
Interest rate & foreign exchange hedging	90	67.7
Interest rate & commodity price hedging	1	0.8
Interest rate & foreign exchange & commodity price hedging	24	18.0
Total	**133**	**100**

Table 4.44 Firms Not Hedging Interest Rate Exposure

	No.	%
Interest Rate Non-Hedgers	27	50.9
Interest Rate Non-Hedgers Hedging Other Exposures	26	49.1
Total	**53**	**100**

Table 4.44 shows that the sample of interest rate non-hedgers consists of 27 non-hedging firms and 26 firms hedging other exposures. The breakdown of firms not hedging interest rate exposure but hedging other exposures is shown in Table 4.45. The overwhelming majority of this group of firms is hedging foreign exchange exposure only.

Table 4.45 Interest Rate Non-Hedgers Hedging Other Exposures

Type of Exposure Hedged	**No.**	**%**
Foreign exchange only	24	92.3
Foreign exchange & commodity price	1	3.8
No mention	1	3.8
Total	**26**	**100[a]**

[a]Percentages do not sum to 100 due to rounding.

Section 4.3.5 examined the qualitative disclosures in annual reports of firms that did not hedge interest rate exposure and of those that had no discussion of interest rate hedging. The analysis found that these firms made statements in their annual reports, which suggested they had low levels of interest rate exposure. Survey respondents were not required to provide reasons why they did not hedge interest rate exposure. However, all firms that perceived they had exposure to interest rate risks were required to indicate how significant this exposure was to the current and future performance of their firm. A likert scale from 1 to 5 was used with 1 indicating a low level of significance and 5 a high level of significance. Table 4.46 presents the results of a t-test for the difference in the mean scores between interest rate hedgers and interest rate non-hedgers. The result shows that interest rate exposure was found to be of lower significance for non-hedgers relative to hedgers with the difference in the mean scores being statistically significant. This result is consistent with the analysis of qualitative disclosures in annual reports in section 4.3.5.

Table 4.46 Difference in the Mean Scores Between Interest Rate Hedgers and Non-Hedgers For the Perceived level of Importance of Interest Rate Exposure

	Hedgers		Non Hedgers		Mean	T-	P-
	N	Mean	N	Mean	Difference	Statistic	value
Interest Rate Exposure	133	3.19	42	2.33	0.86	4.296	0.000

4.3.21 The Use of Derivatives by Interest Rate Hedging Firms

All interest rate hedging firms reported the use of interest rate derivatives and 71.5 percent of all respondents used interest rate derivatives (see Table 4.47). In the annual report sample 88.5 percent of interest rate hedgers disclosed the use of interest rate derivatives and 39.3 percent of the full sample disclosed the use of interest rate derivatives.

Table 4.47 Firms Using Interest Rate Derivatives

Panel A:			**Panel B:**		
Interest Rate Hedgers	**No.**	**%**	**Full Sample**	**No.**	**%**
Using derivatives	133	100.0	Using derivatives	133	71.5
Not using derivatives	0	0.0	Not using derivatives	53	28.5
Total	**133**	**100**	**Total**	**186**	**100**

Consistent with the annual report evidence and several previous studies the survey evidence presented in Table 4.48 reveals that the interest rate swap is the most popular interest rate derivative.[75] This is followed by the forward rate agreement and then the interest rate cap.

Table 4.48 Types of Interest Rate Derivative Used by Interest Rate Derivative Users

Type of Derivative	No.	%[a]
Swap	115	86.5
Forward Rate Agreement	90	67.7
Cap	63	47.4
Floor	34	25.6
Collar	32	24.1
Swaption	23	17.3
Futures	8	6.0
Participating Cap	3	2.3

[a]Proportion of foreign currency derivative users (i.e., 133 firms).

4.3.22 Foreign Currency Hedging Practices of Survey Firms

This section presents evidence on the foreign currency hedging practices of survey respondents. Table 4.49 shows that 74.7 percent of survey respondents say that they hedge foreign currency exposure. This figure is only slightly higher than 70.4 percent reported for the annual report sample.

Table 4.49 Foreign Currency Hedging Activity of Survey Respondents

	No.	%	%[a]
Firm hedges foreign currency exposure	**139**	**74.7**	**70.4**
Firm does not hedge foreign currency exposure	**47**	**25.3**	**29.6**
Total	**186**	**100**	**100**

[a]Annual report data from Table 4.19

The survey data showed that over 80 percent of foreign exchange hedging firms were also hedging other exposures such as interest rate and commodity price risks. Table 4.50 shows that 64.7 percent of foreign exchange hedgers also hedged interest rate

[75] Bodnar et al. (1995) and Phillips (1995) found that US firms use swaps more than any other interest rate derivative.

exposure. This combination of exposures hedged was also the most frequent in the annual report sample.

Table 4.50 Foreign Exchange Hedgers Hedging Other Exposures

Combination of Exposures Hedged	No.	(%)	No.[a]	(%)[a]
Foreign exchange only	24	17.3	128	44.1
Foreign exchange & interest rate	90	64.7	137	47.2
Foreign exchange & commodity price	1	0.7	7	2.4
Foreign exchange & interest rate & commodity price	24	17.3	18	6.2
Total	**139**	**100**	**290**	**100**

[a]Annual report data taken from Table 4.20.

Analysis of foreign currency non-hedgers reveals that some of these firms are hedging other exposures. Table 4.51 shows that over 40 percent of foreign exchange non-hedgers hedge interest rate and/or commodity price exposure.

Table 4.51 Foreign Exchange Non-Hedgers Hedging Other Exposures

	No.	(%)	No.[a]	(%)[a]
Not hedging any category of exposure	27	57.4	91	74.5
Interest rate hedging	18	38.3	28	23.0
Commodity price hedging	0	0.0	3	2.5
Interest rate & commodity price hedging	1	2.1	0	0.0
No mention	1	2.1	0	0.0
Total	**47**	**100**	**122**	**100**

[a]Annual report data taken from Table 4.22.

Section 4.3.8 examined the qualitative disclosures in annual reports of firms that did not hedge various categories foreign currency exposure and of those that had no discussion of foreign currency hedging. The analysis found that these firms made statements in their annual reports, which suggested they had low levels of foreign currency exposure. Survey respondents were not required to provide reasons why they did not hedge foreign currency exposure. However, all firms that perceived they had exposure to foreign currency risks were required to indicate how significant this exposure was to the current and future performance of their firm. A likert scale from 1 to 5 was used with 1 indicating a low level of significance and 5 a high level of significance. Table 4.52 presents the results of a t-test for the difference in the mean scores between foreign currency hedgers and foreign currency non-hedgers. The result shows that foreign currency exposure was found to be of lower significance for non-hedgers relative to hedgers with the difference in the mean scores being statistically significant. This result is consistent with the analysis of qualitative disclosures in annual reports in section 4.3.8. The results also show that the difference in perceptions of the importance of interest rate and commodity price exposure between foreign currency hedgers and non-hedgers was not statistically significant.

Table 4.52 Difference in the Mean Scores Between Foreign Currency Hedgers and Foreign Currency Non-Hedgers For the Perceived level of Importance of Foreign Currency, Interest Rate and Commodity Price Exposures

	Hedgers		Non Hedgers		Mean	T-	P-value
	No.	Mean	No.	Mean	Difference	Statistic	
Foreign Exchange Exposure	138	3.07	21	2.14	0.92	**2.873**	**0.005**
Interest Rate Exposure	135	3.01	39	2.87	0.14	0.600	0.551
Commodity Price Exposure	74	2.84	7	2.14	0.70	1.433	0.156

4.3.23 The Use of Derivatives by Foreign Currency Hedging Firms

Derivative use among foreign currency hedging firms is not universal. Table 4.53 shows that 88.5 percent of foreign currency hedgers use foreign currency derivatives. Fourteen of the firms not using derivatives indicated that their reason was because the level of residual exposure did not warrant their use and/or they had employed other methods for managing their risks.

Table 4.53 Firms Using Foreign Currency Derivatives

Panel A:			Panel B:		
Foreign Currency Hedgers	**No.**	**%**	**Full Survey Sample**	**No.**	**%**
Using derivatives	123	88.5	Using derivatives	123	66.1
Not using derivatives	16	11.5	Not using derivatives	63	33.9
Total	**139**	**100**	**Total**	**186**	**100**

Table 4.54 shows that the forward contract is the most popular foreign currency derivative followed by options and then swaps. The annual report data also showed that the forward contract was the most frequently used foreign currency derivative although swaps use was disclosed more often than options usage. The survey evidence is also consistent with Edelshain (1995) and Bodnar et al. (1995) who reported similar rankings.

Table 4.54 Types of Foreign Currency Derivative Used by Foreign Currency Derivative Users

Type of Foreign Currency Derivative	No.	%[a]
Forward contract	118	95.9
Option	73	59.3
Swap	70	56.9
Cylinder	26	21.1
Average rate option	16	13.0
Participating forward	9	7.3
Swaption	10	8.1
Future	4	3.3
Barrier option	3	2.4
Compound option	2	1.6
Quantos	2	1.6
Break forward	1	0.8

[a]Proportion of foreign currency derivative users (i.e., 123 firms).

4.3.24 Deriatives Use and Speculation – Survey Evidence

The analysis of annual reports in section 4.3.13 found that over a quarter of hedging firms made explicit disclosures indicating that derivatives were not used for speculative purposes. A small number of firms did, however, indicate that they hedged selectively and two firms stated that they used derivatives for trading in addition to hedging. Overall, there was very little evidence to suggest that firms were speculating on a widespread scale.

The survey also attempted to determine whether derivatives were used for speculative or hedging purposes by requiring firm's to state their risk management objectives and their reasons for using derivatives. The first of these questions required firms to specify, in broad terms, their firm's risk management objectives from the following three choices:

1. Seek to minimise risk and maximise certainty of the value of the revenue and cost streams in the business;
2. Actively manage the risks arising from the underlying flows in the business to generate a contribution to group profit; and
3. Generate profit by trading in the financial markets.

Table 4.55 shows that 87 percent of respondents indicated that their objectives were similar to category 1, 4 percent indicated that categories 1 and 2 best described their objectives and the remaining 9 percent indicated that their objectives fell within category 2 only. No firms indicated that their objective was one of generating profits by trading.

Table 4.55 Risk Management Objectives

In broad terms, what are your firm's risk management objectives?	No.	%
1 only	130	86.7
1 & 2	6	4.0
2 only	14	9.3
3 only	0	0.0
TOTAL	**150**	**100.0**

The second question inquired as to the reasons for using derivatives. Firms were given the following choices:

1. Generate additional returns and enhance the profitability of the treasury activity;
2. Reduce funding costs/make the best use of borrowing opportunities; and
3. Financial price risk hedging.

Table 4.56 shows that of the 142 firms that specified their reasons for using derivatives, 66 percent used them for hedging purposes only and a further 30 percent used them for both hedging and funding purposes. These results show that the overwhelming majority of firms indicate that they do not speculate or aim to generate additional profits from their risk management activities. This evidence is consistent with the findings of the analysis of annual report disclosures.

Table 4.56 Reasons for using Derivatives

Reasons indicated for using derivatives	No.	%
1 & 2 & 3	1	0.7
2 & 3	42	29.6
2 only	5	3.5
3 only	94	66.2
TOTAL	**142**	**100.0**

4.3.25 Comparing Annual Report and Survey Hedging Classifications

This study is unique among existing empirical studies in that it has access to both survey data and annual report disclosures for comparable periods for a subset of firms. The availability of both datasets allows comparisons to be made between hedging classifications (i.e., hedging or not hedging) determined by disclosures in annual reports and those stated in survey responses. Since disclosures on hedging and the use of derivatives were not mandatory in 1995 it is quite possible that some firms have been incorrectly classified using annual report disclosures. If firms in the annual report sample are incorrectly classified then this potentially blurs the distinction between hedging and non-hedging firms in this sample and might adversely affect the ability to detect differences in firm level characteristics between hedging and non-hedging firms.

An incorrect classification can occur in two ways; (1) The survey indicates hedging and the annual report indicates non-hedging (or more often non-disclosure), and (2) The survey indicates non-hedging and the annual report indicates hedging. It is expected that inconsistencies will arise due to non-disclosure and so the majority of incorrectly classified firms are expected to arise as a result of the first reason.

Survey respondents were given written assurances that their responses would remain confidential. Therefore, it is assumed that respondents have no incentive, and hence are less likely, to conceal information. Consequently, the survey response is deemed to represent the true position of a firm's hedging behaviour. However, the annual report may not reveal the firm's true behaviour because for competitive reasons it may opt for non-disclosure or the activity may be insignificant and not warrant disclosure.

The analysis in section 4.3.14 shows that the survey to corporate treasurers generated 186 responses. Annual reports were not available for 12 of the survey respondents. Therefore a comparison of survey responses and annual report disclosures can be made for 174 firms (out of 412 annual report disclosures). Table 4.57 shows that a comparison of hedging classifications between the survey data and annual report data reveals significant differences. The survey data classifies 87 percent of these firms as hedgers whereas the annual report data only classifies 76 percent as hedgers. This suggests that some firms have been incorrectly classified.

Table 4.57 Hedging Financial Price Exposure: Survey and Annual Report Evidence

	Survey	%	Survey[1]	%	Report	%
Yes	159	85.5	151	86.8	132	75.9
No[2]	27	14.5	23	13.2	42	24.1
Total	**186**	**100**	**174**	**100**	**174**	**100**

[1]Here we exclude those firms for whom we do not have corresponding annual report evidence. This amounts to 12 firms.
[2]For the annual report evidence "no" includes non disclosure.

Table 4.58 shows that thirty one firms or 17.8 percent of firms whose annual report disclosures could be verified were incorrectly classified. Twenty five firms indicated in their survey response that they hedged but their annual report contained no mention of their hedging activity. For another six firms their survey response showed that they did not hedge whereas their disclosure in the annual report implied that they did. One of the six indicated in its annual report that it conducted limited hedging activities. This company made the following disclosure in its annual report,

"Net debt was established on an initial approximate 50:50 fixed:floating interest rate split. A limited number of interest rate swaps have been established to help achieve this

profile... Foreign currency transaction exposure is not normally hedged. Exceptional planned UK foreign currency cash flows, such as intra group dividends, are hedged selectively by Group Treasury to prevent fluctuation in the anticipated sterling value."

It would seem that when responding to the survey, the treasurer of this company considered it to be a non-hedger, probably because either it generated very few exposures and so hedged very infrequently or it hedged only a small proportion of its various exposures. This is consistent with the arguments of Petersen and Thiagarajan (1996), who suggest that in practice, a firm that hedges a small proportion of its risk is closer to a non hedging firm than to one that hedges most of its risk.

Table 4.58 Comparison of Hedging Classifications Using Survey and Annual Report Data

Firm Classification	No.	%
Survey says Non-hedger & Annual Report says Non-hedger	17	9.77
Survey says Non-hedger & Annual Report says Hedger[a]	6	3.45
Survey says Hedger & Annual Report says Hedger	126	72.41
Survey says Hedger & Annual Report says Non-hedger[a]	25	14.37
Total	**174**	**100**

[a]Incorrectly classified firms.

4.3.26 Comparing Annual Report and Survey Interest Rate Hedging Classifications

The analysis in section 4.3.3 and 4.3.20 examined the interest rate hedging classifications of the annual report and survey data, respectively. This section compares the annual report and survey interest rate hedging classifications. The results of this comparison are presented in Table 4.59, which reveals significant differences in hedging classifications between the two datasets. The survey data classifies 74 percent of these firms as interest rate hedgers whereas the annual report data only classifies 49 percent as interest rate hedgers. Clearly a large number of firms have been misclassified.

Table 4.59 Hedging Interest Rate Exposure: Survey and Annual Report Evidence

	Survey	%	Survey[1]	%	Report	%
Yes	133	71.5	129	74.1	85	48.9
No[2]	53	28.5	45	25.9	89	51.1
Total	**186**	**100**	**174**	**100**	**174**	**100**

[1]Here we exclude those firms for whom we do not have corresponding annual report evidence. This amounts to 12 firms. [2]For the annual report evidence "no" includes non disclosure.

Table 4.60 shows that 46 firms (or 95.8% of misclassified firms) indicated in their survey response that they hedged interest rate exposure, although their annual report contained no mention of this hedging activity.[76] The annual report data incorrectly categorised two firms as interest rate hedgers.[77] This analysis shows that over a quarter of the 174 firms in this sub-sample are incorrectly classified. This level of misclassification has potentially serious implications for any tests conducted using this sub-sample.

Table 4.60 Comparison of Interest Rate Hedging Classifications Using Survey and Annual Report Data

Firm Classification	No.	%
Survey says Non-hedger & Annual Report says Non-hedger	43	24.7
Survey says Non-hedger & Annual Report says Hedger[a]	2	1.2
Survey says Hedger & Annual Report says Hedger	83	47.7
Survey says Hedger & Annual Report says Non-hedger[a]	46	26.4
Total	**174**	**100**

[76] These 46 firms together with the 83 firms correctly categorised as hedgers make up the 129 survey respondents who hedge interest rate risk and for which there is annual report data. Firms that hedge but do not disclose this in their annual report might do this to avoid revealing information to their competitors or because the firm has a low level of exposure and therefore the hedging activity forms a small part of the firm's overall financing policy and does not warrant disclosure. This can be tested by comparing the characteristics of these two groups.

[77] These were Glaxo Wellcome and Christian Salvesen. The latter indicated in its survey response that its used derivatives for funding purposes only. In its annual report it says, "Gearing, the relationship of net debt to shareholders' funds, fell to 23.8%... and leaves us well placed to develop our core activities... Currency and interest options or Swaps are used, where relevant, to implement our Treasury policies." Pg. 21.

[a]Misclassified firms.

4.3.27 Comparing Annual Report and Survey Foreign Currency Hedging Classifications

This section compares the annual report and survey foreign currency hedging classifications. The results of this comparison are presented in Table 4.61, which reveals differences in hedging classifications between the two datasets. The survey data classifies 76 percent of these firms as foreign currency hedgers whereas the annual report data classifies 68 percent as foreign currency hedgers. Some firms have been misclassified, although the level of misclassification is lower than that seen for interest rate hedging.

Table 4.61 Hedging Foreign Exchange Exposure: Survey And Annual Report Evidence

	Survey	%	Survey[1]	%	Report	%
Yes	139	74.7	132	75.9	118	67.8
No[2]	47	25.3	42	24.1	56	32.2
Total	**186**	**100**	**174**	**100**	**174**	**100**

[1]This excludes firms without corresponding annual report evidence. This amounts to 12 firms.
[2]For the annual report evidence "no" includes non disclosure.

Table 4.62 shows that 7 firms are misclassified as foreign exchange hedging firms. Twenty one firms are incorrectly categorised as non foreign exchange hedging firms. One of these indicated in its survey response that it hedged translation exposure only. Another two indicated in their survey response that they hedged economic exposure only. One writes the following in its annual report,

"The US dollar is the currency of greatest significance in which most revenues are denominated as indeed is a large proportion of our costs. Natural diversity of exposure to currencies provides substantial degree of protection... does not believe an active short-term currency hedging program would provide long-term benefit to shareholders."

The other stated in its annual report that turnover related entirely to the UK and that it had a portfolio of property interests in the US and Europe as well as the UK. Another firm was classified as a non-hedger of foreign exchange exposure on the basis of the following statement in its annual report,

"Foreign currency exposures are restricted to meeting short term business requirements and derivatives are not used."

It is clear from this statement that the firm faces foreign currency exposure. This firm indicated in its survey response that it hedged foreign exchange transaction exposure. It is possible that this firm hedges through non-derivative means. This further highlights the problem of assuming non-derivative users to be non-hedgers.

Table 4.62 Comparison of Foreign Currency Hedging Classifications Using Survey and Annual Report Data

Firm Classification	No.	%
Survey says Non-hedger & Annual Report says Non-hedger	35	20.1
Survey says Non-hedger & Annual Report says Hedger[a]	7	4.0
Survey says Hedger & Annual Report says Hedger	111	63.8
Survey says Hedger & Annual Report says Non-hedger[a]	21	12.1
Total	**174**	**100**

[a]Misclassified firms.

4.4 Description of Endogenous Variables

This section describes the two ways this study measures hedging and presents descriptive statistics of these measures.

4.4.1 Measuring Hedging – The Decision to Hedge

The discussion in Chapter 3 identifies several ways in which the empirical literature has measured hedging. Some studies used a binary variable to distinguish between those that hedged or used derivatives and those that did not.[78] This chapter has shown that this study collects data from annual reports and a survey enabling it to determine whether companies choose to hedge, the types of exposures hedged and their choice of hedging techniques. Therefore, this study discriminates between those firms that choose to hedge and those that do not by employing a binary variable to measure hedging activity, 1 for firms classified as hedgers and 0 for non-hedgers. This binary hedging variable is the dependent variable in the regression analyses which follows in subsequent chapters. The use of a binary variable implies that this study examines the determinants of the decision to hedge and tests whether the likelihood that firms hedge is related to their financial and operating characteristics.

4.4.2 Measuring Hedging – The Extent of Hedging

The measure of hedging described in the previous section, based on annual report disclosures and survey responses, groups together all firms that employ some risk

[78] See Francis and Stephan (1993), Nance et al. (1993), Dolde (1995), Wysocki (1996), Mian (1996), Geczy et al. (1997) and Fok et al. (1997).

management and thus fails to discriminate between firms managing say, 1 percent and 100 percent of their financial exposures.[79] Firms hedging most of their exposures may exhibit contrasting financial and operating characteristics relative to those who hedge very little of their exposure. Therefore grouping together all firms engaging in hedging might conceal substantial differences between these firms. For example, a firm that hedges a small portion of its exposure might be closer to a non-hedging firm than one that hedges most of its exposure. Consequently, it may not be possible to identify differences between hedgers and non-hedgers or determine the factors affecting the decision to hedge. This motivates the use of a continuous measure of hedging.

4.4.3 Measuring the Extent of All Hedging, Interest Rate Hedging and Foreign Currency Hedging

Chapter 3 identifies several studies that define hedging as the use of derivatives and derive a continuous measure of hedging using notional values of derivative contracts outstanding.[80] This study follows the approach of previous studies and employs data on the amount of UK firms' use of derivatives, for those firms in the sample that provide quantitative disclosure on derivatives use, to derive a measure of the extent of hedging.

Quantitative disclosure of derivatives tended to be in the form of notional principal amounts - the underlying reference amounts for derivative contracts. Data was

[79] Tufano (1996) recognises this problem, "Corporations disclose only minimal details of their risk management programs, and, as a result, most emprical analyses have torely on surveys and relatively coarse data that at best discriminates between firms that do and do not use specific types of derivative instruments... As a result of data limitations, for most industries we cannot describe which firms manage more risk than others or whether firms engage in dynamic risk management strategies." Journal of Finance, Vol. 51, No. 4, page 1097.

collected separately on the total notional values for interest rate, foreign currency and commodity derivatives. In the majority of cases notional amounts referred to the notional value of derivative agreements outstanding at the balance sheet date. In a few cases firms disclosed data on the notional value of derivatives entered into during the course of the year.[81] A full reconciliation of the notional amounts from the beginning to the end of the period (i.e., a summary of the change in notional amounts resulting from new, terminated, and matured or expired contracts) was not available for the vast majority of firms.[82]

Quantitative disclosure of interest rate derivative use occurred most often in the footnotes pertaining to the Creditors due after 1 year note and mainly related to the use of interest rate swaps. Quantitative disclosure of foreign currency derivative use was not concentrated in any particular section of the annual report. Although some firms had separate sections in their notes to the accounts for Treasury Information or Financial Instruments.

As noted in Table 4.7 67.2 percent of (or 277) firms indicated that they used derivatives. Table 4.63 shows that information on the notional values of derivative activities for 1995 was provided by 44.4 percent (or 123) of these firms.

Table 4.63 Disclosure of Notional Amounts of Derivatives by Derivative Users

Disclosure of Notional Amounts	**No.**	**%**
Derivative users disclosing notional amounts	123	44.40
Derivative users not disclosing notional amounts	154	55.60
Total	**277**	**100.00**

[80] See Berkman and Bradbury (1996), Allayannis and Ofek (1996), Gay and Nam (1998), Howton and Perfect (1998), and Graham and Rogers (1999).
[81] For example, Zeneca Plc entered into forward contracts to sell currency with nominal principal amounts of £395 million, most of the contracts had a maturity of six months or less.

Table 4.64 shows the combinations of derivative instruments used by firms disclosing notional amounts. The overwhelming majority of firms used either interest rate and/or foreign currency derivatives.

Table 4.64 Classification of Derivatives By Exposure Category For Firms Disclosing Notional Amounts

Combinations of Derivatives Used	No. of firms disclosing notional amounts	%
Interest rate only	50	40.65
Foreign currency only	29	23.58
Interest rate & Foreign currency	38	30.89
Interest rate, Foreign currency & Commodity	3	2.44
Not disclosed	3	2.44
Total	**123**	**100**

Table 4.65 presents data on the notional amounts of interest rate and foreign currency derivatives disclosed in annual reports. The Table shows that the average level of foreign currency derivative usage is greater than that for interest rate derivatives, although this seems to be the result of a skewed distribution.

Table 4.65 Notional Values of Derivative Contracts in £millions held by Interest Rate and Foreign Currency Derivative Users

Type of Derivative	N	Min.	25th percentile	Median	Mean	75th percentile	Max.	Std. Dev.
Interest Rate	91	10.00	31.40	91.80	468.55	383.60	7192	1064.10
Foreign Currency	70	0.22	29.83	77.70	738.11	384.55	15179	2123.96

In this study total notional values of interest rate and foreign currency derivative contracts are scaled by the total assets of a firm to derive a measure of the extent of interest rate and foreign currency hedging.[83] Table 4.66 presents this measure for both interest rate and foreign currency derivatives. The median level of the extent of interest

[82] The lack of disclosure in this area may not be surprising considering that such disclosures are not mandatory.
[83] Only 3 firms disclosed the notional amount of commodity derivatives and therefore the extent of commodity price hedging is ignored in this analysis. The discussion in chapter 3 shows that total notional

rate derivative usage is greater than that for the extent of foreign currency derivative usage whereas the average is greater for the extent of foreign currency derivative usage. Firms classified as non-interest rate and non-foreign currency hedgers by the annual report data are defined as having zero levels of the extent of interest rate and foreign currency derivative usage, respectively.

Table 4.66 Notional Values of Interest Rate and Foreign Currency Derivative Contracts Scaled by Total Assets

Type of Derivative	N	Min.	25th percentile	Median	Mean	75th percentile	Max.	Std. Dev.
Interest Rate	90	0.011	0.079	0.147	0.196	0.234	1.214	0.202
Foreign Currency	68	0.002	0.062	0.115	0.284	0.301	5.090	0.653

This study also uses the data on notional amounts of interest rate, foreign currency and commodity derivatives to calculate a measure of total derivatives usage. However, not all of the firms that disclosed notional amounts provided full disclosure. Firms were defined as providing full disclosure if disclosure of notional amounts corresponded with disclosures about the types of derivatives used. For example, if a firm stated that it only used foreign currency derivatives and then disclosed the notional amount of foreign currency derivatives used or outstanding at the year-end the firm was classed as a full disclosing firm. If, on the other hand, a firm stated that it had used interest rate and foreign currency derivatives but only disclosed the notional amounts of interest rate derivatives it was classed as a partial disclosing firm. Therefore a measure of total derivatives use could not be calculated for this firm.[84] On the basis of the above definition 92 firms provided full disclosure of notional amounts of derivatives. As before a continuous measure of hedging was calculated for these firms as the ratio total

values have recently been used in Berkman and Bradbury (1996), Allayannis and Ofek (1998), Gay and Nam (1998) and Howton and Perfect (1998).

notional value of derivatives to total assets of the firm. Table 4.67 presents data for notional values of total derivative positions and these positions scaled by total assets.

Table 4.67 Notional Values of Derivative Contracts in £millions held by Derivative Users

	N	Min.	25th Percentile	Median	Mean	75th percentile	Max.	Std. Dev.
Notional values	92	1.010	32.450	113.500	993.410	520.700	16147	2716.090
Scaled by total assets	90	0.032	0.086	0.183	0.343	0.382	5.414	0.611

Table 4.68 shows the category of derivatives used by these firms.

Table 4.68 Types of Derivatives Used By Firms Providing Full Disclosure

Type of Derivative	No. of firms disclosing notional amounts
Interest rate only	31
Foreign currency only	19
Interest rate and Foreign currency	37
Interest rate, Foreign currency and commodity	3
Not disclosed	2
Total	**92**

This section has described how this study measures hedging. The availability of data on the amount of derivatives used has enabled the construction of a continuous measure of hedging which proxies for the extent of risk management undertaken by a firm. Therefore, in addition to examining the determinants of the decision to hedge using a binary dependent variable this study also investigates the determinants of the decision of how much to hedge, that is, whether the extent that companies hedge is related to their financial and operating characteristics.

[84] However, since the firm disclosed the notional amounts of interest rate derivatives a measure of interest rate derivatives use was calculated.

4.5 Description of Exogenous Variables

The theoretical analysis in chapter 2 suggests that the decision to hedge depends on firm-level attributes that determine the benefits associated with hedging. It argues that the benefits of hedging are likely to differ across firms in ways that depend on their characteristics. These characteristics and their relation to the hedging decision are identified in that chapter. Chapter 3 reviewed the empirical literature and in the process identified to what extent those factors considered important and relevant are measurable. This section takes on board this analysis and describes those factors observable indicators within an UK context. In particular this section describes and defines the independent variables employed in this thesis including a detailed explanation of the method of calculation. We also identify the correlation between each variable and the decision to hedge as predicted by each hypothesis in chapter 2.

Firm level data of the explanatory variables is obtained from several sources including Datastream, Fame and disclosures in the annual report. A three year average for each explanatory variable is calculated.[85] The averages are measured up to the beginning of year in which disclosures are made (fiscal year end 1994). Some variables by virtue of their construction are only available for the fiscal year end 1995.[86]

[85] The average represents a better estimate of a firm's position than obtained by measuring the variable at a single point in time (Geczy et al. 1997). Nance et al. (1993) and Dolde (1995) use three year averages preceding their surveys. In Dolde none of the explanatory variables are contemporaneous with the

4.5.1 Tax Structure

The discussion in chapter 2 showed that more convex the effective tax function the greater is the reduction in the firm's expected tax liability from hedging.[87] The implication of this is that greater the convexity greater the incentive to hedge. In that chapter progressivity in the statutory tax code and tax preference items such as tax loss carry-forwards, investment tax credits and foreign tax credits were identified as factors that cause convexity in the effective tax function. Therefore the tax hypothesis suggests that the benefits of hedging should be greater (1) the higher the probability the firm's pretax income is in the progressive region of the tax schedule, (2) the greater the firm's tax loss carry forwards and (3) the greater the firm's tax credits. The review of the empirical literature in chapter 3 revealed that there is much variation in the methods chosen to measure the extent of convexity in the corporate tax schedule. Despite the use of several different measures of tax schedule convexity the available empirical evidence provides very little support for the tax hypothesis.[88] Not withstanding these findings this study attempts to proxy for the convexity of the corporate tax schedule.

In the UK tax rates are progressive between profit levels of £0 and £1.5m, beyond £1.5m the tax rate is constant. Most firms have pre-tax income in excess of this progressive region and so the range of progressivity in the UK corporate tax structure is relatively small indicating that the vast majority of firms in the FT500 face a constant

dependent variables. Dolde notes that averaging is appropriate in his case since the period includes a macroeconomic peak, a trough, and the early stages of recovery.

[86] These variables are mainly those sourced from the 1995 annual report.

[87] Hedging reduces the volatility of pre-tax income.

[88] Graham and Rogers (1999) use by far the most rigorous approach to explicitly map tax function convexity. They quantify the convexity based benefits of hedging by determining the tax savings resulting from reducing volatility and find no relation between derivative holdings and tax function convexity.

marginal tax rate (effective tax function is linear). This would suggest that for UK firms this tax-based motive for hedging is rather weak. Therefore, because of the lack of progressivity in the UK corporate tax structure this aspect of a firm's tax function is not measured.[89] In the UK where a company makes a loss, it may carry that loss back for up to two years to recover Corporation Tax previously paid or, failing that, can carry the loss forward indefinitely to offset against future profits. Many firms do report the existence of tax loss carry forwards in notes to the accounts contained in annual reports. However, the disclosures tend to be qualitative rather than quantitative. Therefore, in common with several previous empirical tests this study employs a dummy variable equal to 1 if the firm has tax loss carry forwards.[90] Data on this is obtained from a search of notes to the accounts contained in annual reports.[91] The predicted sign on the coefficient of this variable is positive.

4.5.2 Expected Costs of Financial Distress

Chapter 2 argues that firms with higher expected costs of financial distress have a greater incentive to hedge. The size of these expected costs depends on the likelihood of encountering distress and the costs it will face in the event of financial distress. The discussion in chapter 3 argues that in attempting to consider the expected costs of financial distress empirically it is difficult to measure these costs directly. These

[89] Mian (1996) investigates hedging practices across a sample of 3022 US firms and recognises that progressivity in the tax structure applies to a very narrow range of pre-tax income. Wysocki (1996) writes, "Although the progressivity in the tax schedule applies over a small range of taxable income, generous provisions for tax loss carry forwards and investment tax credits reinforce convexities over a larger range of taxable income." (pg. 6) Gay and Nam (1998) note that most public firms in the US have pre-tax income far in excess of the progressive region and hence use the availability of tax preference items to measure convexity in the tax schedule.
[90] Allayannis and Ofek (1996), Berkman and Bradbury (1996), Mian (1996) and Howton and Perfect (1998) employ a similar variable.

include direct bankruptcy costs pertaining to the administration of bankruptcy and indirect costs such as those engendered by a loss of consumer confidence leading to lower demand for a firm's products. Chapter 3 shows that most studies, therefore, use indicators for the probability of encountering financial distress as proxies for the expected costs of financial distress. The probability of financial distress is determined by the level of the firm's fixed claims, such as debt repayments and debt service costs, relative to its cash inflows and the volatility of its cash flows. The preferred measure in all studies is some indicator of the former such as the gearing ratio. However, arguments in chapter 3 suggest that using this type of variable as a proxy for expected financial distress costs critically assumes that exogenous bankruptcy costs are constant across firms and therefore fails to address the possibility that exogenous bankruptcy costs might affect the firm's capital structure choice. This study attempts to control for this by assuming that firms within specific industries have a common exposure to financial distress and therefore uses an industry-adjusted gearing ratio.[92] The industry-adjusted gearing ratio is calculated by scaling a firm's gearing ratio by its industry average.[93] Therefore, firms with gearing above (below) the average for their industry will have an industry adjusted gearing ratio greater (less) than 1.

Despite the concerns raised about the use of the gearing ratio several studies use this variable to measure expected costs of financial distress and find that higher gearing ratios cause greater hedging.[94] These studies interpret this relation as evidence that greater expected financial distress costs increase the likelihood of hedging or cause

[91] This variable may proxy for financial distress as well as convexity in the firm's tax function.
[92] Firms are classified into industries using Datastream industry classifications.
[93] Geczy et al. (1997) derive a similar variable calculated as the difference between a firm's long-term debt ratio and the median long-term debt ratio for the firm's four digit SIC industry.

greater hedging. This interpretation assumes that firms with higher gearing ratios face higher probabilities of encountering financial distress.[95]

As well as the industry adjusted measure of gearing described above this study uses five other variables as proxies for a firm's pre-hedging probability of financial distress. These are gearing (both gross and net), the interest coverage ratio, funds flow ratio, a dummy variable indicating whether a firm has net interest payable or receivable and a firm's credit rating. The higher the firm's gearing, the lower its interest cover ratio, the lower its funds flow ratio, if it is paying net interest, and the lower its credit rating the greater the probability of financial distress. A higher probability of financial distress implies higher expected costs of financial distress, assuming that exogenous bankruptcy costs are constant across firms and thus a greater the incentive to hedge.

4.5.3 Measuring Gearing

This study argues that the numerator in the gearing ratio should be calculated both 'gross', and 'net ' of cash and short-term investments. This is because some companies have highly liquid positions at the same time as high levels of debt. Therefore, the firms' cash position should be accounted for otherwise an unnecessarily pessimistic view of the debt may be taken. Furthermore, the use of the book value of equity in the denominator of the ratio may not be very realistic as a measure of the value of the firm. For example, goodwill may have been acquired by takeover and written off the reserves, thus depleting the reportable equity on the Balance sheet. In this situation, cash or its equivalent

[94] See Dolde (1995), Berkman and Bradbury (1996), Haushalter (1998), Gay and Nam (1998), Howton and Perfect (1998), and Graham and Rogers (1999).
[95] In deriving their continuous dependent variable for interest rate hedging Gay and Nam (1998) assume that a firm's total debt measures its total interest rate exposure.

(tangible assets) are used to acquire intangible value (goodwill) as part of a deal to buy another company. This goodwill is then eliminated from the balance sheet thus wiping out value that would previously have been attributed to the shareholders on the balance sheet. Another possible cause of low reported equity value is that freehold property may be undervalued. This causes understatement of equity, which is merely a reflection of the stated values of the net asset value (assets - liabilities). On the other hand, property values may have been overstated. The problem of uncertain equity value can be overcome by using the market value of equity.

In this study the following are employed as measures of gearing:

i. Gearing is measured as book value of debt as a proportion of the book value of debt plus the book value of equity. This is referred to as **Gross Book Value Gearing** and is measured as follows

$$\frac{\text{Total loan capital}(321) + \text{Borrowings 1 year}(309) + \text{Preference capital}(306)}{\text{Total capital employed}(322) + \text{Borrowings 1 year}(309) - \text{Total intangibles}(344)} \times 100$$

The numbers in brackets in the equation above and in the discussion below refer to Datastream accounting item codes.

Total capital employed (322) shows the sum of all non-current liabilities. Therefore, the denominator also includes borrowings payable within 1 year. The denominator incorporates total share capital and reserves and total debt. It is important, in the UK context, to include short-term loans and overdrafts in the definition of debt, as many short-term debts are rolled over continuously to provide long-term finance.[96] The

[96] Four previous studies use total debt in the numerator of their gearing definition (one study reported a significant relationship between gearing and hedging) and four studies use long term debt (no study reported a significant relationship) and six simply refer to debt and hence do not provide a clear gearing

numerator also treats preference capital as debt based capital. This gearing ratio will be negative when the denominator is negative, since the numerator will always be greater than or equal to zero. The denominator will be negative when the book value of equity is negative.

As mentioned previously gearing is also measured using net debt rather than total debt, where net debt is defined as total debt less cash and short-term investments.[97] A firm that simply borrows funds and places them on deposit is hence treated as having not borrowed the funds. This definition will in some cases give negative debt ratios. Companies with negative debt ratios are generally those with significant cash and short-term investments.[98] This measure of gearing is referred to as **Net Book Value Gearing** and is calculated as follows

$$\frac{\text{Total loan capital(321)} + \text{Borrowings1 year(309)} + \text{Preference capital(306)} - \text{Total cash \& equivalent(375)}}{\text{Total capital employed(322)} + \text{Borrowings1 year(309)} - \text{Total intangibles(344)}} \times 100$$

ii. Gross gearing is also measured using the market value of equity and is referred to as **Gross Market Value Gearing** and is calculated as follows

$$\frac{\text{Total loan capital(321)} + \text{Borrowings 1 year(309)} + \text{Preference capital(306)}}{\text{Total loan capital (321)} + \text{Borrowings 1 year(309)} + \text{Preference capital(306)} + \text{Equity market value(MV)}} \times 100$$

definition (five of these studies reported a significant relationship between gearing and hedging). It is therefore not possible to infer whether the use of total debt rather than long-term debt has a significant bearing on these findings.

[97] Haushalter (1998) uses a binary variable that is set equal to one if a firm's debt ratio is above the sample median and its current ratio is below the sample median and zero otherwise. Pulvino (1997) points out that highly geared firms with little residual debt capacity may still be able to finance value enhancing investments if they possess large levels of cash. Firms with high gearing and low cash levels face the greatest degree of capital constraints and hence have a greater incentive to hedge. This study employs net gearing to proxy for capital (or financial) constraints.

[98] Thirty four firms have negative debt ratios. None of these firms have other debt ratios that are negative.

Net gearing is also measured using the market value of equity and is referred to as **Net Market Value Gearing** and is calculated as follows

$$\frac{\text{Total loan capital}(321) + \text{Borrowings1 year}(309) + \text{Preference capital}(306) - \text{Total cash \& equivalent}(375)}{\text{Total loan capital}(321) + \text{Borrowings1 year}(309) + \text{Preference capital}(306) + \text{Equity market value}(MV)} \times 100$$

In summary, this study employs 6 measures of gearing. The predicted sign on the coefficient of each variable is as follows:

Measure of Gearing	Predicted Sign
1. Gross Book Value Gearing	+
2. Industry Adjusted Gross Book Value Gearing	+
3. Gross Market Value Gearing.	+
4. Industry Adjusted Gross Market Value Gearing	+
5. Net Book Value Gearing.	+
6. Net Market Value Gearing.	+

4.5.4 Measuring Ability to Service Debt

The gearing ratios described above provide no indication of the ability to service a firm's debt. For example, a firm might have a high level of debt but the funds provided may be cheap, or alternatively have a very high average interest rate, and the company may be highly profitable with strong cash flows or very unprofitable with weak cash flow. Therefore, as well as measuring the scale of debt this study considers the firm's ability to service it as a proxy for the expected costs of financial distress. In this study the following are used to measure a firm's ability to service its debt costs:

i. **Interest Cover Ratio.** A company's ability to service its debt can be measured by examining the relationship between the interest cost and the profits or cash flows of the organisation. The ratio used for this purpose is interest cover. The interest cover ratio measures the extent to which interest charges are covered by profits. It gives an indication of the extent to which earnings can decline without resultant financial embarrassment to the firm because of inability to meet annual interest costs. In very simple terms it can be calculated as

$$\frac{\text{Profit before interest and tax}}{\text{Interest expense}}$$

This ratio can be calculated both gross and net interest, where the group receives interest income as well as paying interest. The gross measure is the more conservative approach. The following definition of gross interest cover has been employed in this study.[99]

$$\frac{\text{Adjusted operating profit}(137) + \text{Total non - operating income}(144)}{\text{Total interest charges}(153)}$$

Adjusted operating profit (137) is net profit derived from normal activities of the company after depreciation and operating provisions. This is equal to operating profit (993 - as published by the company; no adjustments are made to exclude items of an exceptional nature) plus adjustments to operating profit (981 - This shows the total of all items that have been excluded from the published operating profit. This will include items of an exceptional nature, which do not form part of a company's normal trading activities).

[99] Berkman and Bradbury (1996) set earnings before interest and tax equal to one if it is negative, and set interest equal to one if a firm has no debt.

Total non-operating income (144) includes dividend income, interest received, rents, grants and any other non-operating income. Gains on sale of investments and exchange gains are excluded.

Total interest charges (153) shows interest on bank, convertible and other loans, bonds and debentures, leasing finance and hire purchase minus interest capitalised. This figure also includes dividends/interest payments of redeemable preference shares described as participative loans.

153 = ([150 + 151] or 933) + 152 + 147 -148

where,

150 = Interest on short-term loans
151 = Interest on long-term loans
933 = 150 + 151 = Short- and long-term loan interest
152 = Interest on convertible loans
147 = Interest (Leasing and HP). This shows the interest element in rentals due in respect of assets leased in by the company, and hire purchase interest.
148 = Interest capitalised.

Interest rate cover can also be measured by the annual value of interest as a percentage of operating income (this is the inverse of the interest cover ratio). Datastream refers to this ratio as income gearing and defines it as

$$\frac{\text{Total interest charges (153)}}{\text{Adjusted operating profit (137) + Total non - operating income (144)}} \times 100$$

For property companies total interest is measured using Datastream item 810. Income gearing is expressed as a percentage and a low percentage implies low interest cost relative to operating profits (or high interest cover). The income gearing ratio is negative when the firm makes operating losses, i.e., when operating profit plus non-operating income is negative (when 137 + 144 is less than zero). Negative ratios are not meaningful for the purposes of this study because a positive ratio close to zero implies low interest rate exposure whereas a negative ratio close to zero implies high interest rate exposure. This problem is avoided by inverting income gearing to arrive at a measure of interest cover.[100] This inverse of the income gearing ratio is the preferred measure of interest cover in this study because it provides data for property companies whereas the Datastream measure of gross interest cover does not.

ii. **Debt to Funds Flow Ratio (or Funds Flow Debt Ratio).** This compares finance debt with funds flows from operations to see whether the profits and resulting cash flows are adequate, bearing in mind servicing costs and debt repayments. As a ratio it reacts quickly to a poor year of profit. It concentrates on the crucial issue of cash flows. Funds flow from operations is the value of the cash flow from operations before adjustment is made for working capital investment. Because year-to-year changes in working capital investment are disregarded the ratio is not at the mercy of window dressing techniques or other temporary changes in working capital investment. [101] This measure focuses on the operational cash flows of the business to determine whether the level of debt is excessive in relation to the internally generated funds. The ratio is measured as follows:

$$\frac{\text{Total debt}}{\text{Funds flow from operations}} = \frac{\text{Total loan capital (321)} + \text{Borrowings 1 year(309)}}{\text{Funds flow from operations(1008} + 1010 + 404 + 1011)}$$

[100] The interest cover ratio is a continuum between positive and negative values. Firms with negative cover ratios are in an inferior financial position relative to firms with low positive cover ratios. Five companies have negative interest cover ratios.

[101] Funds flow is preferred over cash flow as it concentrates on the generation of cash and avoids short-term movements in stocks, debtors and general creditors which can be manipulated at year ends.

Funds flow from operations is the value of the cash flow from operations before adjustment is made for working capital investment. Funds flow from operations is defined as Operating profit (1008) + Total depreciation & provisions (1010) + Other adjustments (404) + Exceptional/Extraordinary items (1011). Items 1010, 404 and 1011 are adjustments for non-cash movements. Operating profit (1008) is the operating profit as stated by the company in the cash flow statement.

The debt funds flow ratio is not meaningful for negative funds flow. For example, two firms A and B have total debt of £10 million. Firms A and B have funds flow of -£100 million and -£1 million respectively. Therefore, A and B's ratios are –0.1 and –10 respectively. Although, B is in a better financial position relative to A, its ratio is significantly lower implying an inferior position relative to A. This is corrected by inverting the ratio to obtain a **Funds Flow Debt Ratio.**

iii. **Net Interest Charge Dummy.** Firms who consistently have net interest receivable might not be overly concerned with interest rate volatility because the downside implies less net interest income and not higher net interest cost. Exposure to interest rate changes in these circumstances is unlikely to impede the firm's financial wellbeing. These firms, therefore, have less incentive to hedge.

The net interest charge is defined as Total interest charges (153) less Interest income (143). When the net interest charge is positive a firm has net interest payable, i.e., its interest cost exceeds its interest income. When the net interest charge is negative, a firm has net interest receivable, i.e., its interest cost is less than its interest income. Absolute values of net interest charges are converted into dummy values, 0 for positive (i.e., net interest cost) and 1 for negative (i.e., net interest income) net interest charges. This is done for each year and then an arithmetic average of the dummy values is calculated. The average values lie between 0 and 1 and are continuous. This variable is referred to as **Net Interest Charge Dummy Average.** Another variable is created that translates the average of the absolute net interest charge for the whole period into a dummy value using the same conversion rules as above. This variable is referred to as **Net Interest Charge Average Dummy.**

It is important to point out some potential difficulties with the aforementioned indicators of the ability or importance of servicing the firm's debt. The interest expense figure may include the gains or losses on interest rate derivative products. If this is the case, the interest coverage ratio measures post-derivative use coverage. The debt-to-equity ratio might also measure post-derivative use leverage since unrealised and deferred gains or losses on futures contracts and options used to hedge debt securities may be included in the book value of debt. This measurement may overstate or understate pre-hedging exposure for the firms using derivatives depending on the type of derivative instrument and the change in interest rates during the period. The preferred measure of the interest coverage ratio uses unhedged interest expense and the preferred measure of gearing uses the market value of debt. Other information that would be useful for the purpose of measuring exposure is the ratio of variable rate debt to total debt, where variable rate debt is defined as short-term plus long-term floating rate debt.[102] Unfortunately, not all firms provide information relating to the fixed floating mix of their long-term debt.[103]

In summary, this study employs 4 measures of the relative size/importance of debt service costs. The predicted sign on the coefficient of each variable is as follows:

Measures of Debt Service Cost	Predicted Sign
1. Interest Cover Ratio	-
2. Funds Flow Debt Ratio	-
3. Net Interest Charge Dummy Average	-
4. Net Interest Charge Average Dummy	-

4.5.5 Measuring Probability of Default

This study also uses a firm's credit rating as an indicator of the likelihood of financial distress. Credit ratings are obtained from the FAME financial database. FAME provides what it refers to as "Qui-scores" which are a measure of the likelihood of firm failure in the twelve months following the date of calculation. The Qui-score is given as a number in the range 0 to 100. This range comprises five distinct bands. Scores lying within 81 to 100 are in the "Secure Band". Companies in this range tend to be large and successful public companies. Failure is very unusual and normally occurs only as a result of exceptional changes within the company or its market. Scores lying within 61 to 80 are in the "Stable Band". Here again, company failure is a rare occurrence and will only

[102] Financial Reporting Standard 13 provides the following definition for floating rate assets and liabilities: Financial assets and liabilities that attract an interest charge and have their interest reset at least once a year. For the purposes of the FRS, financial assets and financial liabilities that have their interest rate reset less frequently than once a year are to be treated as fixed rate financial assets and financial liabilities. FRS 13 does not require firms to treat fixed-rate borrowings with less than 12 months remaining as floating rate borrowings.

[103] Gay and Nam (1998) calculate the extent of interest rate risk hedging by taking the ratio of a firm's notional amount of interest rate derivatives to total debt. They use total debt to proxy for a firm's total interest rate exposure. This hedge ratio indicates the extent of interest rate derivatives use in proportion to total debt.

come about if there are major company or marketplace changes. Scores lying within 41 to 60 are in the "Normal Band". This range contains many companies that do not fail, but some that do. Scores lying within 21 to 40 are in the "Unstable Band". Here there is a significant risk of company failure. Firms in this band are on average four times more likely to fail than those in the "Normal Band". Finally, scores lying within 0 and 20 are in the "High Risk Band". Companies in this range are unlikely to be able to continue trading unless significant remedial action is undertaken or there is support from a parent company. However, a low score does not mean that failure is inevitable.[104] The predicted sign on the coefficient of the qui-score variable is negative.

4.5.6 Costs of Underinvestment

Chapter two argued that hedging can control the underinvestment problem. Two causes of underinvestment were identified. First, a firm with debt outstanding, and which acts in the interest of shareholders, will under conditions of financial distress or where the probability of financial distress is high reject value enhancing projects.[105] Highly geared firms are more likely to suffer from underinvestment because they have a greater probability of financial distress. By reducing the likelihood of financial distress, hedging can control this problem. Also firms with more growth options in their investment

[104] Geczy et al (1997) use a firm's S&P credit rating in place of its long-term debt ratio as a measure of expected distress costs. Haushalter (1998) uses a binary variable to indicate if a firm's debt is rated by Standard and Poors as a measure of the level of informational asymmetry. Graham and Rogers (1999) use the credit rating of senior debt as a measure of the probability of financial distress.

[105] This is because under these circumstances, the benefit from undertaking a positive NPV investment can accrue to the bondholders to such an extent that the shareholders could be worse off than if the investment had not been made.

opportunity set will be exposed to greater potential costs of underinvestment. Therefore, these firms have a greater incentive to hedge to avoid underinvestment costs.[106]

Second, hedging mitigates the underinvestment due to costly external financing. The discussion in chapter two argued that firms with more asymmetric information about the quality of new investment projects would incur higher costs of external finance. This analysis identified firms with more growth options relative to assets in place as facing more asymmetric information and hence costly external finance. Therefore these types of firms have a greater incentive to hedge to avoid having to rely on external finance. Furthermore, if the level of debt captures a firm's dependence on external financing, with highly geared firms having a greater dependency, then with costly external finance highly geared firms are more likely to hedge to avoid having to fund new investments with external finance.

Both of the suggested underlying causes of the underinvestment problem predict that the costs of underinvestment are greater for firms with higher growth opportunities and higher levels of debt. Measures for gearing employed in this study were defined above. This study employs four measures for growth options in the firm's investment opportunity set. These are capital expenditure deflated by total sales,[107] the price earnings

[106] In effect underinvestment is a cost of financial distress.

[107] Financial price volatility can adversely affect cash flow which could bring to a halt the major capital investment programs of firms. The importance of these activities to the firm can be measured by the size of firms' annual capital expenditure scaled by total sales. If risk management is used to protect the continued funding of these programs, theory predicts a positive relationship between measures of investment spending and hedging. Tufano (1996), Geczy et al. (1997), Haushalter (1998) and Graham and Rogers (1999) used capital expenditure as a proxy for growth options.

ratio,[108] the market-to-book value of equity[109] and research and development expenditure deflated by total sales.[110] This study defines these variables as follows:

i. Capital Expenditure or Intensity of Capital Expenditure

The intensity of capital expenditure is calculated as ratio of purchases of fixed assets over total sales.

$$\text{Intensity of capital investment} = \frac{\text{Payments for fixed assets}(1024)}{\text{Total sales}(104)}$$

ii. Price-Earnings ratio

This study defines the price earnings ratio as share price divided by net earnings per share (full tax) (183).[111] Net earnings per share (EPS) (183) is the earned for ordinary figure (182) divided by the average weighted number of shares in the last 12 months. Earned for ordinary (full tax) (182) is the net profit after tax, minority interest and preference dividends.

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[108] Higher price earnings ratios are typically associated with firms with higher growth prospects (see, for example, Brigham and Gapenski (1994)). Berkman and Bradbury (1996) and Gay and Nam (1998) used the price earnings ratio as a proxy for growth options.

[109] A rationale for using the market-to-book-value ratio is that it measures the likelihood that a firm will have positive net present value projects or growth opportunities. This is based on the idea that market value represents both the values of a firm's assets in place and future growth opportunities. Book value measures the value of assets in place and so the ratio is a relative measure of a firm's growth opportunities. Nance et al. (1993), Allayannis and Ofek (1996), Mian (1996), Wysocki (1996), Fok et al. (1997), Geczy et al. (1997), Gay and Nam (1998) and Graham and Rogers (1999) used the market to book ratio as a proxy for growth options.

[110] Nance et al. (1993), Dolde (1995), Allayannis and Ofek (1996), Fok et al. (1997), Geczy et al. (1997), Gay and Nam (1998), Howton and Perfect (1998) and Graham and Rogers (1999) used R&D expenditure as a proxy for growth options.

[111] Adedeji and Stapleton (1996) use the price-earnings ratio as a proxy for expected growth. For values of the price earnings ratio which are either negative or greater than 100 they set equal to 100. They find the majority of their sample have PE ratio values of between 5 and 10.

182 = After tax profit adjusted (175) – Minority interests (176) – Minorities supplementary tax (207) – Other adjustments (177) – Preference dividend for period (181)

$$\text{Net EPS(183)} = \frac{\text{Earned for ordinary (full tax) (182)}}{\text{Ave. weighted no. of shares in last 12 mths}}$$

The price earnings ratio is share price at time t divided by earnings per share in year t.

$$\text{PE} = \frac{\text{Share price, time t}}{\text{Earnings per share (183), year t}}$$

iii. Market Value to Book Value of Equity ratio

This is defined as the ratio of the market value of equity to book value of equity, where the book value of equity, referred to as net tangible assets (or net asset value), is measured as equity capital and reserves (excluding preference capital) less goodwill and other intangibles.

$$\text{Market value to book value} = \frac{\text{Market value of equity}}{\text{Net tangible assets}} \times 100$$

Market value is the share price multiplied by the number of ordinary shares in issue. Datastream defines net tangible assets as fixed assets less depreciation, plus longer-term investments and current assets, less current and deferred liabilities and prior charge capital and minority interest. Alternatively, net tangible assets is equal to equity capital and reserves (305) minus total intangibles (344).

iv. Research and Development Expenditure

This is defined as research and development expenditure deflated by total sales. The use of R&D expenditure as a growth proxy is justified on the grounds that these expenses are predictors of the development of future projects. Research and development (R&D) data is obtained from the R&D Scoreboard produced by Company Reporting Ltd for the Department of Trade and Industry's Innovation Unit. The R&D expenditure is that which is funded by the companies themselves. It excludes R&D undertaken under contract for customers such as governments or other companies. Where part or all of R&D costs have been capitalised, the additions to the appropriate intangible assets are included as R&D expenditure and any amortisation eliminated. The UK R&D expenditure data is independent of the location of the R&D activity. The data shows the level of R&D funded by UK companies, not all of which is carried out in the UK.

In summary, this study employs 4 measures of firm growth. The predicted sign on the coefficient of each variable is as follows:

Measures of Growth	Predicted Sign
1. Capital Expenditure	+
2. Price-Earnings ratio	+
3. Market-to-Book value ratio	+
4. R&D/Sales	+

4.5.7 Measuring Gearing-Growth Interaction

The arguments in chapter two and three show that both the forces of firm growth and debt determine the expected costs of underinvestment. A firm with high growth opportunities and lower levels of debt will experience fewer states in which the firm would default on its debt payments than a corresponding firm higher levels of debt. The latter would face higher expected costs of underinvestment due to financial distress than the former.

Similarly, the Froot et al. (1993) model predicts that firms with high growth opportunities and low levels of internal finance (i.e., high levels of debt) have a greater incentive to hedge[112] relative to those with high growth opportunities and high levels of internal funding[113] (i.e., low levels of debt) because the former are more likely to require costly external finance. Therefore, this framework identifies two conditions to induce hedging activity. First, the firm must have access to positive net present value projects. Second, there must be a reasonable probability that the firm will have insufficient internally generated funds to finance these projects.

These arguments suggest that allowing for both the level of a firm's growth options and its debt better captures the costs of underinvestment. Therefore, following the approach of Geczy et al. (1997) this study creates additional variables to measure underinvestment costs by interacting multiplicatively the four variables measuring firm growth (i.e., capital expenditure, R&D expenditure, price-earnings ratio and the market-to-book ratio) with gross book value gearing and gross market value gearing. This process generates eight interaction variables. The predicted sign on the coefficient of each variable is as follows:

Gross Gearing – Growth Interaction Variable	**Predicted Sign**
1. Gross Book Value Gearing × Capital Expenditure/Sales	+
2. Gross Book Value Gearing × Price-Earnings ratio	+
3. Gross Book Value Gearing × Market-to-Book ratio	+
4. Gross Book Value Gearing × R&D Expenditure/Sales	+
5. Gross Market Value Gearing × Capital Expenditure/Sales	+
6. Gross Market Value Gearing × Price-Earnings ratio	+
7. Gross Market Value Gearing × Market-to-Book ratio	+
8. Gross Market Value Gearing × R&D Expenditure/Sales	+

[112] In other words, firms with many positive NPV investments together with a strong possibility of not having sufficient internal resources to finance these projects have a strong incentive to hedge.
[113] Firms with high growth opportunities face costly external finance because of asymmetric information. However, if they have access to a high level of internal funds this lowers the likelihood of using external finance.

The discussion in chapter 3 suggests that the use of gross gearing in the Geczy et al. (1997) interactive variable is an incomplete proxy for a firms financial constraint. The arguments suggest that a firm faces the greatest degree of capital constraints when it is both highly geared and it has low cash balances. It is, therefore, more appropriate to take account of a firm's cash position to avoid an unnecessarily pessimistic view of debt being taken. Therefore, a potentially more reliable measure of the financial constraint facing a firm is the net gearing ratio rather than the gross gearing ratio. This study extends the Geczy et al. (1997) analysis by creating an interactive term that utilises a firm's net gearing. As discussed above net gearing uses debt net of cash in the numerator of the gearing equation. By taking into account the level of cash and short-term investments this measure potentially provides a more realistic picture of the level of debt and hence the financial constraint faced by the firm. The interaction of net gearing and growth proxies creates eight variables. The predicted sign on the coefficient of each variable is as follows:

Net Gearing – Growth Interaction Variable	Predicted Sign
1. Net Book Value Gearing × Capital Expenditure/Sales	+
2. Net Book Value Gearing × Price-Earnings ratio	+
3. Net Book Value Gearing × Market-to-Book ratio	+
4. Net Book Value Gearing × R&D Expenditure/Sales	+
5. Net Market Value Gearing × Capital Expenditure/Sales	+
6. Net Market Value Gearing × Price-Earnings ratio	+
7. Net Market Value Gearing × Market-to-Book ratio	+
8. Net Market Value Gearing × R&D Expenditure/Sales	+

4.5.8 Measuring Gearing-Growth Interaction Dummy

This study also uses a dummy interaction variable to identify those firms expected to have the greatest need for external finance, that is, firms with high growth opportunities and low levels of cash.[114] The dummy variable is set equal to one if a firm's net gearing ratio is above the sample median and its growth proxy is also above the sample median. Additional binary variables are created using measures of liquidity and cash holdings. In this case the dummy variable is set equal to one if the firm's liquidity ratio (or cash holdings ratio) is below the sample median and the growth proxy is above the sample median. The predicted sign on the coefficient of each of these variables is positive.

4.5.9 Measuring Cash Flow Volatility

The discussion in chapter 2 suggested that given the incentives for hedging, a firm's ultimate decision to hedge also depended on the level of its exposure to financial price risks. It was argued that firms with more volatile operating income were more likely to hedge to reduce risk. Therefore, it is important to control for the size of a firm's cash flow variability when investigating the determinants of corporate hedging.

Chapter 3 shows that three approaches have been followed by the literature. The first approach is to use a measure of cash flow volatility such as the standard deviation of past operating income. A problem with this measure is that it is an ex post measure of risk, while management's decision to hedge is based on expected risk exposure. The second approach is to use regression analysis. The third approach is to use sources of potential cash flow volatility rather than measuring volatility directly. This is the approach followed in this study. In common with several previous empirical studies this

[114] This assumes that a firm's cash holdings can be utilised to funds its investments. This might be the case if cash is managed centrally and then diverted to those divisions requiring funding. However, cash may not fulfil this function if it is dispersed widely across many divisions.

study uses indicators of a firm's foreign currency exposure as proxies for a firm's cash flow volatility implying greater potential benefits from hedging.[115]

In the notes to the accounts most firms provide segmental information with regard to the geographical origin and destination of turnover. The destination analysis shows the countries into which goods/services have been sold (the geographical area to which goods or services are supplied). Analysis by origin relates to the country from which the goods/services have been sold (the geographical area from which goods or services are supplied to a third party or another geographical area). This study measures the level of exposure to foreign exchange rate changes by using the ratio of overseas sales by destination to total sales and the ratio overseas sales by origin to total sales.[116] These ratios measure the proportion of sales destined and originating outside the UK for 1994 and are sourced from a firm's annual report.[117]

1. $\dfrac{\text{Foreign sales by destination}}{\text{Total sales}} \times 100$

2. $\dfrac{\text{Foreign sales by origin}}{\text{Total sales}} \times 100$

---

[115] Dolde (1995), Berkman and Bradbury (1996) and Howton and Perfect (1998) employ foreign currency exposure variables across all categories of hedging.

[116] Geczy et al. (1997) use the ratio of pre-tax foreign income (from the firm's foreign operations) to sales, the ratio of identifiable foreign assets to total assets and the ratio of foreign sales plus export sales to sales. Mian (1996) uses annual 1992 foreign sales as a percentage of total sales. Howton and Perfect (1998) use a dummy variable equal to one if firms report foreign income, and zero otherwise. They recognise that this variable is less sophisticated than those used in Berkman and Bradbury (1996) and Geczy et al. (1997), however, they find it identifies a similar number of firms facing foreign currency exposure.

[117] Some studies demonstrate that a firm's exchange rate exposure is significantly related to the level of its foreign operations. For example, Jorion (1990) examines a sample of major U.S. multinationals and finds that dollar depreciation exposure is positively related to the ratio of a firm's foreign sales to total sales. Allayannis (1995) shows that the exchange-rate exposure of U.S. manufacturing industries is related to the level of exports and imports. He and Ng (1998) find the higher a Japanese multinational's level of export ratios, the larger its exchange rate exposure.

The study also uses the ratio of foreign tax to total tax as a proxy for the proportion of foreign assets.[118] This ratio is sourced from Datastream and is defined as, (numbers in brackets refer to Datastream accounting item codes)

3. $$\frac{\text{Total overseas tax charge (169)}}{\text{Total domestic tax (166)} + \text{Total overseas tax charge (169)}} \times 100$$

Foreign exchange transaction exposure arises from both the sale of goods/services in foreign markets and the buying of goods/services from foreign markets. Foreign exchange transaction exposure may also arise from the repatriation of dividends and other investment income (firms may lend to overseas associated companies) from overseas. Data on import, export and repatriated income values is limited with only a minority of firms disclosing actual amounts in sterling in their annual report and accounts. Because of this the study employs dummy variables to indicate the presence of import, export and repatriation activity.

The discussion in chapter 2 on the methods of hedging suggested that foreign denominated debt could act as a natural hedge of foreign revenues, thereby decreasing a firm's foreign currency exposure.[119] The definition of hedging employed in this study includes the use of foreign currency debt for hedging purposes. The analysis earlier in this chapter showed that a large proportion of foreign currency hedging firms were

[118] Lee and Kwok (1988) find significant correlations between foreign asset ratios and foreign tax ratios.

[119] Foreign debt service payments represents a cash outflow in a foreign currency and therefore it can be used as a hedge when a firm has foreign currency revenues either from foreign operations or from exports. Where the company has extensive overseas investments, borrowings will probably arise in the foreign subsidiaries, this is desirable; but borrowings in currencies other than those in which the assets are held and revenue is earned (if left unhedged) pose additional risk through mismatch of currencies. For example, BTR says, "Borrowings are managed so that a significant portion of non sterling denominated net assets are hedged by matching currency borrowings, thus safeguarding shareholder' interests against foreign exchange risk." The purpose of the foreign currency borrowing is to protect shareholders' funds from the effect of currency movements on the net operating assets of the group.

disclosing the use of foreign currency debt for hedging purposes. Therefore, given that the definition of foreign currency hedging incorporates foreign debt usage this precludes the use of foreign debt as a proxy for exposure for the foreign currency hedging sample. However, the definition of interest rate hedging does not incorporate the use foreign debt as a hedging vehicle. Therefore, foreign debt can be employed as a proxy for financial price exposure for the interest rate hedging sample. Because of the non-availability of data this study is unable to report a continuous measure of a firm's currency debt mix, such as the sterling equivalent amount of foreign currency debt over total debt. Therefore, consistent with earlier studies,[120] this study employs a dummy variable equal to one if the firm has quantifiable foreign-denominated long- or short-term debt, or makes a qualitative disclosure about the existence of foreign-denominated debt.

Finally this study controls for the importance of foreign operations by using a dummy variable denoting the existence of foreign subsidiaries.[121] With the exception of the foreign tax ratio all of the above data is collected from notes and footnotes to the financial statements within the annual report. The predicted sign on the coefficient of each of these variables is as follows:

Measures of Foreign Currency Exposure	Predicted Sign
1. Foreign Sales by Destination	+
2. Foreign Sales by Origin	+
3. Foreign Tax Payments	+
4. Foreign Currency Transactions dummy	+
5. Foreign Currency Debt dummy	+
6. Foreign Operations dummy	+

[120] Geczy et al. (1997) also indicate the use of foreign currency debt using dummy variables. Allayannis and Ofek (1996) use both a continuous and dummy variable to measure existence of foreign debt.

[121] Wysocki (1996) utilises a dummy variable equal to one if a firm has foreign sales operations in an identified country or region. Fok et al. (1997) constructed a dummy variable which is equal to one if the firm is defined as a multinational corporation and zero otherwise.

4.5.10 Substitutes For Hedging

Although this thesis focuses on hedging chapter 2 argued that instead of managing risk with derivatives (a risk reducing or hedging strategy), a firm could pursue alternative hedging or cost reducing strategies that substitute for derivative hedging strategies. For example, firms can lower the probability of financial distress by issuing preference capital instead of debt (Nance et al. (1993)). A dividend payment due on preference capital can be postponed without any threat of insolvency, whereas non-payment of interest on debt can trigger insolvency. Alternatively, a firm could lower the likelihood of financial distress by possessing more liquid assets ensuring that funds will be available to pay debt claims. Lower dividend payments might also help to limit financial distress and agency costs (Nance et al. (1993)).

The discussion in chapter 2 argued the mitigation of various agency type problems, such as the shareholder-bondholder conflict, as one explanation for hedging. The analysis also examined alternative methods of alleviating the conflict between shareholders and bondholders. Reducing the level of debt in the capital structure lowers agency costs. However, some studies have shown the loss in the value of a firm's debt tax shield as a result of lowering a firm's debt capacity reduces firm value (Ross (1997) and Leland (1998)).[122] In view of this countervailing effect it was shown in chapter 2 that firms could control the aforementioned agency problems by issuing convertible debt as opposed to lowering the level of straight debt and so maintain the tax benefits of debt.[123]

[122] Conversely, these models show that hedging which increases debt capacity enhances firm value.
[123] Bond covenants that restrict dividend payments can help control the underinvestment problem by forcing the firm to retain funds and undertake investment projects (see Myers (1977), Smith and Warner (1979) and Kalay (1982)).

Previous empirical tests have used several different proxies for hedging alternatives. The variable used most often as a proxy for hedging substitutes is a measure of a firm's liquidity. Ten of the fourteen studies reviewed in chapter 3 have employed some measure of liquidity. In recent empirical tests the preferred measure of liquidity has been the quick assets ratio. A measure for a firm's dividend policy appears in eight studies. Levels of convertible debt and preference capital are used in six studies. A measure of firm level diversification is used in three studies.

This study controls for hedging alternatives by using measures of preference capital usage, convertible debt usage, a firm's liquidity and dividend yield. The use of preference capital is measured by the ratio of book value of preference capital to total assets.

$$\textbf{1. Use of preference capital} = \frac{\text{Book value of preference capital (306)}}{\text{Total assets(391)}}$$

The use of convertible debt is measured by the ratio of book value of convertible debt to total assets.

$$\textbf{2. Use of convertible debt} = \frac{\text{Book value of convertible loans(320)}}{\text{Total assets(391)}}$$

Arguments presented in chapter 3 suggest that because converting marketable securities to cash can create information costs similar to those related to debt financing, the cash ratio can capture the concept of internal wealth used in Froot et al. (1993) better than the quick assets ratio. Therefore, in this study liquidity is measured by the ratio of cash over current liabilities.

3. Cash ratio $= \dfrac{\text{Total cash and equivalent(375)}}{\text{Total current liabilities (389)}}$

However, to facilitate comparisons with previous studies this thesis also employs two other measures of liquidity, these are the current ratio and the quick assets ratio.[124]

4.Quick assets ratio =

$$\frac{\text{Total current assets(376) - Total stock \& work in progress(364)}}{\text{Total current liabilities(389)}}$$

5. Working capital ratio $= \dfrac{\text{Total current assets (376)}}{\text{Total current liabilitie s(389)}}$

An alternative to the measures of liquidity is the cash holdings ratio which is measured as the ratio of cash holdings to total assets.

6. Cash holdings ratio $= \dfrac{\text{Total cash and equivalent(375)}}{\text{Total assets(391)}}$

The ratio of the gross dividend per share over share price is used to proxy for a firm's dividend behaviour.

7. Dividend yield $= \dfrac{\text{Gross dividend per share}}{\text{Share price}} \times 100 = \dfrac{190 \times 1.25}{\text{Share price}} \times 100$

Although the discussion above suggests that preference capital and convertible debt can be considered as substitutes for hedging, arguments presented in chapter 2 suggest that preference capital potentially more closely mimics the properties of debt rather than equity and so increases a firm's effective debt (Geczy et al. (1997)). This increases the probability of financial distress and limits the availability of internal funds.

Other arguments questioned the efficiency with which convertible debt could deal with the agency costs of straight debt (Doherty (1995)). Furthermore, it was also argued that the use of convertible debt might reflect additional gearing, which constrains a firm's access to external financing (Geczy et al. (1997)). Given these competing hypotheses concerning the use of preference capital and convertible debt the predicted impact of these variables on the decision to hedge is indeterminant.

In summary, this study employs seven measures of substitutes for hedging. The predicted sign on the coefficient of each of these variables is as follows:

Measures of Substitutes for Hedging	Predicted Sign
1. Use of preference capital	+ or -
2. Use of convertible debt	+ or -
3. Cash ratio	-
4. Quick assets ratio	-
5. Current ratio	-
6. Cash holdings ratio	-
7. Dividend yield	+

4.5.11 Measuring Information and Transaction Cost Scale Economies

The discussion in chapter 2 suggested that hedging activity exhibits significant information and transaction cost scale economies implying that larger firms are more likely to hedge. However, other arguments based around the costs of raising external finance and the direct costs associated with financial distress suggested an inverse relationship between firm size and hedging. This study uses the natural logarithm of total assets and the natural logarithm of the market value of equity to proxy for firm size. This data is sourced from Datastream.

[124] Nance et al. (1993), Mian (1996) and Fok et al. (1997) use the current ratio. Berkman and Bradbury (1996), Tufano (1996), Geczy et al. (1997), Howton and Perfect (1998) and Graham and Rogers (1999) use the quick assets ratio.

Other arguments presented in chapter 2 suggested that firms employing personnel that possess the skills and knowledge of risk management are more likely to participate in hedging activity because they have a greater ability to hedge effectively. This hypothesis is tested by using a dummy variable equal to one for firms with at least one employee with membership of the Association of Corporate Treasurers (ACT) and zero otherwise. This information is taken from the Treasurer's Handbook 1994-95 published by the ACT. The ACT is a professional body offering education, training and a professional qualification in the area of treasury management. Firms employing staff with membership of the ACT are expected to have greater knowledge of hedging practices and therefore are more likely to hedge. In summary, this study employs two measures of firm size and one measure of hedging knowledge. The predicted sign on the coefficient of each of these variables is as follows:

Measures of Economies of Scale/Ability to Hedge	Predicted Sign
1. Natural logarithm of Total Assets	+ or -
2. Natural logarithm of Market Value of Equity	+ or -
3. Membership of ACT dummy	+

4.5.12 Managerial Risk Aversion

Arguments in chapter 2 suggested that managers are often unable to diversify firm-specific risks. For this reason, risk averse manage often choose to take actions that reduce the variability of the firm's returns. These arguments imply that, all else equal, managers with more wealth invested in the firm's equity will have greater incentives to hedge. It was also argued that managers' compensation plans can influence their hedging choices. Specifically, the incorporation of option-like provisions in managers' compensation increases the incentives for managers to take risks. Consequently, the more option-like features there are in the compensation plans, the less managers will hedge.

In this study we are unable to examine the relation between hedging policy and managerial risk aversion because data regarding the ownership of the firm's equity and the managers' compensation packages was not consistently disclosed in annual reports for the 1995 year-end.

4.6 Conclusion

This chapter began by describing the sample of firms employed in this study and indicated that the sample constituents were the largest firms by market value in the UK corporate sector. With over 400 firms, the sample incorporated a vast cross-section of UK corporate activity and was larger than several previous empirical studies.

The chapter then went onto identify where this study sourced data on hedging, how the data was collected and the type of data collected. The study sourced data on hedging activities from both annual reports and a survey of corporate treasurers and therefore is the first to simultaneously use both sources of data. Annual report disclosures were examined in great detail to glean information on the company's risk management activities. Both qualitative and quantitative data were collected. Firms were classified as hedgers if they made any reference to hedging financial price exposures. Unlike previous studies the definition of hedging was not restricted to those firms that used derivatives but included those that employed internal hedging techniques as well on-balance-sheet financial hedging strategies, such as the use of foreign currency debt.

On the basis of this definition a detailed analysis of the hedging activities of the sample firms was presented. This included a discussion of the number of hedgers and non-hedgers in the sample. The range and quality of data collected enabled this study to examine features of the data set that had not been previously examined in other studies. In particular a close examination of both the interest rate and foreign currency samples revealed a potentially important characteristic that had not been identified in any previous empirical study. This was the fact that both the non-interest rate hedging and non-foreign currency hedging samples included firms that hedged other exposures. The discussion in the chapter suggested that this characteristic had potentially important implications for the empirical tests on the determinants of interest rate hedging and foreign currency hedging. In particular the inclusion of other hedging firms in the non-hedging sample might obscure the differences between hedgers and non-hedgers and therefore the empirical tests would need to control for these factors.

The analysis of annual report disclosures also focused on an examination of the qualitative statements of firms that provided no disclosure on hedging and of those firms that indicated they did not hedge. This was the first time that an analysis of this kind had been undertaken in an empirical study. This analysis was important because it demonstrated that the majority of non-disclosing firms made statements implying they had low levels of exposure. Hence this finding provided strong support for the assumption that non-disclosing firms could be classified as non-hedgers. Furthermore, the analysis of qualitative disclosures of non-disclosing firms revealed that their reasons for 'not hedging' were consistent with several of the theories of hedging examined in chapter two.

The chapter then went onto discuss the data obtained from the survey to corporate treasurers. The survey required firms to indicate whether they hedged, what exposures they hedged and whether they used derivatives. Firms were also asked to provide their reasons for hedging or not hedging. Tests showed that non-hedging firms were perceived to have significantly lower levels of financial price exposure relative to hedging firms. These results were consistent with the analysis of qualitative disclosures made by non-disclosing firms in their annual reports. Other tests showed no significant differences in the perceived size of exposures between hedging firms that used derivatives and hedging firms that did not. Furthermore, tests that compared these two groups of hedgers with respect to characteristics that measured firm's incentives to hedge revealed no statistically significant differences in all measures with the exception of firm size. These findings provided support for the arguments presented in this chapter that hedging firms should include hedgers that do not use derivatives as well as those that do.

The analysis of annual report disclosures and survey responses found no evidence of widespread speculation. Although there was evidence that some firms hedged selectively. Basic frequency analysis was also carried out on both data sets. A comparison of the findings revealed that the results were very similar. This suggested that the exhaustive and careful reading of accounting disclosures had produced reliable data.

Since the study obtained data from annual reports and a survey the analysis showed for a subset of the full sample the study had access to hedging data from both the annual report and the survey. The availability of both sources of hedging data enabled this study to compare annual report data with the survey data with respect to a firm's hedging classification. This process identified inconsistencies in how firms had been classified. The analysis in the chapter showed that in some instances the annual report data classified firms as non-hedgers whereas the survey classified these firms as hedgers and vice versa. The discussion suggested that the availability of this data would enable this study to be the first to assess the effect on the empirical results of having misclassified firms.

The chapter then described the two ways this study measures hedging. The first measure is a binary variable, which assigns a value of one to firms classified as hedgers and zero to non-hedgers. The second is a continuous measure of hedging constructed by using data on the notional amount of derivatives employed divided by a firm's total assets. Finally, this was followed by a discussion of the independent variables employed in this study.

This chapter has laid the foundation for a detailed empirical investigation into the determinants of corporate hedging activity for UK non-financial firms, which follows in subsequent chapters.

Appendix A4.1 Questionnaire Sent to Corporate Treasurers

RESEARCH SURVEY

A SURVEY OF CURRENT CORPORATE RISK MANAGEMENT PRACTICES OF UK COMPANIES 1995

Questionnaire

Guidelines for Participation

1. Please do not be put off by the size of this questionnaire. There are many questions that will not be relevant to your company.

2. This questionnaire has been designed so that most questions an be answered by selecting an answer already provided, or by short identification of relevant facts or practices. Please carefully follow the instructions in answering the questions in each section. If a question does not apply to your company you will be directed to the next relevant question or section.

3. Please refer to the glossary for definition of terms used in the questionnaire.

4. Supplementary information not contained in your annual report and accounts on any aspect of your company's financial price risk management returned with the completed questionnaire will be greatly appreciated.

5. Access to the survey responses is restricted to the following persons:

   Amrit Judge, Research Student
   Nick Robinson, Professor of Finance
   Brian Eales, Principal Lecturer in Econometrics and Financial Economics

   In all cases, the anonymity of the respondent and his or her firm will be carefully protected. The contents of this questionnaire are **absolutely** confidential. Information identifying the respondent will not be disclosed under **any** circumstances.

6. Please return the completed questionnaire in the self addressed envelope enclosed with the questionnaire. Please keep a copy of the completed questionnaire for your records.

7. Should you have any questions concerning any aspect of this research project, please contact:

   Amrit Judge 0207 – 320 1499

8. Your agreement to participate in this survey is very much appreciated.

SECTION II: TYPES OF FINANCIAL PRICE EXPOSURE

1) Please indicate with a tick if your firm has exposure to any of the following financial price risks.

	YES (√)	NO (√)
Foreign exchange risk		
Interest rate risk		
Commodity price risk		
Equity price risk		

If "yes" to any of the above, please go on to **question 2.**
If "no" to all of the above, please go on to **section VIII, page 16.**

2) How significant are the financial price exposure to the current and the future performance of your company? On a scale of 1 to 5, **where 1 = low level of significance and 5 = high level of significance. Please indicate with a tick (√).**

	low 1	2	3	4	**high** 5
Foreign exchange exposure					
Interest rate exposure					
Commodity price exposure					
Equity price exposure					

3) From your company's point if view, would you consider the financial price risk to have been more or less of a problem in the last 5 years? **Please indicate with a tick (√).**

	More of a problem	Less of a problem	No change
Foreign exchange risk			
Interest rate risk			
Commodity price risk			
Equity price risk			

SECTION III: MANAGING FINANCIAL PRICE RISK

1) Does your firm hedge its financial price risks?

	√
YES	☐
NO	☐

If **"yes"** please go on to **question 2.**
If **"no"** please go on to **section VIII, page 16.**

2) Please indicate with a tick the purpose of your hedging activity and a rank in order of importance, **where 1 = primary purpose.**

	√	**Rank 1, 2 etc.**
Hedge interest rate risks arising from existing and new financing	☐	☐
Asset/liability management	☐	☐
Hedge asset or liabilities with embedded options	☐	☐
Hedge future income	☐	☐
Hedge foreign exchange transaction exposure	☐	☐
Hedge foreign exchange translation exposure	☐	☐
Hedge foreign exchange economic exposure	☐	☐
Hedge commodity price exposure	☐	☐
Hedging equity exposure	☐	☐

Other, please specify:

____

____

____

3) What hedging policy does your company pursue? **(Refer to glossary for explanation of terms).**

	Passive hedge		Active Hedge
	Static √	**Dynamic** √	√
Interest rate risks arising from existing/new financing			
Asset/liability management			
Options positions that are embedded in assets/liabilities			
Future **expected** income/expense			
Foreign exchange transaction exposure			
Foreign exchange translation exposure			
Foreign exchange economic exposure			
Commodity price exposure			
Equity exposure			

Other, please specify:

4) Do you consider hedging selectively (i.e. active hedging) to be a form of speculation?

	√
YES	
NO	

Other, please specify:

5) In broad terms, what are your company's risk management objectives?

√

- Seek to minimise risk and maximise the certainty of the value of the Revenue and cost streams in business ☐
- Actively manage the risks arising from the underlying flows in the Business to generate a contribution to group profit ☐
    - Generate profit by trading in the financial markets ☐

Other, please specify:

___

___

___

Please explain briefly why this course of action undertaken.

___

___

___

___

SECTION IV: HOLDING VIEWS ON THE DIRECTION OF FINANCIAL PRICES

1) Please indicate with a tick if you hold a view on the direction financial prices will take?

	Always (√)	Sometimes (√)	Never (√)
Exchange rate			
Interest rate			
Commodity prices			
Equity prices			

2) If you sometimes **do** have a view, what percentage of your inherent financial price risk do you attempt to offset, on average?

	%
Foreign exchange risk	
Interest rate risk	
Commodity price risk	
Equity price risk	

3) If you do **not** have a view, what percentage of your inherent financial price risk do you then attempt to offset, on average?

	%
Foreign exchange risk	
Interest rate risk	
Commodity price risk	
Equity price risk	

SECTION V: MOTIVATIONS FOR HEDGING

1) Hedging reduces the variability of clash flows to movements in financial price risks. What are the benefits to **your** company of a reduction in cash flow?

____

____

____

____

____

____

2) Please indicate the relative importance of the following considerations in governing **your** firm's hedging decisions . On the scale of 1 to 5, **where 1 = Unimportant and 5 = Very Important. Please indicate with a tick (√).**

	1	2	3	4	5
Maintaining ability to create sufficient liquidity to meet obligations					
Enhancing debt-servicing capability					
Ensuring short-term survivability if the firm					
A defence against catastrophic financial price movements, e.g.,, avoiding costs of bankruptcy/financial distress					
Maintaining a competitive cost structure					
Protecting budgeted revenue/cost					
Maintaining comparability with firms in the industry					
Maintaining a high debt rating/Views of credit rating agencies					
Maintaining a predictable source of funds					
Sending a signal of sound financial management to financial markets					
Maintaining dividend payments/growth in dividends					
Ensure that a company has the cash resources to carry out future investment (e.g. R&D expenditure)					

3) Please indicate with a tick the relative importance of the following factors in governing **your** firm's hedging decisions. On scale of 1 to 5, **where 1 = Unimportant and 5 = Very Important.**

	1	2	3	4	5
Accounting for treasury hedging activities					
Tax rules affecting the use of derivative instruments					
Costs of Bankruptcy/financial distress					
Bond indenture requirements/loan covenants					
Other, please specify					

4) Does financial price volatility affect the value of your company's investment opportunities?

	√
YES	
NO	

Other, please specify:

---

5) Has hedging removed some of the volatility form your firm's capital/investment spending?

	√
YES	
NO	

Other, please specify:

---

6) In your opinion do you think your firm's risk management policy has improved contractual relations between your firm and its non-investor stakeholders?

	YES	NO CHANGE
Suppliers	☐	☐
Customers	☐	☐
Management	☐	☐
Employees	☐	☐

Other, please specify:

___

___

If yes to any of the above, please describe briefly how you think the relationship(s) has (have) improved?

___

___

___

7) Have lenders made it a condition of providing finance that your company undertakes hedging transactions to reduce the adverse effects of interest rate or other financial price changes?

√

YES	☐
NO	☐

If "yes" please describe briefly:

___

___

___

8) In your opinion are your major shareholders aware of the financial price risks faced by your firm?

	√
YES	
NO	
DON'T KNOW	

If "**yes**" go on to **question 9.**
If "**no**" go on to **question 10.**
If "**don't know**" go on to **question 10.**

9) In your opinion do you think your major shareholders want the firm's financial price risks as part of a well diversified portfolio?

	√
YES	
NO	
DON'T KNOW	

If "**yes**" go on to **section VI.**
If "**no**" go on to **question 10.**
If "**don't know**" go on to **question 10.**

10) In your opinion do you think your major shareholders expect the treasury operation to hedge the firm's financial price risks?

	√
YES	
NO	
DON'T KNOW	

Other, please specify:

____

____

____

SECTION VI: COMPETITORS' HEDGING POLICIES

1) When hedging your financial price exposures do you take into consideration how your competitors might be hedging similar financial price exposures (for example, foreign currency exposures)?

√

YES	☐
NO	☐

If "yes" please go on to **question 2.**
If "no" please go on to **section VII, page 14.**

2) Please indicate with a tick the relative importance of your competitors hedging strategies in governing your firm's hedging decisions. On scale of 1 to 5, **where 1 = Unimportant and 5 = Very Important.**

	1	2	3	4	5	
Unimportant						**Very Important**

Please describe briefly the ways in which your competitors' hedging policies influence your hedging policies.

____

____

____

____

3) Please indicate which hedging strategy you would adopt if you knew how your rivals were hedging.

	√
We would try to match our rivals hedging strategy	
We would hedge more than our rivals	
We would hedge less than our rivals	
Our hedging strategy would primarily depend on our expectations of changes in financial prices after which we would consider our rivals hedging strategies	

Other, please specify:

___

___

___

SECTION VII: CONTRIBUTION OF HEDGING OPERATIONS TO FIRM'S PERFORMANCE

1) Other things held constant, hedging has had the effect of:

	√
Increasing your firm's after-tax cash flows	☐
Decreasing your firm's after-tax cash flows	☐
Leaving your firm's after-tax cash flows unchanged	☐
Stabilising your firm's after-tax cash flows	☐
Don't know/not possible to isolate the effect of hedging	☐

Other, please specify:

____

____

____

2) Other things held constant, do you think that firms with more stable earnings than their rivals trade at a premium over their move volatile rivals?

	√
YES	☐
NO	☐
DON'T KNOW	☐

Other, please specify:

____

____

____

3) Do you think by hedging your company's financial price risks you are lowering your company's beta and hence the firm's cost of capital?

	√
YES	
NO	
DON'T KNOW	

Other, please specify:

SECTION IX: USING DERIVATIVES

1) Do you use derivatives instruments (i.e. forwards, futures, swaps or options)?

	√
YES	☐
NO	☐

If "yes" please go on to **question 2.**
If "no" please go on to **question 18.**

2) Please indicate your reasons for using derivatives.

	√
Generate additional returns and enhance the profitability of the treasury activity	☐
Reduce funding costs/make the best use of borrowing opportunities	☐
Financial price risk hedging	☐

Other, please specify:

___

___

___

- **If you derivatives for hedging please go on to question 3, otherwise go on to question 8.**

3) Is your treasury operation restricted to reducing financial price risks associated with underlying exposures?

	√
YES	☐
NO	☐

If "yes" please go on to **question 5.**
If "no" please go on to **question 4.**

4) Is your treasury operation permitted to trade in derivatives instruments in excess of your company's underlying trading exposure with a view to making profits?

	√
YES	
NO	

If **"yes"** please go on to **question 5.**
If **"no"** please go on to **question 6.**

5) Do you trade in derivative instruments in excess of your company's underlying trading exposures with a view to profit?

	√
YES	
NO	

6) Please indicate with a tick the importance of derivatives and on-balance sheet techniques for controlling your company's financial price risks. On a scale of 1 to 5, **where 1 = Unimportant and 5= Very Important.**

	1	2	3	4	5
Derivatives					
On-balance sheet					

7) How did your firm hedge its financial price risks prior to its use of derivative solutions?

	√
On-balance sheet hedging	
Operating solutions	
Left exposures unhedged	
Exposures not significant	

Other, please specify:

8) How long has your firm been using financial derivatives?

	YEARS
Forward	
Futures	
Options	
Swaps	

9) In the period 1989 – 1994, what was the total face value of derivatives instruments used by your firm (£m – millions of pounds sterling)? * Please provide the total notional principal.

	1989(£m)	**1990(£m)**	**1991(£m)**	**1992(£m)**	**1993(£m)**	**1994(£m)**
Forwards						
Future						
Options						
Swaps*						

10) How would you describe the contribution made by derivatives to your firm's profits?

	√
Profits are more stable	
Profits are more volatile	
Profits have increased	
Profits have decreased	
Some concern over risk/reward profile	

Other, please specify:

____

____

____

11) What impact do you think an announcement of derivatives activity by your firm would have on the market value of your company's shares?

	√
Increase	☐
Decrease	☐
No change	☐

Other, please specify:

____

____

____

12) Are there tax and/or accounting impediments to the use of derivative instruments?

	√
YES	☐
NO	☐

If "yes" please explain briefly why?

____

____

____

____

13) Does the level of understanding of derivatives by senior management/Board influence the way your company uses derivatives?

	√
YES	☐
NO	☐

If "yes" please explain briefly why?

____

____

14) Do you expect your treasury's use of derivatives instruments to increase, decrease or stay the same over the next 5 years?

	√
Increase	
Decrease	
Stay the same	
Don't know	

15) Has your firm ever issued structured debt?

	√
YES	
NO	

If "**yes**" please go on to **question 16.**
If "**no**" please go on to **question 17.**

16) Was the structured debt designed to reduce your firm's exposure to changes in financial prices?

	√
YES	
NO	

If "**yes**" please go on to **section IX.**
If "**no**" please briefly explain the purpose of issuing the structured debt.

____

____

____

17) Has your firm ever considered issuing structured debt as an alternative to straight debt and derivatives for the purpose of managing financial price risk?

	√
YES	☐
NO	☐

Please go to section IX.

18) Please indicate your reasons for not using derivatives and rank in order of importance.

	√	**Rank 1,2 etc.**
Inexperience/insufficient knowledge/lack of expertise	☐	☐
The level of exposure does not warrant taking positive action	☐	☐
Not cost effective	☐	☐
Alternative methods of managing risks, e.g., on-balance sheet hedging	☐	☐
Concerned about the risks of using complex derivatives instruments	☐	☐
Potentially large losses arising from leverage if not employed properly	☐	☐
Tax and/or accounting obstacles to using derivatives	☐	☐

Others, please specify:

___

___

___

19) Do you intend/expect to use derivatives instruments for hedging purposes in the future?

	√
YES	☐
NO	☐
DON'T KNOW	☐

PLEASE GO TO END, PAGE 24.

SECTION IX: TYPES OF DERIVATIVE CONTRACTS

1) Please indicate with a tick if you currently use or have used the derivatives contracts listed below.

i) **Exchange rate derivatives**

	√		√
Forward foreign exchange contracts	☐	Compound Options	☐
Break forward contracts	☐	Look-Back Options	☐
Participating forward contracts	☐	Basket Options	☐
Currency swaps	☐	Double Basket Options	☐
Currency options	☐	Instalment Options	☐
Swaptions	☐	Quantos	☐
Average rate options	☐	Cylinder	☐
Barrier options	☐	Currency futures	☐
Contingent premium options	☐	Others, please specify	☐

____

____

ii) **Interest rate derivatives**

	√		√
Forward rate agreements	☐	Participating cap	☐
Interest rate swaps	☐	Swaptions	☐
Interest rate caps	☐	Barrier Options	☐
Interest rate floors	☐	Interest rate futures	☐
Interest rate collars	☐	Others, please specify	☐

____

____

iii) **Commodity derivatives**

	√		√
Forward commodity contracts	☐	Compound futures	☐
Commodity swaps	☐	Others, please specify	☐
Commodity options	☐		

____

____

____

iv) **Equity derivatives**

	√
Equity options	
Equity swaps	
Others, please specify	

2) Are there any derivative structures that you are not permitted to use?

	√
YES	
NO	

If "yes" please specify:

- **If you use option based derivatives please go on to question 3.**
- **If you do not use option based derivatives please go on to question 7.**

3) Please indicate the types of situations where options are used from the list below.

	√		√
Firm has a market view but it's not 100% sure		Hedging contingent transaction exposure	
Adverse market conditions		Competitors' hedging strategy not known	
Market conditions are volatile		Target return has to be met	
Expect more volatility than the market		Uncertain about size of exposure	

Other, please specify:

4) Do you write options?

	√
YES	
NO	

5) Do you trade options for profits?

	√
YES	☐
NO	☐

6) If your reason for using an option hedge is based at least partly on your view of likely markets rates do you review your hedging strategy periodically as market conditions and expectations change?

	√
YES	☐
NO	☐

If "yes" please describe briefly how this is done.

____

____

____

PLEASE GO TO END.

7) Please give your reason(s) for not using options by choosing from the list below

	√		√
High premium cost	☐	Prohibited by senior management	☐
Accounting and tax treatment	☐	Feel-it is speculative in nature if cash flows are known	☐
Unwillingness to pay up front premium	☐		

Other, please specify:

____

____

END

Thank you very much for your co-operation and assistance. Can I assure you once again that the information you have given will be treated as absolutely confidential and will only be used as part of a pooled analysis.

Amrit Judge
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Appendix A4.2 Glossary sent with questionnaire

Glossary

Active hedging - a company's exposures are selectively hedged depending on the risk manager's view of potential market movements. The selective decision may be based on choosing which currencies or interest rates to cover, because they are perceived to represent significant risks, or selecting what proportion of any particular exposure should be covered.

Beta - a statistical measure of the sensitivity of the movement of a stock's price to the movement of the market as a whole. A stock with a beta value of unity (i.e. 1) would normally be expected to move in line with movements of the FT-SE 100 Index.

Commodity exposure - this exposure arises when a production process depends heavily on raw materials, such as metals and petroleum products.

Cost centre - a cost centre corporate treasury's primary aim is to eliminate risk. Typically, this results in hedging the exposures arising from the company's commercial activities as soon as they are identified. A cost centre seeks to maximise the certainty of underlying business flows. A cost centre treasury is neither permitted to open trading positions nor required to contribute towards the cost of its operations.

Covenants - covenants are clauses contained in the trust deeds of bond issues that place disciplinary controls on issuing companies and oblige issuers to maintain certain criteria which may cover assets, financial ratios, status and future financing.

Derivative instrument - a security or contract whose value is dependent or derived from the value of some other underlying asset. The main classes of derivative instruments are: forwards, futures, options and swaps.

Economic exposure - this is the risk that changes in foreign exchange rates will affect the firm's expected net cash flows because the exchange rate change will change the amount that the firm is expected to buy or sell. This view of financial price risk recognises changes in foreign exchange rates on the firm's sales and market share and then on the firm's net cash flows.

Embedded option - an option implicit in another instrument. For example, bonds with embedded call options which allow the issuer to redeem the bond early. Conversely, bonds with put options allow investors to put (sell) the bond back to the issuer at a predetermined price.

Equity exposure - 3 equity exposures can be identified

- Significant restricted equity holdings. A company may consider an equity holding to be "restricted" for one of three reasons; (i) legal conditions prohibiting its sale for a specific period of time, (ii) a strategic holding on a technically saleable stock, or (iii) the company holds such a large percentage of the stock that it cannot exit the stock without rapidly depressing the price.

- Exposures relating to the client's own stock. A company may have exposure to the value of its own stock, for example, via Employee Stock Ownership Plans (ESOPs) or Employee Stock Options. Firms with ESOPs usually guarantee a minimum performance for their stock to their employees. This creates a problem if the stock were to fall because the firm would be faced with the costs of meeting its guarantee.

- Business sensitivity to particular stocks on the equity markets as a whole. The company's earnings or asset value may have a positive or negative correlation with equities. For example, the value of a tyre-manufacture may depend upon the performance of motor manufacturers.

Exchange rate exposure - transaction exposure, translation exposure, economic exposure.

Exposure - exposure is the amount of the asset or liability that is subject to a fluctuation in financial prices.

Exposure management - the process of minimising the risk of changes in financial prices using various techniques which are both internal and external to the company.

Financial price risk - unpredictable movements in exchange rates, interest rates, commodity prices, and equity prices.

Hedging - the process of reducing exposure to financial price risk (for example, currency and interest rate risk) by using techniques such as netting, matching or forward contracts, etc. See **Risk management.**

Interest rate exposure - interest rate exposure is the amount of financing or investments which is subject to the risk that an adverse movement in interest rates will lead to a higher debt servicing requirement or to a lower return on investments. This risk arises because interest rates are not completely fixed over the relevant period. Hedging can neutralise the effect of adverse interest rate movements on financing costs or investment returns. The rate fixed by the hedge is not necessarily the current market rate, but is the view of the future rate which can be inferred from the yield curve for a given term structure of interest rates.

Non-investor stakeholders - a firm's non-investor stakeholders includes its customers, suppliers, distributors, managers and employees.

Passive hedging - a company **always** hedges its exposures and focuses on developing strategies to allow it to take advantage of potential market movements. In passive hedging, strategies can be either **dynamic** or **static.**

- **A static approach** is one where exposures are hedged at the start of the fiscal year or when the exposure is incurred and the hedge is left in place for the duration. This strategy would be preferred where the policy objective is to lock in known rates or fix prices and there is little incentive to take advantage of upside potential.
- **A dynamic approach** is one where exposures are hedged at all times but with a mix of instruments to provide an acceptable risk profile. The dynamic strategy provides protection of exposures, with the flexibility to take advantage of favourable market movements.

Profit centre - a profit centre corporate treasury is allowed to manage the company's financial risks to take advantage of opportunities to use financial instruments to earn additional profits for the company. Treasury is allowed to trade, taking speculative positions which need not directly relate to the underlying commercial exposures of the company. The risk profile will therefore be significantly higher with the expectation of higher reward.

Quasi-profit centre - a quasi-profit centre corporate treasury will aim to make a contribution to profits by actively managing the company's underlying exposures. A treasury which operates as a quasi-profit centre in its foreign exchange activity might be authorised not to fully hedge the anticipated currency flows and hold open positions to generate a profit contribution from management of these positions.

Risk - risk means the possibility of a loss arising as a result of fluctuation in financial prices.

Risk management - the process of reducing the impact of financial price risk.

Speculation - a series of deals made independently of any underlying commercial transaction, usually instigated in order to generate additional profits. Speculative decisions need not involve an actual transaction, in that not hedging known exposures is tantamount to speculation.

Structured debt - structured debt, also referred to as "hybrid debt", effectively combines straight debt with one or more embedded derivatives contracts that often correspond to a corporate exposure to interest rate, currency, or commodity price risks. For example, some oil, copper, and gold producers have issued bonds with interest or principal tied to the prices of their principal products, combining straight debt with a commodity forward or option contract. Building such a derivatives position into the bonds can make a company's cash flow more stable than if it had issued conventional debt.

Trading - the volume of positions is disproportionate to the volume of underlying transactions.

Transaction exposure - the risk that the domestic value of contracted foreign currency-denominated transaction will vary as a direct result of changes in exchange rates over a period of time.

Translation exposure - foreign exchange translation exposure is the risk that reported earnings are reduced because of the translation of the profit and loss accounts of overseas companies from foreign currency into sterling and the risk that the net worth of a UK company is reduced because of the translation of the foreign currency net worth of overseas subsidiaries into sterling.

Appendix A4.3

Table A4.1 Comparing Survey Respondents with Non-Respondents

Variable	Survey Respondents		Non-Respondents		Mean	t-test for Equality of Means	
	N	Mean	N	Mean	Difference	t-statistic	Sig. (2-tailed)
Gross Book Value Gearing	171	31.43	227	32.39	-0.96	-0.201	0.841
Interest Cover	171	16.35	230	17.26	-0.91	-0.342	0.733
Credit Rating	171	69.90	229	70.15	-0.25	-0.130	0.896
Capital Expenditure	125	0.10	180	0.07	0.02	1.131	0.260
Market-to-Book Ratio	156	3.84	209	4.39	-0.54	-0.461	0.645
Price-Earnings Ratio	154	29.79	204	25.40	4.38	0.676	0.500
R&D Expenditure	75	3.61	106	3.42	0.19	0.078	0.938
Foreign Sales by Destination	168	35.00	235	36.08	-1.08	-0.335	0.738
Foreign Sales by Origin	160	29.18	227	28.83	0.35	0.118	0.906
Foreign Operations	174	0.74	238	0.79	-0.04	-1.040	0.299
Cash ratio	171	0.51	229	0.46	0.05	0.686	0.493
Dividend Yield	157	3.63	209	3.54	0.09	0.503	0.616
Natural logarithm of Total Assets	171	5.78	229	5.57	0.21	1.346	0.179

Chapter 5. Methodology, Model and Estimation

5.1 Introduction

This chapter identifies the appropriate models for conducting multivariate tests. The discussion in chapter 4 described the two ways in which this study measures hedging. Firstly, it was shown the study measures hedging using a binary variable. Firms that indicate in their annual report they hedge are assigned a value of one for the binary variable, and all other firms are assigned a zero. Similarly, for the survey sample firms who say they hedge in their survey response are assigned a value of one and those who say they do not hedge are assigned a value of zero. This measure constitutes the binary dependent variable. Secondly, the study has derived a continuous measure of hedging. This is constructed by using data on the notional amount of derivatives employed by firms scaled by total assets of the firm. Firms defined as non-hedgers by definition have zero holdings of derivatives and therefore a value of zero for this measure. This measure constitutes the continuous dependent hedging variable.

This chapter discusses the econometric methodology to be employed in this study.

5.2 Model for the Binary Dependent Variable

In this study the first dependent variable is binary, 1 for hedging and 0 for non-hedging.[1] The independent variables are both dummy and quantitative in nature. In this case we have,

[1] Since the dummy variable takes on two values, it is called a dichotomous variable.

$$y = \begin{cases} 1 & \text{if a firm hedges} \\ 0 & \text{otherwise} \end{cases}$$

There are several methods to analyse regression models where the dependent variable is a zero or 1 variable. The method of ordinary least squares could be used in which case the model is called the **linear probability model (LPM).** Another method related to the linear probability model is the **linear discriminant function.** The third alternative is to say that there is an underlying or latent variable y^* which is not observed. What we observe is

$$y = \begin{cases} 1 & \text{if } y^* > 0 \\ 0 & \text{otherwise} \end{cases}$$

This is the idea behind the **logit** and **probit** models.

5.3 Objective of the Binary Choice Model

Binary choice models assume that firms are faced with a choice between two alternatives, to hedge or not to hedge, and that their choice depends on their characteristics. The objective is to predict the likelihood that a firm with certain characteristics will hedge and so ascertain what characteristics determine the likelihood of hedging. Therefore, one purpose of the model is to determine the probability that a firm with a given set of attributes will hedge. More generally, the objective is to find a relationship between a set of attributes describing a firm and the probability that the firm will make a given choice.

5.4 Methods of Model Estimation[2]

The first dependent variable is a dichotomous variable defined by:

$y_i = 1$ if the ith firm belongs to the hedging group, and

$y_i = 0$ if the ith firm belongs to the non hedging group.

When ordinary least squares regression (OLS) is applied to the data of the type described above the resulting model (see equation 5.1) is known as the linear probability model (LPM) since $E(y_i)$ can be interpreted as the conditional probability that the event y (i.e., a firm will hedge) will occur, conditional on the given values of explanatory variables.

$$y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_k X_{ki} + u_i \qquad (5.1)$$

We can express equation 5.1 in two equivalent forms:

$$E(y = 1 \mid X_1, X_2, \ldots, X_k) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_k X_{ki} \qquad (5.2)$$

and since,

$$\begin{aligned} E(y \mid X_1, X_2, \ldots, X_k) &= 1.P(y = 1 \mid X_1, X_2, \ldots, X_k) + 0.P(y = 0 \mid X_1, X_2, \ldots, X_k) \\ &= P(y = 1 \mid X_1, X_2, \ldots, X_k) \end{aligned}$$

we have

$$P(y = 1 \mid X_1, X_2, \ldots, X_k) = P_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_k X_{ki} \qquad (5.3)$$

where P stands for probability. Then,

$$\hat{P} = \hat{b}_0 + \hat{b}_1 X_1 + \hat{b}_2 X_2 + \ldots + \hat{b}_k X_k \qquad (5.4)$$

will give an estimate of the probability that a firm with the given values of explanatory variables will hedge.

[2] This section relies heavily on Maddala (1992) and Maddala (1983).

When a model of this type is estimated by OLS it suffers from the following problems:

1. The error term in the model does not follow the normal distribution; rather it follows the binomial (probability) distribution. Although we do not need the assumption of normality if the objective is the estimation of parameters only, we need it for the purpose of hypothesis testing. In reality, however, the fact that the error term in the model follows the binomial distribution is not a great handicap if the sample size is large. This is because as the sample size increases, the binomial distribution converges to the normal distribution.

2. Another problem with the OLS estimation of the model is that the error term is heteroscedastic. But this too is not a serious problem in practice because we can use appropriate transformations to make the error term homoscedastic.

3. The real problem with the model (equation 5.1) is that since it gives the probability that the event Y will occur (e.g., a firm hedging), the probability of necessity must lie between the limits of 0 and 1. Although this is true a priori, when we obtain it by the regression (equation 5.4), there is no guarantee that the estimated P_i will in fact lie between these limits. An estimated value P_i less than 0 or greater than 1 has no practical meaning.

4. Another problem with the model (equation 5.1), or its equivalent equation 5.2, is that it assumes that the rate of change of probability per unit change in the value of the explanatory variable is constant, given by the value of the slope. Thus, β_2 tells us that if X_2 increases by one unit, the probability of hedging increases by the constant

amount β_2 regardless of the value of X_2 from which we measure the unit change, which in practice, can be an unrealistic assumption. Rather, it is to be expected that the probability of a firm hedging would increase at a diminishing rate, if one considers the law of "diminishing returns."[3]

It is because of these reasons, especially reason 3, that models like equation 5.1 are generally not estimated by OLS. Discriminant analysis could be used for addressing this problem.[4] However, because the independent variables are a mixture of categorical and continuous variables, the multivariate normality assumption will not hold.[5]

What is needed is a (probability) model that has the following features:

1. As X_i increases, $P_i = E(Y=1|X)$ increases but never steps outside the 0-1 interval, and

---

[3] Estimation of the linear probability model will lead to the false inference that the slope is constant when in fact the change in probability associated with change in X is dependent on the value of X selected. (See Pyndick (1998), pg. 306)

[4] Maddala (1983), "If the independent variables are normally distributed, the discriminant-analysis estimator is the true maximum-likelihood estimator (MLE) and therefore is asymptotically more efficient than the logit MLE. However, if the independent variables are not normal, the discriminant-analysis estimator is not even consistent, whereas the logit MLE is consistent and therefore more robust. Press and Wilson (1978) calculated the probability of correct classification for the two estimators in two empirical examples in which the independent variables were dummy variables, and thus the assumption of normality was violated. In both examples, the logit MLE did slightly better than the discriminant-analysis estimator." (pg. 27) In this study the exogenous variables are a mixture of categorical and continuous variables and thus, the multivariate normality assumption will not hold. Maddala (1983), "To apply any test of significance, we need to make the assumption of normality. The usual assumption made is that the explanatory variables in the two groups come from normal populations with means μ_1 and μ_2, respectively, and the same covariance matrix Σ." pg. 18.

[5] In these cases one could use logistic regression as it does not make any assumptions about the distribution of the independent variables. If the explanatory variables are normally distributed, then one should use discriminant analysis because it is more efficient than logit analysis in this case. However, if the explanatory variables are not normally distributed, then discriminant analysis gives inconsistent estimates, and one is better off using logit analysis.

2. the relationship between P_i and X_i is non-linear, that is, one which approaches zero at slower and slower rates as X_i gets small and approaches one at slower and slower rates as X_i gets very large.

This model would look like the cumulative distribution function (CDF) of a random variable.[6] In this model the probability lies between 0 and 1 and the probability varies non-linearly with X. It follows then that we can use the CDF to model regressions where the response variable is dichotomous, taking 0-1 values. The practical question now is which CDF? For although all CDFs are S-shaped, for each random variable there is a unique CDF. The CDFs commonly chosen to represent the 0-1 response models are,

1. the logistic, which gives the logit model, and
2. the normal, which gives the probit (or normit) model.

Assume we have a regression model

$$y_i^* = \beta' x_i + u_i \tag{5.5}$$

where $\beta = (\beta_1, \beta_2, \ldots, \beta_k)'$ is the $k \times 1$ vector of unknown coefficients, x_i is the $k \times 1$ vector of explanatory variables, u_i are independent and identically distributed random variables with mean 0. The regression relationship is defined in terms of y^*_i which is not observed (likelihood/probability of hedging). This is usually called a "latent" variable. What we observe is a dummy variable y_i defined by

$$y_i = \begin{cases} 1 & \text{if } y^* > 0 \\ 0 & \text{otherwise} \end{cases} \tag{5.6}$$

[6] The CDF of a random variable X is simply the probability that it takes a value less than or equal to x_0, where x_0 is some specified numerical value of X. In short, F(X), the CDF of X, is : $F(X = x_0) = P(X \leq x_0)$.

The probit and logit models differ in the specification of the distribution of the error term u in equation 5.5.[7] The difference between the specification equation 5.5 and the linear probability model is that in the linear probability model we analyse the dichotomous variables as they are, whereas in equation 5.5 we assume the existence of an underlying latent variable for which we observe a dichotomous realisation. For instance, in this study the observed dummy variable is whether or not a firm hedges, and thus y^*_i is defined as "propensity/desire or ability to hedge." In this case there is both "desire" and "ability" involved. Thus the explanatory variables in equation 5.5 should contain variables that explain both of these elements. Note from equation 5.6 that multiplying y^*_i by any positive constant does not change y_i. Hence if we observe y_i we can estimate the β's in equation 5.5 only up to a positive multiple. Hence it is customary to assume $\mathrm{var}(u_i) = 1$. This fixes the scale of y^*_i. From the relationships in equation 5.5 and equation 5.6 we get

$$\begin{aligned} P_i &= \mathrm{Prob}(y_i = 1) = \mathrm{Prob}(u_i > -\beta' x_i) \\ &= 1 - F(-\beta' x_i) \end{aligned} \tag{5.7}$$

where y_i, $i = 1, 2, \ldots, n$ are independently distributed binary random variables taking the value of 1 or 0 and F is the CDF of u.

(Note: $y_i = 1$ when $y^*_i > 0$, we know from equation 1 that $y^*_i > 0$ if $u_i > -\beta' x_i$).

If the distribution of u is symmetric, since $1 - F(-Z) = F(Z)$, we can write

$$P_i = F(\beta' x_i) = \Lambda_i = \Lambda(\beta' x_i) \tag{5.8}$$

Since the observed y_i are just realisations of a binomial process with probabilities given by equation 5.8 and varying from trial to trial (depending on x_i), we can write the likelihood function as

[7] If u_i has the normal distribution, we have the probit model. If u_i has the hyperbolic $\sec^2$ distribution, then we have the logit model.

$$L = \prod_{y_i = 1} P_i \prod_{y_i = 0} (1 - P_i)$$

or

$$L = \prod_{y_i = 1} 1 - F(-\beta ' x_i) \prod_{y_i = 0} F(-\beta ' x_i) \tag{5.9}$$

or

$$L = \prod_{y_i = 1} F(\beta ' x_i) \prod_{y_i = 0} 1 - F(\beta ' x_i)$$

The functional form for F in equation 5.8 will depend on the assumption made about the error term u_i in equation 5.5. If the CDF of u_i is logistic we have what is known as the logit model. In this case

$$P_i = F(Z_i) = F(\beta' x_i) = \Lambda(\beta' x_i) = \frac{\exp(\beta' x_i)}{1 + \exp(\beta' x_i)} = \frac{e^{(\beta' x_i)}}{1 + e^{(\beta' x_i)}} = \frac{1}{1 + e^{-(\beta' x_i)}} \tag{5.10}$$

Equation 5.10 represents what is know as the (cumulative) logistic distribution function. Hence

$$\log \frac{F(Z_i)}{1 - F(Z_i)} = Z_i = \beta' x_i = \text{log of the odds of hedging}$$

Note that for the logit model

$$\log \frac{P_i}{1 - P_i} = Z_i = \beta ' x_i \tag{5.11}$$

where

$$odds(Hedging \mid x_1, x_2, \ldots, x_k) = \frac{p}{1 - p} = \text{odds of hedging}$$

The left-hand side of equation 5.11 is the log of the odds ratio (or log-odds ratio). Equation 5.11 models the log of the odds of hedging as a linear function of the independent (explanatory) variables, and is equivalent to a multiple regression equation with **the log of the odds as the dependent variable.**[8] The independent variables can be a combination of continuous and categorical variables. The natural log of the odds is also referred to as logit, therefore equation 5.11 is commonly referred to as (multiple) logistic regression. Note that the higher the value of the logit (i.e., ln(p/1-p)) the higher the odds in favour of a firm being a hedger and therefore the higher the probability of a firm being a hedger.

Features of the logit model:

1. As P goes from 0 to 1 (i.e., as Z varies from $-\infty$ to $+\infty$), the logit (log of the odds ratio) goes from $-\infty$ to $+\infty$. That is, although the probabilities lie between 0 and 1, the logits are not so bounded.

2. Although the logit (log of the odds ratio) is linear in X, the probabilities are not. For the logit model the effects of changes in any of the explanatory variables on the probabilities of any observations belonging to either of the two groups are given by:

$$\frac{\partial P_i}{\partial x_{ij}} = \beta_j P_i(1-P_i) = \beta_j F(Z_i)(1-F(Z_i)) = \beta_j \Lambda_i(1-\Lambda_i) \qquad (5.12)$$

for $j = 1, 2, \ldots, k$ and $i = 1, 2, \ldots, n$

where $\Lambda_i = \Lambda(\beta' x_i) = P_i$

In the case of the linear probability model these derivatives are constant. In the case of the logit and probit models, we need to calculate them at different levels of the explanatory variables to get an idea of the range of variation of the resulting changes in probabilities. The marginal effects of the independent variables (regressors) on the probabilities are usually calculated at the means of the independent variables.

[8] For the linear probability model (LPM) it is P_i that is assumed to be a linear function of the explanatory variables. Note: [Gujarati (1988) (p.423)] In order to apply OLS to eq. 5.10, we must know the value of the dependent variable ln(p/1-p), which obviously is not known.

The factor needed to compute the marginal effects for different coefficients evaluated at sample means is

$$\Lambda\left(\hat{\beta}' \bar{x}_i\right)\left(1 - \Lambda\left(\hat{\beta}' \bar{x}_i\right)\right) \qquad 5.13$$

The probability approaches zero at a slower and slower rate as the value of an explanatory variable gets smaller and smaller and the probability approaches 1 at a slower and slower rate as the value of the explanatory variable gets larger and larger.[9]

If one is interested in the prediction of the effect on the log of the odds ratio, then for the logit model, this effect is constant since

$$\frac{\partial}{\partial x_{ij}}\left(\log \frac{P_i}{1 - P_i}\right) = \beta_j \qquad (5.14)$$

3. The interpretation of the logit model is as follows: β_1, the slope measures the change in the log of the odds ratio (logit) for a unit change in X, that is, it tells us how the log-odds in favour of a firm hedging change as X changes by a unit. The intercept β_0 is the value of the log-odds in favour of a firm hedging if the explanatory variables zero. Like most interpretations of intercepts, this interpretation may not have any physical meaning.

[9] The slope of the cumulative logistic distribution is greatest at p=½. This implies that changes in the independent variables will have their greatest effect on the probability of choosing a given option at the midpoint of the distribution. The low slopes near the endpoints imply that large changes in X are necessary to bring about a small change in probability. See Pyndick and Rubinfeld (1998) pg. 309.

4. Given certain values for the explanatory variables, if we actually want to estimate not the odds in favour of a firm hedging but the probability of a firm hedging, this can be done directly from equation 5.10 once the estimates of β' are known.

If the errors u_i in equation 5.5 follow a normal distribution, we have the probit (or normit) model. In this case

$$F(Z_i) = \int_{-\infty}^{Z_i/\sigma} \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{t^2}{2}\right) dt \tag{5.15}$$

Maximisation of the likelihood function equation 5.9 for either the probit or the logit is accomplished by nonlinear estimation methods. The likelihood function, equation 5.9, is concave (does not have multiple maxima), and hence any starting values of the parameters would do. We could start the iterations for the logit and probit models with the estimates from the LPM.

Since the cumulative normal and the logistic distributions are very close to each other except at the tails, we are not likely to get very different results using the logit or probit method, unless the samples are large (so that we have enough observations at the tails).[10] Therefore, the choice between the two models is not an important one. In view of this, this study uses a logit specification to investigate the factors that affect the decision to hedge.

[10] Aldrich and Nelson (1984) say, "The similarities in the shapes of the logistic and normal distributions suggest that results of probit and logit analysis will differ by very little. Indeed, the inferences drawn from the two methods applied to the same data are invariably similar, and even parameter estimates from the two models will agree, approximately, up to a factor of proportionately. (Logit coefficients tend to exceed probit coefficients by a scale factor in the range 1.6 to 1.8.) A choice between the two models, therefore, is not an important one may often be ruled by convenience factors, such as availability of appropriate computer programs." Pg. 41. Pindyck and Rubinfeld (1998) "...the logistic and probit formulations are quite similar; the only difference is that the logistic has slightly fatter tails. Because it is similar to the cumulative normal function but easier to use computationally, the logit model is often used as a substitute for the probit." Pg. 308.

5.5 Dependent Variable with More than Two Categories

When the dependent variable can take more than two categorical values multinomial modelling techniques should be used. Given that a firm is classified into one of J+1 outcomes, the general form of the multinomial logit model can be written as:

$$\Pr ob(y_i = j) = \frac{e^{\beta'_j x_i}}{1 + \sum_{k=1}^{j} e^{\beta'_k x_i}} \qquad (5.16)$$

for j = 1,2,...,J

The β are the parameters of the model and x_i is a vector of characteristics for firm *i*. This technique uses the logistic distribution to estimate the probability that firm *i* with specific characteristics x_i, prefers choice *j*. As with logit models, multinomial logit techniques use maximum likelihood estimation techniques.

5.6 Model for the Continuous Dependent Variable

Chapter 4 described the construction process for the extent of hedging measure and presented a summary of the characteristics of this variable. An examination of the summary statistics for this continuous measure of hedging reveals two features of its distribution. First, there is a mass of firms whose extent of hedging exactly equals zero. Second, there are no firms with negative hedging (or derivatives use). These characteristics of the dependent variable suggest that the extent of hedging is a censored variable (i.e., censored at zero).[11] This means that the extent of hedging can, in principle, take on negative values. However, they are not observed

[11] The word censored refers to a situation where we know both the number of observations for which the dependent variable takes zero value and the value of the independent variables for those observations.

because of censoring. Thus the zero values are due to non-observability. There are at least two reasons why the extent of hedging with derivatives could be censored. First, if there are costs associated with initiating a derivatives hedging program that prohibit some firms from hedging with derivatives, the dependent variable will be censored.[12] Second, if treasurers use derivatives to increase the exposure of a firm's cash flow to financial price (that is, speculate), the extent of hedging with derivatives will be censored, that is, negative hedging cannot be observed. This type of data is typically analysed using tobit regression methodology.[13] Therefore, a tobit specification is used to analyse the factors that affect the extent of hedging. The Tobit model takes the form

$$\begin{aligned} y_i^* &= \beta x_i + u_i \qquad \text{where } u_i \sim \mathrm{IN}(0, \sigma^2) \\ y_i &= y_i^* \text{ if } y_i^* > 0 \\ y_i &= 0 \text{ if } y_i^* \leq 0 \end{aligned} \tag{5.17}$$

where x_i is the vector of independent variables.

In the tobit model, y^* can be less than zero, but these observations with $y^* < 0$ are not observed because of censoring. The limit (zero) observations arise because of non-observability. The dependent variable, y_i^*, is unobservable if its true value is negative. Although the dependent variable never takes a value below zero, "negative hedging" can occur if as noted above firms use derivatives to speculate. If this occurs, the parameter estimates may be biased towards zero, in which case the Tobit specification may lack power to reject the null hypothesis of no relation between the dependent and explanatory variables.

[12] Below certain threshold levels, firms choose not to use derivatives to reduce their financial price exposure and a zero extent of derivative use is observed.

5.7 Limitations of the Tobit Model

One limitation of the tobit model as applied here in determining the extent of hedging, is that it implies that the decision of whether to hedge and how much to hedge are both determined by the same latent variable y* (i.e., it sees the two decisions as linked). In effect the tobit model does not accommodate the possibility that the relation between a characteristic and the probability a firm decides to hedge is different from its relation to the extent a firm decides to hedge, if it is hedging. As observed by Gunther and Siems (1995), both the decision to use derivatives to hedge and the extent of that activity are important behaviour for research. The influence of a specific variable on the decision by a firm to use derivatives for hedging could differ from the influence of the same variable on the level of use by those firms that have decided to use derivatives for hedging. For example, information economies and economies of scale arguments suggest that larger firms would be more likely to participate in hedging activity using derivatives, yet other arguments suggest that hedging is inversely related to size. If these hypotheses hold, then once a firm reaches a sufficient size to possess the necessary skills to engage in hedging with derivatives, the relation between size and the extent of hedging would cease to be positive. This differential response between the decision equation and the extent of participation equation would be impossible to model in a standard tobit analysis since there is only one equation with a unique coefficient on each variable.[14] Constraining the coefficients to be fixed across these two models precludes any assessment of the difference between the decision to participate and the extent of participation. The implication of this is that the hedging decision might involve two

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[13] Berkman and Bradbury (1996), Gay and Nam (1998) and Howton and Perfect (1998) also employ tobit methodolgy in their studies of the determinants of the extent of derivatives use.
[14] For example, the probability that a firm hedges and the amount of hedging when it does hedge might both depend on the size of the firm, but in opposite directions. The tobit model precludes this.

steps. First, the firm decides whether or not to hedge, and then, how much to hedge (if it hedges).

To overcome this limitation, this study uses a variant of the tobit model proposed by Cragg (1971). The Cragg model applies when the probability of a non-limit outcome (i.e., the decision to hedge) is determined separately from the level of the non-limit outcome (i.e., the extent of hedging). Cragg's model treats the two decisions as sequential. The more general model that addresses this limitation of the tobit model can be written as

1. Decision equation:

$$\text{Prob}\,[y^*_i > 0] = \Phi(\gamma' x_i), \qquad z_i = 1 \quad \text{if } y^*_i > 0, \tag{5.18}$$

$$\text{Prob}\,[y^*_i \leq 0] = 1 - \Phi(\gamma' x_i), \qquad z_i = 0 \quad \text{if } y^*_i \leq 0. \tag{5.19}$$

2. Regression equation for non-limit observations:

$$E[y_i|z_i = 1] = \beta' x_i + \sigma\lambda_i \tag{5.20}$$

The first stage examines whether or not a firm hedges using a probit model and the second stage examines the extent of hedging, given that a firm hedges using a truncated regression. In the Cragg procedure, zero derivative holdings indicate a decision not to hedge, rather than the extent of hedging, and so the truncated regression only uses observations with non-zero derivatives holdings.[15] The model is estimated in two parts by using a probit model for the indicator of whether y_i^* is greater than zero or less than or equal to zero and a truncated regression model for the non-limit observations. This means that the probit model determining whether to

[15] This means all of the zero observations are effectively lost.

hedge and the model determining how much to hedge have different parameters with the same regressors, although different regressors are permitted.

5.8 Conclusions

This chapter examined the range of modelling techniques employed in this study. The discussion argued that the modelling technique that should be employed was determined by the nature of the dependent variable. Given that the first dependent variable was restricted to two values, it was argued that logit or probit modelling should be implemented. In the event that the dependent variable took on more than two categorical values it was shown that multinomial modelling techniques would be appropriate.

The features of the continuous dependent variable strongly suggested that it was a censored variable which required the use of tobit regression analysis. However, it was argued that the tobit model did not accommodate the possibility that the relation between a characteristic and the probability a firm decides to hedge is different from its relation to the extent a firm decides to hedge, if it is hedging. In an effort to obviate this limitation, it was suggested the study use a variant of the tobit model proposed by Cragg (1971).

The following chapters employ the techniques described in this chapter to examine the determinants of the decision to hedge and the extent to which firms hedge.

Chapter 6. An Empirical Analysis of Hedging Practices of UK Firms

6.1 Introduction

This chapter examines which theories of hedging are most important in determining cross-company differences in UK hedging activity. The theoretical arguments for why companies hedge have been examined. It has been shown that under perfect market assumptions, hedging does not add to shareholder wealth. Modern theories of hedging question the validity of the perfect market assumptions, and show how their relaxation leads to different conclusions about the value of hedging. These theories argue that:

i) Hedging reduces the expected corporate tax liability for a firm with a convex corporate tax schedule.

ii) Hedging lowers the probability of the firm encountering financial distress which in turn lowers the expected costs of financial distress.

iii) Hedging reduces the risk imposed on the firm's managers, employees, suppliers, and customers.

iv) Hedging can control the conflict of interest between bondholders and shareholders, thus reducing the agency costs of debt.

v) Hedging enhances the ability of a firm to finance future potential investment opportunities.

These theories identify relationships between the benefits of hedging and various firm level characteristics that provide empirically testable implications. The empirical analysis in this chapter investigates the determinants of hedging using a sample of hedging firms that hedged any type of financial price exposure.[1] This approach is consistent with previous studies that have focused on firms hedging any type of financial price exposure.[2]

This chapter makes a contribution to the empirical literature on corporate hedging by testing the predictive power of the various hedging theories using a new data set. This thesis constructs a detailed database of UK hedging activity. This is achieved by collecting qualitative and quantitative data from annual reports and a questionnaire sent to corporate treasurers.

The empirical analysis in this chapter can be contrasted to that of previous empirical studies in that it employs both survey data and annual report disclosures for a subset of firms for the same period. This enables the tests in this chapter to assess the robustness of the empirical results using two independently derived sources of data. Furthermore, since the annual report sample is twice the size of the survey sample additional robustness checks are conducted by employing samples of different size. The availability of the two data sources also facilitates the identification of firms providing consistent and inconsistent information across both datasets. In particular, we are able to identify two groups of firms, those whose responses to the question "Does the firm hedge?" correspond (referred to as correctly classified firms) and those that do not (referred to as incorrectly classified firms).[3] The former group consists of both correctly classified non-hedgers and hedgers. It is believed the empirical tests in this chapter are the first to identify the existence of incorrectly classified firms and

[1] The ways in which hedging theoretically increases firm value are not limited to a particular type of exposure hedged or type of hedging method, but relate to hedging activities the primary focus of which is to reduce income or cashflow volatility. The theories of hedging do not specify the source of the volatility, nor which type of derivative should be used to hedge. Consequently, it is not necessary empirically to arbitrarily restrict hedging activities to a particular category of exposure hedged or derivative instruments.
[2] For example, Francis and Stephan (1993), Nance et al. (1993), Dolde (1995), Berkman and Bradbury (1996), Wysocki (1996), Mian (1996), Fok et al. (1997), Gay and Nam (1998) and Howton and Perfect (1998).

test the effect of this. Subsequent tests make the assumption that incorrectly classified firms are hedging firms but hedge less extensively than correctly classified hedgers. Given this assumed variation in hedging policies among firms, multinomial logit tests show that this variation is associated with several differences in the firms' characteristics.

Another major contribution of the empirical tests in this chapter is that the data set employed in these tests has been constructed for the UK for which there are no existing studies to our knowledge.

This chapter begins by identifying the hypotheses to be tested in this chapter. This is followed by a description of dependent variable and descriptive statistics of the independent variables employed in the empirical tests. Section 6.5 describes the multivariate logit model employed to examine the effects of the independent variables on the probability of hedging by the firm. Thereafter, section 6.6 describes the variable selection and the model building strategy employed in this study. Section 6.7 describes the results of the variable selection strategy. Sections 6.8 and 6.9 present the multivariate results of estimating various specifications of the model. Section 6.10 refits the multivariate logit model using the hedging classifications for the subset of firms for which both survey and annual report data are available. This section also employs a multinomial logit model with categorical variables as indicators for the amount of risk management undertaken to examine the determinants of hedging choice. Section 6.11 uses tobit regression methodology and a continuous dependent variable to examine the determinants of the extent of hedging and section 6.12 presents conclusions.

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[3] See section 4.3.25 page 206 for discussion on comparisons between annual report and survey data.

6.2 Testable Hypotheses

This study is interested in testing what determines a firm's hedging decision. A number of potential hypotheses were identified in chapter 2 of the thesis and summarised in the introduction to this chapter. The hypotheses that this study investigates are as follows:

Hypothesis 1:

The more convex the effective tax schedule the greater the incentive to hedge.

Hypothesis 2:

Firms with higher expected costs of financial distress have a greater incentive to hedge.

Hypothesis 3:

Firms with higher underinvestment costs have a greater incentive to hedge.

Hypothesis 4:

Firms with greater cash flow volatility have a greater incentive to hedge.

Hypothesis 5:

Firms with substitutes for financial risk management activity have less incentive to hedge.

Hypothesis 6:

Firms with information and transaction cost scale economies are more likely to hedge.

The discussion in chapter 4 describes the variables employed to proxy for the above firm level factors or attributes. The testable propositions relating corporate hedging policy to firm level operating and financial characteristics are summarised in Table 6.1.

Table 6.1 Expected Relations Among The Variables And Predicted Sign Of Parameter Estimate In Multivariate Tests

Variable	Hypothesised relation between hedgers (H) and non-hedgers (NH)	Predicted sign of parameter estimate
1. Tax function convexity		
Tax loss dummy	H > NH	Positive
2. Expected costs of financial distress		
Gearing	H > NH	Positive
Interest cover	H < NH	Negative
Credit rating	H < NH	Negative
Funds flow debt ratio	H < NH	Negative
Net interest charge dummy	H < NH	Negative
3. Underinvestment costs		
Capital expenditure/Sales	H > NH	Positive
Price-earnings ratio	H > NH	Positive
Market-to-book ratio	H > NH	Positive
R&D expenditure/Sales	H > NH	Positive
4. Cash flow variability		
Foreign operations dummy	H > NH	Positive
Foreign sales/Total sales	H > NH	Positive
Foreign tax/Total tax	H > NH	Positive
Foreign transactions dummy	H > NH	Positive
5. Hedging Substitutes		
Liquidity	H < NH	Negative
Convertible debt/Total assets	H < NH or H > NH	Negative/Positive
Preferencecapital/Total assets	H < NH or H > NH	Negative/Positive
Dividend yield	H > NH	Positive
6. Information and transaction cost economies		
Firm size	H < NH or H > NH	Negative/Positive
Treasury qualified staff	H > NH	Positive

6.3 Dependent Variable: Measuring Firm Hedging

The dependent variable of a sample firm for the multivariate model is determined by reviewing a firm's annual report. In the event that there is a discussion of hedging, then the firm is assigned a value of one, classifying it as a "hedger". If the firm states that it does not hedge or there is no discussion of hedging, then the firm is assigned a value of zero, classifying it as a "non-hedger." The use of a binary variable implies that this study examines the determinants of the decision to hedge and tests whether the likelihood that firms hedge is related to their financial and operating characteristics.[4]

Table 6.2 shows that over three quarters of the sample are classified as hedging firms.

Table 6.2 Classification of Firms

	No.	%
Hedging firms	321	77.9
Non-hedging firms	91	22.1
TOTAL	**412**	**100**

6.4 Descriptive Statistics – Independent Variables

Descriptive statistics of the independent variables are presented in Table 6.3. This table shows that there is wide variation in some of the measures used to proxy for the expected costs of financial distress. For example, the range for the gross gearing variable is zero through to 845.16 percent and the interest cover ratio lies between –20.63 and 5107.53. It appears that some firms were clearly having financial problems indicated by their negative interest cover ratios.[5] The table also shows that there are some extreme observations for the interest cover ratio. To control the influence of these extreme values the interest cover ratio is set equal to 100 for values of the ratio which are greater than 100. This affects approximately 5 percent of the sample. The net gearing ratio is negative for at least a quarter of the sample. The discussion of variable definitions in Chapter 4 explains that this measure of gearing is constructed by deducting cash and short-term investments from

[4] This type of dependent variable and approach has been employed in previous studies such as Francis and Stephan (1993), Nance et al. (1993), Dolde (1995), Wysocki (1996) Mian (1996), Geczy et al. (1997), and Fok et al. (1997).

[5] The interest cover ratio is negative when a firm makes operating losses, i.e., when operating profit plus non-operating income is negative. Firms with higher levels of operating losses will generally have higher negative interest cover ratios.

the value of debt. Firms with negative ratios are generally those with high levels of cash and or short-term investments.

Less than half of the sample publish data on R&D expenditure in their annual report which explains the relatively low number of observations. The majority (up to the third quartile) of the sample has a PE ratio between 6 and 23.[6] The market-to-book ratio has negative values suggesting that some firms have negative book values of equity. There are also several extreme observations, for example, 75 percent of the ratios are between -9.56 and 3.36. The range for this variable, however, is -9.56 to 103.16.[7]

Foreign sales data ranged from zero to 96 percent for sales by destination and from zero to 92.2 percent for sales by origin. In 1994 a quarter of firms had up to 1.63 percent of foreign sales by destination and another quarter had in excess of 65.3 percent of foreign sales.

The ratio of convertible debt to total assets ranged between 0 and 13.5 percent, although at least three quarters of firms had no convertible debt. Seventy five percent of firms had a preference capital to total assets ratio of up to 0.4 percent.

Measures of firm size also exhibit wide variation. Total assets ranged from £11.33 million to over £28700 million and the market value of equity ranged from just under £65 million to over £31000 million. For the various measures of firm size the sample firms' mean is on average four times as high as the median.

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[6] Adedji and Stapleton (1996) set equal to 100 the values of the price-earnings ratios which are either negative or greater than 100. They find that the majority of their sample has PE ratio values of between 5 and 10.

[7] Barclay and Smith (1995) ignore observations if the market-to-book ratio is greater than 10. They do this in order to eliminate the influence of these extreme observations on the regression results.

Table 6.3 Summary of Financial and Operating Characteristics of Sample Firms

Summary statistics are reported for proxies related to incentives for hedging. The sample includes all non-financial firms in the FT500 with available data in the period 1992-94 and for some variables up-to financial year end 1995.

	Minimum	25th percentile	50th percentile	Mean	75th percentile	90th percentile	95th percentile	99th percentile	Maximum	Std. Dev.	N
1. Tax Function Convexity											
Tax loss carry forwards dummy	0.00	0.00	0.00	0.36	1.00	1.00	1.00	1.00	1.00	0.48	398
2. Expected Costs of Financial Distress											
Gross gearing book value	0.00	16.90	27.08	31.98	37.31	51.47	67.62	143.10	845.16	47.02	398
Industry adjusted gross gearing book value	0.00	0.61	0.98	1.01	1.32	1.68	2.00	2.98	4.85	0.60	396
Gross gearing market value	0.00	8.00	15.00	18.64	26.00	40.33	50.00	65.93	85.33	14.99	359
Industry adjusted gross gearing market value	0.00	0.51	0.94	1.00	1.34	1.94	2.54	3.19	3.48	0.70	359
Net gearing book value	-196.00	-3.17	12.00	9.62	24.67	39.47	50.23	95.73	373.33	39.56	365
Net gearing market value	-56.67	-1.00	6.67	8.37	15.67	30.13	39.23	61.01	77.67	16.64	365
Interest cover (set = 100 if Interest cover >100)	-20.63	3.79	6.92	16.96	13.67	46.94	100.00	100.00	100.00	26.48	398
Interest cover	-20.63	3.79	6.92	43.37	13.67	46.94	115.46	860.05	5107.53	278.21	398
Funds flow debt ratio	-7.50	0.49	0.75	1.30	1.27	2.13	3.28	17.50	33.33	2.77	359
Credit rating Quiscore	0.00	58.00	69.00	70.19	86.00	96.00	96.00	96.00	96.00	19.02	387
Net interest charge dummy average	0.00	0.00	0.00	0.26	0.50	1.00	1.00	1.00	1.00	0.38	362
Net interest charge average dummy	0.00	0.00	0.00	0.25	0.25	1.00	1.00	1.00	1.00	0.43	362
3. Costs of Underinvestment: Firm Growth Options											
Capital expenditure	0.00	0.03	0.04	0.08	0.08	0.15	0.25	0.58	2.33	0.17	303
Price-earnings (PE) ratio	6.87	16.13	18.60	26.89	23.11	29.09	45.65	285.92	791.30	60.60	352
Market-to-book ratio	-9.45	1.62	2.36	4.16	3.54	5.49	10.45	41.97	164.33	11.14	358
R&D	0.03	0.40	0.95	3.56	2.46	5.01	7.12	126.10	194.27	16.66	177

Table 6.3 Summary of Financial and Operating Characteristics of Sample Firms

Summary statistics are reported for proxies related to incentives for hedging. The sample includes all non-financial firms in the FT500 with available data in the period 1992-94 and for some variables up-to financial year end 1995.

	Minimum	25th percentile	50th percentile	Mean	75th percentile	90th percentile	95th percentile	99th percentile	Maximum	Std. Dev.	N
4. Sources of Cash Flow Volatility – Measures of Foreign Currency Exposure											
Foreign sales by destination	0.00	1.63	31.30	36.05	65.30	81.60	87.00	92.82	96.00	31.80	389
Foreign sales by origin	0.00	0.00	22.80	29.31	53.83	72.00	79.28	89.85	92.20	28.25	374
Foreign tax payments	0.00	0.00	0.16	0.26	0.43	0.64	0.79	1.29	3.12	0.32	332
Import/export transactions dummy	0.00	0.00	1.00	0.66	1.00	1.00	1.00	1.00	1.00	0.47	398
Foreign operations dummy	0.00	1.00	1.00	0.77	1.00	1.00	1.00	1.00	1.00	0.42	398
5. Hedging Substitutes											
Liquidity - Cash ratio	0.00	0.17	0.31	0.48	0.51	0.88	1.58	3.50	6.88	0.67	398
Liquidity - Quick assets ratio	0.08	0.72	0.96	1.08	1.21	1.62	2.31	4.67	7.35	0.74	398
Liquidity - Current ratio	0.24	1.07	1.38	1.57	1.78	2.38	3.04	6.90	8.54	0.96	398
Convertible debt/Total assets	0.00	0.00	0.00	0.01	0.00	0.03	0.05	0.11	0.14	0.02	398
Preference capital/Total assets	0.00	0.00	0.00	0.03	0.00	0.06	0.16	0.38	1.96	0.12	398
Dividend yield	0.00	2.44	3.53	3.59	4.70	5.67	6.32	7.86	8.65	1.64	359
6. Information and Transaction Cost Economies of Scale											
Firm size - Market value of equity (Natural log)	4.17	5.37	6.07	6.36	7.17	8.19	8.86	10.07	10.36	1.28	398
Firm size -Total assets (Natural log)	2.43	4.47	5.49	5.66	6.77	7.78	8.34	9.69	10.27	1.52	398
Treasury staff dummy	0.00	0.00	0.00	0.48	1.00	1.00	1.00	1.00	1.00	0.50	398

6.5 The Decision to Hedge Model

This study employs an empirical model to determine the effects of the independent variables on the firm's hedging decision. The dependent variable is binary, 1 for hedgers and zero for non-hedgers. The discussion in chapter 5 suggests the use of either probit or logit modelling. Since the shapes of the logistic and normal distributions are very similar the results of probit and logit analysis will differ by very little and therefore, the choice between the two models is not an important one. Consequently, the analysis consists of a logit model to examine the effect of the independent variables on the probability of hedging by the firm.

The following logistic model is used to test theories of incentives for firms to hedge:

$$y^*_i = \beta_1 + \beta_2 \text{Tax Convexity}_i + \beta_3 \text{Financial Distress}_i + \beta_4 \text{Underinvestment Cost}_i + \beta_5 \text{Cash Flow Volatility}_i + \beta_6 \text{Hedging Substitutes}_i + \beta_7 \text{Transaction Costs}_i + u_i \qquad 6.1$$

This model assumes the existence of an underlying latent variable for which we observe a dichotomous realisation. In this study, the observed dummy variable is whether or not the firm hedges and therefore, y^*_i is defined as the "desire or ability to hedge." The explanatory variables in the model contain variables that explain both these elements. Thus, Tax Convexity is a proxy for tax convexity of the tax schedule, Financial Distress is a proxy for expected costs of financial distress, Underinvestment Cost is a proxy for the agency costs of debt and costly external financing, Cash Flow Volatility is a proxy for a firm's financial price exposure, Hedging Substitutes is a control variable for alternative methods of hedging and Transaction Costs is a proxy for information and transaction cost economies of scale.

The logit model estimates the odds of hedging, given the above firm-level operating and financial characteristics. The slope coefficient shows how the odds of hedging change as the independent variable changes by one unit. A positive (negative) coefficient indicates that the odds of hedging increase (decrease) as the independent variable increases (decreases), ceteris paribus. In addition, as an estimated positive (negative) coefficient increases, the contribution of that particular attribute to the likelihood of (not) hedging rises.

6.6 Variable Selection Strategy[8]

For most factors/attributes chapter 4's analysis identifies several independent variables as potential proxies and therefore which could be included in a logistic regression model. Clearly problems of multicollinearity could arise if we were to use all the variables simultaneously. Furthermore, the traditional approach to regression model building involves seeking the most parsimonious model that still explains the data. The more variables included in a model, the greater the estimated standard errors become, and the more dependent the model becomes on the observed data. One approach is to include all economically relevant variables in the model, irrespective of their contribution to the model. A problem with this approach is that the model may be overfitted and produce numerically unstable estimates. Overfitting is typically characterised by unrealistically large estimated coefficients and/or estimated standard errors. This may be especially problematic in a model where the number of the variables is large relative to the number of observations and/or when the overall proportion responding $y = 1$ is close to either 0 or 1.[9]

[8] This section draws from David Hosmer and Stanley Lemeshow, Applied Logistic Regression, Wiley, (1989).

[9] Nance et al. (1993) find that the power of their full (unrestricted) model is low. In this model the sample size is small relative to the number of parameters estimated. They use 12 right-hand side variables while there are only 65 observations in the non-hedging group. To increase the power of their tests they consider restricted specifications for the logit regressions. The benefit of this is offset by any bias introduced by omitting relevant correlated independent variables

Existing studies that have used multiple proxies have examined all possible combinations of the proxies selected.[10] Other studies that employ one proxy or a small number of proxies for each firm attribute consider a small number of specifications for their regressions (Howton and Perfect (1998) and Graham and Rogers (1999)).

This study employs an alternative method to that of previous studies for handling multiple proxies. The objective is to select those variables that result in the "best" model within the economic context of the hedging problem. The variable selection methodology employs univariate logistic regression techniques. The model building stage begins by selecting from each group the proxy with the highest individual level of significance. In addition to selecting proxies with the highest level of significance the model building process includes variables that are not statistically significant but theory argues as being of economic importance.[11]

6.7 Results of Variable Selection Strategy

For each variable a univariate logistic regression model is fitted and these results are displayed in Table 6.4. This Table presents, for each variable listed in the first column, the following information: (1) the estimated slope coefficient, (2) the estimated standard error, (3) the estimated odds ratio, (4) the Wald statistic, (5) the p-value of the odds ratio, (6) the likelihood ratio test statistic for the hypothesis

[10] See, for example, Nance et al. (1993), Geczy et al. (1997), Fok et al. (1997). Nance et al. estimated 48 regressions and Fok et al. estimated 192 regressions. Both studies employed the distribution of probability values for the variables in their regressions to draw conclusions about the importance of the variables on the hedging decision.

[11] In general, the appropriateness of the decision to begin the multivariate model with all possible variables depends on the overall sample size and the number in each outcome group relative to the total number of independent variables. When the data are adequate to support such an analysis it is feasible to begin the multivariate modelling from this point. However, when the data are inadequate, this approach can produce a numerically unstable multivariate model. When this occurs the Wald statistics should not be used to select variables because of the unstable nature of the results. In this case the

that the slope coefficient is zero, and (7) the p-value for the likelihood ratio test statistic.

The slope coefficient of the independent variable gives the change in the log of the odds ratio per unit change in the independent variable. A coefficient with a positive sign means that the log of odds increases as the independent variable increases. For example, Table 6.4 shows that the estimated coefficient (log of the odds) on the gearing variable in the univariate model is positive (0.068). Therefore, the likelihood of hedging increases as gearing increases. Taking the exponential of the coefficient on the gearing variable gives the odds ratio of 1.071 for firms that are a unit apart on the gearing variable. The odds ratio shows that each unit increase in the gearing variable changes the odds of a firm hedging by a factor of 1.071 (i.e. the odds of hedging increase by 1.071). Alternatively, 7.1 percent (100[1.071 - 1]) is the estimated percentage change (i.e. increase) in the odds for a unit increase in the gearing variable. The Wald statistic is obtained by taking the square of the maximum likelihood estimate of the slope parameter to an estimate of its standard error. The resulting ratio, under the hypothesis that the slope parameter equals zero, will follow a standard normal distribution. This statistic tests the null hypothesis that a coefficient in a logistic regression model is zero. Column five in Table 6.4 shows the gearing variable has a Wald statistic of 41.319 with a p-value of 0.000. This suggests the gearing variable is significant at less than the 1 percent level. However, the Wald statistic has the undesirable property that when the absolute value of the regression coefficient is large, the estimated standard error is too large and the Wald statistic is too small. Whenever there is a large coefficient, it is not appropriate to rely on the Wald statistic for hypothesis testing. Instead it is more appropriate to

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process should select a subset of variables based on results of the univariate analyses and refine the definition of "economically relevant."

look at the improvement in chi-squared when the variable is added to the model using a likelihood ratio test.[12] Column seven gives the chi-squared statistic, for the univariate model in which gearing is the independent variable this is equal to 58.662 with a p-value of 0.0000. Clearly this is significant at less than the 1 percent level and thus the coefficient on the gearing variable is significantly different from zero.

The discussion in Chapter 4 groups the independent variables into six attributes. The variables in these groups are proxying for the following factors or attributes: (1) tax function convexity, (2) expected costs of financial distress, (3) costs of underinvestment, (4) sources of cash flow volatility, (5) hedging substitutes, and (6) information and transaction cost economies of scale. The discussion of hedging theory and the review of the empirical literature has shown that these attributes are of economic importance.

An inspection of the p-values for the coefficients and the p-values for the likelihood ratio test statistics in Table 6.4 shows that there is evidence that several groups of variables have the hypothesised association with hedging. In particular the following factors have some proxies that have a significant relationship with hedging: tax function convexity; expected costs of financial distress; sources of cash flow volatility; hedging substitutes; and information and transaction cost scale economies. All variables proxying for the expected costs of financial distress, sources of cash flow volatility and information and transaction cost economies of scale are significantly related to hedging.

Variables proxying for hedging substitutes offer mixed results. All measures of liquidity and the dividend yield exhibit a significant association with hedging

[12] The likelihood ratio test statistic is obtained as minus twice the difference between the log-likelihoods for the constant only model and the model containing the respective variable. Under the null hypothesis this quantity will follow the chi-squared distribution with 1 degree of freedom. This is a test of the null hypothesis that the coefficients for all of the variables in the model are zero.

whereas measures for convertible debt and preference capital exhibit no significant relationship. The univariate results provide no support for the costs of underinvestment hypothesis. None of the four growth option variables exhibit the hypothesised relationship with hedging, in fact all have negative coefficients with the coefficient on the market-to-book ratio significant at the 5 percent level. This evidence contrasts strongly with previous empirical studies, which find that hedging firms have significantly higher levels of R&D expenditure relative to non-hedging firms.

The discussion in chapter 2 argued that each of the above firm level attributes potentially has a bearing on the decision to hedge by a firm. The implication of this for the model building process is that this stage should consider the inclusion of a proxy for all economically relevant attributes into the multivariate model regardless of the results of univariate analyses. Each of the aforementioned categories, with the exception of tax function convexity, contains several potential proxies. To mitigate problems of multicollinearity the multivariate analysis should avoid employing more than one variable from each group. On the basis of the above variable selection procedure the following variables are chosen for model estimation: the tax loss dummy, gearing, capital expenditure, foreign operations dummy, cash ratio and the natural log of total assets.

Table 6.4 Univariate Logistic Regression Results for Firms Hedging Any Financial Price Exposure

***, **, * denote significance at the 1%, 5%, and 10% levels, respectively. Variables in shade are selected for the multivariate model.

Variable	Coeff-icient	Standard error	Odds ratio	Wald statistic	P-value (coeff)	Chi-Squared statistic	P-value (model)
1. Tax Function Convexity							
Tax loss carry forwards dummy	0.777***	0.280	2.175	7.690	0.006	8.360	0.004
2. Expected Costs of Financial Distress							
Gross gearing book value	0.068***	0.011	1.071	41.319	0.000	58.662	0.000
Industry adjusted gross gearing book value	2.000***	0.304	7.389	43.200	0.000	56.030	0.000
Gross gearing market value	0.088***	0.015	1.092	32.337	0.000	49.345	0.000
Industry adjusted gross gearing market value	1.822***	0.296	6.182	37.977	0.000	53.392	0.000
Net gearing book value	0.016***	0.004	1.016	15.687	0.000	18.669	0.000
Net gearing market value	0.047***	0.009	1.048	19.042	0.000	22.836	0.000
Credit rating Quiscore	-0.028***	0.008	0.973	13.440	0.000	14.930	0.000
Interest cover	-0.029***	0.004	0.972	42.338	0.000	47.602	0.000
Funds flow debt ratio	-0.087**	0.043	0.917	4.059	0.044	4.442	0.035
Net interest charge dummy average	-1.560***	0.318	0.210	24.163	0.000	24.131	0.000
Net interest charge average dummy	-1.229***	0.276	0.293	19.835	0.000	19.344	0.000
3. Costs of Underinvestment: Firm Growth Options							
Capital expenditure	-0.277	0.785	0.758	0.125	0.724	0.117	0.732
Price-earnings (PE) ratio	-0.001	0.002	0.999	0.483	0.487	0.445	0.505
Market-to-book ratio	-0.029**	0.016	0.971	3.365	0.067	5.917	0.015
R&D	-0.087***	0.063	0.917	1.910	0.166	9.630	0.002
4. Sources of Cash Flow Volatility - Measures of Foreign Currency Exposure							
Foreign sales by destination	0.030***	0.005	1.030	35.160	0.000	45.400	0.000
Foreign sales by origin	0.040***	0.007	1.040	35.350	0.000	51.180	0.000
Overseas tax	4.750***	0.888	115.58	28.660	0.000	47.430	0.000
Import/Export transactions dummy	1.420***	0.255	4.137	31.200	0.000	32.260	0.000
Foreign operations dummy	2.170***	0.275	8.758	62.320	0.000	65.190	0.000
5. Hedging Substitutes							
Liquidity - Cash ratio	-0.524***	0.174	0.592	9.029	0.003	10.066	0.002
Liquidity - Quick assets ratio	-0.325**	0.148	0.723	4.785	0.029	4.722	0.030
Liquidity - Current ratio	-0.339***	0.115	0.713	8.645	0.003	8.860	0.003
Convertible debt/Total assets	10.300	7.610	29733	1.830	0.176	2.240	0.135
Preference capital/Total assets	-0.725	0.906	0.484	0.640	0.420	0.612	0.434
Dividend yield	0.154*	0.080	1.166	3.710	0.054	3.792	0.052
6. Information and Transaction Cost Economies of Scale							
Firm size - Market value of equity (Natural log)	0.646***	0.129	1.908	25.060	0.000	31.960	0.000
Firm size -Total assets (Natural log)	0.653***	0.107	1.921	37.170	0.000	47.740	0.000
Treasury staff dummy	1.750***	0.299	5.755	33.960	0.000	41.890	0.000

6.8 Model Estimation

A theory that explains which traits are important in determining which firms hedge can be assessed by comparing the characteristics of firms that hedge with those that do not hedge. However, given correlations among the different firm characteristics, these tests cannot reveal significant differences in firm traits, holding other firm attributes constant. Thus multivariate tests are necessary.

The following logistic model is estimated to test theories of incentives for firms to hedge:

$$y^{*}_{i} = \beta_1 + \beta_2 \text{Tax Convexity}_i + \beta_3 \text{Financial Distress}_i + \beta_4 \text{Underinvestment Cost}_i + \beta_5 \text{Cash Flow Volatility}_i + \beta_6 \text{Hedging Substitutes}_i + \beta_7 \text{Transaction Costs}_i + u_i \qquad 6.1$$

Using the variables identified in section 6.7 the results from fitting this model are given in Table 6.5 under heading model 1.[13] The importance of each variable in the model is assessed by an examination of its significance.

Table 6.5 Multivariate Logistic Regression Results For All Hedging Firms
The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Univariate Model	Model 1	Model 2	Model 2A
Tax loss carry forwards dummy	0.777***	0.846*	0.841*	0.486
	0.006	0.052	0.053	0.159
Gross book value gearing	0.068***	0.052***	0.053***	0.041***
	0.000	0.001	0.000	0.000
Capital expenditure	-0.277	0.221		
	0.724	0.853		
Overseas operations dummy	2.170***	1.882***	1.869***	1.905***
	0.000	0.000	0.000	0.000
Liquidity - Cash ratio	-0.524***	-0.631	-0.597*	-0.395*
	0.003	0.108	0.087	0.070
Firm size -Total assets (Natural log)	0.653***	0.530***	0.532***	0.575***
	0.000	0.000	0.000	0.000
No. of Observations	NA	303	303	398
No. of hedgers	NA	244	244	312
No. of non-hedgers	NA	59	59	86
-2 Restricted Log Likelihood (Slopes=0)	NA	298.755	298.755	415.434
-2 Restricted Log Likelihood at Convergence	NA	200.987	201.024	285.565
Chi-squared (log-likelihood ratio)	NA	97.768***	97.731***	129.869***
Degrees of Freedom	NA	6	5	5
P-value	NA	0.000	0.000	0.000
Likelihood ratio test between models			1 and 2	
Chi-squared			0.037	
P-value			0.8478	

The number of observations for model 1 is restricted to 303 because of missing data for the capital expenditure variable. In model 2 this data restriction is maintained despite dropping the capital expenditure variable so that models 1 and 2 can be compared. In model 2A the missing data restriction is lifted and consequently the sample size increases to 398.

[13] This table also includes the results of the univariate regressions to enable a comparison to be made between the two sets of results.

Model 1 in Table 6.5 shows that the gearing, overseas operations dummy, and firm size variables make a contribution to the model. The log of the odds ratios for all these variables are significant at the 5 percent level or better indicating that these variables demonstrate considerable importance in the multivariate model. Using the aforementioned criteria suggests that the tax loss dummy, capital expenditure and liquidity variables do not contribute to the model.

Since the tax loss, capital expenditure and liquidity variables are insignificant a new model should be fitted excluding one of these variables. Model 1 shows that the coefficient to the capital expenditure variable has changed markedly relative to its coefficient in the univariate model whereas the coefficient to the tax loss or cash ratio variable has changed by very little. This evidence indicates that the capital expenditure variable is of lower statistical importance relative to the other two variables. Therefore, model 2 is fitted excluding the capital expenditure variable. The results of model 2 are qualitatively similar to those of model 1.

Model 2 is compared to model 1 through the likelihood ratio test. The likelihood ratio test for the difference between models 1 and 2 yields a chi-squared value of -2[-201.024– (-200.987)] = 0.037. Comparing this to a chi-squared distribution with 1 degree of freedom yields a p-value of 0.8478, demonstrating that the capital expenditure variable adds little to the model once the other variables have been included in the model. This is further supported by the fact that the values of the estimated coefficients for the other variables are nearly identical in the two models.

In this study due to the problem of missing values for some variables the sample size for each model specification might vary. The capital expenditure variable, which is excluded in model 2, has only 305 observations. This limits the number of observations in model 1 to a maximum of 305.[14] Its exclusion from model 2 means that the sample size for model 2 can go up to 398. In view of this model 2 is refitted using a sample size of 398. The results of fitting this model, model 2A, are given in Table 6.5. The coefficients on the variables are qualitatively similar across models 2 and 2A.[15]

The above results from the logit regressions have identified several variables as significantly related to a firm's decision to hedge various financial price risks.

The results show the coefficient on the gross gearing ratio is positive and significant at the 1% level. Additionally, Table A6.1 in Appendix 6.1 shows that several alternative proxies for the expected costs of financial distress are also significantly related to the hedging decision. These results provide strong support for the view that firms hedge in order to reduce the costs of financial distress and ease the financial constraints arising from high gearing. Furthermore, these results are more supportive of a financial distress cost motive than those found in most empirical studies.[16]

As most firms hedge to reduce risk, hedging activity should be positively related to the need to reduce risk. Firms with more volatile income are exposed to more risk and hence are more likely to hedge. In view of this it is surprising that several previous studies make no attempt to examine the relationship between the decision to hedge and the level of financial price exposure such as foreign currency

[14] The number of observations for model 1 is restricted to 303 because of missing data.
[15] Model 2 and 2A cannot be compared through the likelihood ratio test because their sample sizes differ.
[16] For example, Francis and Stephan (1993), Nance et al. (1993) and Wysocki (1996) find that neither gearing nor the interest cover ratio is significant in their logit tests. Mian (1996) only uses firm size as a proxy for financial distress costs in logit tests and finds evidence inconsistent with the notion that there is a large fixed cost component to financial distress costs. Dolde (1995) finds gearing has a positive effect on hedging only after the empirical tests control for primitive risk (p-values vary between 0.07 and 0.11) and then only in one of the three hedging dichotomies used. In the Fok et al. (1997) study gearing is significant in less than half of the models specified and interest cover is

exposure.[17] The results show that firms with foreign operations are more likely to hedge. This study also employs several alternative proxies for foreign currency exposure (both continuous and dummy variables) and the results in Table A6.2 (Appendix A6.1) provide further support for the notion that exposure to foreign exchange rate risk is an important factor in the decision to hedge.

The results show that this study's preferred measure of liquidity, the cash ratio, is significantly negatively related to the probability of hedging.[18] This result is consistent with the Nance et al. (1993) argument for reducing the likelihood of financial distress by investing in more liquid assets.[19] Previous empirical tests provide weak evidence of a negative relationship between hedging and liquidity.[20] The results in Table A6.3 (Appendix A6.1) show that the quick ratio, which has been the preferred measure in some earlier studies, and the current ratio are also negatively related to hedging but were not significant. These results are consistent with the arguments in chapter 3, which suggest that the cash ratio can capture the concept of internal wealth used in Froot et al. (1993) better than either the current ratio or the quick asset ratio.

The evidence in this study suggests the costs associated with conducting a hedging strategy also play a role in a firm's decision to hedge. Assuming that firm

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significant in only a third of the models tested. Overall, these logit studies find relatively weak evidence that financial distress costs affect the decision to hedge.

[17] For example, Francis and Stephan (1993), Nance et al. (1993), Mian (1996), Wysocki (1996), Fok et al. (1997) and Gay and Nam (1998).

[18] Several specifications in Tables A6.1 and Table A6.2 show that the cash ratio is significant at the 1 and 5 percent level.

[19] As noted above the data are also consistent with a positive relationship between hedging and gearing; capitalising the firm with greater equity is another form of financial cushion.

[20] For example, in four previous logit studies (Francis and Stephan (1993), Dolde (1995), Wysocki (1996) and Mian (1996)) liquidity is not employed in multivariate tests and in three where it is used (Nance et al. (1993), Fok et al. (1997) and Geczy et al. (1997)) only Geczy et al. find evidence in support of the Nance et al. or Froot et al. arguments.

size proxies for economies of scale, the observed positive coefficients indicate the existence of cost-driven motives for hedging.[21]

The results provide weak support for the notion that the convexity induced by the existence of tax loss carry forwards provides an incentive for firms to reduce the variability of their taxable income and maximise the present value of their tax shields.[22] This finding is consistent with that of previous papers which have found no statistically significant relationship.[23] The review of the empirical literature in chapter 3 shows that other previous empirical tests using a range of proxies for tax convexity find very little support for the tax hypothesis.[24]

It is possible to test the underinvestment hypothesis by testing either for the statistical significance of a proxy for growth opportunities or a proxy for gearing or liquidity or a variable that combines growth opportunities and gearing or liquidity. The results in Table 6.5 show that the coefficient for the capital expenditure variable is insignificant and therefore the evidence does not support the notion that firms with growth opportunities are more likely to hedge.[25] Furthermore, tests that employ an

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[21] Francis and Stephan (1993), Nance et al. (1993), Mian (1996), Wysocki (1996), Fok et al. (1997) also find a positive relationship between firm size and the likelihood a firm will hedge.

[22] Although, as suggested in chapter 3, it is possible that this variable proxies for financial distress rather than tax function convexity.

[23] For example, Allayannis and Ofek (1996), Mian (1996) and Howton and Perfect (1998).

[24] See Francis and Stephan (1993), Nance et al. (1993), Dolde (1995), Wysocki (1996), Tufano (1996), Fok et al. (1997), Haushalter (1998) and Gay and Nam (1998).

[25] In unreported specifications the coefficients for the other growth variables (PE ratio, market-to-book ratio and R&D over sales) were insignificant. The lack of evidence in support of a relation between hedging and the R&D growth options proxy is possibly due to limitations of the R&D data used in this study. The main limitation is the reliance on disclosure of R&D expenditure in published annual reports and accounts. Company Reporting Ltd, who source the R&D data from annual reports, have found that a significant minority of listed companies with evidence of R&D activities disclose no figures for expenditure. And for those that do disclose R&D expenditure there is confusion as to the definition of R&D expenditure resulting in variation in the expenditure items firms include in arriving at an R&D expenditure figure. R&D data disclosed in the annual report and accounts is subject to the accounting definitions of R&D. In the UK, the definition is contained in Statement of Standard Accounting Practice (SSAP) 13 "Accounting for research and development".

interactive variable that combines a growth and a net gearing variable provide no additional insights into the determinants of hedging.[26]

In summary, the preceding analysis has shown that tax loss carry forwards, gearing and several other proxies for financial distress, foreign operations and sales, liquidity and firm size are important factors in determining the decision to hedge.

6.9 Using Industry Adjusted Gearing

The previous section uses gearing as a measure of a firm's expected costs of financial distress and finds a significant relationship between this variable and the decision to hedge. This finding is consistent with several studies that report higher gearing ratios either increase the likelihood of hedging[27] or cause greater hedging.[28]

Chapter 3 argues that all studies that use gearing as a measure of expected financial distress costs make the limiting assumption that exogenous bankruptcy costs are constant across firms and therefore do not allow for the possibility that exogenous bankruptcy costs might influence the firms debt-equity choice. For example, a firm with high (low) exogenous bankruptcy costs might choose a low (high) level of debt. This study assumes that firms within specific industries have a common exposure to distress and therefore attempts to control the aforementioned problem by creating an industry-adjusted measure of gearing.[29] Therefore the following model is estimated:

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[26] In unreported specifications the results show that neither the growth measure nor the net gearing-growth interactive term are significant in the models estimated. In separate tests we employed gross gearing-growth interactive variables similar to those used by Geczy et al. (1997). None of the coefficients on these were significant.

[27] See Dolde (1995).

[28] See Berkman and Bradbury (1996), Haushalter (1998), Gay and Nam (1998), Howton and Perfect (1998), and Graham and Rogers (1999).

[29] See section 4.5.2 for an explanation of how this measure is constructed.

$$y^*_i = \beta_1 + \beta_2 \text{Tax Convexity}_i + \beta_3 \text{Industry Adjusted Gearing}_i$$
$$+ \beta_4 \text{Underinvestment Cost}_i + \beta_5 \text{Cash Flow Volatility}_i + \beta_6 \text{Hedging Substitutes}_i \qquad 6.2$$
$$+ \beta_7 \text{Transaction Costs}_i + u_i$$

Model 1 in Table 6.5 is refitted replacing gearing with the industry adjusted measure of gearing. The results are presented in Table 6.6. Model 1 uses the book value industry adjusted measure of gearing and model 2 uses the market value measure. The results in Table 6.6 are qualitatively similar to those in Tables 6.5 and Table A6.1 and provide further support for the argument that expected costs of financial distress are a significant factor in determining the decision to hedge. The other results are also qualitatively similar to the results presented in Table 6.5 and Table A6.1.

Table 6.6 Multivariate Logistic Regression Results Employing Industry Adjusted Measures of Gearing

Models 1 and 2 employ the book value and market value measures of industry adjusted gearing, respectively. The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2
Tax loss carry forwards dummy	0.842*	0.746*
	0.055	0.089
Industry adjusted gearing	1.236***	0.998***
	0.002	0.005
Capital expenditure	0.718	0.491
	0.567	0.653
Overseas operations dummy	2.077***	2.206***
	0.000	0.000
Liquidity - Cash ratio	-0.624*	-0.708*
	0.098	0.067
Firm size -Total assets (Natural log)	0.531***	0.484***
	0.000	0.002
No. of Observations	301	299
No. of hedgers	242	242
No. of non-hedgers	59	57
-2 Restricted Log Likelihood (Slopes=0)	297.882	291.316
-2 Restricted Log Likelihood at Convergence	204.778	199.266
Chi-squared (log-likelihood ratio)	93.11***	92.05***
Degrees of Freedom	6	6
P-value	0.000	0.000

6.10 Empirical Tests of the Determinants of Corporate Hedging Using Survey Data

The empirical tests conducted in the previous sections used hedging classifications determined from disclosures in annual reports. This study is unique amongst previous empirical studies in that it has access to both survey data and annual report disclosures for a subset of firms for the same period. Therefore, the tests in this section refit the models from section 6.8 and 6.9 using the subset of firms for which both survey and annual report data are available. One purpose of these additional tests is to assess whether the earlier findings are robust to changes in sample size. The annual report data generated 412 observations whereas the survey generated 186 observations. Of the 186 firms that responded to the survey 174 firms were also in the annual report sample. Therefore, the tests in this section use this subset of 174 firms.

Table 4.57, reproduced below, shows that the survey data classifies 151 firms as hedgers and 23 as non-hedgers. The Table also shows that the Annual Report data classifies 132 of these firms as hedgers and 42 as non-hedgers, clearly there is some degree of inconsistency between these two data sources. The tests in this section investigate the effects of these differences on the empirical results.

Table 4.57 Hedging Financial Price Exposure: Survey and Annual Report Evidence

	Survey	%	Survey[1]	%	Annual Report	%
Yes	159	85.5	151	86.8	132	75.9
No[2]	27	14.5	23	13.2	42	24.1
Total	186	100	174	100	174	100

[1]Here we exclude those firms for whom we do not have corresponding annual report evidence.
[2]For the annual report evidence "no" includes non-disclosure.

6.10.1 Tests Using The Survey Sample and Survey Hedging Classifications

Models 1A, 2A, 3A, 4A, 5A in Table 6.7 present the results of fitting the logistic regression model described in equation 6.1 to the subset of 174 survey firms. These regressions employ the hedging classifications based on the survey data.[30]

$$y^*_i = \beta_1 + \beta_2 \text{Tax Convexity}_i + \beta_3 \text{Financial Distress}_i + \beta_4 \text{Underinvestment Cost}_i + \beta_5 \text{Cash Flow Volatility}_i + \beta_6 \text{Hedging Substitutes}_i + \beta_7 \text{Transaction Costs}_i + u_i \qquad 6.1$$

Consistent with the results using the full annual report sample the evidence shows that gearing, measures of foreign currency exposure and firm size are important factors in determining the decision to hedge. However, contrary to the full sample tests the coefficient on the liquidity variable is insignificant in all specifications.

[30] The refitted models exclude the proxies for growth options because none were significant in unreported tests.

Table 6.7 Multivariate Logistic Regression Models Employing Survey and Annual Report Hedging Classifications

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1A Survey	Model 1B Annual Report	Model 2A Survey	Model 2B Annual Report	Model 3A Survey	Model 3B Annual Report	Model 4A Survey	Model 4B Annual Report	Model 5A Survey	Model 5B Annual Report
Tax loss carry forwards dummy	1.310*	0.875	1.475**	1.125**	1.303*	0.894	1.325*	0.985*	1.226*	1.249**
	0.057	0.117	0.028	0.039	0.057	0.109	0.055	0.094	0.075	0.037
Gross book value gearing	0.086***	0.095***	0.100***	0.096***	0.085***	0.095***	0.101***	0.122***	0.088***	0.102***
	0.002	0.000	0.001	0.000	0.002	0.000	0.000	0.000	0.002	0.000
Overseas operations dummy (models 1,3 and 5)	1.477***	1.902***	0.017*	0.032***	1.501***	2.045***	1.857***	2.816***	1.596***	1.865***
Foreign sales (model 2)	0.009	0.000	0.079	0.001	0.008	0.000	0.003	0.000	0.005	0.001
Foreign transactions dummy (model 4)										
Cash ratio (models 1, 2 and 4)	-0.130	-0.744**	-0.531	-1.026***	-0.074	-0.758**	-0.294	-0.874**	0.267	-0.767**
Quick ratio (model 3)	0.700	0.042	0.126	0.002	0.821	0.038	0.400	0.014	0.327	0.010
Current ratio (model 5)										
Firm size –Total assets (Natural log)	0.475**	0.468**	0.447**	0.455**	0.473**	0.453**	0.574**	0.613***	0.500**	0.422**
	0.036	0.016	0.040	0.019	0.037	0.020	0.020	0.006	0.030	0.028
No. of Observations	171	171	165	165	171	171	171	171	171	171
No. of hedgers	148	131	142	126	148	131	148	131	148	131
No. of non-hedgers	23	40	23	39	23	40	23	40	23	40
-2 Restricted Log Likelihood (Slopes=0)	135.041	186.0372	133.274	180.461	135.041	186.037	135.041	186.037	135.041	186.037
-2 Restricted Log Likelihood at Convergence	87.755	107.9772	87.936	106.56	87.849	107.758	84.612	95.551	86.938	104.25
Chi-squared (log-likelihood ratio)	47.286***	78.06***	45.339***	73.901***	47.192***	78.279***	50.429***	90.486***	48.103***	81.787***
Degrees of Freedom	5	5	5	5	5	5	5	5	5	5
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

6.10.2 Tests Using Survey Sample and Annual Report Hedging Classifications

The tests in the previous section use the survey data hedging classifications. However, as noted previously and illustrated in Table 4.57 a comparison of hedging classifications between the survey data and annual report data reveals significant differences implying that some firms have been incorrectly classified. An incorrect classification can occur in two ways. Firstly, if the survey indicates that a firm hedges and the annual report classifies this firm as a non-hedger (usually because of non-disclosure), and secondly, if the survey indicates a firm does not hedge and the annual report indicates it does hedge. Table 6.8 provides a breakdown of correctly and incorrectly classified firms.[31] This Table shows that thirty one firms were incorrectly classified. Of these, twenty five firms indicated in their survey response that they hedged but their annual report contained no mention of their hedging activity and six indicated in their survey response that they did not hedge whereas their disclosure in the annual report implied that they did.

Table 6.8 Comparison of Hedging Classifications Using Survey and Annual Report Data

Firm Classification	Group	No.	%
Survey says Non-hedger & Annual Report says Non-hedger	0	17	9.77
Survey says Hedger & Annual Report says Non-hedger[a]	1	25	14.37
Survey says Hedger & Annual Report says Hedger	2	126	72.41
Survey says Non-hedger & Annual Report says Hedger[a]	3	6	3.45
Total		174	100

[a]Incorrectly classified firms.

To test the effect of these differences in firm classifications models 1A through to 5A in Table 6.7 are refitted using the annual report hedging classifications for the subset of 174 firms. These refitted models are labelled 1B though to 5B in Table 6.7.

[31] This is a slightly revised version of Table 4.58.

The results show that measures for gearing, foreign currency exposure and firm size are significant in all models for both the survey and annual report hedging classifications. However, the coefficients for both the gearing variable and foreign currency exposure variables are greater and more significant for the tests that employ the annual report classifications. Additionally, there is a substantial difference in the results for the liquidity variable, which in tests using the survey data classifications was insignificant in all specifications compared to being statistically significant in all specifications in tests using the annual report classifications. This evidence seems to suggest that survey hedging firms classified as non-hedging firms by the annual report data have characteristics more in common with non-hedgers than hedgers and conversely survey non-hedging firms classified as hedging firms by the annual report data exhibit characteristics that are similar to hedging firms.

6.10.3 Comparing Characteristics Of Incorrectly Classified Firms Relative To Correctly Classified Hedgers And Non-Hedgers

Since there are four categories of firm more effective tests comparing the characteristics of incorrectly classified firms relative to correctly classified hedgers and non-hedgers can be conducted using multinomial logistic regression. It has been shown that if a firm is classified into one of J+1 outcomes, the general form of the multinomial logit model can be written as:

$$\Pr ob(y_i = j) = \frac{e^{\beta'_j x_i}}{1 + \sum_{k=1}^{j} e^{\beta'_k x_i}} \qquad 5.16$$

for j = 1,2,...,J

The β are the parameters of the model and x_i is a vector of characteristics for firm *i*.

The multinomial logit tests examine the characteristics of incorrectly classified firms relative to non-hedging and hedging firms. Panel A in Table 6.9 shows that the Group 1 incorrectly classified firms (i.e., survey says hedger annual report says non-hedger) are larger and are more likely to have foreign currency exposure in the form of foreign transactions than non-hedgers (Group 0 firms i.e., correctly classified non-hedgers). Similarly, the Group 3 incorrectly classified firms (i.e., survey says non-hedger annual report says hedger) are also larger and have more foreign currency exposure relative the non-hedging group. However, Group 2 correctly classified hedging firms (i.e., firms classified as hedgers by both the survey and annual report data) are significantly different across all of the variables in the model relative to the group of non-hedgers.

Panel B in Table 6.9 shows that Group 2 firms (i.e., correctly classified hedgers) are significantly different across 4 of the 5 variables in the model relative to Group 1 incorrectly classified firms and that both incorrectly classified groups (i.e., Groups 1 and 3) do not exhibit significantly different characteristics relative to one another. Finally, panel C in Table 6.9 shows that Group 2 firms (i.e., correctly classified hedgers) are significantly different in only one of the factors in the model relative to Group 3 incorrectly classified firms (i.e., survey says non-hedger annual report says hedger). This evidence provides confirmation of the suggestion above that incorrectly classified annual report non-hedgers (i.e., survey classifies these firms as hedgers) are closer in characteristics to non-hedgers and incorrectly classified annual report hedgers (i.e., survey classifies these firms as non-hedgers) are closer to hedgers.

Table 6.9 Multinomial Logistic Regression Results: Characteristics of Incorrectly Classified Firms Relative to Correctly Classified Non Hedging and Hedging Firms

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Panel A: Group 1	Group 2	Group 3	Panel B: Group 2	Group 3	Panel C: Group 2
Tax loss carry forwards dummy	1.918*	2.660**	1.921	0.743	0.003	0.739
	0.076	0.020	0.165	0.226	0.998	0.431
Gross book value gearing	0.082*	0.202***	0.084	0.119***	0.002	0.117**
	0.061	0.000	0.167	0.000	0.968	0.012
Foreign currency transactions dummy	2.806**	5.169***	4.789***	2.364***	1.982	0.381
	0.019	0.000	0.003	0.000	0.112	0.751
Liquidity - Cash ratio	-0.318	-1.183**	-1.155	-0.864**	-0.837	-0.028
	0.473	0.024	0.289	0.023	0.423	0.979
Firm size -Total assets (Natural log)	1.0111**	1.480***	1.291**	0.469**	0.280	0.189
	0.023	0.001	0.014	0.041	0.418	0.522
No. of Observations	171	171	171	171	171	171
-2 Restricted Log Likelihood (Slopes=0)	289.308	289.308	289.308	289.308	289.308	289.308
-2 Restricted Log Likelihood at Convergence	173.298	173.298	173.298	173.298	173.298	173.298
Chi-squared (log-likelihood ratio)	116.01	116.01	116.01	116.01	116.01	116.01
Degrees of Freedom	15	15	15	15	15	15
P-value	0.000	0.000	0.000	0.000	0.000	0.000
Normalised with respect to:	Group 0	Group 0	Group 0	Group 1	Group 1	Group 3

Group 0= Correctly classified non-hedging firms - survey identifies firms as non-hedgers and annual report identifies firms as non-hedgers.
Group 1= Incorrectly classified firms - survey identifies firms as hedgers and annual report identifies firms as non-hedgers.
Group 2= Correctly classified hedging firms - survey identifies firms as hedgers and annual report identifies firms as hedgers.
Group 3= Incorrectly classified firms - survey identifies firms as non-hedgers and annual report identifies firms as hedgers.

We can extend the above analysis by assuming that all incorrectly classified firms are in fact hedging but hedge either very infrequently or hedge very little of their exposure and correctly classified hedgers are more frequent hedgers or hedge more of their exposure (more extensive hedgers). This assumption leads to the prediction that incorrectly classified firms undertake a small amount of hedging relative to correctly classified hedgers because they have a smaller incentive to hedge, for example, because they face lower costs of financial distress.

All incorrectly classified firms now form one group and the correctly classified non-hedgers and hedgers form the other two groups. Table 6.10 presents the results from the multinomial logit model using the three hedging categories.

Models in panel A are normalised with respect to correctly classified non-hedgers (Group 0) and the model in panel B is normalised with respect to all incorrectly classified firms (Group 1). The results in panel A for Group 1 firms (i.e., all incorrectly classified firms) show that foreign currency exposure and firm size are statistically significant factors in determining their decision to hedge. The coefficient signs for the tax loss, gearing and liquidity variables are as hypothesised but are not significant at the 5 percent level. For Group 2 firms (i.e, correctly classified hedgers) the results in panel A show that tax losses, gearing, foreign currency exposure, liquidity and firm size are important factors in their hedging decision. The results in panel B show that gearing, foreign currency exposure, liquidity and firm size are important factors in determining the decision to undertake more hedging activity. Using dummy dependent variables to proxy for the extent of hedging the evidence shows that firms considered to be undertaking more hedging activity exhibit contrasting financial and operating characteristics relative to those assumed to be hedging very little of their exposure (undertake little hedging activity).

Table 6.10 Multinomial Logistic Regression Results: Characteristics of All Incorrectly Classified Firms Relative to Correctly Classified Non Hedging and Hedging Firms

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Panel A: Group 1	Group 2	Panel B: Group 2
Tax loss carry forwards dummy	1.941*	2.662**	0.722
	0.070	0.019	0.191
Gross book value gearing	0.084*	0.201***	0.117***
	0.053	0.000	0.000
Foreign currency transactions dummy	3.133***	5.081***	1.947***
	0.008	0.000	0.001
Liquidity - Cash ratio	-0.397	-1.165**	-0.768**
	0.369	0.025	0.036
Firm size -Total assets (Natural log)	1.068**	1.454***	0.386**
	0.015	0.001	0.048
No. of Observations	171	171	171
-2 Restricted Log Likelihood (Slopes=0)	259.736	259.736	259.7362
-2 Restricted Log Likelihood at Convergence	148.086	148.086	148.0862

Table 6.10 Multinomial Logistic Regression Results: Characteristics of All Incorrectly Classified Firms Relative to Correctly Classified Non Hedging and Hedging Firms

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Panel A: Group 1	Group 2	Panel B: Group 2
Chi-squared (log-likelihood ratio)	111.65***	111.65***	111.65***
Degrees of Freedom	10	10	10
P-value	0.000	0.000	0.000
Normalised with respect to:	Group 0	Group 0	Group 1

Group 0= Correctly classified non-hedging firms - survey identifies firms as non-hedgers and annual report identifies firms as non-hedgers.
Group 1= All incorrectly classified firms - i) survey identifies firms as hedgers and annual report identifies firms as non-hedgers and
ii) survey identifies firms as non-hedgers and annual report identifies firms as hedgers.
Group 2= Correctly classified hedging firms - survey identifies firms as hedgers and annual report identifies firms as hedgers.

6.11 Analysing the Relationship Between the Extent of Risk Management and Firm Characteristics Using Tobit Analysis

In this study the definition of hedging based on annual report qualitative disclosures or survey respondents indicating whether they hedge or not, groups together all firms that employ some risk management and thus fails to discriminate between firms managing 1 percent and 100 percent of their financial exposures. The analysis in the previous section identified three groups of firms, correctly classified non-hedgers, incorrectly classified firms and correctly classified hedgers. The evidence in section 6.10 showed that in terms of their financial and operating characteristics these incorrectly classified firms lie between firms classified correctly as non-hedgers and firms classified correctly as hedgers. Consequently, this analysis also reveals that grouping together all firms engaging in some hedging conceals substantial differences, motivating use of a continuous measure of risk management activity.

The analysis in chapter 4 showed that 86.3 percent of hedgers (277 firms) disclosed the use of derivatives and of these 33.2 percent (92 firms) provided data on the total notional amount of derivatives. Table 6.11 provides descriptive statistics of the derivative positions held by firms disclosing notional amounts of derivatives at the end of financial year 1995. The Table shows that the distribution of derivatives use is skewed with mean derivative contract values well above median contract values. The mean and median notional values of all derivative positions are £993.41 million and £113.5 million, respectively.

Data on notional values is used to construct a continuous measure of hedging. The extent of hedging is measured by using total notional value of derivative contracts scaled by the book value of total assets.[32] This measure ranges from 3.2 percent to 541.4 percent of the book value of total assets, with a mean of 34.3 percent.

Table 6.11 Notional Values of Derivative Contracts in £millions held by Derivative Users

	N	Min.	25th percentile	Median	Mean	75th percentile	Max.	Std. Dev.
Total positions (£m)	92	1.01	32.45	113.5	993.41	520.7	16147	2716.086
Scaled by total assets	90	0.032	0.086	0.183	0.343	0.382	5.414	0.611

Note: Data on total assets is missing for 2 firms.

The 91 firms classified as non-hedgers in this study were also non-users of derivatives and hence deemed to have zero holdings of derivatives. Derivative users not disclosing data on notional amounts are excluded from the tests in this section. Therefore, the full sample comprises 181 firms made up of 91 firms with zero derivative holdings and 90 firms with the extent of risk management being greater than zero and none less than zero.[33] The discussion in chapter 5 suggests that given these characteristics of the dependent variable the extent of derivative use can be

[32] Similar measures of the extent of derivatives use (or hedging) have been employed by Berkman and Bradbury (1996), Gay and Nam (1998) and Howton and Perfect (1998) in their studies of the determinants of all hedging.

[33] The number of observations for each model might vary due to missing values for variables.

analysed using tobit regression methodology.[34] This discussion shows that the tobit model takes the following form

$$y_i^* = \beta x_i + u_i \qquad \text{wh ere } u_i \sim \mathrm{IN}(0,\ \sigma^2)$$
$$y_i = y_i^* \text{ if } y_i^* > 0 \qquad 5.17$$
$$y_i = 0 \text{ if } y_i^* \leq 0$$

The models in Table 6.12 present the results from a tobit regression using total notional derivatives scaled by the book value of assets as the dependent variable. The variables proxying for growth options are excluded since none of these were significant in unreported tests.

[34] Berkman and Bradbury (1996), Gay and Nam (1998) and Howton and Perfect (1998) also employ tobit methodolgy in their studies of the determinants of the extent of derivatives use.

Table 6.12 Multivariate Tobit Regression Results For All Hedgers Using Annual Report Hedging Classifications

The data are presented as coefficients and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Tax loss carry forwards dummy	-0.001 0.937	-0.068 0.602	-0.002 0.986	-0.049 0.715	-0.056 0.673	-0.001 0.995	0.089 0.458
Financial distress - see below	0.008*** 0.000	-0.006** 0.039	-0.045 0.298	-0.463** 0.020	-0.006* 0.078	0.007*** 0.001	0.008*** 0.000
Foreign operations dummy: Models 1 to 5 Foreign sales by destination: Model 6 Foreign transactions dummy: Model 7	0.365*** 0.008	0.416*** 0.004	0.456*** 0.003	0.476*** 0.002	0.389*** 0.008	0.007*** 0.000	0.284** 0.016
Cash ratio	-0.048 0.543	-0.066 0.427	-0.103 0.263	0.038 0.685	-0.041 0.619	-0.073 0.331	-0.067 0.376
Firm size -Total assets (Natural log)	0.144*** 0.000	0.148*** 0.000	0.161*** 0.000	0.145*** 0.000	0.186*** 0.000	0.144*** 0.000	0.158*** 0.000
No. of Observations	177	177	160	167	170	175	177
No. of hedgers	90	90	84	87	88	89	90
No. of non-hedgers	87	87	76	80	82	86	87
-Log Likelihood at Convergence	121.865	126.712	120.174	121.779	124.171	117.351	122.567
Chi-squared	62.71	53.01	45.04	50.91	49.66	69.25	61.3
Degrees of Freedom	5	5	5	5	5	5	5
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Financial distress variable employed in model.	Gross Book Value Gearing	Interest cover	Funds Flow Debt ratio	Net Interest Charge Dummy Average	Credit Rating	Gross Book Value Gearing	Gross Book Value Gearing

The tobit results show that the extent of derivatives use is significantly related to several proxies for expected costs of financial distress and the financial constraints faced by firms.[35] These results provide more support for the financial distress hypothesis than similar previous empirical studies.[36]

The extent of derivatives use is strongly and positively related to the percentage of foreign sales in total sales. This suggests that the factors that expose a firm to exchange rates are important determinants for the extent of derivative use.

The evidence shows that the extent of hedging increases with firm size. This result is consistent with fixed costs limiting hedging by small firms, but not consistent with informational asymmetry leading to increased hedging. Finally, we find that the existence of tax losses and liquidity are not related to the extent of derivative use.

The tobit sample is approximately half the size of the logit samples in Tables 6.5 and A6.1. Observations are lost because as noted above only 92 firms provided full disclosure of notional amounts of derivatives. Therefore, to facilitate comparisons with the previous logit tests Table A6.6 in appendix A6.4 presents the results from logit regressions employing the same sample for the corresponding model in Table 6.12.[37] Table A6.6 shows that the logit results are qualitatively similar to the tobit results.

[35] See Table A6.5 in appendix A6.3 for results using various measures of gearing.
[36] For example, Gay and Nam (1998) and Howton and Perfect (1998) use two and three proxies for financial distress costs, respectively, but find that only gearing is related to the extent of derivative use. Berkman and Bradbury (1996) using a relatively small sample of New Zealand firms find that both gearing and interest cover are significantly related to the level of derivative use.
[37] The samples used in the logit models correspond to those used in the tobit tests.

6.12 Conclusions

This chapter employed three multivariate methods (logit, multinomial logit and tobit) to empirically examine the determinants of corporate hedging for a sample of non-financial firms. The evidence from these tests shows that firms' risk management decisions are consistent with some of the extant theory. The expected costs of financial distress seem particularly relevant; the data bear out Smith and Stulz's (1985) prediction that firms with higher expected costs of financial distress are more likely to hedge. These results are robust under a variety of econometric specifications, as well as employing a number of alternative proxy variables and using various subsets of the full sample. The strong evidence in support of the financial distress cost hypothesis is contrary to the findings of similar US studies employing a binary dependent variable, which find little or no evidence that the likelihood of hedging is significantly related to the expected costs of financial distress.

The results of the logit and multinomial logit analysis were consistent with firms using financial risk management and cash balances as substitutes, in that firms that held greater cash balances were less likely to hedge. There was also support for the theory that firms hedge in order to reduce expected taxes.

The empirical tests in this chapter considered how a firm's exposure to financial price risks affected the potential benefits of hedging. The evidence showed that firm characteristics related to these benefits, such as the level of debt and foreign currency exposure, were related to both the decision to hedge and the extent of hedging. The logit and tobit evidence also strongly supported the hypothesis that hedging activities exhibit economies of scale.

The major innovation in this chapter was the use of multinomial logit regression methods to demonstrate that cross-sectional variation in the extent of risk management was consistent with some of the extant hedging theory. These tests assumed that incorrectly classified firms were hedging firms but hedged less extensively than correctly classified hedgers. The chapter used for the first time dummy dependent variables to proxy for the extent of hedging and showed empirically that firms considered to be undertaking more hedging exhibit significantly different characteristics compared to firms that carry out only a small amount of hedging. In particular theories that explain risk management as a means to reduce the costs of financial distress and to break the firm's dependence on external financing were supported strongly.

Appendix A6.1

The discussion in chapter 4 shows that this study employs several proxies for the expected costs of financial distress. The models in Table 6.5 use the gross book value gearing proxy and find a significant positive relationship with hedging. The robustness of this finding is assessed by refitting model 2 in Table 6.5 using the other distress cost proxies discussed in chapter 4 and the variations on the gearing measure also defined in chapter 4. The results, presented in Table A6.1, show that the probability of hedging is significantly related to all, bar one, of these additional proxies. Furthermore, of the three additional gearing measures the gross market value gearing (model 6) and the net market value gearing (model 8) measures are significantly related to the decision to hedge.

Table A6.1 Multivariate Logistic Regression Results Employing Various Proxies for Expected Financial Distress Costs

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Tax loss carry forwards dummy	0.410	0.493	0.447	0.479	0.364	0.456	0.455	0.485
	0.232	0.174	0.215	0.182	0.315	0.225	0.205	0.182
Financial distress - see below.	-0.017***	-0.038	-1.400***	-1.175***	-0.031***	0.060***	0.007	0.032***
	0.001	0.467	0.001	0.001	0.001	0.000	0.137	0.005
Overseas operations dummy	1.968***	2.340***	2.418***	2.388***	2.004***	2.388***	2.271***	2.417***
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Liquidity - Cash ratio	-0.420**	-0.447*	-0.052	0.079	-0.303	-0.482*	-0.244	-0.151
	0.045	0.065	0.832	0.740	0.135	0.066	0.306	0.520
Firm size -Total assets	0.550***	0.665***	0.574***	0.621***	0.806***	0.408***	0.613***	0.554***
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
No. of Observations	398	360	362	362	387	359	365	365
No. of hedgers	312	284	282	282	306	281	286	286
No. of non-hedgers	86	76	80	80	81	78	79	79
-2 Restricted Log Likelihood (Slopes=0)	415.434	371.106	382.391	382.391	397.086	375.824	381.325	381.325
-2 Restricted Log Likelihood at Convergence	292.793	262.965	263.854	263.473	276.423	251.322	272.391	266.129
Chi-square (log-likelihood ratio)	122.641	108.141	118.537	118.918	120.663	124.502	108.934	115.196
Degrees of Freedom	5	5	5	5	5	5	5	5
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Financial distress variable Employed in model	Interest cover	Funds Flow Debt ratio	Net Interest Charge Dummy Average	Net Interest Charge Average Dummy	Credit Rating	Gross Market Value Gearing	Net Book Value Gearing	Net Market Value Gearing

Models in Table A6.2 employ four alternative proxies for foreign currency exposure. The results show that the tests are robust to the use of alternative measures of foreign currency exposure.

Table A6.2 Multivariate Logistic Regression Results Employing Various Proxies for Foreign Currency Exposure

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4
Tax loss carry forwards dummy	0.542 0.104	0.573* 0.089	0.728** 0.031	0.713** 0.043
Gross book value gearing	0.042*** 0.000	0.039*** 0.000	0.051*** 0.000	0.041*** 0.000
Foreign currency exposure - see below.	0.030*** 0.000	0.033*** 0.000	1.789*** 0.000	3.956*** 0.000
Liquidity - cash ratio	-0.613*** 0.005	-0.505** 0.026	-0.479** 0.016	-0.341 0.140
Firm size –Total assets (Natural log)	0.585*** 0.000	0.542*** 0.000	0.631*** 0.000	0.429*** 0.000
No. of Observations	389	374	398	352
No. of hedgers	304	291	312	244
No. of non-hedgers	85	83	86	108
-2 Restricted Log Likelihood (Slopes=0)	408.461	395.941	415.434	374.852
-2 Restricted Log Likelihood at Convergence	288.979	282.694	287.991	268.563
Chi-square (log-likelihood ratio)	119.482	113.247	127.443	106.289
Degrees of Freedom	5	5	5	5
P-value	0.000	0.000	0.000	0.000
Foreign currency variable employed in model	Foreign sales by destination	Foreign sales by origin	Import/Export dummy	Foreign tax ratio

Models in Table A6.3 employ the quick assets ratio and current ratio measures of liquidity. In five of the six models these measures of liquidity are not significantly related to the hedging decision. As noted in section 6.8, the preferred measure of liquidity, the cash ratio, is significantly related to the hedging decision.

Table A6.3 Multivariate Logistic Regression Results Employing Various Proxies for Liquidity

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Tax loss carry forwards dummy	0.853* 0.051	0.856** 0.049	0.484 0.159	0.856** 0.048	0.872** 0.044	0.491 0.154
Gross book value gearing	0.053*** 0.001	0.052*** 0.001	0.041*** 0.000	0.053*** 0.001	0.051*** 0.001	0.041*** 0.000
Capital expenditure	-0.126 0.902			-0.456 0.609		

Table A6.3 Multivariate Logistic Regression Results Employing Various Proxies for Liquidity

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Overseas operations dummy	1.948***	1.956***	1.967***	1.846***	1.867***	1.922***
	0.000	0.000	0.000	0.000	0.000	0.000
Liquidity - see below.	-0.450	-0.460*	-0.257	-0.260	-0.273	-0.133
	0.124	0.099	0.171	0.262	0.236	0.329
Firm size –Total assets (Natural log)	0.521***	0.520***	0.569***	0.519***	0.511***	0.563***
	0.001	0.001	0.000	0.001	0.001	0.000
No. of Observations	303	303	398	303	303	398
No. of hedgers	244	244	312	244	244	312
No. of non-hedgers	59	59	86	59	59	86
-2 Restricted Log Likelihood (Slopes=0)	298.76	298.76	415.43	298.76	298.76	415.43
-2 Restricted Log Likelihood at Convergence	201.30	201.31	287.19	202.41	202.64	288.18
Chi-square (log-likelihood ratio)	97.46	97.44	128.24	96.35	96.12	127.26
Degrees of Freedom	6	5	5	6	5	5
P-value	0.000	0.000	0.000	0.000	0.000	0.000
Liquidity variable employed in model	Quick asset ratio	Quick asset ratio	Quick asset ratio	Current ratio	Current ratio	Current ratio

Appendix A6.2

Table A6.4 Pearson Correlation Coefficients

Pearson correlation coefficients for a selection of the variables used in the logit regressions. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

		Tax losses	Gearing	Capital Expenditure	Gearing/ Growth Interaction	Overseas Operations	Cash ratio
Tax losses	Correlation	1					
	Sig. (2-tailed)						
	N	412					
Gearing	Correlation	-0.0209	1				
	Sig. (2-tailed)	0.6770					
	N	400	400				
Capital Expenditure	Correlation	-0.0547	-0.0142	1			
	Sig. (2-tailed)	0.3407	0.8053				
	N	305	304	305			
Gearing/Growth Interaction	Correlation	-0.0628	0.2082***	0.9178***	1		
	Sig. (2-tailed)	0.2732	0.0002	0.0000			
	N	306	306	304	306		
Overseas Operations	Correlation	0.1784***	0.0948*	-0.0881	-0.0075	1	
	Sig. (2-tailed)	0.0003	0.0582	0.1246	0.8955		
	N	412	400	305	306	412	
Cash ratio	Correlation	0.0237	-0.0469	0.4099***	0.3173***	-0.1335***	1
	Sig. (2-tailed)	0.6368	0.3496	0.0000	0.0000	0.0075	
	N	400	400	304	306	400	400
Total assets	Correlation	0.0200	0.1523***	0.0822	0.1294**	0.1676***	-0.0632
	Sig. (2-tailed)	0.6903	0.0023	0.1530	0.0235	0.0008	0.2075
	N	400	400	304	306	400	400

Note: Gearing/Growth interaction variable is derived by taking the product of gearing and capital expenditure. N signifies the number of observations.

Appendix A6.3

Table A6.5 Multivariate Tobit Regression Results For All Hedgers Using Annual Report Hedging Classifications

The data are presented as coefficients and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Tax loss carry forwards dummy	-0.027	-0.036	-0.057	0.001	-0.010
	0.848	0.780	0.677	0.989	0.942
Financial distress - see below.	0.007	0.006***	0.008*	0.392***	0.297***
	0.149	0.003	0.057	0.000	0.009
Foreign operations dummy	0.491***	0.454***	0.487***	0.337***	0.469***
	0.002	0.002	0.002	0.013	0.003
Cash ratio	-0.081	0.034	-0.014	-0.031	-0.047
	0.379	0.705	0.873	0.685	0.598
Firm size -Total assets (Natural log)	0.142***	0.137***	0.145***	0.129***	0.116***
	0.001	0.000	0.000	0.000	0.006
No. of Observations	162	166	166	176	162
No. of hedgers	84	87	87	90	84
No. of non-hedgers	78	79	79	86	78
-Log Likelihood at Convergence	120.583	120.061	122.714	119.771	118.103
Chi-squared	46.5	53.2	47.89	65.78	51.47
Degrees of Freedom	5	5	5	5	5
P-value	0.000	0.000	0.000	0.000	0.000
Financial distress variable employed in model	Gross Market Value Gearing	Net Book Value Gearing	Net Market Value Gearing	Ind. Adj. Gross Book Value Gearing	Ind. Adj. Gross Market Value Gearing

Appendix A6.4

Table A6.6 Multivariate Logit Regression Results For All Hedgers Using Annual Report Hedging Classifications

Sample compositions correspond with the tobit models in Table 6.12. The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Tax loss carry forwards dummy	0.712	0.573	0.868*	0.893*	0.677	0.820*	1.077**
	0.130	0.211	0.067	0.066	0.152	0.087	0.020
Financial distress - see below.	0.041***	-0.029***	-0.237	-1.783***	-0.032**	0.045***	0.046***
	0.001	0.006	0.127	0.004	0.018	0.000	0.000
Models 1 to 5:Foreign operations dummy Model 6:Foreign sales by destination Model 7:Foreign transactions dummy	1.375*** 0.001	1.478*** 0.001	1.499*** 0.001	1.661*** 0.001	1.303*** 0.003	0.030*** 0.000	1.481*** 0.001
Cash ratio	-0.094	-0.123	-0.247	0.239	-0.059	-0.323	-0.197
	0.718	0.601	0.334	0.896	0.796	0.230	0.416
Firm size -Total assets (Natural log)	0.797***	0.766***	0.841***	0.807***	1.021***	0.897***	0.847***
	0.000	0.000	0.000	0.000	0.000	0.000	0.000
No. of Observations	177	177	160	167	170	175	177
No. of hedgers	90	90	84	87	88	89	90
No. of non-hedgers	87	87	76	80	82	86	87
-Log Likelihood at Convergence	74.609	77.391	72.907	72.492	75.091	70.363	73.451
Chi-squared	96.1	90.54	75.59	86.23	85.28	101.82	98.42
Degrees of Freedom	5	5	5	5	5	5	5
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0 000
Financial distress variable employed in model	Gross Book Value Gearing	Interest cover	Funds Flow Debt ratio	Net Interest Charge Dummy	Credit Rating	Gross Book Value Gearing	Gross Book Value Gearing

Chapter 7. An Empirical Analysis of Interest Rate Hedging Practices of UK Firms

7.1 Introduction

This chapter investigates empirically the determinants of interest rate hedging activity by UK non-financial firms recognising that the theories of hedging do not specify which type of exposure should be hedged or which type of derivative should be used to hedge. The analysis examines both the factors influencing the firm's decision to hedge interest rate exposure and the extent of interest rate hedging. Firstly, a logit regression model with a binary dependent variable is used to examine the effect of the independent variables on the probability of hedging by the firm. Secondly, a tobit and a two stage estimation regression model with a continuous dependent variable analyse the effect of the independent variables on the degree of hedging by the firm.

Most of the existing research examining interest rate risk management focuses on the financial institutions industry because mandatory disclosure requirements have provided information about the use of derivatives by financial institutions since the early 1990s. By examining interest rate hedging activity by non-financial firms that face different interest rate risk problems than financial institutions, this chapter makes a contribution to the literature on interest rate risk management.

Furthermore, by focusing on the type of exposure hedged (i.e., interest rate exposure) rather than hedging in general the empirical tests in this chapter recognise that different factors might be important for each type of hedging. In particular the results show a strong link between a firm's investment opportunities as proxied by capital expenditure and the interest rate hedging decision. Tests in chapter 6 found no relationship between investment opportunities and all hedging. These findings seem to demonstrate that the financial contracting cost implications of higher levels of capital expenditure are controlled better via interest rate hedging rather than other types of hedging.

Initial multivariate tests show that none of the various proxies employed for financial distress costs are significantly related to interest rate hedging. These results are in stark contrast to those of chapter 6, which show that all bar two of the financial distress proxies are significantly related to hedging. However, close scrutiny of the non-interest rate hedging sample reveals that the interest rate tests are biased because the non-interest hedging sample incorporates firms that hedge other exposures. Subsequent tests which exclude these other hedgers not only demonstrate an improvement in the ability to detect a relationship between the interest rate hedging decision and various proxies for financial distress costs but also other financial and operating characteristics. It is believed that these tests are the first to demonstrate this kind of result. This evidence suggests that the conflicts between the results of this study and the results of previous studies might be explained by the treatment of other hedgers in the non-interest rate hedging sample.

This chapter begins by describing the dependent variables employed in the empirical tests. Section 7.3 presents the results of estimating various specifications of the multivariate logit model. Section 7.4 presents the results of refitting the multivariate logit model using the sample of non-interest rate hedgers that excludes other hedgers. Section 7.5 examines the determinants of interest rate hedging for a sample of small firms. Section 7.6 refits the multivariate logit model using the hedging classifications for the subset of firms for which both survey and annual report data are available. Section 7.7 uses tobit regression methodology and Cragg's (1971) two-stage model to examine the determinants of the extent of interest rate hedging. Finally, section 7.8 presents conclusions.

7.2 Identifying Interest Rate Hedging Firms and Measuring Interest Rate Hedging

As discussed previously, this study uses qualitative disclosures by firms in their annual reports to identify interest rate hedging firms. In the event that a firm discloses it hedges interest rate exposure, then the firm is assigned a value of one, classifying it as an 'interest rate hedger'.[1] On the other hand, if the firm states that it does not hedge interest rate exposure or there is no discussion of interest rate hedging, then the firm is assigned a value of zero, classifying it as a 'non-interest rate hedger'.[2] Table 7.1 shows that 44.4 percent of firms were classified as interest rate hedgers.[3]

Table 7.1 Interest Rate Hedging Activity Disclosures by UK Firms

	No.	%
Interest rate hedging	183	44.4
Not hedging interest rate exposure/Non-disclosure	229	55.6
Total	**412**	**100.0**

Table 7.2 shows that of those firms classified as interest rate hedgers 162 firms or 88.5 percent disclose the use of derivatives and of these 91 firms or 56 percent disclose notional amounts of interest rate derivatives.

[1] These firms might also be hedging other exposures such as foreign currency or commodity price exposure.
[2] Mian (1996), Visvanathan (1997) and Li (1998) have also employed the use of a dichotomous dependent variable for interest rate hedging, whereas Graham and Rogers (1999) use both a dummy dependent and continuous dependent variable. Several studies use binary dichotomous dependent variables in the examination of the determinants of the use of interest rate swaps. See, for example, Samant (1996), Li (1996), Visvanathan (1997), Saunders (1999), and Simkins (1999).
[3] This Table is a modified version of Table 4.10.

Table 7.2 Interest Rate Hedging and Derivatives Disclosure by UK Firms

	No.
Interest rate hedging	183
Interest rate derivatives	162
Notional amounts of interest rate derivatives	91

Descriptive statistics of the interest rate derivative positions held by firms disclosing notional amounts of interest rate derivatives at the end of financial year 1995 are displayed in Table 7.3. This Table shows that the distribution of interest rate derivatives use is skewed with mean derivative contract values fives times higher than the median contract value. The mean and median notional values of interest rate derivative positions are £468.549 million and £91.8 million, respectively.

For the extent of participation models (i.e., tobit and second stage of the Cragg model) the dependent variable is a continuous measure of the extent of hedging for those firms that report the notional value of interest rate derivatives in their annual report. The ratio of the total notional value of interest rate derivative contracts to total assets of the firm constitutes the dependent hedging variable.[4] The 229 firms categorised as non-interest rate hedgers are designated as having zero holding of interest rate derivatives and therefore the extent of interest rate hedging is zero. For firms disclosing notional amounts of interest rate derivatives Table 7.3 shows that this measure ranges from 1.1 percent to 121.4 percent of the book value of total assets, with a mean of 19.6 percent.

[4] Although several studies examine the use of interest rate derivatives only Gay and Nam (1998), Howton and Perfect (1998) and Graham and Rogers (1999) develop a continuous measure of interest rate hedging activity. All three studies use notional values as a measure of interest rate derivatives activity. Graham and Rogers (1999) also use net notional amounts and Howton and Perfect (1998) also use fair values.

Table 7.3 Notional Values of Interest Rate Derivative Contracts in £millions held by Interest Rate Derivative Users

	N	Min.	25th Percentile	Median	Mean	75th Percentile	Max.	Std. Dev.
Total positions (£m)	91	10	31.4	91.8	468.549	383.6	7192	1064.103
Scaled by total assets	90	0.011	0.079	0.147	0.196	0.234	1.214	0.202

Note: Data on total assets missing for 1 firm.

7.3 Estimating the Interest Rate Hedging Decision Model

Following exactly the methodology employed for 'all hedging' in Chapter 6, the determinants of the decision to hedge interest rate exposure are now investigated. Prior to estimating the multivariate model a univariate logistic regression model is fitted for each variable. The results of this univariate analysis are presented in Table 7.4.

Table 7.4 Univariate Logistic Regression Results for Interest Rate Hedging Firms

***, **, * denote significance at the 1%, 5%, and 10% levels, respectively. Variables in shade are selected for the multivariate model.

Independent Variables	Coeff-icient	Standard error	Odds ratio	Wald statistic	P-value (coeff-icient)	Chi-Squared statistic	P-value (model)
1. Tax Function Convexity							
Tax loss carry forwards dummy	0.378*	0.210	1.459	3.242	0.072	3.248	0.072
2. Expected Costs of Financial Distress							
Gross gearing book value	0.044***	0.007	1.045	39.040	0.000	54.525	0.000
Industry adjusted gross gearing book value	1.175***	0.212	3.238	30.751	0.000	37.517	0.000
Gross gearing market value	5.886***	0.924	359.809	40.614	0.000	52.553	0.000
Industry adjusted gross gearing market value	0.868***	0.174	2.381	24.730	0.000	28.460	0.000
Net gearing book value	2.923***	0.517	15.596	31.973	0.000	48.893	0.000
Net gearing market value	4.933***	0.842	138.806	34.303	0.000	44.642	0.000
Credit rating (Quiscore)	-0.003	0.005	0.997	0.271	0.603	0.271	0.603
Interest cover	-0.031***	0.007	0.970	21.389	0.000	36.025	0.000
Funds flow debt ratio	-0.101**	0.060	0.904	2.780	0.096	4.104	0.043
Net interest charge dummy average	-1.504***	0.318	0.222	22.359	0.000	25.160	0.000
Net interest charge average dummy	-1.085***	0.268	0.338	16.459	0.000	17.917	0.000
3. Costs of Underinvestment							
Firm Growth Options							
Capital expenditure	3.476***	1.371	32.321	6.423	0.011	9.452	0.002
Price-earnings ratio	-0.004	0.003	0.996	1.295	0.255	2.409	0.121
Market-to-book ratio	-0.045**	0.026	0.956	2.965	0.085	5.679	0.017
R&D sales ratio	-0.078**	0.063	0.925	1.532	0.216	4.445	0.035
4. Sources of Cash Flow Volatility							
Measures of Foreign Currency Exposure							
Foreign sales by destination	0.006*	0.003	1.006	3.101	0.078	3.115	0.078
Foreign sales by origin	0.011***	0.004	1.011	8.833	0.003	8.986	0.003
Overseas tax	0.755**	0.376	2.127	4.036	0.045	4.396	0.036
Foreign currency transactions dummy	0.083	0.213	1.086	0.150	0.698	0.150	0.698
Foreign operations dummy	1.012***	0.264	2.750	14.660	0.000	15.941	0.000
Foreign currency debt dummy	1.372***	0.237	3.944	33.396	0.000	36.979	0.000

Table 7.4 Univariate Logistic Regression Results for Interest Rate Hedging Firms
***, **, * denote significance at the 1%, 5%, and 10% levels, respectively. Variables in shade are selected for the multivariate model.

Independent Variables	Coeff-icient	Standard error	Odds ratio	Wald statistic	P-value (coeff-icient)	Chi-Squared statistic	P-value (model)
5. Hedging Substitutes							
Liquidity - Cash ratio	-0.183	0.164	0.833	1.241	0.265	1.338	0.247
Liquidity - Quick assets ratio	-0.304**	0.161	0.738	3.569	0.059	4.092	0.043
Liquidity - Current ratio	-0.450***	0.146	0.638	9.541	0.002	12.527	0.000
Convertible debt/Total assets	17.96***	5.794	6.3E+06	9.608	0.002	11.651	0.001
Preference capital/Total assets	-0.589	1.008	0.555	0.341	0.560	0.388	0.533
Dividend yield	0.167**	0.066	1.181	6.287	0.012	6.452	0.011
6. Information and Transaction Cost Scale Economies							
Firm size - Market value of equity (Natural log)	0.899***	0.108	2.457	68.904	0.000	94.392	0.000
Firm size - Total assets (Natural log)	0.988***	0.105	2.687	89.544	0.000	138.477	0.000
Treasury staff dummy	1.760***	0.222	5.810	63.029	0.000	69.358	0.000

These results show that several groups of variables have the hypothesised relationship with interest rate hedging at the univariate level. All of the proxies for the expected costs of financial distress and information and transaction cost scale economies have a significant relationship with interest rate hedging. Several of the proxies for hedging substitutes are significantly related to interest rate hedging. For example, two of the three liquidity measures, and the dividend yield exhibit the hypothesised relationship with interest rate hedging. The convertible debt variable has a significant positive relationship with hedging contrary to the arguments put forward by Nance et al. (1993) but consistent with the Froot et al. (1993) argument that convertible debt implies additional gearing and so limits a firm's access to external funds. Firms that are financially constrained in this way are exposed to higher underinvestment costs and thus have a greater incentive to hedge.

For the group of growth option variables only the capital expenditure variable is significantly positively related to interest rate hedging while the other three variables exhibit a negative relationship. Table 7.4 also presents univariate results for the relationship between interest rate hedging and variables that the empirical analysis in chapter 6 used as indicators of foreign currency exposure. Most of these variables give an indication of either the existence of foreign operations (i.e., foreign operations dummy and foreign currency debt dummy) or the level of foreign operations (i.e., foreign sales by origin and level of foreign tax). The univariate results show that interest rate hedging is significantly related to these foreign operations variables.[5]

The variables for the multivariate logistic regression interest rate hedging model are selected using the approach employed in chapter 6, that is, selecting from each group the variable with the hypothesised sign and the highest chi-square statistic in the univariate logistic regression model. The univariate logistic regression results indicate the inclusion of the following variables for estimating the multivariate model: tax losses dummy, gross book value gearing, capital expenditure, foreign currency debt dummy, current ratio and the natural log of total assets. The following logistic model is estimated to test theories of incentives for firms to hedge interest rate risk:

$$\begin{aligned} y^*_i = \beta_1 + \beta_2 \text{Tax Convexity}_i + \beta_3 \text{Financial Distress}_i + \beta_4 \text{Underinvestment Cost}_i \\ + \beta_5 \text{Cash Flow Volatility}_i + \beta_6 \text{Hedging Substitutes}_i + \beta_7 \text{Transaction Costs}_i + u_i \end{aligned} \qquad 7.1$$

The results of fitting this multivariate model, labelled Model 1, together with results of the univariate tests for each variable in the model are presented in Table 7.5.

Table 7.5 Multivariate Logistic Regression Model Results for Interest Rate Hedging Firms
The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Univariate Model	Model 1	Model 2	Model 3	Model 4
Tax loss carry forwards dummy	0.378	0.389		0.361	0.366
	0.072*	0.218		0.250	0.243
Gross book value gearing	0.044***	0.015*	0.016*	0.017**	0.017**
	0.000	0.082	0.079	0.047	0.048
Capital expenditure	3.476**	4.118**	3.897**	5.332**	4.826**
	0.011	0.026	0.032	0.011	0.015

[5] A foreign transactions dummy measuring the incidence of exports or imports is not significantly related to interest rate hedging.

Table 7.5 Multivariate Logistic Regression Model Results for Interest Rate Hedging Firms
The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Univariate Model	Model 1	Model 2	Model 3	Model 4
Foreign currency debt dummy	1.372***	0.989**	1.051***	0.958**	0.999**
	0.000	0.014	0.009	0.016	0.013
Models 1 & 2 use the current ratio	-0.450***	-0.521**	-0.491*	-0.671*	-0.534*
Model 3 uses the cash ratio	0.002	0.043	0.052	0.091	0.078
Model 4 uses the quick ratio					
Firm size -Total assets (Natural log)	0.988***	0.905***	0.899***	0.925***	0.906***
	0.000	0.000	0.000	0.000	0.000
No. of Observations	NA	303	303	303	303
No. of interest rate hedgers	NA	139	139	139	139
No. of non-interest rate hedgers	NA	164	164	164	164
-2 Restricted Log Likelihood (Slopes=0)		417.982	417.982	417.982	417.982
-2 Restricted Log Likelihood at Convergence		276.799	278.324	278.263	277.863
Chi-squared (log-likelihood ratio)	NA	141.183	139.658	139.719	140.119
Degrees of Freedom		6	5	6	6
P-value	NA	0.000	0.000	0.000	0.000
Likelihood ratio test for the difference between model			1 and 2		
Chi-squared			1.525		
P-value			0.217		

For each variable the table displays the log of odds and p-value. The Table also presents summary statistics. The particular summary statistic of interest is the model's chi-squared statistic, which provides a test for the overall significance of the model. The test statistic for model 1 is 141.183, which, with 6 degrees of freedom, is also highly significant (p-value = 0.000). Therefore, at least one of the coefficients in the model is nonzero.[6] An inspection of p-values reveals that capital expenditure, foreign currency debt, current ratio and natural logarithm of total assets are significant at the 5 percent level or better.

The coefficient on the tax loss dummy and the gearing variable is not significant suggesting that one of these variables should be dropped in fitting the next model. The lower p-value for the tax loss dummy variable indicates that this should be dropped. The results of fitting this model, Model 2, are also presented in Table 7.5. All bar one of the remaining five variables have statistically significant coefficients which are qualitatively similar to those in Model 1.[7] Model 2 is compared to Model 1 using the likelihood ratio test, which reveals a chi-square value of 1.525 with a p-value of 0.217. This demonstrates that the tax loss dummy variable makes no contribution to the model even once the other variables have been included in the model.[8]

A significant positive relation between capital expenditure and interest rate hedging is consistent with firms hedging to minimise underinvestment costs when they have growth options (Bessembinder (1991) and Froot et al. (1993)).[9]

This study also documents a relationship between the use of foreign currency debt and the likelihood of interest rate hedging. Given that the most popular interest rate hedging tool was identified as being the interest rate swap this finding is consistent with the notion that firms issuing foreign currency debt use interest rate derivatives to manage the interest rate risk profile of the foreign debt.[10]

A significant negative relation between the level of liquidity and the likelihood of interest rate hedging is consistent with the notion that the availability of internal funds implies a lower likelihood of hedging (Froot et al. (1993)) and that firms with

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[6] The model chi-squared in logistic regression tests only whether any of the predictors are linearly related to the log odds of the event of interest. It is not a test for the goodness of fit of the model to the data (Demaris (1992)).

[7] Variables whose coefficients have changed markedly in magnitude would indicate that the excluded variable was important in the sense of providing a needed adjustment of the effect of the variable that remained in the model.

[8] Li (1996) finds contrary to expectations statistically significant negative coefficients for tax loss carryforwards.

[9] The other three growth proxies, price earnings ratio, market-to-book ratio and R&D expenditure, are not significantly related to interest rate hedging. These tests are not reported.

[10] Howton and Perfect (1998) report a significant positive relationship between their foreign income dummy variable (which proxies for currency exposure) and the level of interest rate derivatives.

higher liquidity are faced with lower levels of agency costs of debt and expected costs of financial distress (Nance et al. (1993)).[11]

The positive association between firm size and interest rate hedging suggests that the relation between size and hedging is more strongly influenced by economies of scale in hedging activities rather than direct financial distress costs or information asymmetry costs such as those associated with raising external finance.[12]

7.3.2 Using Alternative Proxies for The Expected Costs of Financial Distress

This study employs in addition to gearing several other proxies for the expected costs of financial distress, these are interest cover, funds flow ratio, two dummy variables indicating whether a firm has net interest receivable or payable and a firms' credit rating as measured by its Qui score.[13] Each of these variables replaces gearing in model 3 of Table 7.5. The results in Table 7.6 show that none of the coefficients for these expected financial distress costs proxies are significant.

Table 7.6 Multivariate Logistic Regression Model Results for Interest Rate Hedging Firms Employing Alternative Proxies for Financial Distress Costs

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Tax loss carry forwards dummy	0.331	0.337	0.339	0.345	0.278
	0.289	0.278	0.282	0.274	0.392
Financial distress proxy - see below	-0.003	0.014	-0.279	-0.276	-0.009
	0.696	0.809	0.574	0.492	0.316
Capital expenditure	5.676***	5.862***	5.667***	5.678***	6.159***
	0.008	0.004	0.009	0.008	0.006

[11] Li (1996) finds that firms with more liquid assets (higher quick ratios) are less likely to use interest rate swaps. In tobit tests Howton and Perfect (1998) report a significantly negative relationship between liquidity and the level of interest rate derivatives. Mian (1996) and Graham and Rogers (1999) employ a liquidity variable in univariate tests and find that interest rate hedgers have lower levels of liquidity relative to non interest rate hedgers.

[12] Mian (1996), Li (1996), Howton and Perfect (1998) and Graham and Rogers (1999) all document a positive relationship between firm size and interest rate hedging. However, Gay and Nam (1999) report a significant negative relationship between interest rate derivatives use and firm size.

[13] See discussion in chapter 4 for a full explanation of how this variable is measured.

Table 7.6 Multivariate Logistic Regression Model Results for Interest Rate Hedging Firms Employing Alternative Proxies for Financial Distress Costs

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Foreign currency debt dummy	1.159***	1.230***	1.182***	1.174***	1.146***
	0.004	0.002	0.003	0.003	0.004
Liquidity - cash ratio	-0.737*	-0.777**	-0.665	-0.656	-0.651
	0.071	0.049	0.140	0.133	0.130
Firm size -Total assets (Natural log)	0.962***	0.968***	0.996***	0.999***	0.988***
	0.000	0.000	0.000	0.000	0.000
No. of Observations	303	300	300	300	294
No. of interest rate hedgers	139	139	137	137	135
No. of non-interest rate hedgers	164	161	163	163	159
-2 Restricted Log Likelihood (Slopes=0)	417.982	414.274	413.632	413.632	405.609
-2 Restricted Log Likelihood at Convergence	283.529	283.207	276.19	276.032	272.498
Chi-squared (log-likelihood ratio)	134.453	131.067	137.442	137.6	133.111
Degrees of Freedom	6	6	6	6	6
P-value	0.000	0.000	0.000	0.000	0.000
Proxies for the Expected Costs of Financial Distress Employed in Model:	Interest Cover	Funds Flow Debt Ratio	Net Interest Charge Dummy Average	Net Interest Charge Average Dummy	Credit rating (Qui-Score)

The empirical tests also use several additional measures of gearing. These are a market value measure of gross gearing, a market and book value measure of net gearing and following the arguments in chapter 3, industry adjusted gearing measures. Table 7.7 shows that none of these alternative measures of gearing are significant.

Table 7.7 Multivariate Logistic Regression Results for Interest Rate Hedging Firms Employing Alternative Measures of Gearing

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Tax loss carry forwards dummy	0.330	0.354	0.338	0.364	0.365
	0.293	0.256	0.278	0.244	0.246
Various measures of gearing - see below	0.003	0.009	0.006	0.174	-0.099
	0.801	0.179	0.615	0.518	0.654

Table 7.7 Multivariate Logistic Regression Results for Interest Rate Hedging Firms Employing Alternative Measures of Gearing

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Capital expenditure	5.514**	4.867**	5.390**	5.888***	5.741***
	0.011	0.025	0.017	0.005	0.007
Foreign currency debt dummy	1.216***	1.072***	1.173***	1.142***	1.263***
	0.002	0.006	0.003	0.003	0.001
Liquidity - cash ratio	-0.788**	-0.478	-0.652	-0.730*	-0.834**
	0.048	0.283	0.161	0.066	0.038
Firm size -Total assets (Natural log)	0.952***	0.927***	0.955***	0.945***	0.979***
	0.000	0.000	0.000	0.000	0.000
No. of Observations	298	302	302	301	298
No. of interest rate hedgers	137	139	139	137	137
No. of non-interest rate hedgers	161	163	163	164	161
-2 Restricted Log Likelihood (Slopes=0)	411.181	416.752	416.752	414.849	411.181
-2 Restricted Log Likelihood at Convergence	279.834	281.365	283.417	281.298	279.696
Chi-squared (log-likelihood ratio)	131.347	135.387	133.335	133.551	131.485
Degrees of Freedom	6	6	6	6	6
P-value	0	0	0	0	0
Proxies for the Expected Costs of Financial Distress: Various measures of gearing	Gross Market Value Gearing	Net Book Value Gearing	Net Market Value Gearing	Industry Adjusted Book Value Gearing	Industry Adjusted Market Value Gearing

Overall, of the 11 specifications (model 3 in Table 7.5 and models in Tables 7.6 and 7.7) that use various proxies for expected costs of financial distress none display a significant relationship between a proxy for expected distress costs and the probability of interest rate hedging. Therefore, these results provide no support for the hypothesis that expected costs of financial distress influence the decision to hedge interest rate exposure. These findings are in sharp contrast to those of Chapter 6, which showed that 9 of the 11 corresponding specifications displayed significant financial distress cost coefficients.

7.4 Estimating the Interest Rate Hedging Decision Model with Hedgers Excluded from the Non-Hedging Group

The results presented in section 7.3 identified empirically the determinants of interest rate hedging using a sample of interest rate hedgers and non-interest rate hedgers. A very surprising result was that none of the proxies for expected financial distress costs were significantly related to the likelihood of interest rate hedging. This was unexpected since one of the main purposes of interest rate hedging is to hedge the interest rate cash flows from debt liabilities. Furthermore, most of the distress cost proxies employed in this study are also indicators of the level of interest rate exposure.

Previous discussions have noted that the non-interest rate hedging group includes firms that are in fact hedging other exposures such as foreign currency or commodity price risks. Table 4.12 in chapter 4, reproduced below, shows that over 60 percent of non-interest rate hedgers are hedging other exposures.

Table 4.12 Firms Not Hedging Interest Rate Exposure

	No.	%
Interest Rate Non-Hedgers	**91**	**39.7**
Interest Rate Non-Hedgers Hedging Other Exposures	**138**	**60.3**
Total	**229**	**100**

From Table 4.13, also reproduced below, it can be seen that over 90 percent of these "other hedgers" are hedging foreign currency exposure only.

Table 4.13 Interest Rate Non-Hedgers Hedging Other Exposures

Hedgers	**No.**	**%**
Foreign exchange only	**128**	**92.8**
Foreign exchange & commodity price	**7**	**5.1**
Commodity price only	**3**	**2.2**
Total	**138**	**100[a]**

It has been argued previously that the inclusion of "other hedgers" in the non-hedging sample might have a significant bearing on the ability to detect a relationship between the decision to hedge interest rate exposure and various firm level characteristics.[14] To test whether the inclusion of "other hedgers" biases the empirical results against the a priori expectations several of the models estimated in section 7.3 are refitted excluding these "other hedgers" from the non-interest rate hedging group.[15]

The results in Table 7.8 show that the exclusion of these firms has a significant impact on the size and significance of the various proxies for the expected costs of financial distress. The coefficients on all of the financial distress cost variables have increased in absolute terms and the p-values have fallen and several measures of gearing are now statistically significant at the 5 percent level. All of these variables were statistically insignificant in tests, which included "other hedgers" in the non-hedging group.[16] The coefficients on the liquidity variable (cash ratio) and firm size variable have increased in absolute terms in all specifications bar one. Finally, the tax loss dummy variable is now significant in all specifications compared to being insignificant prior to the adjustment.

These results demonstrate empirically that removing "other hedgers" from the non-interest rate hedging group significantly improves the ability to identify

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[14] This problem of the composition of the non-hedging group was identified as a criticism of several previous studies (Mian (1996), Visvanathan (1997), Howton and Perfect (1998) and Graham and Rogers (1999)). Allayannis and Weston (2001) recognise this as being a problem in their study of the effect of the use of foreign currency derivatives on firm value. They point out that interest rate derivative users that have been misclassified as nonhedgers would "bias results against us" if interest rate hedging is also a value increasing strategy. Their empirical results demonstrate this to be the case.

[15] Table A7.1 in Appendix A7.1 presents tests for differences in the mean values of firm size between non-hedgers, other hedgers and interest rate hedgers. The results show that non-hedgers and other hedgers are not significantly different with respect to firm size whereas interest rate hedgers are significantly larger than both other hedgers and non-hedgers. These results demonstrate that the removal of other hedgers from the non-interest rate hedging sample does not significantly change the samples size characteristics. Additionally, Table A7.2 shows that the size characteristics of the other hedging and non-hedging groups are similar.

relationships between the explanatory variables and the interest rate hedging decision. The improvement in the results is most significant for the financial distress cost variables. This finding not only demonstrates the importance of the expected costs of financial distress for interest rate hedgers but also indirectly indicates the importance of these costs to firms that do not hedge interest rate exposure but hedge other financial price exposures. Finally, the results in this section seem to suggest that the lack of strong evidence in support of several theories of hedging in previous empirical studies might be due to the inclusion of "other hedgers" in the non-hedging sample.

[16] See Tables 7.6 and 7.7.

Table 7.8 Multivariate Logistic Regression Results for Interest Rate Hedging Firms - Excluding Hedging Firms from the Non-Interest Rate Hedging Group

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11
Tax loss carry forwards dummy	1.705**	1.766**	1.820***	1.914***	1.849***	1.671**	1.721**	1.823***	1.900***	1.781**	1.910***
	0.015	0.012	0.009	0.007	0.008	0.020	0.018	0.009	0.008	0.012	0.007
Financial distress proxy - see below	0.041**	-0.010	0.001	-1.234*	-1.067*	-0.024	0.079***	0.0172	0.053**	1.141**	9.419*
	0.019	0.337	0.984	0.100	0.089	0.208	0.010	0.176	0.048	0.042	0.068
Capital expenditure	4.320	5.511**	6.200**	5.248**	5.552**	6.644**	1.7377	4.4783	2.863	4.999*	4.302
	0.104	0.033	0.011	0.037	0.024	0.013	0.489	0.1024	0.322	0.053	0.107
Foreign currency debt dummy	3.197***	3.467***	3.636***	3.569***	3.587***	3.377***	3.412***	3.418***	3.456***	3.420***	3.466***
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Liquidity - Cash ratio	-1.221**	-1.262**	-1.405***	-0.974	-1.024*	-1.238**	-1.267**	-0.978	-0.510	-1.202**	-1.584***
	0.033	0.026	0.008	0.119	0.087	0.040	0.025	0.123	0.489	0.034	0.006
Firm size -Total assets (Natural log)	1.040***	0.984***	1.007***	1.008***	1.051***	1.025***	0.868***	1.019***	0.998***	0.953***	1.119***
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
No. of Observations	198	198	195	196	196	194	194	197	197	196	198
No. of interest rate hedgers	139	139	139	137	137	135	137	139	139	137	139
No. of non-interest rate hedgers	59	59	56	59	59	56	57	58	58	59	59
-2 Restricted Log Likelihood (Slopes=0)	241.221	241.221	233.847	239.797	239.797	231.105	234.946	238.787	238.787	239.797	241.221
-2 Restricted Log Likelihood at Convergence	95.832	101.315	100.457	99.147	98.821	96.918	88.91	100.263	97.688	97.666	98.808
Chi-squared (log-likelihood ratio)	145.389	139.906	133.39	140.65	140.976	134.187	146.036	138.524	141.099	142.131	142.413
Degrees of Freedom	6	6	6	6	6	6	6	6	6	6	6
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Proxies for the Expected Costs of Financial Distress Employed in Model:	Gross Book Value Gearing	Interest Cover Ratio	Funds Flow Debt Ratio	Net Interest Charge Dummy Average	Net Interest Charge Dummy Average	Credit Rating (Qui Score)	Gross Market Value Gearing	Net Book Value Gearing	Net Market Value Gearing	Industry Adjusted Gross Book Value Gearing	Industry Adjusted Gross Market Value Gearing
Model specification equivalent to:	Model 3 Table 7.5	Model 1 Table 7.6	Model 2 Table 7.6	Model 3 Table 7.6	Model 4 Table 7.6	Model 5 Table 7.6	Model 1 Table 7.7	Model 2 Table 7.7	Model 3 Table 7.7	Model 4 Table 7.7	Model 5 Table 7.7

7.5 Estimating the Interest Rate Hedging Decision Model Using a Sample of Small Firms

The analysis in the previous section demonstrated that the inclusion of other hedging firms in the non-interest rate hedging sample biased the results against finding a significant relationship. In particular, the removal of other hedgers resulted in finding a significant relationship between gearing and interest rate hedging. However, the exclusion of other hedgers from the non-interest rate hedging sample leaves a sample of non-interest rate hedgers that has a significantly smaller firm size than interest rate hedgers. Therefore, it might be the case that firm size is influencing the results with respect to other variables found to be relevant to the interest rate hedging decision. In view of this potential problem the interest rate hedging model is estimated using a sample of small firms. Small firms are defined as those that are ranked below 300 in the FT500 ranking. Table 7.9 presents the results of fitting model 7.1 to the sample of small firms. The results show that gearing, capital expenditure, foreign currency debt and liquidity are important determinants of the interest rate hedging decision for small firms. These results demonstrate that the firm size variable is not driving the results with respect to the other variables in the model. The results also show that the exclusion of other hedgers from the non-interest rate hedging sample leads to changes in coefficients and p-values which are generally consistent with the a priori expectations (compare models 1 and 2, and 3 and 4).

Table 7.9 Multivariate Logistic Regression Results: Determinants of Interest Rate Hedging For Small Firms

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively. Models 2 and 4 exclude other hedgers from the non-interest rate hedging sample.

Independent Variables	Model 1	Model 2	Model 3	Model 4
Tax loss carry forwards dummy	-0.023 0.973	2.518 0.117	-0.367 0.460	0.455 0.668
Gross book value gearing	0.031 0.157	0.111** 0.043	0.041*** 0.004	0.058*** 0.010

Table 7.9 Multivariate Logistic Regression Results: Determinants of Interest Rate Hedging For Small Firms

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively. Models 2 and 4 exclude other hedgers from the non-interest rate hedging sample.

Independent Variables	Model 1	Model 2	Model 3	Model 4
Capital expenditure	9.131**	3.329		
	0.026	0.637		
Foreign currency debt dummy	1.657*	5.354***	1.226**	4.745***
	0.059	0.004	0.020	0.000
Liquidity	-1.247**	-1.773	-0.671*	-1.105**
	0.031	0.122	0.094	0.048
Firm size	0.237	0.997	0.401	0.921*
	0.567	0.322	0.149	0.066
No. of Observations	105	52	155	86
No. of Hedgers	18	18	32	32
No. of Non-hedgers	87	34	123	54
-2 Restricted Log Likelihood (Slopes=0)	96.210	67.083	157.857	113.530
-2 Restricted Log Likelihood at Convergence	74.593	21.106	126.358	43.916
Chi-squared (log-likelihood ratio)	21.617	45.977	31.499	69.615
Degrees of Freedom	6	6	5	5
P-value	0.001	0.000	0.000	0.000

7.6 Estimating the Interest Rate Hedging Decision Model Using Survey Data

The empirical tests in all previous sections used the hedging and non-hedging classifications determined by the data collected from annual reports. A unique aspect of this study is the fact that it has collected data through both information published in annual reports and a survey mailed to corporate treasurers. The tests in this section utilise the survey responses to identify hedgers and non-hedgers.

Earlier analysis revealed that of the 186 firms responding to the survey this study had annual report data for 174 firms.[17] Table 7.10 shows the interest rate hedging classification of firms in both the survey sample and the corresponding annual report sample. The difference in the number of hedgers and non-hedgers between the two samples indicates a significant degree of inconsistency in hedging classifications.

[17] See section 4.3.25 in Chapter 4.

Table 7.10 Hedging Interest Rate Exposure: Survey and Annual Report Evidence

	Survey[1]	%	Annual Report	%
Yes	129	74.1	85	48.9
No[2]	45	25.9	89	51.1
Total	174	100	174	100

[1]Here we exclude the 12 firms for which we do not have corresponding annual report evidence.
[2]For the annual report evidence "no" includes non disclosure.

A detailed comparison was made between the annual report disclosure and the survey response for these 174 firms in chapter 4. Table 4.60, reproduced below, presents the results of this comparison. The Table shows that 126 of the 174 firms in the annual report database were classified correctly as either interest rate hedgers or non-hedgers (i.e., their survey interest rate hedging classification corresponded with that determined from the annual report). However, 46 hedging firms were classified incorrectly as non-hedgers (i.e., their survey response indicated that they hedged interest rate exposure whereas their annual report contained no mention of this hedging activity) and 2 non-hedging survey firms were incorrectly classified as hedgers by annual report data.[18]

Table 4.60 Comparison of Interest Rate Hedging Classifications Using Survey and Annual Report Data

Firm Classification	No.	%
Survey says Non-hedger & Annual Report says Non-hedger[a]	43	24.7
Survey says Non-hedger & Annual Report says Hedger[b]	2	1.2
Survey says Hedger & Annual Report says Hedger[a]	83	47.7
Survey says Hedger & Annual Report says Non-hedger[b]	46	26.4
Total	174	100

[a]Correctly classified firms total 126.
[b]Incorrectly classified firms total 48.

The models that were estimated previously in section 7.3 are now re-estimated using the subset of 174 survey firms and employing the survey hedging classifications. Table 7.11 presents the results of estimating the following logistic regression model:

$$y^*_i = \beta_1 + \beta_2\text{Tax Convexity}_i + \beta_3\text{Financial Distress}_i + \beta_4\text{Underinvestment Cost}_i + \beta_5\text{Cash Flow Volatility}_i + \beta_6\text{Hedging Substitutes}_i + \beta_7\text{Transaction Costs}_i + u_i \qquad 7.1$$

The results show that the financial distress cost variable is significant at the 5 percent level in five of the eleven models specified. In section 7.3 the same models were fitted using the annual report classifications and it was shown that none of the eleven models had a significant financial distress cost variable. The results in Table 7.11 demonstrate that correcting for firm misclassifications leads to a significant improvement in the ability to detect a relationship between the various financial distress cost variables and the interest rate hedging decision. The tax loss dummy variable also follows a similar pattern. The effect of misclassification seems to have only a small impact on the foreign currency debt dummy and firm size variables with very little change in the overall results. However, both the capital expenditure and liquidity variables are now insignificant as opposed to being significant in the models discussed in section 7.3.

[18] The correct classification is deemed to be that contained in the survey response.

Table 7.11 Multivariate Logistic Regression Results for Interest Rate Hedging Firms - Survey Data

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11
Tax loss carry forwards dummy	1.285**	1.281**	1.333**	1.345**	1.158**	1.148**	1.256**	1.280**	1.301**	1.308**	1.366**
	0.028	0.022	0.017	0.014	0.038	0.041	0.031	0.020	0.019	0.024	0.016
Financial distress various - see below	0.084***	-0.007	-1.942**	-0.436	-0.027*	-0.423	0.112***	0.011	0.049*	1.848***	1.161**
	0.002	0.523	0.041	0.518	0.096	0.154	0.003	0.272	0.066	0.007	0.022
Capital expenditure	2.223	3.302	1.993	3.327	5.029	2.063	0.727	2.418	0.841	3.256	2.493
	0.541	0.297	0.527	0.293	0.138	0.496	0.677	0.450	0.745	0.353	0.394
Foreign currency debt dummy	0.783	1.254**	1.168**	1.277**	1.236**	0.896	1.012*	1.241**	1.253**	1.044*	1.126*
	0.208	0.035	0.046	0.028	0.035	0.147	0.082	0.031	0.023	0.088	0.057
Liquidity - Cash ratio	0.216	-0.347	1.102	-0.132	-0.398	-0.091	-0.144	0.093	0.869	-0.172	-0.277
	0.810	0.674	0.372	0.892	0.622	0.915	0.886	0.923	0.415	0.840	0.737
Firm size -Total assets (Natural log)	0.484**	0.616***	0.505**	0.623***	0.697***	0.632***	0.407*	0.578***	0.514**	0.456**	0.518**
	0.017	0.003	0.017	0.002	0.001	0.002	0.054	0.005	0.013	0.030	0.013
No. of Observations	125	125	123	123	124	124	123	125	125	124	123
No. of interest rate hedgers	92	92	90	90	92	91	90	92	92	91	90
No. of non-interest rate hedgers	33	33	33	33	32	33	33	33	33	33	33
-2 Restricted Log Likelihood (Slopes=0)	144.299	144.299	143.062	143.062	141.614	143.684	143.062	144.299	144.299	143.684	143.062
-2 Restricted Log Likelihood at Convergence	94.748	94.748	102.467	106.634	104.088	94.133	93.224	106.569	104.182	97.817	99.803
Chi-squared (log-likelihood ratio)	49.551	49.551	40.595	36.428	37.526	49.551	49.838	37.73	40.117	45.867	43.259
Degrees of Freedom	6	6	6	6	6	6	6	6	6	6	6
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Proxies for the Expected Costs of Financial Distress Employed in Model:	Gross Book Value Gearing	Interest Cover Ratio	Net Interest Charge Dummy Average	Net Interest Charge Average Dummy	Credit Rating (Qui Score)	Funds Flow Debt Ratio	Gross Market Value Gearing	Net Book Value Gearing	Net Market Value Gearing	Industry Adjusted Gross Book Value Gearing	Industry Adjusted Gross Market Value Gearing

Table 7.12 presents the results of fitting Table 7.11 models but excluding "other hedgers" from the non-hedging sample. Consistent with the results in section 7.3 the results in Table 7.12 show an improvement in the ability to detect a relationship between variables proxying for the expected costs of financial distress and the interest rate hedging decision.[19]

[19] All of the financial distress coefficients increased.

Table 7.12 Multivariate Logistic Regression Results for Interest Rate Hedging Firms - Survey Data Excluding Hedgers from Non-Hedger Sample

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11
Tax loss carry forwards dummy	1.858**	1.154*	1.516*	1.333	1.291	1.281	1.646*	1.531*	1.518*	1.815**	1.719*
	0.045	0.089	0.076	0.104	0.132	0.135	0.081	0.066	0.073	0.007	0.055
Financial distress various - see below	0.126**	-0.011	-3.922**	-2.023*	-0.035	-0.459	0.209***	0.012	0.078**	2.891***	1.564**
	0.005	0.363	0.017	0.065	0.127	0.213	0.009	0.285	0.035	0.007	0.030
Capital expenditure	1.825	4.111	2.244	3.549	7.066	2.515	-0.172	3.279	-0.081	4.527	3.079
	0.737	0.312	0.589	0.377	0.125	0.533	0.939	0.428	0.980	0.397	0.559
Foreign currency debt dummy	1.950**	2.260***	2.720***	2.767***	2.336***	1.786**	1.999**	2.341***	2.485***	2.269***	2.247***
	0.017	0.003	0.002	0.002	0.003	0.029	0.015	0.002	0.001	0.007	0.004
Liquidity - Cash ratio	0.128	-0.498	2.466	0.774	-0.895	-0.234	0.195	-0.081	1.557	-0.153	-0.405
	0.923	0.662	0.231	0.610	0.412	0.843	0.911	0.950	0.314	0.906	0.720
Firm size -Total assets (Natural log)	0.490*	0.569*	0.355	0.499*	0.722**	0.654**	0.288	0.580**	0.410	0.289	0.459
	0.086	0.055	0.254	0.094	0.011	0.028	0.356	0.045	0.166	0.359	0.121
No. of Observations	109	109	107	107	108	108	107	109	109	108	107
No. of interest rate hedgers	92	92	90	90	92	91	90	92	92	91	90
No. of non-interest rate hedgers	17	17	17	17	16	17	17	17	17	17	17
-2 Restricted Log Likelihood (Slopes=0)	94.375	94.375	93.69	93.69	90.608	94.035	93.69	94.375	94.375	94.035	93.69
-2 Restricted Log Likelihood at Convergence	48.489	60.114	53.004	56.697	57.078	57.579	45.336	59.662	55.401	49.78	54.021
Chi-squared (log-likelihood ratio)	45.886	34.261	40.686	36.993	33.53	36.456	48.354	34.713	38.974	44.255	39.669
Degrees of Freedom	6	6	6	6	6	6	6	6	6	6	6
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Proxies for the Expected Costs of Financial Distress Employed in Model:	Gross Book Value Gearing	Interest Cover Ratio	Net Interest Charge Dummy Average	Net Interest Charge Average Dummy	Credit Rating (Qui Score)	Funds Flow Debt Ratio	Gross Market Value Gearing	Net Book Value Gearing	Net Market Value Gearing	Industry Adjusted Gross Book Value Gearing	Industry Adjusted Gross Market Value Gearing

7.7 The Determinants of the Extent of Interest Rate Hedging

7.7.1 The Tobit Model

The analysis in Chapter 6 revealed that grouping together all firms engaging in some risk management concealed substantial differences amongst hedging firms and hence this provided motivation for the use of a continuous measure of hedging activity. In this section we follow the methodology employed in Chapter 6 to examine the determinants of the extent of interest rate hedging.

Table 7.3 in section 7.2 presented descriptive statistics of the extent of interest rate hedging. The discussion in chapter 5 suggested that this type of data could be investigated using tobit regression methodology.[20] The tobit model takes the form

$$\begin{aligned} y_i^* &= \beta x_i + u_i \qquad \textit{where } u_i \sim \mathrm{IN}(0, \sigma^2) \\ y_i &= y_i^* \text{ if } y_i^* > 0 \qquad\qquad 5.17 \\ y_i &= 0 \text{ if } y_i^* \leq 0 \end{aligned}$$

The results from estimating a tobit regression using total notional interest rate derivatives scaled by the book value of assets as the dependent variable are presented in Table 7.13.

Table 7.13 Multivariate Tobit Regression Results for Interest Rate Hedging Firms
The data are presented as coefficient and p-value. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Tax loss carry forwards dummy	-0.210	-0.026	-0.033	-0.020	-0.024	-0.030
	0.692	0.649	0.592	0.742	0.670	0.618
Financial distress various - see below	0.005***	0.111**	0.001	-0.034	0.003***	0.002
	0.000	0.011	0.509	0.462	0.003	0.303

[20] Several recent studies also employ tobit regression methodology in tests of the determinants of the extent of interest rate hedging (Howton and Perfect (1998), Gay and Nam (1998) and Graham and Rogers (1999)). Berkman and Bradbury (1996) use tobit methodology in examining the extent of use of all derivatives. Tufano (1996) employs tobit methods in tests of gold price hedging by US gold mining firms. Samant (1996) uses tobit techniques to investigate the extent of interest rate swap usage.

Table 7.13 Multivariate Tobit Regression Results for Interest Rate Hedging Firms

The data are presented as coefficient and p-value. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Capital expenditure	0.794***	0.909***	0.944***	1.049***	0.645**	0.832**
	0.003	0.002	0.004	0.001	0.033	0.014
Foreign currency debt dummy	0.027	0.067	0.103	0.121*	0.056	0.832**
	0.653	0.312	0.152	0.091	0.391	0.014
Liquidity - Cash ratio	-0.072	-0.079	-0.093	-0.106*	-0.003	-0.057
	0.191	0.187	0.140	0.095	0.955	0.409
Firm size -Total assets (Natural log)	0.087***	0.093***	0.099***	0.108***	0.091***	0.100***
	0.000	0.000	0.000	0.000	0.000	0.000
No. of Observations	237	237	233	233	236	236
No. of Interest rate hedgers	72	72	71	71	72	72
No. of non-interest rate hedgers	165	165	162	162	164	164
Log Likelihood at Convergence	-63.872	-71.524	-73.838	-73.527	-70.024	-74.15
Chi-squared (log-likelihood ratio)	86.00	70.69	63.69	63.81	73.00	64.75
Degrees of Freedom	6	6	6	6	6	6
P-value	0.000	0.000	0.000	0.000	0.000	0.000
Proxies for the Expected Costs of Financial Distress Employed in Model:	Gross Book Value Gearing	Industry Adjusted Gross Book Value Gearing	Gross Market Value Gearing	Industry Adjusted Gross Market Value Gearing	Net Book Value Gearing	Net Market Value Gearing

These results show that the gearing ratio is positively related to the extent of interest rate derivative use, which supports the notion firms hedge in response to large expected costs of financial distress.[21] There is also a significantly positive relation between capital expenditure and hedging which is consistent with the argument that firms undertake more hedging to control potential underinvestment costs when they have

[21] This result is consistent with the findings of Howton and Perfect (1998) and Graham and Rogers (1999). Howton and Perfect (1998) find that the level of hedging with interest rate derivatives is significantly positively related to the level of gearing but other measures of distress costs, such as interest cover and tangible assets, are not significantly related. Graham and Rogers (1999) show that gearing, the product of gearing and the market-to-book ratio and profitability are significantly related to the level of hedging. Although contrary to expectations net operating losses are significantly negatively related to interest rate hedging. Samant (1996) studies the determinants of the extent of participation in the interest rate swap market by fixed rate payers and finds that higher gearing is associated with higher levels of fixed rate swap usage. However, Gay and Nam (1998) find no significant relationship between interest cover and the level of interest rate derivatives use.

growth options.[22] The results show that the extent of interest rate hedging with derivatives increases with firm size which is consistent with fixed costs limiting hedging by small firms, but not consistent with informational asymmetry leading to increased hedging.[23]

The empirical tests report an overall insignificant negative relation between the level of liquidity and the likelihood of interest rate hedging.[24] Finally, the parameter estimate for the tax loss variable is negative and insignificant. This result does not support the tax convexity motive for hedging and is consistent with the findings of Howton and Perfect (1998) who use a similar tax loss variable to that employed in this study and Graham and Rogers (1999).[25]

7.7.2 Excluding "Other Hedgers" From The Non-Hedger Sample

The tests above have included "other hedging" firms in the non-hedging sample. In view of the bias this generates in the results these tests are repeated excluding these firms. The results show (see Table 7.14) that there is a considerable improvement in the relationship between gearing and the extent of interest rate hedging. Similar patterns are observed for the liquidity and foreign currency debt variables. The former finding is consistent with the notion that the availability of internal funds implies less hedging

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[22] Graham and Rogers (1999) find that R&D expenditure is significantly related to the level of interest rate hedging but insignificant results for capital expenditure and the book-to-market ratio. Howton and Perfect (1998) show that both R&D expenditure and cash flows scaled by total assets are significantly related to the level of interest rate hedging.

[23] In general, hypotheses linking hedging to financial contracting costs predicts firms with fewer assets will hedge more extensively.

[24] In tobit tests Howton and Perfect (1998) report a significantly negative relationship between liquidity and the level of interest rate derivatives. Graham and Rogers (1999) exclude the liquidity variable from multivariate tests.

[25] Howton and Perfect (1998) also employ a tax progressivity dummy variable which they find is significantly positively related to the extent of hedging in their tobit analysis.

(Froot et al. (1993)) and that firms with higher liquidity are faced with lower levels of agency costs of debt and the expected costs of financial distress (Nance et al. (1993)).

Once again these findings demonstrate the importance of eliminating bias in the results by removing other hedgers from the non-hedging sample. Furthermore this shows that the effect of removing other hedgers from the non-hedging sample is robust to alternative econometric techniques.

Table 7.14 Multivariate Tobit Regression Model for Interest Rate Hedging Firms – Excluding Other Hedgers from Non-Hedgers

Models correspond to those in Table 7.16. The data are presented as coefficient and p-value. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Tax loss carry forwards dummy	0.037 0.486	0.049 0.398	0.022 0.736	0.037 0.569	0.036 0.535	0.031 0.622
Financial distress various - see below	0.004*** 0.000	0.162*** 0.000	0.004* 0.080	0.037 0.470	0.003*** 0.000	0.004* 0.086
Capital expenditure	0.617*** 0.008	0.673*** 0.007	0.617** 0.035	0.788*** 0.005	0.455* 0.080	0.529* 0.083
Foreign currency debt dummy	0.168*** 0.006	0.208*** 0.001	0.258*** 0.000	0.278*** 0.000	0.206*** 0.002	0.244*** 0.001
Liquidity - Cash ratio	-0.084* 0.076	-0.085* 0.091	-0.098* 0.08	-0.101* 0.068	-0.017 0.749	-0.048 0.399
Firm size -Total assets (Natural log)	0.030* 0.051	0.024 0.163	0.024 0.207	0.029 0.139	0.029* 0.083	0.032* 0.082
No. of Observations	132	132	129	129	131	131
No. of interest rate hedgers	72	72	71	71	72	72
No. of non-interest rate hedgers	60	60	58	58	59	59
Log Likelihood at Convergence	-19.832	-24.959	-29.448	-30.751	-26.273	-30.814
Chi-squared (log-likelihood ratio)	72.5	62.24	50.74	48.13	58.2	49.12
Degrees of Freedom	6	6	6	6	6	6
P-value	0.000	0.000	0.000	0.000	0.000	0.000
Proxies for the Expected Costs of Financial Distress Employed in Model:	Gross Book Value Gearing	Industry Adjusted Gross Book Value Gearing	Gross Market Value Gearing	Industry Adjusted Gross Market Value Gearing	Net Book Value Gearing	Net Market Value Gearing

7.7.3 The Cragg Model

The empirical tests in sections 7.3 examined the determinants of the interest rate hedging decision (i.e., the yes/no hedging decision). Given the large variation in the extent of hedging (or derivatives use), a strength of the analysis in section 7.7.1 was that the use of a continuous dependent variable enabled the incorporation of more information into the dependent variable. Although, the results were qualitatively similar to those of the logit tests. However, a problem with tobit analysis is that it implicitly assumes that firms make one hedging decision, the choice of how much hedging to perform. In a strict sense, in the tobit analysis, a zero for the dependent variable reflects the outcome of the extent of hedging decision, rather than a decision not to hedge. To mitigate this problem, this study employs an econometric approach, suggested by Cragg (1971), in which the probability of a limit (or zero) observation is independent of the regression model for the nonlimit (or continuous) data.[26] Chapter 5 shows that this model can be written as

1. Decision equation:

$$\text{Prob}\,[y^*_i > 0] = \Phi(\gamma' x_i), \qquad z_i = 1 \quad \text{if } y^*_i > 0, \qquad 5.18$$

$$\text{Prob}\,[y^*_i \leq 0] = 1 - \Phi(\gamma' x_i), \qquad z_i = 0 \quad \text{if } y^*_i \leq 0. \qquad 5.19$$

2. Regression equation for nonlimit observations:

$$E[y_i|z_i = 1] = \beta' x_i + \sigma\lambda_I \qquad 5.20$$

This approach is used in several recent hedging studies to model this two-step hedging process.[27]

Table 7.15 presents results of a binomial probit regression employing the same sample of firms as that used in the tobit analysis. The signs and significance for the

[26] In this model the probability of the nonlimit outcome is determined apart from the level of the nonlimit outcome.

probit coefficients are generally similar to those for the tobit analysis with a few exceptions. Unlike the tobit results the probit tests indicate that interest rate hedging is not significantly positively related to the level of gearing.[28] Consistent with the tobit analysis the probit results indicate that large firms, those with greater investment opportunities (as measured by capital expenditure) and those with foreign currency debt are more likely to undertake interest rate hedging. Finally, as in the tobit tests the level of liquidity is not a significant determinant of the interest rate hedging decision.

Table 7.15 Multivariate Probit Regression Results for Interest Rate Hedging Firms
The data are presented as coefficient and p-value. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Tax loss carry forwards dummy	-0.057	-0.041	-0.039	0.008	-0.039	-0.041
	0.801	0.853	0.866	0.972	0.864	0.855
Financial distress various - see below	0.012*	0.089	0.001	-0.175	0.004	0.003
	0.058	0.625	0.932	0.294	0.421	0.717
Capital expenditure	2.196*	2.659**	2.760**	3.051***	2.297*	2.504*
	0.072	0.025	0.029	0.012	0.075	0.063
Foreign currency debt dummy	0.422	0.559**	0.613**	0.672***	0.537**	0.568**
	0.104	0.026	0.018	0.009	0.033	0.023
Liquidity - Cash ratio	-0.199	-0.262	-0.279	-0.337	-0.157	-0.216
	0.415	0.279	0.250	0.171	0.573	0.461
Firm size -Total assets (Natural log)	0.518***	0.530***	0.529***	0.558***	0.522***	0.530***
	0.000	0.000	0.000	0.000	0.000	0.000
No. of Observations	237	237	233	233	236	236
No. of Interest rate hedgers	72	72	71	71	72	72
No. of non-interest rate hedgers	165	165	162	162	164	164
Log Likelihood at Convergence	-98.589	-100.6	-99.048	-98.486	-100.366	-100.653
Chi-squared (log-likelihood ratio)	93.88	89.86	88.41	89.53	89.6	89.03
Degrees of Freedom	6	6	6	6	6	6
P-value	0.000	0.000	0.000	0.000	0.000	0.000
Proxies for the Expected Costs of Financial Distress Employed In Model:	Gross Book Value Gearing	Industry Adjusted Gross Book Value Gearing	Gross Market Value Gearing	Industry Adjusted Gross Market Value Gearing	Net Book Value Gearing	Net Market Value Gearing

[27] See Haushalter (1998), Allayannis and Ofek (1998), and Graham and Rogers (1999).

Table 7.16 shows that consistent with the logit and tobit results the removal of "other hedgers" from the non-hedging sample shows a significant improvement in the results for all of the proxies of the expected costs of financial distress.

Table 7.16 Multivariate Probit Regression Results for Interest Rate Hedging Firms – Excluding Other Hedgers from Non-Interest Rate Hedgers

The data are presented as coefficient and p-value. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Tax loss carry forwards dummy	0.727	0.888*	0.725	0.907*	0.939**	0.944**
	0.130	0.059	0.141	0.056	0.041	0.044
Financial distress various - see below	0.029***	0.791**	0.044**	0.450	0.009	0.028*
	0.008	0.032	0.023	0.156	0.229	0.071
Capital expenditure	1.059	1.737	0.354	2.119	1.705	0.857
	0.513	0.263	0.848	0.180	0.321	0.629
Foreign currency debt dummy	1.686***	1.850***	1.863***	1.979***	1.886***	1.904***
	0.000	0.000	0.000	0.000	0.000	0.000
Liquidity - Cash ratio	-0.417	-0.454	-0.442	-0.477	-0.327	-0.123
	0.217	0.173	0.201	0.155	0.402	0.750
Firm size -Total assets (Natural log)	0.544***	0.503***	0.429***	0.450***	0.516***	0.499***
	0.000	0.000	0.002	0.001	0.000	0.000
No. of Observations	132	132	129	129	131	131
No. of interest rate hedgers	72	72	58	58	59	59
No. of non-interest rate hedgers	60	60	71	71	72	72
Log Likelihood at Convergence	-37.555	-38.981	-36.169	-38.133	-40.687	-39.738
Chi-squared (log-likelihood ratio)	106.79	103.94	105.18	101.25	98.94	100.84
Degrees of Freedom	6	6	6	6	6	6
P-value	0.000	0.000	0.000	0.000	0.000	0.000
Proxies for the Expected Costs of Financial Distress Employed in Model:	Gross Book Value Gearing	Industry Adjusted Gross Book Value Gearing	Gross Market Value Gearing	Industry Adjusted Gross Market Value Gearing	Net Book Value Gearing	Net Market Value Gearing

Table 7.17 presents the results of the truncated regression. The truncated regression in the second stage of the Cragg analysis examines the determinants of the extent of interest rate hedging activity. As in the tobit analysis, the truncated regression

[28] These findings are consistent with the argument that the use of a continuous measure of hedging facilitates the detection of differences between hedgers and non-hedgers which might be masked when employing a simple dichotomous measure.

indicates that the extent of interest rate hedging is significantly affected by gearing.[29] This finding suggests that the extent of interest rate hedging is affected by the expected costs of financial distress. The capital expenditure variable is not significantly related to the extent of interest rate hedging which is contrary to the findings of the tobit results. The tax loss coefficient is negative in the truncated regression and in the full sample tobit analysis. The coefficient on the liquidity variable is negative but not significant which is consistent with the full sample tobit analysis.

The existence of foreign currency debt is negatively related to the extent of hedging in the truncated analysis unlike the tobit and probit analysis. This is consistent with the notion that firms issue foreign currency debt to hedge overseas assets and avoid breaching agreements on gearing and interest cover ratios in bank loan covenants. The implication of this is that firms then require less interest rate hedging. The coefficient on the size variable is negative in the truncated regression, opposite to the result in the tobit analysis. Although not significant the negative sign for the size coefficient is consistent with the amount of hedging increasing with the degree of informational asymmetry or distress costs given that a firm hedges.

Finally, one interpretation of the differences between the tobit and the truncated analysis is that the tobit methodology blurs the distinction between the choice of whether to hedge with the decision about how much to hedge.

[29] Graham and Rogers (1999) also report a similar result.

Table 7.17 Multivariate Truncated Regression Results for Interest Rate Hedging Firms

The data are presented as coefficient and p-value. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Tax loss carry forwards dummy	-0.092 0.647	-0.099 0.623	-0.098 0.630		-0.127 0.678
Financial distress various - see below.	0.009*** 0.003	0.009*** 0.003	0.009*** 0.003	0.010** 0.011	0.457** 0.047
Capital expenditure	0.942 0.175	0.862 0.167	0.883 0.167	1.747* 0.065	1.417 0.184
Foreign currency debt dummy	-0.441 0.102	-0.465* 0.080	-0.510* 0.052		-0.565 0.191
Liquidity - Cash ratio	-0.042 0.786			-0.158 0.392	-0.033 0.884
Firm size -Total assets (Natural log)	-0.025 0.688	-0.026 0.679		-0.081 0.284	-0.062 0.507
No. of Observations	72	72	72	72	72
No. of Interest rate hedgers	72	72	72	72	72
No. of non-interest rate hedgers	0	0	0	0	0
Log Likelihood at Convergence	54.308	54.27	54.183	52.351	52.078
Wald Chi-squared	9.66	9.35	9.15	6.7	4.3
Degrees of Freedom	6	5	4	4	6
P-value	0.139	0.096	0.058	0.152	0.636
Proxies for the Expected Costs of Financial Distress Employed in Model:	Gross Book Value Gearing	Gross Book Value Gearing	Gross Book Value Gearing	Gross Book Value Gearing	Industry Adjusted Gross Book Value Gearing
Likelihood ratio test between models:		1 and 2	2 and 3		
Chi-squared		0.07	0.17		
P-value		0.785	0.677		
Corresponding model in Table 7.19	1	-	-	-	2

7.8 Conclusions

This chapter has empirically investigated whether firms' decision to undertake interest rate hedging and the extent of interest rate hedging is consistent with corporate hedging theory. Using a logit regression model to examine the determinants of the decision to undertake interest rate hedging the findings showed that none of the financial distress cost proxies were significantly related to interest rate hedging. This was a very surprising result since most of these proxies are also indicators of the level of interest rate exposure.

A positive relationship was found between hedging and capital expenditure and a negative relationship between hedging and firm liquidity. These results provided strong support for the Froot, Scharfstein and Stein (1993) hypothesis that hedging can reduce underinvestment costs associated with investment opportunities in the presence of financial constraints. Consistent with earlier studies, the results indicated that larger firms were more likely to participate in interest rate hedging activity.

The chapter argued that the initial multivariate tests were potentially misleading because the non-interest rate hedging sample included firms that hedged other exposures. Therefore, the tests were repeated excluding "other hedgers" from the non-interest rate hedging sample. The evidence showed the exclusion of these firms' leads to a dramatic improvement in the ability to detect a relationship between the decision to hedge interest rate exposure and various firm level characteristics. In particular the most notable improvement was seen with the various proxies for the expected costs of financial distress. Overall, the results demonstrated that excluding "other hedgers" significantly improves the ability to identify relationships between the explanatory variables and the interest rate hedging decision.

In a second series of tests tobit analysis and the two stage Cragg methodology were employed to examine the determinants of the extent of interest rate hedging. For the full non-interest rate hedging sample the tobit results showed that gearing, capital expenditure and firm size were positively related to the level of interest rate derivatives use. In tests that excluded "other hedgers" from the non-interest rate hedging sample the foreign currency debt and liquidity variables were also significant.

The first stage of the Cragg estimation employed a probit model. The results indicated that tax loss carry forwards, gearing, capital expenditure, foreign currency debt and firm size were all positively related to the firm's likelihood of hedging with derivatives. The second stage truncated results showed a strong positive relationship between the extent a firm hedges and its level of gearing, which was consistent with both the tobit and probit results. However, firm size produced different results between the truncated model and both the probit and tobit models. Although firm size was an extremely significant predictor of the likelihood of a firm's decision to hedge, it was not an important predictor of a firm's extent of hedging activity. This result is consistent with the argument that informational economies play an important role in explaining corporate hedging behaviour with derivatives.

Appendix A7.1

Table A7.1 Differences In Firm Size Between Non-Hedgers, Other Hedgers And Interest Rate Hedgers Using Two Sample T-Test

The t-statistics are given for tests of the equality of means between hedgers and non-hedgers. T-tests assume equal variances unless the null hypothesis of equal variances is rejected at a 5% significance level. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively. N denotes number of firms.

Firm Size	Non-hedgers		Other hedgers		Interest rate hedgers		Non-hedger v Other hedger		Other hedger v Interest rate hedger	
	N	Mean	N	Mean	N	Mean	t-stat	P-value	t-stat	P-value
Market value of equity	89	5.712	138	5.908	179	7.010	-1.543	0.124	-8.590	0.000***
Total assets	87	4.730	135	5.038	178	6.590	-1.959	0.051*	-11.026	0.000***

Table A7.2 Size Distribution of Interest Rate Sample

	Interest Rate Hedging		Hedging Other Exposures*		Non-Hedging	
FT500 Ranking	No. of firms	Percent	No. of firms	Percent	No. of firms	Percent
1 – 100	70	38.3	8	5.8	3	3.3
101 – 200	47	25.7	27	19.6	12	13.2
201 – 300	31	16.9	33	23.9	21	23.1
301 – 400	16	8.7	39	28.3	28	30.8
401 – 500	19	10.4	31	22.5	27	29.7
TOTAL	183	100.0	138	100.0	91	100.0

*These firms do not hedge interest rate exposure but hedge other exposures such as foreign currency and or commodity price exposure.

Chapter 8. An Empirical Analysis of Foreign Currency Hedging Practices of UK Firms

8.1 Introduction

The theories of optimal hedging in general have provided explanations for the costs associated with cash flow volatility such as volatility in exchange rates, interest rates and commodity prices. However, the hedging theories do not make specific predictions about the type of exposures hedged. Therefore, the empirical tests in this chapter examine whether sample firms that report they hedge foreign currency exposure exhibit features that are consistent with the predictions of hedging theories.

This chapter contributes to the empirical literature on foreign currency through its sample construction and empirical methodology. Several studies have examined which theory of optimal hedging is consistent with the use of foreign currency derivatives. Unlike these previous studies this study recognises that foreign denominated debt and currency derivatives can act as substitutes for foreign currency hedging and therefore includes both methods in the definition of foreign currency hedging.[1]

This study also identifies flaws in the construction of the non-foreign currency hedging sample of many previous foreign currency hedging studies. In these studies the non-hedging sample includes non-foreign currency hedging firms that might be hedging interest rate and/or commodity price exposure. The inclusion of these "other" hedging firms in the non-hedging sample might make it more difficult to identify differences in financial and operating characteristics between hedging and

[1] Kedia and Mozumdar (2001) make a similar point.

non-hedging groups.[2] Given that the majority of these "other" hedgers are interest rate hedgers, this error in sample construction might explain why previous empirical studies have not been able to detect a relationship between foreign currency hedging and various proxies for the expected costs of financial distress. This study controls for this by excluding these "other" hedging firms from the non-foreign currency hedging sample. The tests show that the removal of these firms results in a stronger relationship between several exogenous variables and the foreign currency hedging decision.

The third major innovation in this chapter is the recognition that the sample of firms that hedge both foreign currency and interest rate exposure could be exerting undue influence on the relationship between foreign currency hedging and factors that are potentially more important for interest rate hedgers, such as the various proxies for the expected costs of financial distress. In order to control for this the study estimates specifications of the empirical model for the sample of foreign currency only hedgers. The empirical tests show that gearing is significantly related to the likelihood of foreign currency hedging.

This study examines the determinants of foreign currency hedging employing annual report disclosures and survey data. The survey sample is a subset of the annual report sample and equates to approximately 44 percent of the latter. The availability of the survey data enables the tests in this chapter to control for the possibility of incorrectly classified firms. This is particularly important for the tests employing the annual report sample of foreign currency only hedgers. An analysis of the survey and annual report samples reveals that some of the firms classified as foreign currency only hedgers by the annual report data are also interest rate hedgers.

[2] Allayannis and Weston (2001) make a similar point and show the existence of a bias in their tests.

This implies that the validity of the tests employing the annual report sample of foreign currency only hedgers could be called into question. To avoid this problem the tests are repeated using the survey data since the survey hedging classifications give a true indication of the types of exposures firms are hedging. Using this clean sample of foreign currency only hedgers the results show a significant relationship between foreign currency hedging and various measures of financial distress costs.

The chapter proceeds as follows. Section 8.2 describes the dependent variables employed in the multivariate tests. Section 8.3 describes the model building strategy employed in this study and presents the results of estimating various specifications of the multivariate logit model. Section 8.4 reports the affect on the results of excluding "other" hedgers from the non-hedging sample. Section 8.5 examines the determinants of foreign currency hedging for those firms only hedging foreign currency exposure. Sections 8.6 and 8.7 refit the multivariate logit model using the hedging classifications from the survey data. Section 8.8 uses tobit regression methodology and a continuous dependent variable to examine the determinants of the extent of foreign currency hedging. Section 8.9 employs Cragg's (1971) two-stage model to analyse the effect of the independent variables on the extent of foreign currency hedging and finally, section 8.10 presents conclusions.

8.2 Identifying Foreign Currency Hedging Firms and Measuring Foreign Currency Hedging

A feature of this study that distinguishes it from previous empirical tests of foreign currency hedging is not only the recognition that derivatives offer only one means of managing risks but the incorporation of other hedging strategies into this study's definition of hedging. These other strategies come in the form of on-balance sheet financial strategies and in particular the use of foreign currency debt for hedging purposes. Most previous studies conduct electronic searches using keywords to identify derivative users and ignore firms adopting other hedging strategies.[3] This study conducts a manual search of annual reports to glean any information on foreign currency hedging activity not just foreign currency derivative use. Clearly this approach is far more time consuming but is considered more accurate in classifying hedging and non-hedging firms. Table 8.1 shows that 70.4 percent of firms were classified as foreign currency hedgers. This classification of firms into foreign currency hedgers and non foreign currency hedgers forms the binary dependent variable in the logistic regression analysis.[4]

Table 8.1 Foreign Currency Hedging Activity Disclosures by UK Firms

	No.	%
Foreign Currency Hedging	**290**	**70.4**
Not hedging foreign currency exposure/Non-disclosure	**122**	**29.6**
Total	**412**	**100.0**

For the models examining the determinants of the extent of foreign currency hedging the dependent variable is a continuous measure calculated by taking the ratio of the total notional value of foreign currency derivative contracts to total assets of the firm.[5] Table 8.2 shows that of those firms classified as foreign currency hedgers 215

[3] For example, Graham and Rogers (2000) use an electronic keyword search and focus their investigation on the use of derivatives on the grounds that derivative holdings are disclosed in financial statements, while other strategies are more difficult to observe.
[4] The use of a dichotomous dependent variable for foreign currency hedging has also been employed by Wysocki (1995), Mian (1996) and Geczy et al. (1997). Also Allayannis and Ofek (2001), and Graham and Rogers (2000) use both a dummy and continuous dependent variable.
[5] Although several studies examine the use of foreign currency derivatives only Howton and Perfect (1998), Graham and Rogers (2000) and Allayannis and Ofek (2001) develop a continuous measure of foreign currency hedging activity. All three studies use notional values as a measure of foreign currency derivatives activity.

firms or 83.8 percent disclose the use of foreign currency derivatives and of these 70 firms or 32.6 percent disclose notional amounts of foreign currency derivatives.

Table 8.2 Foreign Currency Hedging and Derivatives Disclosure by UK Firms

	No.
Foreign Currency hedging	290
Using Foreign Currency derivatives	215
Notional amounts of foreign currency derivatives	70

Table 8.3 presents descriptive statistics of the foreign currency derivative positions held by firms disclosing notional amounts of foreign currency derivatives at the end of financial year 1995. The Table also shows the foreign currency derivative positions scaled by total assets which forms the dependent variable for the extent of hedging models.[6] The mean and median notional values of all foreign currency derivative positions are £738.11 million and £77.7 million.[7]

Table 8.3 Notional Values of Contracts in £millions held by Foreign Currency Derivative Users

	N	Min.	25th Percentile	Median	Mean	75th Percentile	Max.	Std. Dev.
Total positions (£m)	70	0.220	29.825	77.7	738.1084	384.55	15179	2123.960
Scaled by total assets	68	0.002	0.062	0.115	0.284	0.301	5.090	0.653

Note: Data on total assets missing for 2 firms.

8.3 Variable Selection and Model Estimation

As in previous empirical chapters for each independent variable a univariate logistic regression model is fitted. The univariate logistic results for foreign currency hedging are displayed in Table 8.4. The format of Table 8.4 is exactly the same as the corresponding tables in chapters 6 and 7.

[6] The 122 firms not hedging foreign currency exposure are assumed to have zero holdings of derivatives and therefore their measure of the extent of foreign currency derivative use is equal to zero. This gives a total of 190 observations (122=0 and 68>0).

[7] Graham and Rogers (2000) report a mean value of $2750 million and a median value of $171 million for their foreign currency derivative sample.

An examination of the univariate results in Table 8.4 provides evidence showing that several groups of variables have the hypothesised relationship with foreign currency hedging at the univariate level. All of the proxies for the expected costs of financial distress, foreign currency exposure and information and transaction cost scale economies have a significant relationship with foreign currency hedging. The three liquidity measures and the dividend yield exhibit the hypothesised relationship with foreign currency hedging. The convertible debt and preference capital variables have a positive and negative relationship with hedging, respectively, although neither are significant. The measure of cash holdings is not significantly related to hedging. Finally, contrary to expectations the four variables proxying for growth options exhibit a negative relationship with foreign currency hedging.

Table 8.4 Univariate Logistic Regression Results: Foreign Currency Hedging Firms

***, **, * denote significance at the 1%, 5%, and 10% levels, respectively. Variables in shade are selected for the multivariate model.

Variable	Coefficient	Standard error	Odds ratio	Wald statistic	P-value (coeff)	Chi-squared	P-value (model)
1. Tax Function Convexity							
Tax loss carry forwards dummy	0.832***	0.251	2.297	10.983	0.000	11.802	0.000
2. Expected Costs of Financial Distress							
Gross gearing book value	0.046***	0.008	1.048	30.888	0.000	41.449	0.000
Industry adjusted gross gearing book value	1.405***	0.250	4.073	31.601	0.000	38.677	0.000
Gross gearing market value	0.031***	0.009	1.031	10.468	0.001	12.119	0.000
Industry adjusted gross gearing market value	1.190***	0.231	3.286	26.585	0.000	33.672	0.000
Net gearing book value	0.009***	0.003	1.009	7.165	0.007	7.924	0.005
Net gearing market value	0.013*	0.007	1.013	3.076	0.080	3.171	0.075
Credit rating Quiscore	-0.036***	0.007	0.965	24.853	0.000	28.610	0.000
Interest cover ratio	-0.024***	0.004	0.977	30.833	0.000	35.046	0.000
Funds flow debt ratio	-0.076*	0.043	0.927	3.157	0.076	3.504	0.061
Net interest charge dummy average	-1.048***	0.298	0.351	12.398	0.000	12.274	0.001
Net interest charge average dummy	-0.845***	0.256	0.430	10.849	0.001	10.639	0.001
3. Costs of Underinvestment							
Firm Growth Options							
Capital expenditure	-1.259	0.851	0.284	2.190	0.139	2.690	0.101
Price-earnings (PE) ratio	-0.001	0.002	0.999	0.511	0.475	0.490	0.484
Market-to-book ratio	-0.019*	0.012	0.981	2.339	0.126	3.190	0.074
R&D	-0.053***	0.046	0.949	1.312	0.252	7.583	0.006
4. Sources of Cash Flow Volatility:							
Measures of Foreign Currency Exposure							
Foreign sales by origin	0.056***	0.007	1.057	60.275	0.000	103.354	0.000
Foreign sales by destination	0.044***	0.005	1.045	65.582	0.000	99.258	0.000
Overseas tax ratio	6.596***	0.965	732.19	46.707	0.000	93.020	0.000
Foreign currency transactions dummy	2.163***	0.250	8.701	75.000	0.000	83.880	0.000
Foreign operations dummy	3.205***	0.311	24.651	106.46	0.000	139.465	0.000
5. Hedging Substitutes							
Liquidity - Cash ratio	-0.517***	0.177	0.597	8.495	0.004	9.989	0.002
Liquidity - Quick assets ratio	-0.250*	0.143	0.779	3.063	0.080	3.070	0.080
Liquidity - Current ratio	-0.298***	0.113	0.743	6.972	0.008	7.355	0.007
Convertible debt/Total assets	10.071*	6.595	23637.5	2.332	0.127	2.748	0.097

Table 8.4 Univariate Logistic Regression Results: Foreign Currency Hedging Firms
***, **, * denote significance at the 1%, 5%, and 10% levels, respectively. Variables in shade are selected for the multivariate model.

Variable	Coefficient	Standard error	Odds ratio	Wald statistic	P-value (coeff)	Chi-squared	P-value (model)
Dividend yield	0.171**	0.074	1.187	5.330	0.021	5.480	0.019
6. Information and Transaction Cost							
Economies of Scale							
Market value of equity (Natural logarithm)	0.495***	0.106	1.640	21.960	0.000	25.920	0.000
Total assets (Natural logarithm)	0.411***	0.084	1.508	23.861	0.000	27.101	0.000
Treasury staff dummy	1.469***	0.249	4.342	34.934	0.000	39.241	0.000

The variables for the foreign currency hedging model are selected using the approach employed in previous chapters, that is, selecting from each group the variable with the hypothesised sign and the highest level of significance as indicated by the chi-squared statistic in the univariate logistic regression model. The results in Table 8.4 indicate the inclusion of the following variables for estimating the multivariate model: tax losses carried forward dummy, gross book value gearing, foreign operations dummy, cash ratio and the existence of treasury qualified staff.[8] Additionally, the model includes a proxy for the investment opportunity set, the capital expenditure variable is employed for this purpose. The logistic regression model described by equation 8.1 is estimated.

$$\begin{aligned} y^*_i &= \beta_1 + \beta_2 \text{Tax Convexity}_i + \beta_3 \text{Financial Distress}_i + \beta_4 \text{Underinvestment Cost}_i \\ &+ \beta_5 \text{Cash Flow Volatility}_i + \beta_6 \text{Hedging Substitutes}_i + \beta_7 \text{Transaction Costs}_i + u_i \end{aligned} \qquad 8.1$$

The results of fitting this model, labelled Model 1, together with results of the univariate tests for each variable in the model are presented in Table 8.5. For each variable the table displays the log of odds, the odds ratio, the Wald statistic and p-value and various summary statistics for the model. In model 1 the chi-squared

[8] In univariate tests the variable measuring the number of treasury qualified staff employed by a firm outperforms the other variables in its group, however, this variable is not scaled and is therefore not considered in the multivariate analysis.

statistic is 127.166, which is significant at less than the 1 percent level indicating that at least one of the coefficients in the model is nonzero.

An inspection of the Wald statistic and p-value indicates gearing, foreign currency operations, and the treasury staff variables make a contribution to the model with their coefficients significant at the 10 percent level or better. The coefficients on the tax loss dummy and liquidity variables are not significant although they have the hypothesised sign. The capital expenditure variable is also insignificant and its sign is opposite to that predicted by theory. Given this and the fact that the Wald statistic for this coefficient is the smallest, the capital expenditure variable is dropped from model 2. The results for model 2 show that as in model 1 the gearing, foreign operations and treasury qualified staff variables are significant with small changes in the size of their coefficients. The coefficient on the tax loss dummy is slightly larger whilst for the liquidity variable it goes from –0.417 to –0.578.

Model 2 is compared to Model 1 using the likelihood ratio test, which reveals a chi-square value of 1.144 with a p-value greater than 0.25. This demonstrates that the capital expenditure variable makes no contribution to the model once the other variables have been included in the model. Examination of the Wald statistics in Model 2 suggests that the tax loss variable should be dropped. Model 3 in Table 8.5 presents the results for this refitted model. A likelihood ratio test for the tax loss variable gives a chi-squared statistic 2.468 with a p-value greater than 0.1 indicating that this variable makes no contribution to the model.

To facilitate comparisons with earlier studies the model in equation 8.1 is estimated replacing the treasury qualified staff dummy variable with the natural log of total assets measure for firm size which also proxies for information and transaction cost scale economies.[9] The results shown under models 4 and 5 in Table 8.5 indicate that firm size is significantly positively related to the decision to hedge foreign currency exposure.

Model 6 in Table 8.5 employs the foreign sales by origin proxy for foreign currency exposure instead of the foreign operations dummy variable. The model 6 results are qualitatively similar to those of model 5.[10]

Table 8.5 Multivariate Logistic Regression Results for Foreign Currency Hedging Firms

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Univar. Model	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Tax loss carry forwards dummy	0.832***	0.616	0.631		0.700*	0.723*	0.630**
	0.000	0.135	0.124		0.088	0.078	0.039
Gross gearing book value	0.046***	0.043***	0.041***	0.041**	0.041***	0.039***	0.022**
	0.000	0.001	0.002	0.016	0.002	0.003	0.011
Capital expenditure	-1.259	-1.010			-0.735		
	0.139	0.261			0.418		
Models 1 to 5: Foreign operations dummy	3.205***	2.943***	2.969***	3.081***	2.964***	2.998***	0.051***
Model 6: Foreign sales by origin	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Liquidity - Cash ratio	-0.517***	-0.417	-0.578	-0.604*	-0.568	-0.692*	-0.540**
	0.004	0.288	0.109	0.093	0.161	0.062	0.025
Models 1 to 3:Treasury Employees dummy	1.467***	1.326***	1.282***	1.318***	0.395***	0.392***	0.322***
Models 4 to 6:Natural log of Total Assets	0.000	0.001	0.001	0.001	0.004	0.004	0.002
No. of Observations	NA	303	303	303	303	303	374
No. of foreign currency hedgers	NA	230	230	230	230	230	262
No. of non-foreign currency hedgers	NA	73	73	73	73	73	112
-2 Restricted Log Likelihood (Slopes=0)	NA	334.599	334.599	334.599	334.599	334.599	456.587
-2 Restricted Log Likelihood (Convergence)	NA	207.433	208.577	211.045	210.795	211.464	319.204
Chi-squared (log-likelihood ratio)	NA	127.166	126.022	123.554	123.804	123.135	137.383
Degrees of Freedom	NA	6	5	4	6	5	5
P-value	NA	0.000	0.000	0.000	0.000	0.000	0.000
Likelihood ratio test for the difference between models:			1 and 2	2 and 3		4 and 5	
Chi-squared			1.144	2.468		0.669	
P-value			>0.25	>0.1		>0.3	

In summary, the empirical results presented in Table 8.5 provide strong support for the financial distress cost hypothesis, the cash flow volatility hypothesis,

[9] Graham and Rogers (2000) and Allayannis and Ofek (2001) use a similar measure for firm size.
[10] The sample size for model 6 is larger than the previous models because the sample is not restricted to those firms with data for capital expenditure. See Table A8.1 in Appendix A8.1 for results using alternative proxies for foreign currency exposure.

the substitutes for hedging hypothesis, the costs of external finance hypothesis and the information and transaction economies of scale hypothesis. In particular, this study is one of only a few studies to find using logit regression methodology a significant relationship between foreign currency hedging and the level of gearing proxy for financial distress costs.[11] This relation is consistent with Froot et al. (1993), Smith and Stulz (1985) and Bessembinder (1989) who argue that risk management serves to reduce financial contracting costs. This is also consistent with other work that suggests that firms' financing costs are linked to the level of gearing. For example, Whited (1992) argues that highly levered firms face high premiums for external funds. Also, Kaplan and Zingales (1996) show that the likelihood of a firm being financially constrained increases with its gearing.

The results show that there is a strong relationship between the decision to hedge foreign currency exposure and employment of treasury qualified personnel. This factor is more important as a determinant of foreign currency hedging than it is for interest rate hedging.[12] This is consistent with the argument that the identification, measurement and management of foreign currency exposures are a more complex process than that for interest rate exposure. Therefore dealing with

[11] Geczy et al. (1997) use gearing, industry adjusted gearing, S&P credit ratings and find no evidence in support of the financial distress cost hypothesis. Wysocki (1995) does not include financial distress variables in his foreign currency hedging model. Mian's (1996) logit model does not include any debt based measures of financial distress but in univariate tests he finds that currency non-hedgers have significantly higher levels of gearing than currency hedgers. Howton and Perfect (1998) find using a tobit model that the interest coverage ratio is positively related, gearing negatively related and cash holdings positively related to foreign currency hedging (all results opposite to theory). Although, they find liquidity is significantly negatively related to foreign currency hedging (at the 10 percent level). Graham and Rogers (2000) find using a probit model no significant relation between foreign currency hedging and measures for financial distress costs, such as gearing, gearing times market-to-book ratio, firm profitability, tax losses and credit ratings. Allayannis and Ofek (2001) use gearing, return on assets, Altman's z-score, liquidity in a probit model and find that gearing is significantly negatively related to foreign currency hedging (opposite to that predicted by theory) and the other measures are not significantly related to foreign currency hedging.

[12] The results in chapter 7 show that the treasury qualified dummy variable does not perform as well as firm size in univariate tests of interest rate hedging.

foreign currency exposure requires employees with relevant skills and qualifications such as those possessed by members of the Association of Corporate Treasurers.

The positive size effect shown in models 4, 5 and 6 may indicate that there is a significant fixed cost component to implementing a hedging program, and small firms are less likely to achieve sufficient benefits to offset this cost. This finding is inconsistent with the notion that small firms face substantial informational asymmetry costs and therefore are more likely to hedge.

The results show that financing constraints provide incentives for hedging. Using the cash ratio, which this thesis argues as being a far more appropriate measure of the availability of internal funds, the results for model 6 show that a higher cash ratio implies a significantly lower probability of foreign currency hedging.[13] This result is consistent with the Froot et al. prediction that hedging activity is beneficial because it secures the availability of internal funds. It also supports the Nance et al. prediction that the existence of negative debt (i.e., cash) reduces a firm's relative need to hedge because the agency costs of debt and the expected costs of financial distress are lower.[14]

The empirical tests also provide evidence that a firm's foreign currency exposure factors are significantly and positively related to hedging (i.e., controls for exposure are important determinants in a firm's decision to hedge foreign currency exposure).[15]

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[13] Geczy et al. (1997), Howton and Perfect (1998)and Graham and Rogers (2000) all use the quick ratio. Mian (1996) uses the current ratio and Allayannis and Ofek (2001) use cash over total assets as their measures of liquidity. Wysocki (1995) does not include a measure for liquidity in his tests.

[14] Geczy et al. (1997) also report a negative association between a firm's decision to use foreign currency derivatives and short-term liquidity. However, the significant results (10% level) pertain to their restricted R&D sample only. Mian (1996) and Graham and Rogers (2000) use measures of liquidity, the current ratio and quick ratio respectively, in univariate tests only. Both studies find that foreign currency hedgers have significantly lower levels of liquidity. Allayannis and Ofek (2001) find no evidence of a relationship between liquidity and the decision to use foreign currency derivatives.

[15] This finding is consistent with the results of Wysocki (1995), Geczy et al. (1997), Howton and Perfect (1998), Graham and Rogers (2000) and Allayannis and Ofek (2001).

8.4 Excluding Other Hedgers from the Non-Foreign Currency Hedging Group

The tests in the previous section investigated the determinants of foreign currency hedging using samples of foreign currency hedgers versus non-hedgers of foreign currency exposure. The group of non-foreign currency hedgers includes firms hedging interest rate and/or commodity price exposure. As noted in chapter 3 this approach is followed by many previous studies investigating the determinants of foreign currency hedging (or foreign currency derivatives use).[16] However, a problem with this approach is that the inclusion of these firms in the non-hedging sample might potentially bias the results against the a priori expectations.

The results presented in Table 8.5 suggest that the bias, if any, resulting from the inclusion of hedging firms in the non-foreign currency hedging sample is not large enough to remove the relationship between foreign currency hedging and firm level characteristics. However, a similar analysis in chapter 7 shows a significant improvement in the relationship between interest rate hedging and various financial and operating characteristics when other hedgers are excluded from the non-hedging sample. Table 4.12 shows that in the interest rate hedging tests over 60 percent of the non-interest rate hedging group are hedging other exposures whereas Table 4.21 shows that the corresponding figure for the foreign currency sample is 25.5 percent. Therefore these results show that a lower proportion of other hedgers in the non-hedging group induces a smaller bias.

Notwithstanding this the models estimated previously (i.e., Table 8.5) are refitted excluding those firms that are classified as non-foreign currency hedgers but hedge interest rate and/or commodity price exposure from the non-hedging sample to

[16] Studies investigating the determinants of hedging any category of financial price exposure or the use of any category of derivative are not faced with this problem.

assess the affect their exclusion has, if any, on the results. The results of refitting model 1 (Table 8.5) are shown under model 1A presented in Table 8.6.

Table 8.6 Multivariate Logistic Regression Results for Foreign Currency Hedging Firms - Excluding Hedging Firms from the Non-Hedging Sample

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1A	Model 2A	Model 3A	Model 4A	Model 5A	Model 6A
Tax loss carry forwards dummy	0.837*	0.844*		0.943**	0.946**	0.721**
	0.066	0.064		0.038	0.037	0.037
Gearing book value	0.061***	0.060***	0.059***	0.056***	0.056***	0.037***
	0.000	0.000	0.000	0.001	0.001	0.001
Capital expenditure	-0.496			-0.139		
	0.648			0.891		
Models 1A to 5A: Foreign operations dummy Model 6A: Foreign sales by origin	2.505***	2.519***	2.643***	2.510***	2.515***	0.040***
	0.000	0.000	0.000	0.000	0.000	0.000
Liquidity - Cash ratio	-0.532	-0.602*	-0.657*	-0.630	-0.652*	-0.539**
	0.198	0.100	0.082	0.134	0.091	0.026
Models 1A to 3A:Treasury Employees dummy Models 4A to 6A:Natural log of Total Assets	1.468***	1.446***	1.484***	0.444***	0.444***	0.476***
	0.001	0.001	0.000	0.003	0.003	0.000
No. of Observations	289	289	289	289	289	345
No. of foreign currency hedgers	230	230	230	230	230	262
No. of non-foreign currency hedgers	59	59	59	59	59	83
-2 Restricted Log Likelihood (Slopes=0)	292.529	292.529	292.529	292.529	292.529	380.705
-2 Restricted Log Likelihood at Convergence	180.852	181.030	184.725	183.682	183.700	259.882
Chi-squared (log-likelihood ratio)	111.677	111.499	107.804	108.847	108.829	120.823
Degrees of Freedom	6	5	4	6	5	5
P-value	0.000	0.000	0.000	0.000	0.000	0.000
Likelihood ratio test for the difference between models:		1A & 2A	2A & 3A		4A & 5A	
Chi-squared		0.178	3.695		0.018	
P-value		>0.5	<0.1		>0.8	

A comparison of the coefficients between models in Table 8.5 and the corresponding models in Table 8.6 shows that the coefficients on the tax loss, gearing, treasury employees and liquidity variables increase and those on the foreign operations and capital expenditure variables decrease.

The exclusion of the aforementioned hedging firms from the non-foreign currency hedging sample clearly has an affect on the estimated coefficients. The tax loss variable is now significant in three models whereas previously it was not. The coefficient on the gearing variable increases by between one third and one half. For example, comparing the coefficients in models 3 and 3A shows it going from 0.041 to

0.061 with an increase in the odds ratio from 1.042 to 1.063. Therefore, a 1 percent increase in gearing is estimated to increase the odds of hedging by 4.2 percent in model 3 and by 6.3 percent in model 3A. In four of the six models in Table 8.6 the coefficient on the liquidity variable is higher than the corresponding coefficient in Table 8.5. Finally, the coefficients on the treasury qualified staff dummy and firm size proxy are higher for the models presented in Table 8.6.

Overall, these results show that the inclusion of other hedgers in the non-foreign currency hedging sample adversely affects the ability to detect a relationship between foreign currency hedging and the explanatory variables and therefore biases the empirical results against the a priori expectations. This is particularly the case for the type of variables that are potentially more important for interest rate hedgers, such as those measuring the level of debt, the ability to service it, and liquidity. None of the previous five studies reviewed in chapter 3 that investigate the determinants of foreign currency hedging found a link between financial distress costs and currency hedging.[17] In the multivariate tests of four studies researchers use between 3 and 5 proxies for financial distress costs. [18] Furthermore, only two studies report a significant relationship between hedging and liquidity.[19] As shown previously a common feature of all six studies is the inclusion of hedging firms (i.e., interest rate and/or commodity price hedgers) in their non-hedging samples.[20] None of these studies reports attempts to clean their samples by excluding these firms in their tests. The empirical tests reported here clearly demonstrate that the inclusion of these firms

[17] Wysocki (1995) does not test the financial distress cost hypothesis in his study.
[18]Geczy et al. (1997) use gearing, industry adjusted gearing, S&P credit ratings. Allayannis and Ofek (2001) use gearing, return on assets, and Altman's z-score. Howton and Perfect (1998) use the interest coverage ratio, gearing and cash holdings in a tobit model. Graham and Rogers (2000) use gearing, gearing times market-to-book ratio, firm profitability, tax losses and credit ratings.
[19] Geczy et al. (1997) report that hedging is significantly negatively related the level of liquidity at the 10% level in only their restricted sample (i.e. firms with R&D data). Howton and Perfect (1998) find a significant relationship in only one of the four models estimated.
[20] See Table 3.4 page 85.

affects the ability to detect a relationship between foreign currency hedging and the potential determinants of hedging. This might explain why these studies fail to detect a relationship between foreign currency hedging and measures for financial distress costs.[21]

8.5 Multivariate Tests for Foreign Currency Only Hedgers

The empirical results in the previous sections indicate that gearing, measures of foreign currency exposure, liquidity and firm size affect the likelihood of foreign currency hedging. It was also noted that the relationship between foreign currency hedging and gearing existed despite the existence of "other hedgers" in the non-foreign currency hedging sample. However, the validity of the strength of this link can be called into question because of the structure of the foreign currency hedging sample.

The analysis in chapter 4 shows that closer inspection of the foreign currency hedging sample reveals a few interesting characteristics. Table 4.20 in chapter 4 shows that 44.1 percent of foreign currency hedgers are foreign currency only hedgers and 53.4 percent of foreign currency hedgers are also hedging interest rate exposure. Since over half the sample of foreign currency hedgers are also interest rate hedgers it is quite possible that this group of firms is driving the results with respect to those variables that are potentially of greater relevance to interest rate hedging firms such as the level of debt and the firm's ability to service its debt.

The empirical tests in this section test for this by investigating the determinants of foreign currency only hedging (i.e., firms that only hedge foreign

[21] In chapter 7 it was suggested that firm size might be exerting undue influence on the results. In view of this appendix A8.2 presents the results of estimating the foreign currency hedging model on a sample of small firms. The results are qualitatively similar to those presented in Table 8.5 and Table 8.6. This indicates that firm size is not driving the results.

currency exposure). If measures such as gearing and other proxies for financial distress costs are found to be significant for the sub-sample of foreign currency only hedgers then this will demonstrate empirically for the first time an unambiguous link between foreign currency hedging and the expected costs of financial distress.

The results of this analysis are presented in Table 8.7. The models in Table 8.7 do not include a proxy for investment/growth opportunities since none of the variables were significant in the models estimated in section 8.3.

Table 8.7 Multivariate Logistic Regression Results for Foreign Currency Only Hedging Firms

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Tax loss carry forwards dummy	0.372	0.631*	0.556	0.663*	0.556	0.661*
	0.276	0.095	0.105	0.075	0.103	0.073
Gross book value gearing	0.016	0.032***	0.011	0.024**	0.014	0.027**
	0.122	0.010	0.284	0.043	0.157	0.022
Models 1 & 2: Foreign operations dummy	2.508***	2.266***	0.049***	0.039***	0.043***	0.036***
Models 3 & 4: Foreign sales by origin	0.000	0.000	0.000	0.000	0.000	0.000
Models 5 & 6: Foreign sales by destination						
Liquidity - Cash ratio	-0.409	-0.357	-0.570*	-0.532*	-0.799***	-0.709**
	0.119	0.152	0.058	0.059	0.007	0.011
Natural log of Total Assets	0.007	0.226	-0.058	0.183	0.015	0.246
	0.961	0.144	0.665	0.227	0.912	0.113
No. of Observations	246	217	233	204	245	216
No. of foreign currency only hedgers	131	131	121	121	131	131
No. of non-foreign currency hedgers	115	86	112	83	114	85
-2 Restricted Log Likelihood (Slopes=0)	339.987	291.426	322.658	275.684	338.46	289.568
-2 Restricted Log Likelihood at Convergence	254.323	217.392	243.841	213.539	247.96	217.617
Chi-squared (log-likelihood ratio)	85.664	74.034	78.817	62.145	90.5	71.951
Degrees of Freedom	5	5	5	5	5	5
P-value	0.000	0.000	0.000	0.000	0.000	0.000

Note:
Model 1,3 & 5: foreign currency only hedgers versus foreign currency non-hedgers.
Model 2,4 & 6: foreign currency only hedgers versus non-hedgers.

The results for models 1, 3 and 5 show that the coefficients on the tax loss dummy, gearing and firm size are no longer significant. However, in these models the non-foreign currency hedging sample includes firms that might hedge other exposures such as interest rate and commodity price risks. Therefore, models 2, 4 and 6 exclude these firms to generate a "clean" non-hedging group (i.e., those firms that do not hedge any type of exposure). Comparing the results for models 2, 4 and 6 with those of models 1, 3 and 5 shows that the coefficient on the gearing variable is now significant while the coefficients on tax loss and firm size variables are greater although insignificant.

The results for model 2, 4 and 6 demonstrate that the level of gearing is a significant determinant of the decision to hedge for those firms that only hedge foreign currency exposure. However, comparing these results with those in Table 8.6 shows that the effect is greater for foreign currency hedgers than for foreign currency only hedgers. For example, model 4 in Table 8.7 shows that a unit increase in the level of gearing leads to a statistically significant increase in the odds of foreign currency only hedging by 2.5 percent. Model 6 in Table 8.6 estimates the same model for all foreign currency hedgers and shows that a unit increase in gearing is estimated to increase the likelihood of foreign currency hedging by 3.8 percent. This difference in the change in the odds of hedging is not unexpected since the group of all foreign currency hedgers includes firms that might be hedging interest rate exposure.

The models in Table 8.7 are refitted using two alternative measures of expected costs of financial distress costs, these being the interest coverage ratio and a firm's credit rating as measured by its Qui Score. The results, presented in Table A8.3 of Appendix A8.3, are qualitatively similar to those shown in Table 8.7 and so demonstrate that the empirical results are robust to alternative measures of expected financial distress costs.

In summary, this study recognises the existence of a potential bias created by including in the foreign currency hedging sample firms that hedge both foreign currency and interest rate exposure. The tests in this section eliminate this bias by selecting firms for inclusion in the model that only hedge foreign currency exposure. The empirical results demonstrate that the finding of a significant relationship between foreign currency hedging and several proxies for the expected costs of financial distress is not driven by the fact that foreign currency hedging firms are also hedging interest rate exposure. The tests show that proxies for expected financial distress costs are important determinants of the likelihood of hedging for those that only hedge foreign currency exposure.

8.6 Multivariate Tests For Foreign Currency Hedging Using Survey Data

As mentioned previously this study has collected data through both information published in annual reports and a questionnaire mailed to corporate treasurers. The empirical tests in sections 8.3 through to 8.5 use the hedging and non-hedging classifications determined by the data collected from annual reports. The tests in this section utilise the survey responses to identify hedgers and non-hedgers. Of the 186 firms responding to the survey, financial and annual report data was only available for 174 firms. Therefore, several of the models estimated in sections 8.3, 8.4 and 8.5 are re-estimated using the subset of 174 firms.

The models do not include proxies for growth since none of the four proxies were statistically significant in any of the models tested. Table 8.8 presents the results of fitting these models using the survey hedging classifications. Model 1 results show that the likelihood of hedging is significantly related to the existence of foreign operations and firm size. These findings are consistent with the notion that these firms face higher levels of foreign currency exposure and with the fixed costs of hedging acting as a barrier to small firms. The signs of the coefficients on the other three variables are as hypothesised although not significant.[22]

Model 2 in Table 8.8 shows the affect of excluding other hedgers from the non-foreign currency hedging survey sample. The results show that the gearing variable goes from being statistically insignificant in model 1 to statistically significant at less than the 1 percent level and the coefficient increases by a factor of 10.[23] The firm size coefficient also increases as does the tax loss dummy coefficient although the latter is still insignificant. The coefficients on both the foreign operations and liquidity variables decrease although the former is still significant at less than the 1 percent level. The above pattern of changes is repeated across models 3 to 6. These results once again demonstrate the bias that exists in the tests as a result of including other hedging firms in the non-foreign currency hedging sample. The consequences are most severe for the gearing variable. The finding of no significant relationship between hedging and gearing in models 1, 3 and 5 is consistent with the results of previous studies (Geczy et al. (1997), Allayannis and Ofek (2001), Howton and Perfect (1998) and Graham and Rogers (2000)). The common feature across all these studies and models 1,3 and 5 is the inclusion of other hedging firms in the non-foreign currency hedging sample. It is quite conceivable that this is the explanation for why these studies find no relationship between foreign currency hedging and gearing (or other financial distress proxies).

[22] Model 1 in Table 8.8 contains the same explanatory variables as model 5 in Table 8.5, although the latter model uses the annual report hedging classification and so is estimated using more observations. All the explanatory variables in model 5 are statistically significant.

Table 8.8 Multivariate Logistic Regression Results for Foreign Currency Hedging - Using Survey Data

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Tax loss carry forwards dummy	0.332	1.059	0.785*	1.634**	0.606	1.356**
	0.497	0.135	0.081	0.020	0.175	0.044
Gross book value gearing	0.008	0.082***	0.015	0.102***	0.019	0.097***
	0.592	0.005	0.334	0.002	0.212	0.001
Foreign Operations dummy (Models 1 & 2)	2.690***	1.999***	0.038***	0.014	0.037***	0.021***
Foreign sales by origin (Models 3 & 4)	0.000	0.001	0.000	0.266	0.000	0.033
Foreign sales by destination (Models 5 & 6)						
Liquidity - Cash ratio	-0.093	-0.005	-0.488	-0.434	-0.700**	-0.577
	0.757	0.988	0.113	0.228	0.022	0.123
Natural log of Total Assets	0.351***	0.428***	0.343***	0.413***	0.343***	0.403***
	0.047	0.060	0.036	0.057	0.036	0.061
No. of Observations	171	153	157	139	165	147
No. of foreign currency hedgers	130	130	117	117	124	124
No. of non-foreign currency hedgers	41	23	40	22	41	23
-2 Restricted Log Likelihood (Slopes=0)	188.377	129.522	178.202	121.429	185.019	127.525
-2 Restricted Log Likelihood at Convergence	131.130	79.702	136.857	77.666	138.968	82.480
Chi-squared (log-likelihood ratio)	57.247	49.82	41.345	43.763	46.051	45.045
Degrees of Freedom	5	5	5	5	5	5
P-value	0.000	0.000	0.000	0.000	0.000	0.000

Notes:

Models 1, 3, 5: foreign currency hedgers versus foreign currency non-hedgers.
Models 2, 4, 6: foreign currency hedgers versus non-hedgers.

8.7 Empirical Tests for Foreign Currency Only Hedgers Using Survey Data

The tests in section 8.5 show that the likelihood of foreign currency only hedging increases as the expected costs of financial distress increase. Foreign currency only hedgers were identified on the basis of disclosures in annual reports. However, it was noted in chapter 4 that treasury disclosures were not mandatory for the sample year. A comparison of annual report and survey hedging classifications in chapter 4 revealed that 46 firms were incorrectly classified as non-interest rate hedgers by the annual report data. Furthermore, the annual report data classified 15 of these firms as non-hedgers and 31 firms as foreign currency hedgers. Therefore, at least 31 of the firms previously classified as foreign currency only hedgers by the

[23] Table A8.4 in Appendix A8.4 shows qualitatively similar results for the interest coverage ratio proxy for expected costs of financial distress.

annual report data are also interest rate hedgers. The implication of this is that the conclusion reached in section 8.5 suggesting that the expected costs of financial distress are an important factor in determining the decision to hedge foreign currency exposure might not be entirely correct.

The results in section 8.5, however, can be verified using the questionnaire survey data collected as part of this study. This study assumes the questionnaire data presents a true picture of a firms hedging activity. Therefore, in this section the data provided by respondents to the questionnaire is used to validate the finding that the expected costs of financial distress are an important determinant of the hedging decision for foreign currency only hedgers.

Table 8.9 presents results of logit regressions investigating the determinants of foreign currency only hedging. Models 2 and 4 refit models 1 and 3 respectively, excluding other hedging firms from the non-foreign currency hedging sample. The results show that in addition to the level of foreign currency exposure, the gearing proxy for expected financial distress costs is a statistically significant factor in determining the foreign currency only hedging decision.[24] Since these firms are correctly classified as foreign currency only hedgers there can be no other forces driving this result. This evidence provides confirmation of the results presented in section 8.5.

Table 8.9 Multivariate Logistic Regression Results for Foreign Currency Only Hedging Firms - Using Survey Data

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4
Tax loss carry forwards dummy	0.547 0.404	1.849* 0.053	0.135 0.836	1.208 0.154

[24] In Table A8.5 in appendix A8.5, the coefficient on the industry adjusted gearing variable in model 2 is significant at the 5 percent level. In model 4 the coefficient on the interest cover variable increases as a result of dropping hedgers from the non-foreign currency hedging sample although it remains insignificant. In an unreported test the coefficient on the credit rating variable fell as a result of removing hedgers from the non-hedging sample and was insignificant.

Table 8.9 Multivariate Logistic Regression Results for Foreign Currency Only Hedging Firms - Using Survey Data

The data are presented as log of odds and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4
Gross book value gearing	-0.005	0.083**	-0.002	0.068*
	0.822	0.042	0.946	0.064
Foreign sales by origin (Models 1 & 2)	0.028**	0.013	0.031***	0.021*
Foreign sales by destination (Models 3 & 4)	0.025	0.405	0.003	0.075
Liquidity - Cash ratio	-0.048	-0.166	-0.299	-0.326
	0.892	0.671	0.430	0.428
Natural log of Total Assets	0.099	0.332	0.046	0.199
	0.700	0.269	0.856	0.486
No. of Observations	58	40	62	44
No. of foreign currency hedgers	18	18	21	21
No. of non-foreign currency hedgers	40	22	41	23
-2 Restricted Log Likelihood (Slopes=0)	71.847	55.051	79.381	60.906
-2 Restricted Log Likelihood at Convergence	66.211	44.386	68.752	50.598
Chi-squared (log-likelihood ratio)	5.636	10.665	10.629	10.308
Degrees of Freedom	5	5	5	5
P-value	0.343	0.058	0.059	0.067

Notes: Models 1 & 3: foreign currency only hedgers versus foreign currency non-hedgers. Models 2 & 4: foreign currency only hedgers versus non-hedgers.

8.8 Multivariate Analysis of The Extent of Foreign Currency Hedging

8.8.1 The Tobit Model

The empirical analysis in the sections above has used a dummy dependent variable indicating whether or not a firm hedges and thus employed logit multivariate methodology to examine the determinants of the decision to hedge. The tests in this section use notional foreign currency derivative holdings to derive a continuous measure of hedging. The use of this type of dependent variable facilitates the study of the determinants of the extent of hedging as opposed to the decision of whether or not to hedge. The empirical tests use this continuous dependent variable to test the theories of optimal hedging.

The discussion in section 8.2 showed that 73.8 percent (215 firms) of foreign currency hedgers disclosed the use of derivatives and of these 33 percent (70 firms) provided data on the total notional amount of foreign currency derivatives. This study measures derivative holdings using total notional value of derivative contracts held scaled by the book value of total assets.

Using the notional value of foreign currency derivatives has several advantages over a dichotomous variable indicating whether or not a firm hedges. For example, such a continuous variable facilitates the testing of hypotheses on the relation between the extent of hedging (as measured by the level of foreign currency derivatives use) and the magnitude of the factors that expose the firm to currency fluctuations, such as foreign operations, foreign sales, exports and imports. However, a problem with using this measure is that firms do not on the whole disclose the direction of the hedge and therefore it is not possible to determine whether the amounts of the foreign currency derivatives represent a short, a long, or a net position in the underlying currency. Notwithstanding the potential measurement error due to the inability to net long and short positions, there are still insights to be gained from the use of this continuous dependent variable.[25]

Table 8.1 shows that 122 firms were categorised as non-foreign currency hedgers. These firms were designated as having zero holdings of foreign currency derivatives. For tests conducted in this section the hedging sample includes only those firms that provide data on the notional amounts of foreign currency derivatives outstanding. Foreign currency hedging firms that do not disclose the use of derivatives and foreign currency derivative users that do not disclose notional amounts are excluded from the tests in this section.

A tobit specification is used to analyse the factors that affect the extent of hedging. The tobit model takes the form

$$
\begin{aligned}
y_i^* &= \beta x_i + u_i \qquad \text{where } u_i \sim \text{IN}(0, \sigma^2) \\
y_i &= y_i^* \text{ if } y_i^* > 0 \\
y_i &= 0 \text{ if } y_i^* \leq 0
\end{aligned} \qquad 5.17
$$

The models in Table 8.10 present coefficient estimates from a tobit regression using total notional foreign currency derivatives scaled by the book value of assets as the dependent variable.

Table 8.10 Multivariate Tobit Regression Results for Foreign Currency Hedging Firms

Models 1, 3 and 5 include "other hedging" firms in the non-hedging sample and models 2, 4 and 6 exclude these firms. The data are presented as coefficient and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Tax loss carry forwards dummy	-0.017	0.043	0.096	0.114	0.049	0.063
	0.909	0.768	0.513	0.450	0.723	0.661
Gross book value gearing	0.010***	0.012***	0.010***	0.012***	0.009***	0.010***
	0.006	0.001	0.005	0.002	0.010	0.005
Foreign operations dummy (Models 1 & 2)	0.940***	0.773***	0.012***	0.010***	0.012***	0.010***
Foreign sales by origin (Models 3 & 4)	0.000	0.000	0.000	0.000	0.000	0.000
Foreign sales by destination (Models 5 & 6)						
Liquidity - Cash ratio	-0.039	-0.034	-0.027	-0.029	-0.082	-0.076
	0.713	0.740	0.781	0.757	0.366	0.401
Natural log of Total Assets	0.106***	0.109***	0.125***	0.132***	0.112***	0.117***
	0.010	0.008	0.004	0.002	0.005	0.004
No. of Observations	184	155	176	147	182	153
No. of foreign currency hedgers	68	68	63	63	67	67
No. of non-foreign currency hedgers	116	87	113	84	115	86
Restricted Log Likelihood	-102.654	-95.157	-93.744	-87.118	-97.558	-91.592
Chi-squared (log-likelihood ratio)	69.32	61.01	73.26	64.12	76.94	65.63
Degrees of Freedom	5	5	5	5	5	5
P-value	0.000	0.000	0.000	0.000	0.000	0.000

The tobit results show that the gearing ratio is positively related to the extent of foreign currency derivative use. Furthermore, the results in Table A8.6 of appendix A8.6 show that a firm's credit rating is also significantly related to the extent of foreign currency hedging. This evidence is consistent with firms hedging in response to large expected costs of financial distress. Additionally, models 2, 4 and 6 in Table 8.10 show that removing "other" hedging firms from the non-hedging sample

[25] Similar measures of derivative use (or the extent of hedging) have been employed by Berkman and Bradbury (1996), Gay and Nam (1998), Howton and Perfect (1998), Graham and Rogers (2000) and Allayannis and Ofek (2001).

strengthens the relationship between gearing and the extent of foreign currency hedging. Overall these results are more supportive of a financial distress motive to hedge foreign currency exposure than those found in previous empirical studies.[26]

The level of foreign currency exposure as proxied by the existence of foreign operations and the level of foreign sales is an important determinant of the amount of foreign currency hedging. All three exposure factors are positively associated with the level of hedging, indicating that firms use their exposure to decide on how much to hedge.

The regression analysis also shows that hedging with derivatives increases with firm size. This is consistent with fixed costs limiting hedging by small firms, but not consistent with informational asymmetry leading to increased hedging. Finally, the parameter estimate for the tax loss variable is positive but insignificant.[27]

8.8.2 Tobit Analysis For Foreign Currency Only Hedgers

The logit analysis in section 8.5 recognised the problem that the finding of a significant relationship between the foreign currency hedging decision and various proxies for financial distress might be driven by the fact that some foreign currency hedgers are also interest rate hedgers. This problem was avoided by focusing on hedging firms that only hedged foreign currency exposure. The tests in this section follow this approach and re-examine the determinants of the extent of foreign currency hedging. The tests employ tobit methodology and include in the hedging

[26] Allayannis and Ofek (2001) and Howton and Perfect (1998) use tobit regression and find no evidence that financial distress costs affect foreign currency hedging. Graham and Rogers (2000) find that of the four measures of expected financial distress costs employed only the debt ratio is significantly related to the extent of hedging in their tobit regressions.

[27] In unreported tests there is a no relation between the various proxies for growth options and hedging, therefore there is no evidence that firms hedge to minimise underinvestment problems when they have growth options.

sample foreign currency derivative using firms that only hedge foreign currency exposure.

Of the 68 firms for which the study has data on the extent of foreign currency derivative use 50 firms also hedge interest rate exposure. Therefore, these 50 firms are excluded from the sample leaving 18 foreign currency only hedgers.[28] The results of estimating a tobit model using the restricted sample of 18 foreign currency hedgers and 122 non-foreign currency hedgers are presented in Table 8.11. Model 1 shows that gearing is no longer a significant determinant of the extent of foreign currency hedging. However, there is a significant relationship between a firm's credit rating and the extent of hedging. This finding is consistent with the argument that the expected costs of financial distress are an important determinant of the extent of foreign currency hedging.

As before the tests exclude "other" hedgers from the non-foreign currency hedging sample and repeat the estimation of the models. The results of this analysis show that the size of the coefficient for each of the three financial distress proxies increases and in the case of the net interest charge variable goes from being insignificant to significant. In summary, these results provide further evidence for the importance of financial distress costs in determining the extent of foreign currency hedging.

Table 8.11 Multivariate Tobit Regression Results for Foreign Currency Only Hedging Firms

Models 1, 3 and 5 include "other hedging" firms in the non-hedging sample and models 2, 4 and 6 exclude these firms. The data are presented as coefficient and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Tax loss carry forwards dummy	0.099	0.128	0.025	0.063	0.088	0.114
	0.342	0.246	0.820	0.580	0.434	0.327
Gross book value gearing (Models 1 & 2)	0.001	0.003	-0.006**	-0.008**	-0.230	-0.242*
Credit rating - Qui score (Models 3 & 4)	0.494	0.374	0.049	0.037	0.117	0.094
Net interest charge average dummy (Models 5 & 6)						

[28] This is small number and thus the validity of the parameter estimates might be called into question.

Table 8.11 Multivariate Tobit Regression Results for Foreign Currency Only Hedging Firms

Models 1, 3 and 5 include "other hedging" firms in the non-hedging sample and models 2, 4 and 6 exclude these firms. The data are presented as coefficient and p-values. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Foreign operations dummy	0.313***	0.269**	0.321**	0.3107**	0.342***	0.3036**
	0.009	0.022	0.012	0.02	0.009	0.018
Liquidity - Cash ratio	-0.012	-0.014	-0.009	-0.018	0.026	0.026
	0.807	0.771	0.857	0.718	0.655	0.645
Natural log of Total Assets	-0.011	0.014	0.000	0.030	-0.014	0.006
	0.745	0.695	0.991	0.448	0.703	0.871
No. of Observations	134	105	127	99	120	97
No. of foreign currency hedgers	18	18	17	17	17	17
No. of non-foreign currency hedgers	116	87	110	82	103	80
Restricted Log Likelihood	-32.241	-28.39	-29.106	-25.139	-29.241	-26.047
Chi-squared (log-likelihood ratio)	14.6	12.92	16.53	15.45	15.17	13.8
Degrees of Freedom	5	5	5	5	5	5
P-value	0.012	0.024	0.006	0.009	0.010	0.017

8.9 Multivariate Analysis of The Extent of Foreign Currency Hedging: The Cragg Model

A feature of the tobit model employed in the previous section is that the same set of variables, with the same coefficients, is held to determine both the probability of hedging and the extent of hedging, conditional on the firm hedging. In other words, the tobit model does not accommodate the possibility that the relation between characteristics of a firm and the probability it decides to hedge is different from their relation to the extent a firm decides to hedge, if it is hedging. For example, the tobit model does not permit the testing of the assertion that the probability a firm hedges might increase with firm size while the extent of hedging among firms might decrease with firm size.

This section employs the Cragg (1971) model where this constraint is relaxed, so that the effects of variables on each of the two steps can be different (i.e., the same variable can influence each of the steps differently). The Cragg model can be written as

1. Decision equation:

$$\text{Prob}\,[y^*_i > 0] = \Phi(\gamma' x_i), \qquad z_i = 1 \quad \text{if } y^*_i > 0, \tag{5.18}$$

$$\text{Prob}\,[y^*_i \leq 0] = 1 - \Phi(\gamma' x_i), \qquad z_i = 0 \quad \text{if } y^*_i \leq 0. \tag{5.19}$$

2. Regression equation for nonlimit observations:

$$E[y_i|z_i = 1] = \beta' x_i + \sigma\lambda_I \tag{5.20}$$

These two parts are estimated separately, under the assumption that the two stages are independent of each other. The first step examines whether or not a firm hedges using a probit model and the second step examines the extent of hedging, given that a firm hedges using a truncated regression.

Table 8.12 presents the probit regression results. The signs and significance for the probit coefficients are generally similar to those for the tobit analysis (see Table 8.10). The results show that the probability of hedging with foreign currency derivatives is significantly positively related to gearing, foreign sales, tax losses and firm size. Foreign currency hedging is negatively related to liquidity although the coefficient is not significant.

Table 8.12 Multivariate Probit Regression Results for Foreign Currency Hedging Firms

The data are presented as coefficient and p-value. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4
Tax loss carry forwards dummy	0.345	0.797***	0.704**	
	0.183	0.007	0.013	
Gross book value gearing	0.013**	0.017***	0.015**	0.018***
	0.039	0.009	0.019	0.009
Foreign currency operations dummy (Model 1)	1.629***	0.033***	0.029***	0.028***
Foreign sales by origin (Model 2)	0.000	0.000	0.000	0.000
Foreign sales by destination (Models 3 & 4)				
Liquidity - Cash ratio	-0.053	-0.033	-0.199	-0.143
	0.750	0.832	0.185	0.323
Natural log of Total Assets	0.335***	0.448***	0.427***	0.377***

Table 8.12 Multivariate Probit Regression Results for Foreign Currency Hedging Firms

The data are presented as coefficient and p-value. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4
	0.000	0.000	0.000	0.000
No. of Observations	184	176	182	182
No. of foreign currency hedgers	68	63	67	67
No. of non-foreign currency hedgers	116	113	115	115
Restricted Log Likelihood	-70.248	-57.029	-61.905	-65.101
Chi-squared (log-likelihood ratio)	101.91	115.53	115.68	109.29
Degrees of Freedom	5	5	5	4
P-value	0.000	0.000	0.000	0.000
Corresponding model in Table 8.10	1	3	5	

The truncated regression in the second stage of the Cragg analysis measures the extent of hedging activity, conditional on a firm hedging. As in the Tobit analysis, the truncated regression results presented in Table 8.13 indicate that the extent of foreign currency derivatives hedging is significantly positively related to gearing. This finding suggests that the extent of foreign currency hedging is influenced by the expected costs of financial distress.[29] This relation is substantially stronger than that for the Tobit models. For example, for the truncated regressions, the coefficient on the gearing ratio ranges between 0.224 and 0.321. For the tobit model it ranges between 0.009 and 0.012. Also in line with the tobit results, the truncated results show that the extent of foreign currency hedging is positively related to the level of foreign currency exposures as proxied by the level of foreign sales.[30]

There are a few differences between the tobit and truncated regression results. The tax loss coefficient is negative in the truncated regression, opposite what is predicted by theory. Size is negatively related to the extent of hedging with foreign

[29] Graham and Rogers (2000) find a similar result while Allayannis and Ofek (2001) do not.

[30] Allayannis and Ofek (2001) find that in their second stage truncated model foreign currency exposure factors are the sole determinants of the amount of foreign currency hedging whereas Graham and Rogers (2000) report a significant negative relationship between foreign sales and the extent of foreign currency derivatives use.

currency derivatives in the truncated regression.[31] The negative relation between size and the extent of hedging reported here is consistent with the amount of hedging increasing with the degree of informational asymmetry and hence costly external finance or direct financial distress costs, given that a firm hedges. Or, perhaps larger firms are naturally diversified through their operations and thus require smaller hedging positions. Alternatively, larger firms are more inclined to leave positions unhedged with a view to generating profits for their treasury functions. However, the size result should be interpreted cautiously, because the firm size (book value of total assets) is the denominator of the dependent variable. Finally, the liquidity variable is negative and significant. This variable is insignificant in the probit model (see Table 8.12). This indicates that among companies hedging, those with lower liquidity tend to hedge more extensively but they are not any more likely to hedge.

Table 8.13 Multivariate Truncated Regression Results for Foreign Currency Hedging Firms

The data are presented as coefficient and p-value. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4
Tax loss carry forwards dummy	-23.249*	-8.799**	-9.463*	
	0.098	0.041	0.066	
Gross book value gearing	0.321*	0.226**	0.224***	0.313***
	0.096	0.026	0.003	0.000
Foreign currency operations dummy (Model 1)	27.411	0.201**	0.212***	0.308***
Foreign sales by origin (Model 2)	0.264	0.012	0.000	0.000
Foreign sales by destination (Models 3 & 4)				
Liquidity - Cash ratio	-9.464	-8.082**	-8.058***	-9.422***
	0.241	0.026	0.000	0.000
Natural log of Total Assets	-0.028	-1.900	-2.489***	-1.877*
	0.985	0.117	0.008	0.070
No. of Observations	68	63	67	67
No. of foreign currency hedgers	68	63	67	67
No. of non-foreign currency hedgers	0	0	0	0
Restricted Log Likelihood	28.1335	32.701	34.919	31.579

[31] Several studies (Nance et al. (1993), Mian (1996), and Geczy et al. (1997)) contend the positive relation between firm size and hedging can be attributed to significant economies of scale in information and transaction costs of hedging. Based on this argument, size should be positively related to the probability that a firm hedges. However, theories linking hedging to financing costs suggest hedging benefits firms with less assets more than larger ones. Therefore, the extent to which a firm hedges, once it decides to hedge, is predicted to be negatively correlated with size. In previous empirical tests Graham and Rogers (2000) report a positive relation between size and the extent of hedging whereas Allayannis and Ofek (2001) find no significant relationship.

Table 8.13 Multivariate Truncated Regression Results for Foreign Currency Hedging Firms

The data are presented as coefficient and p-value. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4
Wald Chi-squared	5.61	28.43	90.52	131.07
Degrees of Freedom	5	5	5	4
P-value	0.3457	0.000	0.000	0.000
Corresponding model in Table 8.10	1	3	5	Not Applicable

8.10 Conclusions

The empirical tests in this chapter examined the determinants of foreign currency hedging. The tests employed a range of techniques to examine both the determinants of the decision to hedge foreign currency exposure and the extent of foreign currency hedging. Unlike similar earlier studies, the empirical tests in this chapter provide strong evidence of a link between foreign currency hedging and various proxies for the expected costs of financial distress. The empirical analysis also demonstrates that a firm's currency exposure through foreign operations and foreign sales is a very important factor that prompts firms to hedge and influences their decision on how much to hedge. A firm's liquidity is also a significant determinant of foreign currency hedging which is consistent with the Nance et al. (1993) proposition that hedging and other financial policies, such as liquidity, are substitutes.

The evidence shows that the size of the firm is positively related to the foreign currency hedging decision, indicating that larger firms are more likely to hedge than smaller firms. This result is consistent with significant information and transaction cost scale economies of hedging discouraging smaller companies from hedging. However, the analysis also demonstrated that the extent to which a firm hedges, once it decides to hedge is negatively correlated with size. This is consistent with theories linking hedging to financing costs which suggest that small firms face substantial informational asymmetry costs (one of which is higher costs of external finance) and therefore should hedge more than large ones.

These results presented in this chapter are more supportive of a financial distress motive to hedge than those found in earlier mainly US empirical studies. One explanation is that the expected costs of financial distress are higher in the UK than the US. The main objective of Chapter 11 of the US Bankruptcy Code is to maintain the business as a going concern, even if that reduces the proceeds to creditors. In contrast the main objective of the UK Code is to increase the likelihood of repayment of creditors' claims. If the UK Code encourages premature liquidation, then it could be argued that UK firms face higher expected costs of financial distress and therefore a greater incentive to hedge inorder to avoid these costs.

The empirical analysis in this chapter has identified a second potential explanation. This is the suggestion that the tests in several US studies are possibly flawed because in these foreign currency hedging studies the non-hedging sample includes other hedging firms, that is, firms that hedge interest rate and/or commodity price exposure but not foreign currency exposure. These other hedgers might be hedging because of financial distress reasons (especially the interest rate hedgers) which potentially blurs the distinction between the two groups making it far more difficult to detect a relationship between foreign currency hedging and expected financial distress costs.

Appendix A8.1

Table A8.1 Multivariate Logistic Regression Results for Foreign Currency Hedging Firms: Using Alternative Proxies for Foreign Currency Exposure

The data are presented as log of odds and p-value. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3
Tax loss carry forwards dummy	0.596**	0.979***	0.988***
	0.049	0.002	0.001
Gross book value gearing	0.024***	0.029***	0.025***
	0.003	0.001	0.002
Foreign sales by destination (Model 1)	0.044***	2.503***	0.262*
Foreign currency trade dummy (Model 2)	0.000	0.000	0.055
Foreign currency tax ratio (Model 3)			
Liquidity - Cash ratio	-0.736***	-0.525***	-0.409**
	0.002	0.009	0.041
Natural log of Total Assets	0.380***	0.445***	0.371***
	0.000	0.000	0.000
No. of Observations	391	400	366
No. of foreign currency hedgers	276	284	264
No. of non-foreign currency hedgers	115	116	102
-2 Restricted Log Likelihood (Slopes=0)	473.734	481.721	433.132
-2 Restricted Log Likelihood at Convergence	327.793	326.979	368.420
Chi-squared (log-likelihood ratio)	145.941	154.742	64.712
Degrees of Freedom	5	5	5
P-value	0.000	0.000	0.000

Appendix A8.2

Table A8.2 Multivariate Logistic Regression Results for Small Firms

Models 1 and 2 include "other hedging" firms in the non-hedging sample and have the same specification as models 4 and 5, respectively, in Table 8.5. Models 3 and 4 exclude "other hedging" firms and have the same specification as models 4A and 5A, respectively, in Table 8.6. The data are presented as log of odds and p-value. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4
Tax loss carry forwards dummy	1.021*	1.191**	1.061*	1.146*
	0.095	0.043	0.085	0.059
Gross gearing book value	0.086***	0.057**	0.089***	0.080***
	0.002	0.012	0.002	0.002
Capital expenditure	-6.170		-5.560	
	0.111		0.212	
Foreign operations dummy	2.332***	2.339***	2.322***	2.336***
	0.001	0.000	0.001	0.001
Liquidity - Cash ratio	0.172	-0.275	-0.079	-0.318
	0.743	0.630	0.893	0.617
Natural log of Total Assets	-0.080	-0.035	-0.133	-0.141
	0.849	0.930	0.754	0.734
No. of Observations	104	104	102	102
No. of foreign currency hedgers	68	68	68	68
No. of non-foreign currency hedgers	36	36	34	34
-2 Restricted Log Likelihood (Slopes=0)	134.167	134.167	129.849	129.849
-2 Restricted Log Likelihood (Convergence)	91.194	98.013	88.917	90.436
Chi-squared (log-likelihood ratio)	42.973	36.154	40.932	39.413
Degrees of Freedom	6	5	6	5
P-value	0.000	0.000	0.000	0.000

Appendix A8.3

Table A8.3 Multivariate Logistic Regression Results for Foreign Currency Hedging and Foreign Currency Only Hedging Firms

Models 1 to 4 employ the interest cover proxy for expected costs of financial distress and Models 5 to 8 employ the credit rating (Qui-score) proxy for expected costs of financial distress. The data are presented as log of odds and p-value. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Tax loss carry forwards dummy	0.637**	0.713**	0.480	0.575	0.449	0.607*	0.346	0.544
	0.037	0.038	0.167	0.128	0.167	0.098	0.351	0.177
Interest cover (models 1 to 4)	-0.011**	-0.015***	-0.012**	-0.014**	-0.036***	-0.037***	-0.035***	-0.038***
Credit rating (models 5 to 8)	0.035	0.008	0.048	0.021	0.000	0.000	0.001	0.001
Foreign sales by origin	0.052***	0.041***	0.048***	0.039***	0.055***	0.046***	0.051***	0.045***
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Liquidity - Cash ratio	-0.502**	-0.492**	-0.505*	-0.495*	-0.373*	-0.387*	-0.482*	-0.490*
	0.031	0.030	0.066	0.059	0.081	0.072	0.070	0.062
Natural log of Total Assets	0.292**	0.448**	-0.137	0.096	0.493***	0.687***	0.082	0.372**
	0.005	0.000	0.334	0.536	0.000	0.000	0.574	0.026
No. of Observations	374	345	233	204	363	335	225	197
No. of foreign currency hedgers	262	262	121	121	257	257	119	119
No. of non-foreign currency hedgers	112	83	112	83	106	78	106	78
-2 Restricted Log Likelihood (Slopes=0)	456.587	380.705	322.658	275.684	438.462	363.596	311.165	264.504
-2 Restricted Log Likelihood at Convergence	321.620	266.103	240.840	212.384	293.663	242.856	221.533	193.770
Chi-squared (log-likelihood ratio)	134.967	114.602	81.818	63.3	144.799	120.74	89.632	70.734
Degrees of Freedom	5	5	5	5	5	5	5	5
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Model 1: foreign currency hedgers versus foreign currency non-hedgers.
Model 2: foreign currency hedgers versus non-hedgers.
Model 3: foreign currency only hedgers versus foreign currency non-hedgers.
Model 4: foreign currency only hedgers versus non-hedgers.
Model 5: foreign currency hedgers versus foreign currency non-hedgers.
Model 6: foreign currency hedgers versus non-hedgers.
Model 7: foreign currency only hedgers versus foreign currency non-hedgers.
Model 8: foreign currency only hedgers versus non-hedgers.

Appendix A8.4

Table A8.4 Multivariate Logistic Regression Results for Foreign Currency Hedging - Using Survey Data

The data are presented as log of odds and p-value. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2
Tax loss carry forwards dummy	0.604	1.106*
	0.176	0.078
Interest cover ratio	-0.008	-0.017**
	0.320	0.043
Foreign sales by destination	0.038***	0.025***
	0.000	0.010
Liquidity - Cash ratio	-0.632**	-0.462
	0.039	0.208
Natural log of Total Assets	0.325*	0.431*
	0.063	0.061
No. of Observations	165	147
No. of foreign currency hedgers	124	124
No. of non-foreign currency hedgers	41	23
-2 Restricted Log Likelihood (Slopes=0)	185.019	127.525
-2 Restricted Log Likelihood at Convergence	139.675	92.113
Chi-squared (log-likelihood ratio)	45.344	35.412
Degrees of Freedom	5	5
P-value	0.000	0.000

Note: Model 1: foreign currency hedgers versus foreign currency non-hedgers.
Model 2: foreign currency hedgers versus non-hedgers.

Appendix A8.5

Table A8.5 Multivariate Logistic Regression Results for Foreign Currency Only Hedging - Using Survey Data

The data are presented as log of odds and p-value. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4
Tax loss carry forwards dummy	0.131	1.067	0.112	0.772
	0.843	0.211	0.865	0.327
Industry adjusted gross book value gearing (Models 1 & 2)	0.730	**2.234**	-0.003	-0.012
Interest cover ratio (Models 3 & 4)	0.315	**0.036**	0.761	0.263
Foreign sales by destination	**0.031**	**0.022**	**0.031**	**0.024**
	0.003	**0.068**	**0.003**	**0.039**
Liquidity - Cash ratio	-0.318	-0.287	-0.262	-0.162
	0.394	0.508	0.502	0.701
Natural log of Total Assets	-0.044	0.198	0.000	0.180
	0.861	0.505	0.999	0.558
No. of Observations	62	44	62	44
No. of foreign currency hedgers	21	21	21	21
No. of non-foreign currency hedgers	41	23	41	23
-2 Restricted Log Likelihood (Slopes=0)	79.382	60.906	79.382	60.906
-2 Restricted Log Likelihood at Convergence	67.737	49.035	68.664	53.069
Chi-squared (log-likelihood ratio)	11.645	11.871	10.718	7.837
Degrees of Freedom	5	5	5	5
P-value	0.040	0.037	0.057	0.166

Note: Models 1 & 3: foreign currency only hedgers versus foreign currency non-hedgers.
Models 2 & 4: foreign currency only hedgers versus non-hedgers.

Appendix A8.6

Table A8.6 Multivariate Tobit Regression Results for Foreign Currency Hedging Firms

Models 1, 3 and 5 include "other hedging" firms in the non-hedging sample and models 2, 4 and 6 exclude these firms. The data are presented as coefficient and p-value. ***, **, *denote significance at the 1%, 5%, and 10% levels, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Tax loss carry forwards dummy	-0.088	-0.019	-0.013	0.022	-0.057	-0.027
	0.574	0.904	0.934	0.896	0.710	0.864
Credit rating - Qui score	-0.0080*	-0.0084*	-0.0085**	-0.0078*	-0.008**	-0.0076*
	0.051	0.055	0.042	0.078	0.039	0.071
Foreign currency operations dummy (Models 1 & 2)	0.967***	0.824***	0.013***	0.011***	0.012***	0.010***
Foreign sales by origin (Models 3 & 4)	0.000	0.000	0.000	0.000	0.000	0.000
Foreign sales by destination (Models 5 & 6)						
Liquidity - Cash ratio	-0.028	-0.031	-0.025	-0.034	-0.087	-0.087
	0.798	0.767	0.799	0.731	0.355	0.357
Natural log of Total Assets	0.151***	0.161***	0.165***	0.174***	0.151***	0.159***
	0.000	0.000	0.000	0.000	0.000	0.000
No. of Observations	176	148	168	140	174	146
No. of foreign currency hedgers	66	66	61	61	65	65
No. of non-foreign currency hedgers	110	82	107	79	109	81
Restricted Log Likelihood	-102.352	-96.339	-93.597	-88.487	-96.696	-92.057
Chi-squared (log-likelihood ratio)	61.82	50.96	65.44	53.7	70.53	57.00
Degrees of Freedom	5	5	5	5	5	5
P-value	0.000	0.000	0.000	0.000	0.000	0.000

Chapter 9. Summary and Conclusions

9.1 Summary and Conclusions

This thesis has undertaken a comprehensive empirical analysis of the economics of corporate hedging. The thesis uses a range of techniques to test whether cross-company differences in hedging activity can be explained by finance theory. This thesis has made a contribution to the empirical literature on corporate hedging by testing the predictive power of the various hedging theories using United Kingdom firm-level data for the first time. The study made several other contributions in terms of research design and scope. The study is the first to simultaneously use both annual report and survey data. The study is the first to use categorical dependent variables to measure the extent of hedging in addition to continuous dependent variables. The study is the first to recognise that the inclusion of other hedging firms in non-hedging samples potentially blurs the distinction between hedging and non-hedging firms and therefore might bias any empirical tests against their a priori expectations. The study is the first to investigate the determinants of foreign currency only hedging recognising that previous tests might be flawed due to the inclusion of interest rate hedgers in the foreign currency hedging sample. The study is also the first to collectively investigate the determinants of the overall hedging decision, the interest rate hedging decision and the foreign currency hedging decision.

As commonly the case, prior to empirical analysis one must know what are the theoretical and the empirical approaches to the economics of corporate hedging. Chapter 1 defined risk and hedging within the context of the thesis. A review of the theoretical approaches was carried out in chapter 2. It was argued that under perfect market assumptions hedging was not value maximising. However, the theories of hedging questioned the validity of the perfect market assumptions and showed how their refutation led to arguments in support of hedging as means to maximise shareholder value. The theories of hedging argued that an equivalent statement of the Modigiliani and Miller proposition is that if financial policy in general - or hedging specifically - is to affect firm value, then it must do so through changes in tax liabilities, through changes in stakeholder contracting costs, or through important interdependencies between the choice of financial policy and future real investment decisions. This implies that hedging can increase firm value by simultaneously minimising external claims to the cash flow stream flowing from the firm's assets. Such claims include taxes paid to government by the firm; bankruptcy costs (both direct and indirect) paid to accountants, lawyers and the firm's non-investor stakeholders; agency costs to align managerial interests with the interests of capital suppliers; and/or costly external finance. Chapter 2 demonstrated that each of these theories had the potential to provide a partial explanation for the corporate demand for hedging and identified the relationships between the benefits of hedging and various firm level characteristics.

Following this, a distinction was made between cost reducing and risk reducing risk management activities. Cost reducing strategies were defined as those that made inconsequential the effects of cash flow volatility on firm value and risk reducing strategies were defined as those that lowered the volatility of cash flows. It was suggested that cost reducing strategies were not explanations for hedging, but rather controls for substitute forms of hedging. Finally, the circumstances where speculative activity would be value maximising for shareholders were identified. It was argued in some instances firms had potentially motives for both hedging and speculating and therefore it might not be possible to distinguish between these two activities.

The aforementioned theories only point to the ways and channels through which corporate hedging could affect firm value. Clearly, the only way to determine the economic effects of corporate hedging is through empirical analysis. Chapter 3 provided a review of the empirical studies on the determinants of corporate hedging, identifying the strengths and weaknesses of previous work and considering some methodological issues that arose from them. The chapter argued that empirical tests should attempt to include both on and off-balance sheet risk management activity in the definition of hedging. The chapter also identified a potentially serious flaw in several studies that have examined the hedging of specific types of financial price exposure. This was the inclusion of firms hedging other exposures in the sample of non-hedgers in studies that examined the determinants of interest rate hedging, foreign currency hedging and commodity price hedging. It was argued that the inclusion of other hedgers in the non-hedging sample might eliminate any differences between hedgers and non-hedgers and therefore bias the empirical tests. It was suggested that the research design should facilitate the identification of the types of exposures hedged by firms in order to correct for the inclusion of other hedgers in the non-hedger sample.

The review of the empirical literature demonstrated that the existing empirical evidence provides mixed support for the various hypotheses advanced to explain hedging activity. The lack of a general consensus might in part be due to the problem highlighted above of biased hedging and non-hedging samples. It was also argued that some hypotheses have not been adequately tested. In particular most previous tests of the financial distress cost hypothesis use indicators of the probability that a firm will enter into financial distress as a proxy for expected financial distress costs. In doing so these studies assume that exogenous bankruptcy costs are constant across firms and hence fail to address the possibility that exogenous bankruptcy costs might influence the firm's capital structure choice. Furthermore, some studies use the level of debt as a measure of the financial constraint faced by a firm. However, it was suggested that a large cash balance offsets the debt capacity problem for firms with high gearing since investments can be financed from the firm's surplus cash. Therefore, it was argued that a firm faces the greatest degree of financial constraint when it is both highly geared and it has low cash balances.

This chapter, by identifying the problem with biased samples and the inadequate testing of the aforementioned hypotheses and the fact that empirical tests of corporate hedging had not been undertaken using UK data demonstrated how this study would contribute to the empirical tests surveyed in the chapter. Finally, the chapter identified a number of additional research questions, empirical in nature, which required consideration to facilitate an empirical investigation.

Chapter 4 provided an explanation of the methods employed in this study to deal with the research questions identified in chapter 3. The chapter discussed where data on hedging was sourced, how it was collected and the type of data collected. It was shown that data on hedging was sourced from both annual reports and a survey to corporate treasurers. This exhaustive data collection process resulted in the creation of an unique database containing both annual report and survey response data. The availability of both data sets enabled comparisons to be made and therefore an assessment of the reliability of both data sources.

The discussion in chapter 3 identified a problem in the sample composition of several previous studies of corporate hedging namely the inclusion of other hedgers in non-hedging groups. This study is the first to recognise this as being a potentially serious criticism of previous empirical work. In view of this the data collection process for both data sets was designed to facilitate the identification of other hedging firms within so called non-hedging groups, with a view to isolating these firms in subsequent empirical tests.

Chapter 4 also demonstrated that by using data from both annual reports and survey data this study was the first to be able to highlight the problem of incorrectly classifying firms as either hedgers or non-hedgers. This is a problem some of the earlier empirical studies using annual report disclosures might have suffered from but unlike this study were not able to measure its magnitude or its effects. Finally, the chapter defined the variables, both endogenous and exogenous.

Chapter 5 identified the appropriate econometric models required to conduct empirical tests of the hypothesis identified in chapter 2. These hypotheses were investigated empirically in Chapters 6, 7 and 8.

These chapters investigated the determinants of corporate hedging. First, chapter 6 empirically investigated the determinants of all categories of hedging using both a binary dependent and continuous dependent variable. A theory's relative importance in determining which firms hedge was assessed by comparing the characteristics of firms that hedged with those that did not. These univariate tests showed that all variables proxying for the expected costs of financial distress, sources of cash flow volatility and information and transaction cost economies of scale were significantly related to hedging. However, variables proxying for hedging substitutes offered mixed results. The various measures of liquidity and the dividend yield exhibited a significant association with hedging whereas measures for convertible debt and preference capital exhibited no significant relationship. Furthermore, proxies for firm growth did not exhibit the hypothesised relationship with hedging in univariate tests. However, given correlations among the different firm characteristics, these tests cannot reveal significant differences in firm traits, holding other firm attributes constant. Therefore, multivariate tests are required. The chapter employed both logit and tobit methodology to estimate the relation between hedging and its determinants. The findings showed that firms' hedging decisions were consistent with some of the extant theory. In particular the study found strong support for the relationship between the expected costs of financial distress and hedging. These results were robust under a variety of econometric specifications (logit and tobit), as well as employing a number of alternative proxy variables and using various subsets of the full sample. The logit results were also consistent with firms using hedging and liquidity as substitutes. This finding is consistent with the theory that explains risk management as means to break the firm's dependence on external financing.

The tests in chapter 6 also examined how a firm's exposure to financial price risks affected the potential benefits of hedging. The evidence showed that firm characteristics related to these benefits, such as the level of debt and foreign currency exposure, were related to both the decision to hedge and the extent of hedging. The logit and tobit evidence also strongly supported the hypothesis that hedging activities exhibit economies of scale.

One of the major innovations in chapter 6 was its ability to compare annual report data with survey responses for a subset of the sample. This comparison revealed a group of firms that were misclassified, that is, there annual report data did not correspond with the survey data. Therefore, this process identified three categories of firm, these being, correctly classified non-hedgers, misclassified firms and correctly classified hedging firms. The misclassified group was assumed to be undertaking some hedging activity but less than the group of correctly classified hedging firms. Using 3 dummy dependent variables and multinomial logit techniques the tests showed for the first time that firms considered to be undertaking more hedging activity exhibited significantly different financial and operating characteristics relative to firms that conducted only a small amount of hedging.

Having completed the empirical investigation for the determinants of all categories of hedging, chapters 7 and 8 were dedicated to investigating the determinants of interest rate hedging and foreign currency hedging, respectively. The empirical tests in chapters 7 and 8 extended the analysis undertaken in chapter 6 by employing a two-step procedure which examined the effects of the independent variables on the decision to hedge and on the degree of hedging by the firm. This analysis recognised that the differences between the decision model and the degree of hedging model would have been masked if a tobit model had been relied upon to evaluate hedging behaviour instead of the two-step procedure.

Chapter 7 provided empirical results for tests on the determinants of interest rate hedging. Using logit methods to examine the determinants of the decision to undertake interest rate hedging the findings showed a positive relationship between interest rate hedging and gearing, although no other financial distress proxies were significantly related. Furthermore, unlike the all hedging sample, there was a significant relationship between interest rate hedging and the capital expenditure proxy for growth. The results also showed a negative relationship between hedging and liquidity. These results provided support for the hypothesis that hedging can reduce underinvestment costs associated with investment opportunities in the presence of financial constraints

The initial multivariate tests were conducted using samples of non-interest rate hedgers that included firms hedging other exposures. The inclusion of these other hedgers might have biased the results against the a priori expectations. Therefore, the tests were repeated excluding "other hedgers" from the non-hedging sample. The evidence showed the exclusion of these firms' leads to a dramatic improvement in the ability to detect a relationship between the decision to hedge interest rate exposure and various firm level characteristics. The most notable improvement was seen with the various proxies for the expected costs of financial distress. Six of these proxies were statistically significant as opposed to only one before the exclusion of these firms. Furthermore, coefficients on the liquidity, capital expenditure and foreign currency debt terms increased in virtually all specifications. These results demonstrated that excluding "other hedgers" from the tests improved the ability to identify relationships between the explanatory variables and the interest rate hedging decision. This study is the first to recognise this problem and as has been demonstrated in this chapter it is conceivable that it is a potential cause of the inability of several previous studies to detect strong relationships between various explanatory variables and the decision to hedge.

The results from the tobit, probit and truncated regression were generally consistent with the logit results. However, firm size produced different results between the truncated model and the probit and tobit models. Although firm size was an extremely significant predictor of the likelihood of a firm's decision to hedge (with derivatives), it was not an important predictor of a firm's extent of hedging activity (with derivatives).

The results in this chapter provided strong evidence that the expected costs of financial distress is a very important factor that motivates a firm to hedge and influences their decision on how much to hedge. These results are robust under a variety of econometric specifications and using a number of alternative proxy variables and using various sub-samples of the full sample.

Chapter 8 tested empirically the determinants of foreign currency hedging. The chapter presented strong evidence of a relationship between various proxies for the expected costs of financial distress and the foreign currency hedging decision. The empirical tests also find strong support for the hypothesis that the factors that expose a firm to exchange rates are important determinants for foreign currency hedging. In particular the tests show foreign currency hedging is strongly and positively related to the level of foreign sales, both by origin and destination, the incidence of foreign currency transactions such as exporting and importing, the level of overseas tax, and the existence of foreign operations.

The results of the logit analysis are consistent with firms using foreign currency hedging and liquidity as substitutes, since firms that have greater liquidity are less likely to hedge. This result is also consistent with the Froot et al. (1993) prediction that hedging activity is useful to secure the availability of internal funds.

The logit results for the foreign currency hedging sample provided support for several of the hypotheses despite the fact the non-foreign currency hedging sample included other hedging firms that hedged interest rate and/or commodity price exposure. Closer inspection of this sample and the non-interest rate hedging sample employed in chapter 7 revealed that the magnitude of the bias resulting from having other hedgers in the non-hedging group depended on the proportion of other hedgers. In the interest rate hedging tests over 60 per cent of the non-hedging group were hedging other exposures whereas for the foreign currency hedging tests the corresponding figure was only 25 per cent. The results demonstrated that a smaller proportion of other hedgers in the non-hedging group induced a smaller bias. In the foreign currency hedging sample it was small enough not to obscure the differences between foreign currency hedgers and non-hedgers. Notwithstanding this, additional tests were conducted which excluded the other hedgers from the non-hedging sample. Consistent with the earlier tests using the interest rate hedging sample, this resulted in a strengthening of the relationship between several variables and the foreign currency hedging decision.

A potential concern with these tests is that the results might be driven by the fact the foreign currency hedgers are also hedging other exposures such as interest rate exposure. Therefore the finding of a strong relationship between foreign currency hedging and various proxies for financial distress might be a spurious one if all of the foreign currency hedgers are also hedging interest rate exposure. To investigate this the tests were repeated but using those firms in the foreign currency hedging sample that hedged foreign currency exposure only, so that foreign currency hedgers that hedged interest rate exposure were excluded. The results demonstrated for the first time that gearing is an important determinant of the decision to hedge for foreign currency only hedgers. The robustness of these results was examined by employing a "clean" sample of foreign currency only hedgers derived from the survey data. The results provided unequivocal support for the argument that financial distress costs play an important role in the firm's foreign currency hedging decision.

Using a sub-sample created by including all non- foreign currency hedgers and those foreign currency hedgers that disclosed details of the notional amounts of foreign currency derivatives outstanding at the year-end a measure of the extent of foreign currency hedging was constructed. In line with chapter 7 a series of additional multivariate tests were conducted using this continuous dependent variable. Examining the extent of hedging using a tobit analysis showed that gearing, foreign currency exposure and firm size are positively related to the level of foreign currency derivatives use. The tests then employed the Cragg (1971) two-step modelling approach, which provided evidence on both the probability of hedging (probit) and extent of hedging (truncated) separately while controlling for the connection between these two decisions. The first stage probit results were generally consistent with the logit and tobit results. The second stage estimations produced slightly different results. The tests found that firms hedged in response to low liquidity when the extent of hedging was measured. This was not the case when the tests examined the binary decision of whether to hedge with foreign currency derivatives. These results are consistent with liquidity affecting the extent of foreign currency hedging but not the decision of whether or not to hedge. The second stage results also found that the extent to which a firm hedges, once it decides to hedge was negatively correlated with size, whereas the probit results showed that size was positively related to the probability that a firm hedges. This is consistent with theories linking hedging to financing costs which suggest that small firms face substantial informational asymmetry costs (one of which is higher costs of external finance) and therefore should hedge more than large ones.

9.2 Limitations of the Study

Although this study has provided a comprehensive empirical analysis of the determinants of corporate hedging in the UK through a detailed case study, it still has a number of problems and limitations in terms of data, levels of analysis and interpretation, most of which are shared with other empirical studies in the area.

A limitation of this study results from the data employed. The study measures the extent of hedging using total notional value of derivative contracts held by each firm. While total notional value effectively gauges derivative ownership, it may not serve well as an estimate of derivatives hedging if a firm holds offsetting contracts. Therefore, a more appropriate measure would be the absolute value of the net derivatives position in each category. The net position is the difference between each firm's long and short positions in a particular derivative contract. However, with regards to this study, during the period investigated firms were not required to report the detailed information on the direction and purpose of notional derivative holdings, which would enable one to net long and short positions. Unfortunately, this is still the position today with regard to derivatives holdings disclosures.

The study employs gearing as an explanatory variable and interprets the gearing ratio as a measure of the expected costs of financial distress, which is a causal determinant of corporate hedging. However, an alternative reason for why gearing and hedging may be positively related is because hedging by reducing the probability of financial distress increases debt capacity. If firms increase their gearing in response to greater debt capacity, the associated increase in interest deductions reduce tax liabilities and increases firm value. Thus, the ability to increase debt capacity provides a tax incentive to hedge. Therefore, theory suggests that the hedging/gearing causality can go both ways: hedging can lead to increased debt capacity, but higher gearing (to the extent that it increases the chances if financial distress) can increase the incentive to hedge. The empirical tests in this study do not address this issue.

Also, it is important to note that although firms facing higher financial contracting costs can benefit from hedging, reducing firms' dependence on external finance does not necessarily lead to an increase in firm value. Tufano (1998) argues that hedging rather than reducing agency costs might be their source if hedging leads to overinvestment. If hedging permits managers to finance projects using internally generated funds and thus avoiding scrutiny from the external capital markets, it may enable managers to undertake investments that enhance managerial utility but reduce firm value. Therefore, although we find that firms with higher financial contracting costs are more likely to hedge and hedge more extensively, these results do not imply that hedging increases shareholder wealth.

Despite these limitations, the overall findings of the study that gearing, foreign currency exposure, liquidity and firm size are important factors in determining the decision to hedge and the extent of hedging do seem to be relatively robust.

9.3 Suggestions for Future Research

These problems point to the need for further consideration of certain issues and suggest useful areas for future research.

Starting from the premise that the hedging and capital structure decisions are jointly determined then an extension of the analysis in this study would be to model the hedging/capital structure decision as a simultaneous equations model. In the model with hedging as a dependent variable and gearing on the right hand side, a positive coefficient would be interpreted as evidence that gearing leads to increased hedging due to higher expected costs of financial distress. In the model with debt as the dependent variable and hedging on the right hand side, a positive coefficient would be interpreted as evidence that hedging leads to increased debt capacity and tax deductions.

In the thesis the question of whether competition within an industry could affect the demand for hedging was not covered. Under models of perfect competition, firms may hedge to mitigate losses that could put them at a competitive disadvantage. At the other extreme, a monopolist may not need to hedge at all if he is able to pass off the risk to other parties through pricing power. This suggests that the competitive structure of an industry could have an impact on a firm's decision to hedge or the extent to which it hedges. Theoretical models exist which show that a firm's exchange rate risk is directly related to industry structure. In industries with less competition, firms can respond to exchange rate movements by changing their prices, which results in lower exchange rate risk. In contrast, firms which operate in industries with a more competitive structure price is set close to marginal cost and the effects of exchange rate movements on a firm's returns can be large. If the competitiveness of industry structure is positively related to exchange rate risk and the demand for hedging is positively related to exchange rate risk, it follows that firms that operate in a more competitive industry should be more likely to hedge or hedge more of their exposure. Therefore an area for future research would be to investigate the relationship between industry structure and foreign currency hedging.

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