

# **THE DETERMINANTS OF CORPORATE RISK MANAGEMENT**

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University of Cape Town

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FINANCE

by

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## **ABSTRACT**

Traditional financial theory which is based on the Modigliani-Miller indifference paradigm, suggests that a firm's financial policies, of which risk management is one component, are irrelevant. However, this conclusion is seemingly contradicted by the observation of widespread use of derivatives by companies, particularly for hedging purposes.

This apparent conflict is receiving attention from international financial researchers. A number of hypothesis have been proposed to explain corporate risk management. To evaluate the strength of these theories, this paper begins with a formalised process of identifying the assumptions underlying the hypotheses. The theories are classified according to which assumptions are relaxed.

A limited number of international empirical studies have been performed to date. The results have been varied; four of the important studies are discussed.

For the first time, an empirical investigation into the determinants of corporate risk management in South Africa is conducted. The most significant findings are that larger firms are more inclined to undertake risk management, and the likelihood of a firm hedging increases with the size of the director's ownership in the company.

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## I. INTRODUCTION

### A. OVERVIEW

Historically, the focus of academic literature concerning risk management has been on the practicalities and the mechanics of the subject (the 'how' question). The risks to be managed are identified and the appropriate type and quantity of financial instrument is selected. There appears to be a growing awareness that a more important question should be addressed prior to the above. Should risks be managed at all, and if so, by whom and to what extent (the 'why' question). Although in its infancy, the body of academic financial risk management literature with this orientation is growing rapidly and has become the research focus of many eminent financial academics, as evidenced by the following:

*It would seem that every firm exposed to increased risk should hedge. Of course, matters are far more complicated than they first appear. Even with the increase in risk, not all firms use risk management products to reduce risk by hedging. ... we want to focus on the primary question: Why should a company hedge its financial price risk? Or, to rephrase the question, which firms have the best reason for hedging? (Smith: 1990: 19-3)*

*Financial hedging or 'risk management', is an aspect of corporate financial policy that has received relatively little attention ... Given the prevalence and importance of this type of activity, the underlying economic rationale for, and implications of corporate hedging, are important questions to be considered. (DeMarzo PM and Duffie D: 1995:743 - 744)*

*Academics know remarkably little about corporate risk management practices, even though almost three-fourths of corporations have adopted at least some financial engineering techniques to control their exposures to interest rates, foreign exchange rates, and commodity prices. (Tufano: 1996b: 1097)*

An overview of the literature highlights two fundamental problems:

- a logically consistent and widely applicable theoretical rationale for risk management that co-ordinates the strategies of investors and firms has not been accepted by academics; and
- the predictions of existing financial theory, notably the Modigliani -Miller indifference theorem, suggests that corporate risk management is irrelevant. However, there is widespread use of risk management products by firms. This suggests that financial theory is not currently applicable in the real world.

The majority of current literature attempts, explicitly or implicitly, to address these concerns offering piecemeal theoretical justifications for corporate risk management. There is no universally accepted theory and the collection of papers dealing with this subject has become replete with competing hypotheses, a number of which are simplistic, unrealistic and duplicated. The value of any hypothesis can only be determined by its relevance; its applicability to reality as decided by empirical observations. However, there is a paucity of empirical work in this area. Several recently published international studies have attempted to test empirically whether the firms' behaviour is consistent with the predictions of financial theory. To date there has been no work in this area using South African data.

## **B. THE PROBLEM**

There appears to be a mismatch between the quantity and form of risk management seen in practice and that which is postulated by financial theory. No comprehensive theoretical framework that legitimises corporate risk management programmes or that co-ordinates the risk management strategies of investors and firms, exists. There is a growing volume of studies which attempt to address these concerns. However, the relative infancy of the subject and enormous interest therein has resulted in numerous hypotheses which are difficult to evaluate and contextualise. Although a few international empirical research papers have been published recently, no similar South African analyses have been undertaken.

## **C. THE OBJECTIVES OF THE RESEARCH**

This research proposes to:

- investigate the implicit assumption underlying most of the literature that there is a conflict between corporate risk management practices in theory and reality;
- critically evaluate existing academic theories that suggest a paradigm for corporate risk management;
- compare and evaluate the results of four international empirical investigations;
- following the international research, perform an empirical investigation utilising a South African data set; and
- identify possible areas for future research.

## D. IMPORTANCE OF THE RESEARCH

The significance of this research must be considered from two perspectives: the importance of the subject matter and the contribution which this paper makes to the body of knowledge. Investigating the rationale for hedging which is undertaken by a company is currently attracting attention from eminent financial academics. The importance thereof lies in the attempt to model fundamental behaviour observed in the real world and to form a paradigm which can be used to guide corporate risk management practices. South African research in this field is minimal.<sup>1</sup> The growing interest and enthusiasm in this field has produced a voluminous number of papers proposing different reasons for corporate risk management. The relative worth of a number of these theories has not been assessed. It is important to develop a logical structure within which the work to date can be evaluated.

This paper will develop a framework which facilitates a clearer understanding of the existing literature. The manner in which the framework is constructed allows for an objective evaluation of the hypotheses through logical classification and overt enunciation of all underlying assumptions. Additionally, results of significant international empirical research will be presented and synthesised such that the global relevance of theories can be investigated. For the first time, an empirical investigation into rationales for corporate risk management utilising South African data will be conducted and the results examined. Areas with potential for future research, both theoretical and empirical, are identified.

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<sup>1</sup> See DeVilliers JU and Vivian RW (1991) for similar investigations relating to the insurance industry.

## **E. PLAN OF THE PAPER**

This research can be broken into three primary divisions. The first, which comprises the following two sections, is introductory. Section II clarifies and defines terms and concepts utilised in this research. Section III presents a framework for the evaluation of existing theories and considers the implications thereof in general terms. The second division includes Section IV to Section IX. These examine the theories that are implied by inefficiencies introduced through the relaxing of critical assumptions. The first section discusses the international empirical studies in general terms. Thereafter, in each section, the various hypotheses are evaluated and the results of the international empirical studies are presented. The remainder of the paper focuses on the South African empirical research undertaken. Section X sets out the methodology of the study. The sample design and selection and the choice of independent and dependant variables is discussed. The various statistical tools utilised are briefly explained. Section XI contains the results of the empirical study. Areas for future research and concluding remarks comprise the final section.

## II. RISK MANAGEMENT

This section will clarify and define terms and concepts to be utilised in this research.

### A. RISK<sup>1</sup>

The academic concept of risk differs from a layperson's perception thereof. The Oxford English Dictionary defines risk as: 'hazard, chance of bad consequences, loss, etc.'. This focuses exclusively on the downside, 'negative' risk of changes relative to *today's* values, while the academic definition of risk is a 'measure of the likelihood and magnitude of unanticipated changes' (Oxelheim and Wihlborg: 1987: 5). This encapsulates *unexpected* movements in *either* direction (positive or negative): it is concerned with the spread of values around the expected value and can thus be calibrated using the standard deviation or variance of a probability distribution.

$$\begin{aligned}
 \text{Variance } (r) &= \text{the expected value of } (r - r^*) \\
 &= E [ (r - r^*) ] \\
 &= \sigma_r^2
 \end{aligned}$$

$$\text{Standard deviation} = \sigma_r$$

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<sup>1</sup>There is a theoretical distinction between risk and uncertainty. Risk refers to the unique results for a given decision which can be assigned *objective* probabilities. Uncertainty implies that it is not entirely possible to identify outcomes or to assign probabilities. Nevertheless, subjective probabilities can often be assigned to the predicted outcomes and thus a situation involving uncertainty is evaluated as a risky situation. This blurs the distinction between the two concepts in practice. This distinction is not necessary for the purposes of this paper.

where:

$r$  = actual return

$r^*$  = expected return (sum of probability weighted possible returns)

The shareholder views risk in relation to their portfolio of assets. The portfolio variance is the average covariance among all the constituents of the portfolio. Thus the marginal risk of asset  $j$  is the relative increase in the portfolio variance that accompanies a marginal increase in the proportional of asset  $j$  in the portfolio. Therefore, the risk relating to a particular asset in a portfolio is evaluated not on the asset's individual variance but rather on the effect it has on portfolio variance.

The expected return on the portfolio is:

$$r^*_p = \sum_{i=1}^N \theta_i r^*_i$$

where:

$r^*_p$  =  $E[r_p]$  = expected return on the portfolio

$r^*_i$  =  $E[r_i]$  = expected return on the  $i$ th asset

$r_i$  = return on the  $i$ th asset in the portfolio

$\theta_i$  = value weighted proportion of the portfolio held in the  $i$ th

asset with  $\sum_{i=1}^N \theta_i = 1$

$N$  = number of assets in the portfolio

The variance of the return on the portfolio (or the portfolio risk) is:

$$\sigma_p^2 = \sum_{i=1}^N \sum_{j=1}^N \theta_i \theta_j \sigma_i \sigma_j \rho_{ij}$$

where:

$\sigma_p^2$  = variance of the return on the risky portfolio

$\sigma_i$  = standard deviation of the return on the *i*th asset

$\rho_{ij}$  = correlation between the returns on the *i*th and *j*th assets

### A.1. Evolution of the concept of exposure

The exposures that have concerned corporate treasurers have changed over the decades.<sup>2</sup> Initially the risks that were managed were those that had a direct impact on the reported accounting earnings of a corporation. The simplest exposure to manage is **transaction exposure**: the exposure associated with specific and identifiable cash flows. It arises from macroeconomic fluctuations which affect committed cash flows; for example, interest and capital payments on loans; repatriation of profits; receivables; and payables. This exposure creates uncertainty as to cash profits. **Translation exposure** is also accounting based, specifically a balance sheet exposure. It results from the translation of foreign assets and liabilities into a company's domestic currency for financial statement purposes. This exposure has no effect on cash flow and '(h)edging translation exposure is, therefore, almost entirely a question of image' (Oxelheim and Wihlborg: 1987: 178). However, overall corporate performance in the long run is exposed to more than merely transaction and translation exposures.

In the early 1970's the tools available to manage risk became more sophisticated. In addition, methodologies which facilitated the aggregation and netting off of risk positions were developed. Thus the concept of **competitive or economic exposure** was devised. Although authors employ different terminology and definitions,

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<sup>2</sup> For an informative and interesting discussion on the history of risk see Bernstein (1996).

the notion of competitive or economic risk is widely accepted in the literature.<sup>3</sup> This risk is concerned with the *direct and indirect* impact on the earnings of the firm in *future* periods. Effects of transaction and translation exposures are examples of the direct impact on earnings. The indirect impact can result from a number of competitive exposures. These include adjustments in a competitor's behaviour that are attributable to changes in macroeconomic variables; namely, interest rates, currency prices or commodity prices. A further exposure arises from competition for market share with companies whose cash flows are denominated in a different currency.

Since the blurring of the distinction between commercial insurance and financial derivatives, a new science of operational risk management is receiving attention in the literature. See for example *Corporate Finance Risk Management and Derivatives Yearbook (1996)*, Brady (1996), and Parsley (1996). The generic definition of **operational risk** is any risk that ultimately results in operational losses caused by the volatility of earnings that is not market or credit related. Examples include risk of loss from events related to technology and infrastructure failures, business interruptions, staff related problems, the dramatic changing of client relationships, and external events such as regulatory changes (Parsley: 1996). The evolution of the concept of exposure was aided by a number of spectacular losses resulting from the misuse of derivative instruments to manage accounting based risks.

The redefinition and expansion of the concept of exposure has resulted in a completely new way of viewing the risk a firm faces. Instead of merely focusing on changes in accounting earnings, both indirect and direct changes in economic earnings are now considered. Academics and practitioners have realised that it is not merely the

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<sup>3</sup> see Oxelheim and Wihlborg (1987); Dickens (1988); MeVay (1990); Ambolia (1996).

accounting earnings of the company that are at risk from macroeconomic changes, but the entire fabric of the company.<sup>4</sup>

## **A.2. Evolution of the concept of manageable risk**

Modern portfolio theory, notably the capital asset pricing model (CAPM), arbitrage pricing theory (APT) and the underlying theoretical support therefor, suggests that companies should not manage non-systematic risk as it can be managed more efficiently by individual investors through diversification. Thus the premiums that investors demand for incurring greater risks are comprised only of systematic risk. CAPM identifies the non-diversifiable risk using a 'beta' measure: generally, the sensitivity of a firm's share price to the market. Systematic risk according to APT is the sensitivity of market prices to a number of common economic factors. According to modern portfolio theory, investors are concerned not with the total variability of the firm's cash flows (total risk which incorporates both systematic and diversifiable risk) but only with the co-variability of those flows with the performance of the economy as a whole (systematic risk). The non-systematic risk can effectively be ignored as it can be costlessly eliminated by the investor through diversification. The systematic risk faced by companies is immutable as it is faced by all the companies in the market. Firms are therefore situated along the securities market line and the investor chooses the required level of returns according to the amount of risk they are prepared to incur. The risk return trade-off is fixed. Any firm not situated along the securities market line,

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<sup>4</sup> Case studies which are frequently cited in the literature include Kodak in Dickens (1988); Caterpillar and Komatsu in Froot (1994) and Heston and Grief (1990); Lufthansa in Ambolia (1996) and Heston and Grief (1990); and the US automotive industry in Dickens (1988) and Heston and Grief (1990).

whose risk return profile is not in line with the market, is mispriced. This unstable situation will revert to equilibrium in an efficient market.

This view has been changing in recent years. There are two readily identifiable reasons for this. Firstly, risk management products which specifically address systematic risks are freely available: futures, forwards, options and swaps used to manage exchange rate, interest rate, and commodity price changes are ubiquitous. Even the more fundamental market risks are being addressed by instruments such as inflation and 'Act of God' derivatives listed on the Chicago Board of Trade. Systematic risk can be and is widely managed.

The second argument is comprehensively covered in Shapiro and Titman (1986). They claim that there has been an almost exclusive focus on the effect of risk on the investor's required rate of return because of the encompassing influence of modern portfolio theory in recent years. Little attention has been paid to the effect on the expected future cash flows of a company. The value of a firm is dependant on both the current and the future cash flows. The majority of financial texts hold that the objective of the firm is to maximise shareholder wealth<sup>5</sup>. One of the most common proxies for shareholder wealth is the present value of the expected future cash flows, where the discount rate used is the investor's required rate of return as determined by the CAPM or APT type models. These models, as pointed out above, assume that non-systematic risk can be costlessly eliminated by investors and is thus irrelevant in the determination of the discount rate. The focus on the discount rate, as determined by modern portfolio theory, in the determination of the value of the firm effectively ignores the fact that diversifiable risk also has an impact thereon. This impact is through changes in the expected cash flows (the numerator) as opposed to changes in

the discount rate (the denominator). Thus if the firm is able to reduce total risk by managing the diversifiable risk, the value of the firm will be increased.

In this research no distinction between systematic and diversifiable risk will be drawn. Risk refers to the total likelihood and magnitude of changes in the value of the firm due to changes in macroeconomic variables.

## B. RISK MANAGEMENT

### B.1. The objective of risk management

All financial activities, including risk management, are directed towards achieving the objective of the firm. The most commonly accepted goal of a company is to maximise shareholder value or shareholder wealth<sup>6</sup>. As shareholder wealth is not objectively measurable, representative values have to be employed. The two most widely used proxies are the present value of future expected cash flows and the share price.

The approach followed by Oxelheim and Wihlborg (1987) is that shareholder value can be represented as the present value of expected future cash flows.

$$E[V_j] = \sum_{t=0}^T \frac{E[NCF_{j,t}]}{(1+r_j)^t}$$

where

$E[V_j]$  = expected value of firm  $j$

$NCF_{j,t}$  = net cash flows of firm  $j$  in time period  $t$

$r_j$  = discount rate of firm  $j$

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<sup>5</sup> See section II.B.1.

<sup>6</sup>Henceforth these two terms will be used interchangeably.

The objective of the company under this scenario is the maximisation of the expected present value of future net cash flows, *i.e.* the maximisation of  $E [ V_j ]$ . The market value of the existing shareholders' ordinary shares proxies shareholder wealth. In perfectly efficient capital markets the effects of all financial decisions are instantaneously incorporated into the share price. The share price therefore encapsulates all future cash flows. Pike and Neal (1996: 10) explicitly state that '(i)n finance, we assume that the objective of the firm is to maximise the value of the firm's shares'.<sup>7</sup> The objective of the company's risk management programme is therefore to maximise the value (present value of future net cash flows or the share price) of the company.

## B.2. The activities of risk management

It is necessary to delimit the risk management activities included within the scope of this research. Any comprehensive risk management programme encompasses managing the risks inherent within the business in addition to those introduced through the use of financial instruments for reasons other than inherent risk management. The latter includes speculation<sup>8</sup> and achievement of operational<sup>9</sup> and strategic<sup>10</sup> objectives.

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<sup>7</sup>This is supported by Ross and Westerfield (1988: 13), Brealy and Myers (1991: 5), Corraera *et al* (1993:12) and Keown (1994:2) and most standard financial texts.

<sup>8</sup>Géczy, Minton, and Schrand (1996) cite Ljungqvist L (1994), Asymmetric Information: A rationale for corporate speculation, *Journal of Financial Intermediation*, 3, 188 - 203. saying that equity holders are more likely to support the use of currency derivatives for speculation as a profit making activity, if equity shares are viewed as options on the value of a levered firm, or if managers of low output firms want to create noise to mimic high output firms. For speculation to be a profit-making activity in rational markets, a firm must either have an information advantage related to the price of the instruments underlying the derivatives, or it must have economies of scale in transactions allowing for profitable arbitrage opportunities.

<sup>9</sup> for example reducing the cost of capital

<sup>10</sup> Peter Tufano discusses how derivatives have broadened the strategic options available to firms in a fascinating article entitled 'How derivatives can advance corporate strategy' (Harvard Business Review, January - February 1996, pp 136 - 146). If derivatives are employed in the manner suggested,

The objective of employing derivatives for operational and inherent business risk management is to manage the appropriate risk. The objective of employing derivatives for speculative purposes is to make a profit. Risk management programmes are often considered to be concerned with the management of risks resulting from the use of derivative instruments. Indeed, a comprehensive risk management programmes in firms that speculate *must* be concerned with managing the risks introduced by the use of derivatives. In recent years the management of this risk has been refined through the adoption by non-financial companies of the 'value - at - risk' concept.<sup>11</sup> This technique objectively quantifies the risk introduced by holding financial assets. The strategic management decisions necessitated by the inclusion of speculation among the firms activities are well covered by academic theory.<sup>12</sup> However, this is not the definition that will be employed in this research. This paper will focus solely on the risk management activities designed to manage the underlying business risks, of which hedging is an integral, if not all encompassing part.

### **B.3. Hedging and the role of forecasting**

Within academia there is some discussion as to the exact ambit of hedging. Brealy (1991: G5) defines hedging as buying one security and selling another in order to reduce risk. The academic definition of risk discussed in Section II.A is a 'measure

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their management would be the responsibility of the company's risk management department. See also Heston and Grief (1990) for an early discussion on the subject.

<sup>11</sup> The essence of the value - at - risk (VAR) analysis is to generate a single financial estimate of the loss that may be incurred by a portfolio of financial market exposures that is associated with a selected probability level over a given future period. (MeVay: 1996: 49) The objective of the analysis is to measure the impact of changes in market conditions on the value of the hedges, assets, liabilities, revenues and expenses and ultimately the effect on the bottom line over time. (Sharma: 1996: 8). See also MeVay J & Turner C, (1995), Styblo-Beder T, (1995), Parsley M, (1995), Shirreff D, (1995), McKay R and Keefer TE, (1996), Yeager G, (1996).

of the likelihood and magnitude of unanticipated changes' (Oxelheim and Wihlborg: 1987: 5). A change in a macroeconomic variable from today's value to a future value thus comprises an anticipated change (the difference between the current value and the forecasted value) and an unanticipated change (the change from the forecasted value to the actual value). Employing Oxelheim and Wihlborg's definition, hedging should logically be concerned solely with the control of unanticipated changes. Other authors employ a more encompassing definition of hedging:

*... we adopt a fairly general definition of hedging in terms of the market value of the firm. Let  $V(S)$  be the value of the firm if it does not hedge, where  $S$  is a vector of state variables. Consider two firms,  $a$  and  $b$ , that differ from the firm with value  $V(S)$  only in their hedging policies. We say that firm  $a$  hedges more with respect to state variable  $i$  than firm  $b$  if the absolute value of the covariance of firm  $a$  with state variable  $i$  is less than or equal to that of firm  $b$ . Therefore, hedging reduces the dependence of firm value on changes in the state variable. Alternatively, we say that firm  $a$  hedges more than firm  $b$  if the absolute value of the covariance of the value of firm  $a$  with the value of an unhedged firm with the same production policy and capital structure is less than or equal to that of firm  $b$ . (Smith and Stultz: 1986: 392)*

*A position in two or more securities whose returns are negatively correlated; taking opposite trading positions in a particular security. (Ross and Westerfield: 1988 : 832)*

*... the acquisition of financial assets that reduce the variance of the firm's payoffs. (Smith and Stultz: 1985: 399)*

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<sup>12</sup> See for example Tufano P (1996a), Copeland T & Joshi Y (1996), Dolde (1993), Baldoni (1990), Bauman *et al* (1994), Lese (1994).

Oxelheim and Whilborg's definition of risk as the unanticipated change is theoretically correct given that the variance is measured with respect to the expected value (in other words, the forecasted value). However, the risk management procedures used to hedge against unanticipated changes and those utilised to immunise the firm against anticipated changes, are integrally linked and are, certainly to an outsider, indistinguishable. This strict academic distinction is unnecessary for the purposes of this paper where the focus is on the *practice* of risk management. For simplicity's sake, therefore, the generic definitions of hedging will be utilised and the management of both anticipated and unanticipated changes will be included within the ambit of risk management. Risk thus refers to the measure and likelihood of changes in the value of the firm due to changes in macroeconomic variables.

#### **B.4. The tools of risk management**

A company can engage in corporate risk management using a number of techniques. These include the use of financial instruments and adjustment of operational strategies. Financial instruments include forwards, futures, options, swaps, combinations thereof or combinations with financing activities. These can be further divided into those that have a linear (*e.g.* forwards) or a non-linear (*e.g.* options) effect. Tufano (1996b) terms the linear effect, hedging (the shedding of all exposure) and the non linear, insurance (the shedding of downside exposure).<sup>13</sup> For the purposes of this paper this distinction will not be drawn as the focus is not on the methods or form of risk management, but rather on the level of risk management to be undertaken.

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<sup>13</sup> For a discussion on the appropriateness of employing linear and non-linear strategies see Froot, Scharfstein and Smith (1993).

Operational strategies<sup>14</sup> include a scaling down of operations; or shifting a company's operations to a competitively advantageous place, for example, a low cost producing country (termed global relocation)<sup>15</sup>. Mergers and acquisitions are also important risk reducing tools employed by companies.<sup>16</sup>

There has been scant research into whether financial or operational tools should be employed to manage risk; (see Ambolia: 1996; Copeland and Joshi: 1996). Ambolia favours the use of financial tools saying that operational hedges are often more costly, imprecise, expensive, illiquid and time-consuming than financial hedges. (1996: 10) The flexibility in terms of size, materiality and denomination, introduced by employing financial instruments rather than adjusting operational strategies, is considerable. Because of the difficulties in distinguishing between operational changes undertaken for operational or risk management purposes, this research will take these strategies as predetermined and will focus solely on risk management activities involving financial instruments.

It must be noted that the use of financial instruments to mitigate risk in South Africa has been severely hampered by an underdeveloped market. This has been due partially to the infancy of the market, however, restrictions imposed by authorities, notably exchange controls, are the predominate cause. SAFEX, the South African Futures Exchange, provides financial and agricultural futures and options but is unable to offer rand denominated derivatives whose underlying asset is a metal, as the Reserve Bank fears these could be used to speculate on the South African currency.<sup>17</sup>

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<sup>14</sup> These are distinct from and unrelated to the operational risk discussed in A.1.

<sup>15</sup> See van Eenennaam and Brouthers (1996) for a discussion thereof.

<sup>16</sup> For empirical research investigating the reasons why firms peruse risk reduction strategies such as diversification see May (1995) and Amihud and Lev (1981).

<sup>17</sup> Standard Bank recently launched a new hedging tool for South African base metal producers allowing them to operate a daily settlement price on the London Metal Exchange in rands. (Spicer: 1996)

### **B.5. The effect of risk management**

Risk management, when correctly implemented, can have one of three effects on risk: reduction, elimination or transformation. The reduction or elimination of risk is the objective of hedging. Their inclusion in this research is thus self evident. Risk can be transformed into a totally different type of risk. Additionally any partial hedge will transform any risk further into basis risk. The basis is the difference between the price implied by the hedging instrument and the underlying asset price. The risk is thus not that the absolute level will change, but rather that the differential between the implied and underlying price levels will change. Basis risk is therefore the risk that changes in the hedge price will not completely mirror changes in the underlying asset price. As hedges are seldom perfect<sup>18</sup>, this transformation into basis risk must be considered and if necessary, managed.

### **B.6. Conclusion**

The operative definition of risk in the research is the magnitude and likelihood of changes in shareholder value resulting from changes in macroeconomic variables. The statistical definition of variance is employed. The present value of expected future net cash flows or share price proxies shareholder value. Risk management is the use of financial instruments to reduce or eliminate corporate financial exposure or to transform the risk to which the company or investor is exposed. Management of anticipated as well as unanticipated changes is included and there is no breakdown of

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<sup>18</sup> A perfect hedge is where 'the hedging instrument is established in such a way that its price movements are perfectly negatively correlated with those of the underlying cash security' (Blake: 1990: 358).

the total effect of a change in the macroeconomic variable. Management of risk introduced through the use of financial instruments for non-operational objectives namely speculation and strategic, is not included. The research will focus on the use of financial tools only.

## **C. THE CONFLICT BETWEEN RISK MANAGEMENT THEORY AND PRACTICE**

### **C.1. Risk management in theory**

Academic financial literature since the 1950's, in particular market portfolio theory, has suggested that investors, and not firms, should undertake certain financing decisions. Modigliani and Miller, in their prescient 1958 article, established that a firm's financial policies are irrelevant when there are no taxes, no transaction costs, if information is freely available and the investment policies of a company are fixed. In other words, a firm's financial policy has no impact on the valuation of the firm. Risk management is an important component of the financial policies of firm and is therefore also irrelevant. Modigliani and Miller demonstrated that a firm will make money only if it undertakes investments that increase its operating cash flows. The manner of financing these investments is immaterial and merely determines how the firm's value is divided between its various investors.

Thereafter Sharpe and Litner illustrated that investors were able to costlessly diversify away all specific risks. This implies that companies that manage their risks are

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<sup>18</sup> A perfect hedge is where 'the hedging instrument is established in such a way that its price movements are perfectly negatively correlated with those of the underlying cash security' (Blake: 1990: 358).

penalised by the market as risk management is costly and a firm that incurs these costs when the same result could have been costlessly achieved by the investor, does so unnecessarily. It would seem that the optimal division and quantum of risk management suggested by financial theory is one where the investor uses the available financial instruments to manage overall portfolio risk while no risk management is undertaken by the firm. The above is a brief overview of what appears to be the implicit assumption underlying much of the literature.

## C.2. Risk Management in practice

In reality there is evidence of an increasing number of companies establishing corporate risk management programmes, or at the very least employing derivatives. A 1995 survey by the Economist Intelligence Unit polled 100 senior financial and treasury managers. Only 5% indicated that they did not need derivatives (*Corporate Finance*: 1995). In 1993, Dolde surveyed the financial risk management practices of the Fortune 500 companies. 224 firms responded and over 85% reported using swaps, forwards, futures, or options in managing financial risk.<sup>19</sup> This widespread corporate risk management contradicts the theoretical view expounded above. This contradiction is illustrated by the following quotation:

*At first glance, one might expect that no firm in the gold mining industry would choose to manage gold price risk. Given an extensive gold derivatives market, investors can modify gold price risk almost as well as mining firms can. Given the reasonably transparent nature of the mining industry and the tangible nature of its assets, many rationales for corporate risk management*

*derived from considerations of asymmetric information and dead-weight costs of financial distress seem almost irrelevant. Theory might predict that no firms manage gold price risk.*

*To the contrary, the gold industry has embraced risk management: over 85 percent of the firms in this industry used at least some sort of gold price risk management in 1990 - 1993. (Tufano: 1996: 1098)*

Popular explanations for the conflict between theory and practice include the scale and informational advantages experienced by firms. Additionally, the variety and quantity of risk management tools that are publicly available ensure that almost every macroeconomic contingency is covered. It could thus seem logical that firms with exposures *should* use these numerous available securities to manage changes in exchange rates, interest rates and commodity prices. Indeed this appears to be the implicit view of many practitioners. Bauman and his co-authors from the Bank of America wrote in the 1995 Corporate Finance Risk Management and Derivatives Yearbook (3):

*A little more than a decade ago there were no market-imposed penalties for such complacency (not having a comprehensive risk management strategy in place) because the instruments and techniques for efficiently managing most types of price exposure were not available. Today, this is clearly not the case. Shareholders and creditors continue to refine their methods for assessing a company's long term risk-adjusted profitability, as measured by the stability and level of its returns.*

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<sup>19</sup> For further recent evidence of derivatives usage by US non-financial firms see Bodnar, Hayt, Marston and Smithson (1995) and Phillips (1995).

Similarly Pike and Neal, in their standard introductory textbook on corporate finance (1996: 10), state:

*Interest rates and exchange rates can vary considerably. The finance manager should take steps to ensure that exposure to adverse movements is adequately managed. Various techniques for hedging ... are available in this regard.*

Notwithstanding, the above deduction is flawed (Oxelheim: 1987: 19-4). The logical conclusion is *not* that company *should manage* their risks but that *the opportunity* to manage their risks *exists*.

The widespread use and importance of derivatives in practice is also evidenced by the large number and size of court battles concerned solely with risk management. The precedents which have been set may compel companies to undertake risk management merely to comply with the law. The diversity of the legal suits is noteworthy: companies are suing their banks for irresponsible selling of derivatives; shareholders are suing directors for failing to control treasury dealers in addition to negligence, and executives are being sued for failing to hedge their exposures properly.

The defining case involves the directors of Brane, a United States grain elevator co-operative (*Corporate Finance*: 1995). In 1980 the directors were found guilty of breaching their fiduciary duty to shareholders because they failed to hedge against a fall in the price of grain. The judgement was upheld as the directors failed to 'inform themselves adequately' of the available hedging opportunities that could have prevented their losses. Such findings seem to indicate that corporates have a legal duty to hedge against business risks through the use of derivatives. This puts company directors in the vulnerable position of being liable to lawsuits if they either fail to use derivatives or use derivatives but end up making a loss.

One of the most contentious cases of recent years involved an out of court settlement of \$16 million by Compaq, a United States computer company. The company was sued by various small shareholders for breaching federal securities laws. The shareholders alleged that they bought Compaq shares on the basis of a misleading profit prediction statement released by the directors. The statement failed to disclose that no currency risk hedging strategy existed. Soon thereafter the value of the shares fell by 20%.

The Securities and Futures Authority in London recently decreed that senior executive officers of securities houses should "take all reasonable steps to understand the firm's business or businesses". (*Cape Times Business Report*: 1996). This was prompted by the collapse of Barings Bank and implies that an excuse such as that offered by Peter Baring, an executive of Barings Bank, of not understanding the business that Nick Leeson<sup>20</sup> was conducting will not be accepted.

The number of significant losses incurred by companies as a result of derivatives use is additional evidence of the extensive use of risk management tools by companies. Examples of organisations that incurred these losses recently are Hammersmith and Fulham local authority, Metallgesellschaft, Kashima Oil, Orange County, Sumitomo, National Westminster Bank, Daiwa Bank, Sechold and Barings Bank.

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<sup>20</sup> Nick Leeson was employed as a trader of Japanese futures and options at Barings Bank in 1989. Through a series of unauthorised trades he caused Barings Bank to accumulate losses of over £869 million over a number of years. This resulted in the collapse of Barings Bank. Leeson was sentenced to six and a half years in a Singaporean gaol. For further information see Fay S, (1996), *The Collapse of Barings*, Arrow Business Books, United Kingdom.

### C.3. Conclusion

There is an apparent conflict between the predictions of traditional financial theory and what is observed in practice. Given certain assumptions, the Modigliani-Miller indifference paradigm suggests that a firm's financial policy is irrelevant, *i.e.* it has no impact on firm valuation. Corporate risk management is an important component of a firm's overall financial policy, and is therefore also irrelevant. Observation of current business practice contradicts this conclusion. The use of derivatives, particularly for hedging, is widespread. The remainder of this paper is concerned with the hypotheses which attempt to explain risk management on a corporate level.

### III. THE FRAMEWORK

#### A. OVERVIEW

The extent to which any financial theory will prove useful and relevant in practice rests with its ability to offer meaningful and practicable explanations and predictions. This is dependant on the degree of realism in the assumptions underlying the theory. The evaluation of financial theories is thus a two stage process: an examination of the logic and a consideration of the relevance and realism of the underlying assumptions. It is, therefore, imperative that the assumptions of any theory are expressly examined.

The objective in drawing up this framework is twofold:

- to create a structure which facilitates the understanding and evaluation of the evolving body of literature attempting to justify corporate risk management; and
- to investigate the validity of the implicit assumption that underlies most of this literature; *viz.* the irrelevance of risk management by the firm.

Financial theory develops predictors of real world behaviour in the following way: an environment is constructed using standard financial and economic assumptions and conclusions regarding the behaviour of the parties under these assumptions are reached and investigated. This research suggests a structure within which the existing theories can be evaluated by systematically relaxing the standard financial and economic assumptions. The postulates which are based on the resulting restricted set of assumptions are then investigated.

The traditional financial model suggests that it is irrelevant whether corporate risk management occurs on the firm or shareholder level. This concurs with the

Modigliani Miller corporate risk management indifference paradigm. As was shown in section II, this prediction contradicts the observed widespread risk management activity occurring on a corporate level. It is therefore necessary to determine whether financial theory is deficient, or whether the risk management observed in practice is, in fact, illogical. Modigliani and Miller (1958), showed that a firm's financial policies (which include risk management) are irrelevant when there are no taxes, no transaction costs, if information is freely available and the investment policies of a company are fixed.<sup>1</sup> The following quotations illustrate that, given the Modigliani-Miller framework, a company should not manage risk.

*According to the Modigliani-Miller paradigm, buying and selling oil option contracts cannot alter the company's value, since individual investors in the company's stock can always buy and sell contracts themselves if they care to adjust their exposure to oil prices. (Froot, Scharfstein and Stein: 1993: 1630)*

*Thus risk aversion provides an unsatisfactory explanation for the observed volume - portfolio theory implies that, given well-diversified investors, corporate hedging does not benefit shareholders by reducing the firm's cost of capital. (Nance, Smith and Smithson 1993: 268)*

*If one accepts the view of Modigliani and Miller, it follows almost as a corollary that risk management strategies are also of no consequence. They are purely financial transactions that don't affect the value of a company's operating assets. ... a hard-line Modigliani-Miller disciple would argue*

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<sup>1</sup> Although Modigliani and Miller's argument is widely regarded as the foundation, it was anticipated by Williams JB. (1938), *The Theory of Investment Value*, Harvard University Press, Cambridge; and Durand D. (1952), *Cost of Debt and Equity Funds for Business: Trends and Problems of Measurement*, *Conference on Research in Business Finance*, National Bureau of Economic Research, New York.

*against doing any risk management at all. (Froot, Scharfstein and Stein: 1994: 24)*

*Modigliani and Miller show that, with fixed investment policy and with no contracting costs or taxes, corporate financing policy is irrelevant. (Smith and Stultz: 1985: 392)*

*... Merton Miller and Franco Modigliani, ..., demonstrated that firms make money only if they make good investments ... If they are right, it has crucial implications for hedging ... Firms need not manage their financial risks; investors can do it for themselves. (Bishop: 1996: 15)*

The majority of the existing literature in this field attacks the Modigliani-Miller corporate risk management indifference paradigm. These studies claim that the Modigliani - Miller paradigm is not useful as its assumptions do not hold in reality. The assumptions are thus relaxed or altered and models of behaviour under the resulting 'new' paradigm presented. For example, Froot, Scharfstein and Stein's (1993) model rests on the premises that there are inefficiencies within the capital market that result in a hierarchy of funds. Stultz (1984) postulates that the managers' divergence from shareholders' interests is significant enough to drop the assumption that the objective of the firm is to maximise profit. It must be noted that for any of the standard assumptions to be dropped on the grounds of being simplistic, irrelevant or unrepresentative of reality, it is necessary that:

- the assumption is not critical to the paradigm;
- the assumption is significantly violated in the real world; and
- the inefficiencies introduced by relaxing the assumption cannot be costlessly eliminated.

It is thus possible and instructive to classify the existing literature on financial risk management according to the assumptions which have been relaxed. The value of this approach is that it clarifies exactly what assumptions are required for the various postulates.<sup>2</sup>

The chapter proceeds as follows: the assumptions of the Modigliani-Miller indifference paradigm as it relates to risk management and their general implications are listed in section B. Behaviour under the assumptions is reviewed in the section C, while section D looks at the implications of relaxing these assumptions. Concluding remarks are made in the final section.

## **B. THE ASSUMPTIONS AND THEIR IMPLICATIONS**

The theories which have been derived to explain risk management at a corporate level, rely critically on the relaxation of standard assumptions. These theories can be classified according to which assumptions need to be relaxed for the hypothesis to hold. The assumptions which are explicitly considered by this research are strongly rooted in, but not limited to the traditional assumptions of the Modigliani-Miller indifference paradigms.

**A.1. All markets, not just capital markets, are perfectly competitive and efficient.**

**A.2. Information is perfect and can be acquired costlessly.**

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<sup>2</sup> Géczy, Minton, and Schrand (1996) organise the various theories into a single framework by discussing the incentives for derivatives use from the perspectives of managers, bondholders and equityholders. The theories are evaluated further by considering variation in a firm's cash flows and exposure to foreign exchange risk. Finally costs such as liquidity costs, transaction costs of customisation and basis risk are examined. This added structure is an alternative way of evaluating the various theoretical explanations for risk management.

A.1. (perfect markets) and A.2. (perfect costless information) indicate that the strong form of the efficient market hypothesis holds. Market efficiency implies that share prices respond instantaneously and in an unbiased manner to new information. Resultantly all relevant information is instantaneously and fully reflected therein. Price changes are random and no abnormal profit can consistently be made. Markets are perfectly competitive and products are atomistic.

**A.3. Transactions costs are zero.**

Brokerage costs and commissions do not exist: transactions occur at zero cost.

**A.4. No taxes exist.**

A.4. (no taxes) eliminates biased decision making motivated by the inefficiencies introduced by a tax regime.

Perfect and costless information (A.2.), no transaction costs (A.3.) and no taxes (A.4.) imply that the firm does not experience any informational or cost scale advantages over investors. Firms and investors face the same costs when managing risks and the pool of risk management expertise in firms and investors is the same.

**A.5. All individuals undertake maximising behaviour.**

**A.6. The objective of the firm is to maximise shareholder value.**

A.5. (all individuals undertake maximising behaviour) is a standard microeconomic assumption. A.6. (the objective of the firm is to maximise shareholder value) is widely assumed in financial theory. Pike and Neal (1996: 10) explicitly state that '(i)n finance, we assume that the objective of the firm is to maximise the value of the firm's shares'. This is supported by Ross and Westerfield (1988: 13), Brealy and Myers (1991: 5), Corraera *et al* (1993:12) and Keown (1994:2) and most standard financial texts. Oxelheim and Whilborg's methods of assessing risk (1987) assume that the objective of the company is the maximisation of the expected present value of

future net cash flows, *i.e.* the maximisation of  $E [ V_j ]$ . This is a proxy for shareholder wealth.

**A.7. No principal-agent problems exist.**

It can be argued that A.7. (no principal-agent problems exist) follows from A.2.; given perfect, costless information, managers are perfectly controlled by the shareholders to implement value maximising strategies. However, A.7. has a large body of literature in its own right and is important enough to warrant separate inclusion. It must be understood that A.1. (perfect markets) implies that managers and workers can always find another equally attractive job. A.7. is required for A.6. (maximisation of shareholder value as the firm's objective) to hold.

**A.8. Risk neutrality**

The assumption of risk neutrality (A.8.) facilitates the use of expected values when evaluating choices.

**A.9. The investment policy of the firm is fixed.**

This assumption implies that the stream of operating cash flows from the firm's activities are independent of the financial policy of the firm, for example, the firm undertakes all positive net present value projects.

In their 1958 paper, Modigliani and Miller only explicitly state A.6. (the objective of the firm is to maximise shareholder value) (pp 262 - 264) and A.1. (all markets are perfectly competitive and efficient) (p 267) as assumptions. However, it is commonly agreed that A.2. (perfect and costless information), A.3. (zero transaction costs) and A.4. (no taxes) are implicit assumptions which are necessary for their propositions to hold. Later versions of the Modigliani Miller theory do explicitly relax A.3. and A.4.

## C. BEHAVIOUR UNDER THE ASSUMPTIONS

If a similar argument to that used in the Modigliani - Miller framework is followed, it is clearly irrelevant whether the firm or the investor undertakes risk management activities. The investors' expertise at risk management equals the firms' and the investor is as knowledgeable about the future. The access to and ability to employ risk management products is the same for an investor and a firm. Both parties have access to the same information for forecasts and on aggregate the same quantum of forecasting errors will be made. Both parties have the same objective: maximisation of shareholder value. Although strategies may differ, they are employed in pursuit of the same objective and thus on average will have the same outcome. The framework suggests that firm's and investors should be indifferent as to who undertakes corporate risk management. However, this prediction is contradicted by the extensive use of derivative products and introduction of risk management practices at a firm level.

## D. RELAXING THE ASSUMPTIONS

All the current theoretical explanations for corporate risk management relax one or more of the framework's assumptions. The following quotations illustrate this point:

*(I) If the hedging policy affects the value of the firm, it must do so through taxes, contracting costs, or the impact of hedging policy on the firm's investment decisions. (Smith and Stultz: 1985: 392)*

... (T)heoretical research provides several explanations for optimal hedging that result from different types of capital market imperfections.

(Géczy, Minton and Schrand: 1996: 2)

A number of the assumptions listed above may seem to be restrictive and simplistic. Relaxing them may thus present a more realistic explanatory model for the occurrence of corporate risk management. This introduces circumstances where, for example, firms may be able to manage risk internally in ways that cannot be replicated by investors.

Shareholder value is maximised by undertaking cost minimising strategies. The existence of taxes affects the total cost structure of financial alternatives and thus biases decisions. The most common illustration is the tax deductibility of interest which changes the theoretically optimal mix of debt and equity. This may impact risk management strategies at a corporate level.

Relaxing A.2. (perfect and costless information) introduces information asymmetries. Information is a valuable commodity which is conceptually identical to any other commodity (Lipsey: 1990). Markets therein are subject to inefficiencies and where differences in accessibility to information exist, information asymmetries arise. Firms have proprietary information. Reasons for retaining the privacy thereof may include its strategic importance in the firms' markets, or may merely be due to the cost of disseminating up-to-date news on the corporations' plans and other ventures to investors and/or the public.

If the firm did experience informational or scale advantages, then it is clear that corporate risk management should be undertaken by the firm because of cost savings. This is because the economies of scale experienced by the firm results in a lower aggregate cost for risk management than if the investor had to undertake the same

quantum of risk management. The firm's superior information would mean that, on average, forecasting errors, and consequent losses made through incorrect risk management made by the investor, will be greater than those made by the firm.

Once the principal-agent assumption is relaxed a number of intuitive explanations for hedging become clear. The 'no principal-agent problems' assumption stipulated within the environment of the framework, ensures that agency problems and costs do not exist. In reality, however, they are an important factor that has to be considered. Agency costs are incurred to ensure that the agent's actions are aligned with the principal's intended actions. If risk management can be used to achieve the same effect at a lower net cost, value will have been added to the firm. A rationale for risk management is thus created.

The intuitive belief that stakeholders within the firm are risk averse offers an appealing explanation for corporate risk management. Tufano (1996: 1129) mentions the following example:

*Marketers of corporate risk management products sometimes attempt to prey upon fear and risk aversion. One risk manager's advertisement, complete with images of stylised crocodiles and leopards, warns potential customers: 'In the complex financial jungle, you don't dare make a move until you are positioned to survive ... because one false step could risk your entire enterprise.'*

Managers may undertake risk management activities in order to allay their own aversion to variability in the firm's value. In section VIII, the different objective functions that managers may hold are discussed.

## **E. CONCLUSION**

The value of the process of systematically relaxing assumptions and thereby evaluating the theories that explain corporate risk management, is threefold. It provides:

- a clearer understanding of the issues involved;
- an illustration of the chasm between the predictions of financial theory and reality;  
and
- a framework within which current literature can be classified and objectively evaluated.

The remainder of the paper focuses on existing and potential explanations for corporate risk management. Each of assumptions will be lifted. This structure allows for a logical classification of the hypotheses which facilitates a clearer understanding of the concepts, and an awareness of the degree of realism in their underlying assumptions. Thereafter, the theories will be critically examined, both theoretically and empirically.

## IV. EMPIRICAL STUDIES

The second division of this paper commences with the section on empirical studies. This division examines the theories implied by the inefficiencies introduced through the relaxation of certain critical assumptions of the Modigliani-Miller indifference paradigm as it relates to risk management. In this section four of the important international empirical investigations into the determinants of corporate risk management are introduced. A brief overview of the methodology and data sources used in each, is presented. Various limitations of the studies are discussed. A summary of the salient features of each study can be found in Table IV.1. The results of the studies pertaining to each hypothesis are presented in sections V - IX. This section is merely a discussion of the methodology and a critique of four significant international empirical studies. The empirical investigation using South African data that is presented in this research, is based on this international research. It is predominantly based on Berkman and Bradbury (1996) and Géczy, Minton, and Schrand (1996), however, elements of all the studies have been utilised in order to tailor the analysis to the South African environment.

### A. NANCE, SMITH, AND SMITHSON (1993)

Nance, Smith, and Smithson's study is the earliest empirical research which is investigated. The research contributed to the prevailing body of knowledge when it was released as the variables tested were more comprehensive and wide-ranging than any prior study. Given changes in the regulatory environment, a number of these variables are currently redundant; however, this is a seminal study that warrants

examination. Nance, Smith, and Smithson (1993) provide evidence on the hypothesis that hedging increases firm value by decreasing expected taxes, expected costs of financial distress, or other agency costs. 169 firms from the Fortune 500 and the S&P 400 in 1986 are surveyed. The use of survey data, by definition, introduces a sampling bias and consequently constrains the power of the results (Berkman and Bradbury: 1996). All the later studies investigated avoided surveys as a data source.

The data thus obtained is used to perform a univariate analysis of means and a logit regression analysis using a binary dependant variable: 1 for evidence of derivatives use (futures, forwards, options or swaps) and 0 for derivatives non-use. The choice of a dichotomous dependant variable is understandable given the limited public disclosures of derivatives usage. However, the binary nature limits the informational content of the conclusions. Generally, the higher the measurement scale of the data employed for statistical analyses, the richer the information content of the results. The authors did not explicitly limit the use of derivatives to hedging, therefore, the dependant variable 1 may include a firm which uses derivatives for speculative purposes. The use of derivatives for speculative purposes was specifically excluded from the ambit of this research in Section II.

Most of the results are obtained by Nance *et al* are not statistically significant, however, the relationships are directionally consistent with the theory. The paper provides a comparison of results across six empirical analyses of corporate hedging. However, these studies were conducted from 1984 - 1990 and only test two variables. Their outdated and limited results are therefore not considered to meaningfully contribute to the current investigation. Although Nance, Smith, and Smithson's paper is not entirely applicable to any recent study, it is an important component in the

historical development of the understanding of the determinants of corporate risk management.

## **B. GÉCZY, MINTON, AND SCHRAND (1996)**

Géczy, Minton, and Schrand examine firms' use of currency derivatives in order to differentiate among existing theories of hedging behaviour. A sample of 372 of the Fortune 500 non-financial firms for 1990 is employed. All firms in the sample are potentially exposed to foreign currency risk from foreign operations, foreign denominated debt, or a high concentration of foreign competitors in their industries. This is one of the first cross-sectional studies to examine the determinants of corporate derivatives use by employing the annual report disclosures required by the Financial Accounting Standards Board.

A univariate test and a logit regression analysis are performed. The dependant variable is binary. It is defined as 1 if the firm discloses use of currency derivatives and 0 if it does not. The categorical nature of the dependant variable limits the informational content of the results. This was discussed above. Géczy *et al* acknowledge that the dependant variable may measure speculation rather than hedging which would imply an overstatement of risk management and consequently biased results. However, because of the consistency of their results with models of optimal hedging behaviour, Géczy *et al* conclude that, on average, the firms examined are not speculating with currency derivatives. The standard criticisms about the use of accounting data applies.

### **C. BERKMAN AND BRADBURY (1996)**

Berkman and Bradbury investigate the use of derivative financial instruments by all non-financial domestic corporations listed on the New Zealand Stock Exchange in 1994 to determine the relevance of various hypotheses. The data is obtained from annual financial statements.

Derivatives use is measured by the fair value (the absolute value of the net gain or loss on all derivatives outstanding at balance sheet date) and the contract value (notional value) of derivatives outstanding at the balance sheet date; both are scaled by the market value of the firm. Disclosure of these figures are required in the New Zealand annual financial statements. The use of annual financial statement disclosures introduces problems inherent with all accounting information. Additionally the figures are noisy because of the aggregation and netting that occurs with publicly available data. Berkman and Bradbury admit that the use of the fair value and contract value as measures of derivatives use is not perfect because of the above. However, figures for the hedge ratio, which is what they consider to be the ideal measure of the extent of risk management, are unavailable.

Both a univariate non-parametric test and a tobit estimate test are performed.

### **D. TUFANO (1996B)**

Using a new database that details corporate risk management activities in the North American gold mining industry over the years 1991 - 1993, Tufano tests whether cross-sectional differences in risk management activity can be explained by existing theory. Tufano's research is industry specific. Therefore, its applicability to firms in sectors other than the North American gold mining industry is questionable.

The dependant variable is classified as the average portfolio delta percentage. This is a firm-wide summary measure of the reported financial risk management. It represents the economic magnitude of risk modification activities across all types of transactions. The portfolio delta characterises the ounces of gold that the firm has effectively sold short through its financial risk management activities. This measure is scaled by size of the underlying exposure of the firm. The measure of risk management used by Tufano is all-encompassing. It does not distinguish between the different categories of risk management, thus all financial risk management activity is measured. This means that managing the risk inherent in employing instruments for speculation purposes is included with the management of underlying business risks.<sup>1</sup> Univariate tests as well as a tobit regression analysis are performed. The standard criticism about the use of accounting data applies although to a lesser extent as Tufano also employs a wide range of other, independent sources.

## **E. CONCLUSION**

The papers mentioned above are significant international studies that have had an important impact on evolution of the theoretical and empirical research into the determinants of corporate risk management. A table summarising the salient features of each of these international studies is presented hereafter. The remaining sections of this division discuss the hypotheses that are suggested by the relaxing of the assumptions listed in Section III.B. The results of the four international empirical studies pertaining to each hypothesis are included in the relevant sections.

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<sup>1</sup>See Section II. for definitions of the various categories of risk management.

*Table IV.1. Comparison of empirical analyses of rationales for corporate risk management*

	<b>Nance, Smith, and Smithson (1993)</b>	<b>Géczy, Minton, and Schrand (1996)</b>	<b>Berkman and Bradbury (1996)</b>	<b>Tufano (1996)</b>
<b>Year</b>	1986	1991	1994	1991 - 1993
<b>Sample size</b>	169	372	116	48
<b>Sample drawn from</b>	Fortune 500 and S&P 400	Fortune 500	New Zealand Stock Exchange	North American Gold Mining firms
<b>Source of information</b>	Survey	Annual Financial Statements and Independent sources	Annual Financial Statements and Independent sources	Annual Financial Statements and Independent sources
<b>Univariate and Multivariate study performed</b>	Yes	Yes	Yes	Yes
<b>Derivatives use measured by a dichotomous variable</b>	Yes	Yes	No	No
<b>Extent of derivatives use measured</b>	No	No	Yes	Yes

## V. IMPERFECT MARKETS

Relaxing the assumption of perfect markets introduces a number of inefficiencies that have been employed to justify the firm undertaking risk management activity.

### A. CAPITAL MARKET IMPERFECTIONS

#### A.1. Froot, Scharfstein And Stein (1993)

One of the most conceptually developed theories of corporate risk management was introduced by Froot, Scharfstein and Stein in 1993<sup>1</sup>. The central tenet is that without risk management firms are compelled to pursue suboptimal investment policies. The model is founded on Myers' (1977) pecking order theory. This hierarchy of funds hypothesis posits capital market imperfections and information asymmetries. Given these inefficiencies, funds which are raised externally are more expensive than internally generated funds. Moreover, Myers suggested that equity is more expensive to raise than debt. Consequently a hierarchy of funds exists: internally generated funds are the least expensive, followed by debt and then equity.<sup>2</sup> This theory endogenises bankruptcy costs (Géczy, Minton, and Schrand: 1996), thus it must be noted that by developing Myers' hierarchy of funds, Froot, Scharfstein and Stein also extend Smith and Stultz (1985) and Stultz (1984) theories where risk management creates value by reducing expected bankruptcy costs. (See Section VIII.B.4.)

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<sup>1</sup> For a practical discussion of the theory by the authors see Froot, Scharfstein and Stein (1994 a and b).

Froot, Scharfstein and Stein claim that the financial constraints introduced by capital market imperfections create underinvestment costs. Given this cost structure of funds, managers prefer to utilise internally generated monies and will reject certain positive net present value projects if external parties have to provide finance. Variations in cash flows or earnings resulting from changes in interest rates, exchange rates and commodity prices could result in the firm not having sufficient internally generated funds to undertake all profitable investments. In this instance, the firm is faced with the prospect of raising external finance. Given that raising money externally is more costly, the company may choose to abandon or scale back these remaining positive net present value projects.

Froot, Scharfstein and Stein claim that when corporations do not have enough cash internally they tend to cut investment spending more than proportionately. A study performed by Fazzari, Hubbard and Peterson<sup>3</sup> is quoted. These results showed that companies reduced their capital expenditures by roughly 35 cents for each \$1 reduction in cash flow.

A company with a planned investment schedule may underinvest if variations in exchange rates, commodity prices or interest rates result in a shortfall of internally generated funds. Risk management can add value if it is utilised to reduce these variations such that sufficient cash is always available to undertake profitable investments. Risk management does not add value by itself but ensures that the company has the funds available when they are required and in this way reduces underinvestment costs. Risk management breaks the dependence of investment on cash

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<sup>2</sup> Myers (1977: 582) points out that writers on managerial capitalism have interpreted firm's reliance on internal funds as a by-product of the separation of ownership and control: professional managers avoid relying on external finance because it would subject them to the discipline of the capital market.

flow. An example which appears in the literature is that of Merck, an American pharmaceuticals firm, which spends a substantial amount on investment, specifically on research and development. Merck has spearheaded the use of risk management tools to ensure that investment plans are always able to be internally financed. Bishop (1996: 15) quotes Judy Lewitt and John Kearney, Merck executives: 'our experience and that of the (drugs) industry in general, has been that cash flow and earnings uncertainty caused by exchange rate volatility leads to a reduction in research spending.'

Froot, Scharfstein and Stein hypothesise that risk management adds value to a firm and is thus undertaken by corporations with planned future investment and costly external financing.

#### *i. The model*

Froot, Scharfstein and Stein's (1993) two-period model incorporates a marginal cost - marginal benefit relationship that explicates the interplay between investment and financing decisions. A firm can undertake positive net present value projects utilising first period wealth. Externally generated funds are raised when first period wealth is not sufficient to cover the full investment required. Froot, Scharfstein and Stein assume that even though no observable costs exist, managers act as if there are real economic costs attached to raising funds externally. These include the costs of bankruptcy and financial distress (direct and indirect); agency costs associated with motivating and monitoring managers who are no longer full residual claimants; and managers' private benefits which arise from limiting dependence on external funds.

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<sup>3</sup> (1988), Financing constraints and corporate investment, *Brookings Papers on Economic Activity*, 1, 141.

Wealth is thus the profit generated from the positive net present value projects reduced by the costs associated with raising external finance.

The justification for risk management creating value hinges critically on the concavity of the profit function.<sup>4</sup> The model is derived backwards by assuming that risk management has been utilised to completely hedge all movements in wealth such that expected random second period wealth becomes certain. A standard maximisation of profit function is derived given costly external financing. Using the first and second order conditions the optimal level of risk management is found. Given costly external financing the level of investment suggested by the model is lower than the first best level where all profitable projects would be undertaken.

The second derivative of profit is manipulated to yield an equation showing that the optimum level of investment is a function of the level of internal wealth and the marginal returns on investment. Risk management adds value if the function is globally negative. This implies that two conditions are necessary for risk management to be beneficial: marginal returns on investment must be decreasing and the level of internal wealth must have a positive impact on the optimal level of investment. The latter condition is a common feature of models with costly external financing where information asymmetries or principal-agent problems are introduced. The former is a common economic assumption. Thus it can be assumed that risk management should be undertaken by a firm.<sup>5</sup>

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<sup>4</sup> This is a necessary condition if risk management is to be beneficial.

<sup>5</sup> In Froot, Scharfstein and Stein's (1993) model shareholders are repaid their entire investment at the end of the second period. It is therefore not possible to explore the effects of increasing investment cash flows by cutting dividends. This is a feature which could be included in future research.

The model requires the relaxation of the following assumptions: perfect information (A.2.), no principal-agent problems (A.7.), and a fixed investment schedule (A.9.).

## *ii. Empirical findings*

In Nance, Smith, and Smithson's (1993) research, growth options in a firms' investment opportunity set are proxied by research and development expenditures scaled by firm size and the ratio of the book value to the market value. The liquidity ratio represents the availability of funds. Univariate tests indicate that firms which undertake hedging have significantly larger research and development expenditures than non-hedgers. No significant difference is found in the book to market ratio. The results of the restricted logit regressions indicate that firms with higher research and development expenditures are more likely to hedge. The liquidity ratio is very insignificant.

Géczy, Minton, and Schrand (1996) use three variables as measures of the growth opportunities available to a firm: the ratio of research and development expenditures to sales; the ratio of capital expenditures for property, plant and equipment to firm size; and the book value of a firms' common equity scaled by its market value. To determine the availability of internally generated funds, the long term debt ratio and the quick ratio<sup>6</sup> are utilised. Lower long term debt ratios and higher quick ratios would suggest that more internally generated funds are available for use in investment.

The results of the univariate tests show that firms that use currency derivatives are statistically different from firms that do not, with respect to investment growth

opportunities. Research and development ratios show the greatest significance. The logit regression analysis indicates that financing constraints provide incentives for hedging. Higher quick ratios imply a significantly lower probability of using currency derivative instruments. Géczy *et al* conclude that firms with greater growth opportunities and tighter financial constraints are more likely to use currency derivatives.

Capital market imperfections are tested using two variables in Berkman and Bradbury's (1996) study. Long term growth prospects are represented by the earnings-price ratio. The ability to generate cash to finance short term asset growth is measured by the natural logarithm<sup>7</sup> of the ratio of the current year's change in net tangible assets plus depreciation to net income plus depreciation. The results support the suggestion that the earnings-price ratio is higher for firms that use derivatives, however, the measure of the ability to finance short term asset growth is lower for these firms.

Tufano (1996b) introduces two measures for the investment opportunities facing gold mining firms: expenditures on exploration and the value of attempted acquisitions. Both are scaled by firm value. Tufano points out that a drop in gold prices and consequent reduction in cash flow could slow the major investment programmes of mining firms. The hypothesised relationship between the extent of risk management and these two proxies is therefore positive. However, a negative relationship between explorations activities and risk management is found. This is contrary to Froot, Scharfstein and Stein's predictions. In addition, the proposed relationship between the extent of risk management undertaken and acquisition activities is not supported. Thus Tufano concludes that the theories justifying risk management on the basis of costly

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<sup>6</sup> By excluding inventory from current assets, the quick ratio becomes a more stringent measure of liquidity than the liquidity ratio used by Nance, Smith, and Smithson (1993).

external financing affecting investment activity are not supported strongly in the North American gold mining industry. The availability of internally generated funds is not tested.

### **A.2. Size theory**

The Froot, Scharfstein and Stein (1993) argument hinges on costly external financing and predicts that firms for which external financing is costly would be more likely to use risk management. It is reasonable to suspect that information asymmetries or transaction costs for small firms are greater than for larger corporations. If so, theory predicts an inverse relationship between firm size and the extent of risk management.<sup>8</sup> Tufano measures firm size by firm value and the value of the reserves that a firm holds. Neither test produces significant results.

## **B. LEGAL MARKET IMPERFECTIONS**

Inefficient behaviour is often necessitated by the legal system. In the discussion on risk and risk management a number of legal cases involving derivatives use are highlighted (Section II.C.2.). The legal precedent arising from these cases may compel firms to undertake risk management in spite of optimal policies suggested by the theory.

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<sup>7</sup> Henceforth, the term 'log' implies 'the natural logarithm'.

<sup>8</sup> Academics have conflicting views on the effect of size on firms' risk management policies. This is discussed fully in Section VIII.B.5.

## **C. LABOUR MARKET IMPERFECTIONS**

### **C.1. Signalling Managerial Skill**

This theory focuses on the labour markets' perception of managerial ability. Because of information asymmetries, managerial reputations can not be directly observed and are indicated by managerial performance. Managers are thus encouraged to undertake risk management in an attempt to influence their firms' performance and thereby influence labour market perceptions. This theory relies critically on relaxing two further assumptions; namely, the perfect information (A.2.) and principal-agent (A.7.) assumptions. This hypothesis is discussed in the section on information asymmetries (Section VI).

## **D. CONCLUSIONS AND AREAS FOR FUTURE RESEARCH**

Market imperfections give rise to situations where risk management can add value to a firm. Anecdotal evidence suggests that firms with substantial research and development expenditures do safeguard investment cash flows through hedging. The results of the empirical investigations are mixed, nevertheless all expect Tufano (1996b) find at least one variable has a significant relationship with risk management. Both the theoretical and empirical aspects of this area warrant further attention.

## VI. INFORMATION ASYMMETRIES

The impact of asymmetric information is one of the least explored aspects of the determinants of corporate risk management policies and has only begun to receive explicit attention in the very recent past.<sup>1</sup> The work in this generic area has received the most attention from economists and is specifically focused on game theory.<sup>2</sup> Two rationales for corporate risk management which depend critically on information asymmetries have been developed. Both hinge on extensions of basic signalling theory.

### A. SIGNALLING MANAGERIAL SKILL: BREEDEN AND VISWANATHAN (1996) AND DEMARZO AND DUFFIE (1995)

This theory focuses on the markets' perception of managers' skill *i.e.* managerial reputation. Reputations are determined by managerial ability. Markets cannot observe managerial ability directly and thus rely on the performance of the firm run by the manager as a proxy for their ability. If managers can utilise risk management to manipulate firm performance, they can vicariously influence the market's perception of their ability. The theory predicts that there is a positive relationship between the degree of information asymmetry in the labour market regarding managerial ability and the extent of risk management undertaken by the firm.

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<sup>1</sup> James Mirrlees and William Vickery were awarded the 1996 Nobel prize in economics for their work on the economics of information asymmetries. Although their work was not directly concerned with risk management, using the tools they developed it may be possible to adapt their models to be relevant to this subject. For a brief overview of their work see *The Economist*: 1996.

<sup>2</sup> For an excellent game theory reference see Rasmusen E, (1994), *Games and Information*, Second Edition, Blackwell Publishers.

### **A.1. DeMarzo and Duffie's model**

DeMarzo and Duffie's (1995) approach differs from the models discussed elsewhere in this paper as it focuses on the informational effect as opposed to the risk reallocation function of risk management. DeMarzo and Duffie posit that risk management reduces the amount of noise and increases the informational content of firms' profits. The authors develop a model which predicts the optimal level of disclosure and related risk management.<sup>3</sup> This facilitates the exploration of the information effect of financial risk management. The model assumes that managers' future salaries are determined by the markets' perception of their ability and concludes that managers can have a direct impact on the risk of their future salaries. Because managers' reputations are surmised from the firms' performance, managers can influence the perception of their ability and consequently their salaries by reducing the risk of the firms' current performance through risk management. Managers' preferences regarding their future income can thus provide a motive for risk management. DeMarzo and Duffie's model presumes that outsiders are unable to separate a company's profits or losses which are attributable to risk management from those attributable to managerial ability. In addition to patronising market observers, this is a violation of the efficient market hypothesis. This model requires the assumptions of perfect markets (A.2.), no principal-agent problems (A.7.), and a fixed investment schedule (A.9.) to be relaxed.

There have been no empirical tests which have assessed this model. Tufano (1996b) discusses the theory but considers the US gold mining industry to be transparent with respect to signalling managerial ability. Similarly, Géczy, Minton, and

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<sup>3</sup> DeMarzo and Duffie also discuss the consequences of alternative accounting policies and suggest appropriate accounting risk management standards.

Schrand (1996) do not test this theory as their chosen sample does not present any testable implications thereof.

## **B. PROPRIETARY INFORMATION HELD BY FIRMS: DEMARZO AND DUFFIE (1991)**

DeMarzo and Duffie's (1991) model suggests that when a firm has information of which shareholders are unaware, risk management undertaken by the firm may be beneficial. The hypothesis presents an optimisation model which posits that undertaking risk management signals the reduction in variability of a firms' profits and therefore reduces the degree of information asymmetry between the firm and the shareholder. A positive relationship between risk management and firms with greater information asymmetries is thereby predicted. Although the initial section of the model retains the no principal-agent problems assumption (A.7.), this is relaxed in later parts. Transaction costs (A.3.) are introduced.

### **B.2. Empirical findings**

Géczy, Minton, and Schrand (1996) employ the percentage of institutional ownership and the number of investment firms with analysts following the firm as proxies for the degree of information asymmetry. It is assumed that these measures are positively related to the availability of information and thus negatively related to risk management. The results of both tests did not support this hypothesis. The univariate test showed that non-users of derivatives exhibited less informational asymmetry *i.e.* the non-users had fewer analysts monitoring their firms and a lower percentage of

institutional ownership. The logit results showed a positive relationship between the number of analysts following the firm and the likelihood of a firm using currency derivatives. Géczy *et al* point out, however, that the firms which undertake risk management are generally larger firms and are consequently more important economically and will therefore attract attention from analysts. This model is not tested empirically in the other studies.

### **C. CONCLUSIONS AND AREAS FOR FUTURE RESEARCH**

The relative infancy of this particular field within finance means that little empirical or theoretical research has been performed to date. It is therefore not possible to draw meaningful conclusions about the relevance of informational asymmetry hypotheses in the real world. However, the scope for development of the theoretical aspect of information asymmetry hypotheses, in particular, is wide and a notable amount of future research should be focused on this area.

## VII. CONVEXITY OF THE TAX SCHEDULE

### A. REDUCING EXPECTED TAXES

The structure of the prevailing tax code and its effect on the value creation of firms' financial policies has been extensively examined in the debate surrounding the Modigliani - Miller capital structure indifference theorem. Similar principles apply to risk management. Theories suggest that firms facing convex tax functions can add value by managing risk and thus reducing expected taxes. The effect of risk management on expected taxes is one of the most developed areas in this literature and has been comprehensively empirically tested. Risk management can only reduce expected taxes and consequently add value if the tax schedule is convex. Convexity is introduced by assessed (tax) loss carryforwards and a progressive tax regime. The extent to which risk management can add value is dependant upon the degree of convexity and the proportion of taxable income that occurs in the convex region of the tax schedule.

#### A.1. The model

Smith and Stultz (1984) demonstrate that risk management adds value to a unlevered firm which faces taxes. The value of a firm is set equal to the before-tax value less the quantum of taxes. The firm faces two states of the world such that the expected taxes under one state is greater than under the other state. The firm holds a self-financing hedge portfolio<sup>1</sup> which is constructed such that the payoffs under each

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<sup>1</sup> A self-financing portfolio implies that the sum of the payoffs of the portfolio given the probability of either state occurring, is zero.

state added to the value of the firm in that state are identical. The value of the hedged firm less the value of the unhedged firm is greater than zero. This proves that undertaking risk management will add value to a firm. The model assumes costless risk management. However, Smith and Stultz point out that risk management can still add value if the no transaction costs assumption (A.3.) is lifted. This occurs when the costs of risk management do not exceed the benefits. Similar theoretical justifications are discussed in other articles; see for example Froot, Scharfstein and Stein (1993) and Smith (1990).

### A.2. Example illustrating how risk management can add value

The following example illustrates how risk management can add value to a firm by reducing expected taxes (Smith: 1990). A company has an equal probability of receiving a taxable income of -400 or 600 in the same period. To isolate the tax effect assume no transaction costs, a fixed investment schedule and zero interest. The current South African company tax rate is 35%.

$$\begin{aligned} T(E[TI]) &= T(0.5 * -400 + 0.5 * 600) \\ &= T(100) \\ &= 35 \end{aligned}$$

(Eq. VII.1.)

where

T = tax on

TI = taxable income

The tax on the expected taxable income is 35.

*i. The effect of assessed loss carryforwards*

If the company is allowed to carry forward 100% of its assessed loss, risk management does not add value as the tax on the expected taxable income ( 35 - Eq. VII.1.) is identical to the expected tax (35 - below).

$$\begin{aligned} E [ T ] &= 0.5 * T ( -400 ) + 0.5 * T ( 600 ) \\ &= 0.5 * 0 + 0.5 * 70 \\ &= 35 \end{aligned}$$

(Eq. VII.2.)

If the tax regime only permits a fraction (assume 50%) of the assessed loss to be carried forward, the tax on the expected taxable income ( 35 - Eq. VII.1.) will be less than the expected tax (70 - below).

$$\begin{aligned} E [ T ] &= 0.5 * T ( -400 ) + 0.5 * T ( 600 ) \\ &= 0.5 * -70 + 0.5 * 210 \\ &= 70 \end{aligned}$$

(Eq. VII.3.)

The company would clearly prefer to pay the tax on the expected income ( 35 - Eq. VII.1.). By hedging the company could ensure a 100% probability of generating taxable income of 100. In this case the company could guarantee an expected tax of 35 (below).

$$\begin{aligned} E [ T ] &= 1 * T ( 100 ) \\ &= 1 * 35 \\ &= 35 \end{aligned}$$

(Eq. VII.4.)

Thus the benefit from undertaking risk management is 35: the expected tax in an unhedged position (70 - Eq. VII.3.) less the expected tax in a hedged position (35 - Eq. VII.4.). In this scenario risk management has created value.

The greater the degree of convexity, the greater the benefit from hedging. For example, if none of the assessed loss is able to be carried forward, the expected tax is 105 (below).

$$\begin{aligned} E [ T ] &= 0.5 * T ( -400 ) + 0.5 * T ( 600 ) \\ &= 0.5 * 0 + 0.5 * 210 \\ &= 105 \end{aligned}$$

(Eq. VII.5.)

In this case the company is obviously worse off and thus the ability to manage risk becomes more valuable. The benefit from hedging rises to 70 (105 - Eq. VII.5. minus 35 Eq. VII.4.).

*ii. The effect of a greater proportion of taxable income in the convex region of the tax schedule*

The tax benefit of managing risk is a positive function of the proportion of taxable income in the convex region of the tax schedule. If the distribution of taxable income assumed in the example above is shifted to the right, less lies in the convex region. Suppose that the company has an equal probability of receiving a taxable income of -200 and 800 and that none of the assessed loss is able to be carried forward. The tax on the expected taxable income would increase to 105 (below).

$$\begin{aligned}
 T ( E [ TI ] ) &= T ( 0.5 * -200 + 0.5 * 800 ) \\
 &= T ( 300 ) \\
 &= 105
 \end{aligned}$$

(Eq.VII.6.)

The expected tax would increase to 140 (below).

$$\begin{aligned}
 E [ T ] &= 0.5 * T ( -200 ) + 0.5 * T ( 800 ) \\
 &= 0.5 * 0 + 0.5 * 280 \\
 &= 140
 \end{aligned}$$

(Eq.VII.7.)

The benefit from hedging in this instance is 35 (140 - Eq. VII.7. minus 105 Eq. VII.6.). This is less than the 70 derived above.

### *iii. Statutory progressivity in a South African context*

Under a progressive tax regime, higher taxable income attracts a higher tax rate. If a company's earnings fluctuate, the tax bill will be reduced by 'smoothing' the income over the years such that the average tax rate paid is lowered. South Africa's current tax regime results in a linear tax schedule because of the flat corporate tax rate of 35% and 100% assessed loss carryforwards. Therefore the rationale for hedging creating value does not hold in a South African context.

### **A.3. Empirical findings**

Nance, Smith, and Smithson (1993) perform the most comprehensive investigation into the observed relationship between the convexity of the tax schedule and risk management activity. Three measures are employed. The investment tax

credits represents the availability of tax preference items. The probability of a firm facing progressive tax rates is indicated by the range of the firm's pretax income in the progressive region.<sup>2</sup> Tax loss carry forwards are also investigated.

The findings indicate that firms which face convex tax schedules undertake risk management to a greater extent. The result is especially significant for firms with more tax credits and more of their income in the progressive region of the tax schedule.

Géczy, Minton, and Schrand (1996) measure the availability of tax preference items by using the book value of net operating loss carryforwards outstanding scaled by total assets. Neither the univariate nor the logit test generated a statistically significant result that supported the hypothesis.

A dichotomous (1 or 0) variable is employed to indicate the existence of tax loss carryforwards in Berkman and Bradbury's (1996) study. The univariate study indicates that firms with derivatives are more likely to have tax losses carried forward. Furthermore, the tobit analysis shows strong support for the view that firms use derivatives to increase the present value of tax losses.

Tufano (1996) employs tax loss carry forwards scaled by firm value to investigate the hypothesised relationship. The results indicate that tax loss carryforwards have little predictive power in the North American gold mining industry: no statistically significant relationship is found.

## **B. CONCLUSIONS AND AREAS FOR FURTHER RESEARCH**

The tests do not show strong support for the tax convexity hypothesis. Nance, Smith, and Smithson (1993) do generate significant results using the available

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<sup>2</sup> Géczy, Minton, and Schrand (1996) point out that these two proxies are no longer appropriate given

investment tax credits and the probability of a firm facing progressive tax rates variables. These variables are not investigated in the other studies. The nature of the prevailing South African tax regime does not allow for a convex tax structure as assessed losses are carried forward and companies face a flat tax rate of 35%. Thus the above theory is not applicable in this country and there can be no justification for risk management adding value to a company through reducing expected taxes. The reduction of expected taxes hypothesis has been thoroughly investigated on the conceptual front. In addition, given the results of the empirical studies, it would seem that the theory holds little predictive value in reality. Thus this area is not seen as a rich source of potential future research.

## VIII. PRINCIPAL-AGENT PROBLEMS

An agency relationship is defined in Jensen and Meckling's seminal article (1976:306) as: 'a contract under which one or more persons (the principal(s)) engage another person (the agent) to perform some service on their behalf which involves delegating some decision making authority to the agent.' Economic and financial theory assumes that, *ceteris parabus*, all parties are utility maximisers. There is thus good reason to believe that the utility-maximising agent will not always act in the best interests of the principal. Consequently an agency relationship will introduce agency problems: conflicts of interests which arise when self interested individuals have to co-operate. It is therefore impossible, as Jensen and Meckling point out, to ensure, at zero cost, that the agent will make optimal decisions from the principal's point of view. The principal can encourage the agents to adapt their self-serving interests by introducing incentives and incurring costs. Agency costs are defined as the sum of:

- the monitoring expenditures by the principal; for example, stringent reporting requirements or management audits;
- the bonding expenditures by the agent; for example, restrictive covenants and the provision of collateral; and
- the residual loss<sup>1</sup> (Jensen and Meckling: 306).

The two classic principal-agent relationships within a firm are the shareholder - manager and shareholder - debtholder relationships. Each of these will be examined in turn. Theories which attempt to explain the value of risk management are discussed and critically evaluated.

## A. SHAREHOLDER - MANAGER CONFLICT

Separation between ownership and control of the firm has evolved in tandem with the development of the modern corporation. The ownership of most large companies is diffuse, with the day-to-day control of the business resting in the hands of managers (agents) who are appointed by the shareholders (principals) through the directors. A potential conflict arises when ownership and management separate as managers will act in their own interests or maximise their own utility instead of maximising shareholders' utility. Shareholders can encourage managers to change their behaviour, such that they act in shareholders' best interests, by incurring agency costs. These include introducing appropriate incentives, usually in the compensation package, and monitoring managers' behaviour.

### A.1. Studies of firms' objectives

The prediction that firms, which are controlled by managers, do not necessarily maximise shareholder wealth, is borne out by a number of studies. Westerfield (1988: 14) quotes the results of a series of interviews, conducted by Donaldson<sup>2</sup>, with the chief executives of several large corporations. Donaldson concluded that the manager's basic financial objective was based on their underlying motivation when defining the corporate mission. Three motivational forces were identified:

1. Survival. Organisational survival is ensured by management always controlling sufficient resources to support the firm's activities.

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<sup>1</sup> The residual loss is defined as the divergence between the agents' decisions and those decisions which would maximise the welfare of the principal. It is the dollar equivalent of the reduction in welfare.

<sup>2</sup> Donaldson G. (1984), *Managing Corporate Wealth: The Operations of a Comprehensive Financial Goals System*, New York, Praeger.

2. Independence. This is the freedom to make decisions and take action without encountering external parties or depending on outside financial markets.
3. Self-sufficiency. Managers do not want to depend on external parties.

Maximisation of corporate wealth is determined to be the objective of managers. Donaldson distinguishes between corporate wealth and shareholder wealth. Corporate wealth tends to lead to increased growth by providing funds for growth and limiting the extent to which equity is raised. This is the wealth over which management has effective control and is closely aligned to increased size and growth. This concept is distinct from that of shareholder wealth.

Research by Pike and Doi (1989) and updated in Pike and Neal (1996: 11) has shown that maximisation of shareholder wealth is not the only goal of management, nor is it the most important. The finance directors of the largest UK companies were asked to rank specified goals in order of importance. Managers are more concerned with profitability than wealth creation. The results are summarised in Table VIII.1.

*Table VIII.1. The importance of financial objectives: the percentage of finance directors of 100 large UK firms viewing objectives as 'very important'*

	1980 (%)	1986 (%)	1992 (%)
<b>Short term (1-3 years)</b>			
Profitability (e.g. return on investment)	54.7	71.7	69.0
Earnings	42.2	56.1	58.0
<b>Long term (over 3 years)</b>			
Sales growth	20.7	9.5	14.1
Earnings per share growth	9.0	56.3	55.1
Growth in shareholder wealth	19.8	45.7	52.6

Source: Pike and Neal (1996)

The table implies that short term goals are more important than long term goals. This is reasonable assuming that managers are self-serving individuals and their

compensation is dependant on their performance in the short term. The increasing importance of the long term goals, specifically those which relate to shareholder value, suggests that the agency problem is being addressed more effectively and measures such as incentive schemes have been successful.

Studies done in other countries have produced different results. Research by Kagono performed in 1985 (quoted in Pike and Neal: 1996), indicates that the objectives of Japanese companies are primarily profitability, market share and new product development, while shareholder wealth maximisation is not important. It must be noted that this study was done over a decade ago and it is possible that Japan may have experienced similar trends to the UK as shown in the table above. Therefore, the relative importance of shareholder goals may have increased.

Shareholders do not choose the risk management policies of the firm, but managers do. Shareholders, however, choose managerial compensation contracts which encourage managers to undertake risk management practices that maximise their wealth and consequently the value of the firm.

## **A.2 Theories to explain risk management when principal-agent problems exists**

### *i. Lifetime utility maximisation: Stultz (1984)*

Stultz assumes that principal-agent problems exist and that managers are risk averse and managers maximise their expected lifetime utility. Shareholders have recognised that managers will not act in shareholders' best interests and have structured their compensation packages such that managers' income is an increasing function of the changes in the value of the firm. Agency costs are thereby incurred. Managers' actions are determined by their expected lifetime utility given their

compensation contract, including perquisites and fringe benefits, and their expectations of the actions shareholders or other potential investors can take to decrease their expected utility. Stultz's model assumes that shareholder value is determined by the value of the firm. Principal-agent problems are presumed to exist. By introducing a fixed managerial compensation contract that is an increasing function of the changes in value of the firm, the model effectively realigns managers' and shareholders' objectives. The model is comprehensively discussed under the section on the relaxation of the risk neutrality assumption (Section IX).

### *ii. Signalling Managerial Skill*

This theory focuses on the markets' perception of managers, specifically managerial reputation. Reputations are determined by managerial performance. Managers are thus encouraged to undertake risk management, thereby affecting the firm's performance, in an attempt to influence labour market perceptions. This theory relies critically on relaxing the perfect information (A.2.) and perfect markets (A.1.) assumptions in addition to the principal-agent assumption (A.7.) and is consequently discussed in Section VI.A.1.

### *iii. The influence of managerial motives on firms' risk reduction strategies*

May (1995) empirically tests the relationship between managers' personal risk preferences and firm decisions. May's results are not directly applicable to this research as the risk reduction referred to focuses on diversification strategies, specifically conglomerate mergers and acquisitions. These were classified under the risk management tools utilised by operational strategies in Section II.B.4, while the

spectrum of this research is defined to encompass solely the financial risk management instruments such as forwards, futures, options and swaps. The proxies May employs for chief executive officers' motives are years with the firm; proportion of personal wealth vested in firm equity; asset specific expertise; and the firm's recent performance. May's findings suggest empirical support for the view that risk reduction decisions at a firm level are affected by managerial motives.

## **B. SHAREHOLDER - DEBTHOLDER CONFLICT**

The relationship between debtholders and shareholders is one of the most important examples of principal - agent conflict. Two 'classic' areas of this conflict are the underinvestment problem and the distortion of investment problem (Ross and Westerfield: 1988: 486). Both of these illustrate circumstances under which shareholders can benefit at the debtholders' expense. Opportunities whereby hedging can be used to eliminate this conflict and reduce borrowing costs are thus introduced.

### **B.1. The 'distortion of investment' problem**

The 'distortion of investment' problem illustrates that it is in the interests of shareholders to engage in projects that increase the variability of a firm's cash flows when a firm is funded by debt. When shareholders undertake a risky project in preference to a safe one a portion of the risk of the project failing is transferred to existing debtholders. These existing debtholders are not compensated for assuming this additional risk. Expressed differently, if a firm faces bankruptcy or has a low value, shareholders face the prospect of losing their investment therein. An opportunity which

is potentially profitable but risky, will be accepted by the shareholders as it *may* generate a return for them. The project may also generate a loss, however, this will be borne by the debtholders as the shareholders' loss is limited to their initial investment in the firm.

A simple numerical example illustrates the point. In a single period world a firm has borrowed 20 units of debt which are repayable at the end of the period. The firm is faced with two mutually exclusive projects: Project I and Project II. Each project has a 50% possibility of generating a certain quantum of income. This level of income obviously affects the final value of the firm. The following tables show how the expected value of the projects is divided between debt and equity holders.

*Table VIII.2 Outcomes of safe Project I*

	<b>Value at the end of the period</b>	<b>Probability</b>	<b><math>\therefore E [ V ]</math></b>
Firm as a whole $V_F =$	20	0.5	$E [ V_F ] = 40$
	60	0.5	
Debt $V_D =$	20	0.5	$E [ V_D ] = 20$
	20	0.5	
Equity $V_E =$	0	0.5	$E [ V_E ] = 20$
	40	0.5	

*Table VIII.3 Outcomes of risky Project II*

	<b>Value at the end of the period</b>	<b>Probability</b>	<b><math>\therefore E [ V ]</math></b>
Firm as a whole $V_F =$	10	0.5	$E [ V_F ] = 40$
	70	0.5	
Debt $V_D =$	10	0.5	$E [ V_D ] = 15$
	20	0.5	
Equity $V_E =$	0	0.5	$E [ V_E ] = 25$
	50	0.5	

The shareholders clearly prefer Project II which has results in a expected value of 25, five units more than Project I. Even though Project II results in the same expected value to the firm as a whole, the debtholders prefer Project I as the expected outcome of 20 renders their debt risk free (equal to the face value of 20). If Project II is undertaken, there is a 50% possibility that the value of the firm at the end of the period will be 10. If this is the case, not all the debt can be repaid. The shareholders' choice of a risky rather than a safe project demonstrates the 'distortion of investment' problem.

### B.2. The underinvestment problem

The underinvestment problem suggests that shareholders will not undertake positive net present value projects if the benefits accrue to the debtholders. Consider a similar scenario to the 'distortion of investment' example above.

Table VIII.4 Outcomes of Project III

	Value at the end of the period	Probability	$\therefore E[V]$
Firm as a whole $V_F =$	10	0.5	$E[V_F] = 47$
	84	0.5	
Debt $V_D =$	10	0.5	$E[V_D] = 15$
	20	0.5	
Equity $V_E =$	0	0.5	$E[V_E] = 32$
	64	0.5	

Table VIII.5 Outcomes of Project IV

	Value at the end of the period	Probability	$\therefore E [ V ]$
Firm as a whole $V_F =$	20	0.5	$E [ V_F ] = 50$
	80	0.5	
Debt $V_D =$	20	0.5	$E [ V_D ] = 20$
	20	0.5	
Equity $V_E =$	0	0.5	$E [ V_E ] = 30$
	60	0.5	

Shareholders prefer Project III as the expected value of 32 units is greater than 30. However, the firm as a whole would be better off if project IV was undertaken (50 units versus 47 units). All the additional benefits of Project IV accrue to the debtholders and their preference is clearly Project IV as the debt is risk-free. The expected value of 20 covers the face value of the debt (20). The fact that the shareholders prefer the project with the lower expected value illustrates the underinvestment problem.

### B.3. Reduction of borrowing costs

The distortion of investment and the underinvestment problems illustrate circumstances which could be and often are addressed through the introduction of bond covenants. However, the use of bond covenants impose indirect borrowing costs by prescribing non-optimal shareholder behaviour. If the firm manages its risk such that all risky debt is hedged, these indirect costs can be minimised and therefore borrowing costs, as a whole, reduced. Debtholders are aware of how shareholders will act. In pricing debt, debtholders assume shareholders will maximise their own utility

and will undertake projects that are 'sub-optimal' from the debtholders' perspective. The price charged is greater than the cost of risk-free debt<sup>3</sup> to compensate for this suboptimal behaviour. If shareholders undertake to manage the risk in such a way that the payoff the debtholders would receive under their optimal scenario is guaranteed<sup>4</sup>, lower interest rates can be charged. Borrowing costs can be reduced by employing risk management to guarantee the optimal scenario.

#### **B.4. Reduction of expected costs of financial distress: Smith and Stultz (1985)**

Smith and Stultz (1985) show that by reducing the variability of the future value of the firm, risk management lowers the expected cost of bankruptcy. The magnitude of the reduction is a function of the probability of the firm encountering financial distress if it does not hedge and the costs the firm incurs if it does experience financial distress. Bankruptcy costs which need to be considered comprise not only the payments to third parties (the transaction costs of bankruptcy) but also the cost of the deterioration of valuable relationships with employees, buyers and suppliers who value long term alliances with the firm.<sup>5</sup> Reducing the likelihood of costly financial distress by reducing the variance of a firm's cash flows through risk management, increases the expected value of the firm, and thus lowers the expected costs of financial distress.

##### *i. The model*

The model begins by assuming the difference between a levered and unlevered firm to be the present value of bankruptcy costs (a negative difference) and the present

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<sup>3</sup>The debt does not necessarily have to be risk-free. The same argument would apply to less risky debt.

<sup>4</sup>Project I in the 'distortion of investment' example and Project IV in the underinvestment problem.

value of the tax shield from interest payments (a positive difference). The value of the levered firm will increase for a given decrease in the present value of the expected bankruptcy costs. The decrease in expected bankruptcy costs can be brought about by reducing the variability of the future value of the firm. The firm faces two states of the world: bankruptcy and solvency. The firm is assumed to hold a self financing hedge portfolio<sup>6</sup> which is constructed such that the payoff when bankrupt (without risk management) is positive. The sum of the payoff under each state and the value of the firm in that state, is greater than the face value of the debt. When a state of bankruptcy is assumed the face value of the debt is greater than the unhedged value of the firm. The payoff of the portfolio of the hedged firm is positive (assumed above). Thus the expected bankruptcy costs are lowered because the combined value of the firm and the payoff is greater than the value of the firm alone, and the expected value of the tax shield of debt is increased for the same reason. The value of the hedged firm is thus higher than the value of the unhedged firm. Risk management adds value by lowering the probability of incurring bankruptcy costs and increasing the value of the tax shield afforded by debt.

This theory requires the no transaction costs assumption (A.3.) to be lifted because third party bankruptcy payments exist in the model. The assumption of costless risk management is retained. The fixed investment schedule (A.9.) assumption is also lifted as the stream of operating cash flows is altered by bankruptcy costs.

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<sup>5</sup> See Shapiro and Titman (1986) for a discussion hereof.

<sup>6</sup> A self-financing portfolio implies that the sum of the payoffs of the portfolio given the probability of either state occurring, is zero.

### **B.5. Size Implications<sup>7</sup>**

The effect of firm size on the incentive for risk management is indeterminate. Assuming that risk management costs are proportional, Warner (1977) finds that direct bankruptcy costs are less than proportional to firm size. Smith and Stultz (1985) extend this and conclude that the reduction in expected bankruptcy costs is greater for the smaller firm. For this reason, smaller firms are more likely to undertake risk management. Furthermore, Géczy, Minton, and Schrand (1996) contend that if information asymmetries exist, the relationship between firm size and risk management is negative (see Section VI.B.).

A positive relationship is expected in the following circumstances. Nance, Smith, and Smithson (1993) claim that larger firms are more likely to employ people skilled in the management of risk, and that hedging programmes exhibit informational scale economies. Thus it is more likely that firms employing these risk managers (the larger firms) will hedge. This is supported when the assumption of no transaction costs is relaxed. The economies of scale generated by the larger firm's risk management programmes will encourage hedging.

### **B.6. Empirical findings**

Nance, Smith, and Smithson investigate the relationship between the likelihood of firms utilising derivatives and firm size and leverage. Leverage is measured by a debt-size ratio and by an interest cover ratio. The results of the comparison of means suggest a significant positive relationship between hedging and firm size. No significant

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<sup>7</sup> Strictly speaking, size is an endogenous variable. It is a function of scale economies in the organisation and production. However, given the limited understanding of the determinants of size, size itself has been included as a variable.

difference was found with respect to leverage. The logit analysis provides similar findings.

The results of the logit analysis in Géczy, Minton, and Schrand (1996) show that the greater the probability of financial distress the more likely firms are to utilise derivatives. The interest coverage ratio and the long term debt ratio are employed as measures of borrowing capacity and indicators of financial distress. The lower a firm's interest coverage ratio and the higher its long term debt ratio, the more likely firms are to use derivatives.

The univariate results are mixed. The long-term debt ratios of users of currency derivatives are statistically lower than those of non-users. The interest coverage ratios of the two groups are not statistically different.

Berkman and Bradbury (1996) study three proxies for the expected costs of financial distress: firm size, interest cover and leverage. The univariate results indicate that firms with derivatives are significantly larger and have a higher degree of leverage. The interest cover of these firms is lower but this result is not significant. The tobit results give strong support for the theory that firms use derivatives to reduce the expected costs of financial distress.

The likelihood of financial distress is measured by cash costs and leverage in Tufano's (1996b) research. Cash costs include all direct and indirect costs of mining and related activities excluding non-cash items such as interest and extraordinary expenses. Leverage is long term debt scaled by firm size. The hypothesised relationship between these two proxies and risk management is positive.

Tufano finds no observable relationship between the extent of risk management and the likelihood of financial distress (cash costs). Some evidence of a positive relationship between leverage and risk management activity is found. Although these

results indicate that the theory has little predictive power in the North American gold mining industry, it is suggested that the relevance to this industry is limited because the dead-weight costs of bankruptcy may be small. Tufano points out that mines own tangible assets that produce an unbranded commodity product with no after-sales service.<sup>8</sup> Additionally mines are able to exercise the real option<sup>9</sup> to temporarily stop production if financial distress is a consequence of prevailing short term conditions.

### **C. CONCLUSIONS AND AREAS FOR FUTURE RESEARCH**

The reduction of borrowing costs rationale can only be justified if the possibility of financial distress to the firm is real or the firm faces high costs of financial distress. Research into the Modigliani-Miller capital structure debate has suggested that bankruptcy costs are an immaterial fraction of a large firm's assets.<sup>10</sup> If this is the case, the value that risk management programmes can add is limited. Smith and Stultz (1985) acknowledge this potential shortcoming of the theory, however, they claim that small bankruptcy costs can be sufficient to induce larger firms to hedge if the reduction in expected bankruptcy costs exceeds the costs of risk management.

The evaluation of potential financial distress is primarily based on accounting results as opposed to economic earnings. This is especially true for the evaluation of bond covenant provisions. Smith and Stultz (1985) point out that it is possible for a value-maximising firm to choose to reduce the variance of its accounting earnings,

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<sup>8</sup> Shapiro and Titman (1986) discuss characteristics of firms with high costs of financial distress listing industry specific and firm specific factors. One of the firm specific factors mentioned is substantial organisational assets, specifically intangible assets or brand names.

<sup>9</sup> See Brady (1996: 24) for a further (unrelated) discussion of real options.

<sup>10</sup> See, for example, Warner (1977).

even if this increases the variance of economic earnings. Although risk management may have improved the accounting figures, it is questionable whether any real value is added.

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## IX. RISK AVERSE PLAYERS

Lifting the assumption of risk neutrality introduces the possibility of the players having a non-neutral risk profile *i.e.* they are risk inclined or risk averse. The following models assume risk aversity.

### A. RISK AVERSE MANAGERS

Smith (1984) and Smith and Stultz (1985) present models which suggest that a firms' corporate risk management activities might be linked to the risk aversion of corporate managers.

#### A.1. Lifetime utility maximisation: Stultz (1984)

Stultz assumes that principal-agent problems exist, *i.e.* assumption A.7. is relaxed. Managers consequently maximise their expected lifetime utility which includes pecuniary remuneration as well as perceptions of earnings stability and job security. Shareholders recognise that managers will act in their own best interests. As a result, shareholders structure managers' compensation packages such that managers' income is an increasing function of the changes in the value of the firm. This structure realigns shareholders' and managers' objectives, however, it also results in agency costs being incurred. Agency costs are an inevitable consequence of any agency relationship.<sup>1</sup> Managers actions are thus determined by their expected lifetime utility given their compensation contract, including perquisites and fringe benefits; and their expectations

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<sup>1</sup> See Section VIII for further discussion hereon.

of the actions shareholders or other potential investors can take to decrease their expected utility.

Shareholders are able to eliminate non-systematic risk through diversification. This effectively renders them indifferent to the risk management activities of the firm (Froot, Scharfstein and Stein: 1993). However, other stakeholders in the firm may be significantly exposed to the corporation, and may be unable to diversify away this exposure. This is especially true for managers who have a large proportion of their personal wealth invested in the firm. This includes income which is derived from the firm, share option plans, equity stakes, and human capital.

The managers' expected utility depends in part on the distribution of the firms' payoffs. Risk management changes the distribution of the firms' payoffs and, therefore, influences the managers' expected utility. Given their risk aversity, managers will prefer to reduce the risk to which they are exposed. If the variance of firm value is reduced, managers can be made strictly better off without affecting shareholder wealth. Thus corporate risk management is justified on the basis of the risk aversity of managers.

#### *i. The model*

Stultz derives a model where a manager's income is linked to the value of the firm. The firm has to make a payment in foreign currency in the future and can buy foreign currency forward. The change in the value of the firm, and consequently in the value of the managers' wealth is dependant on the change in the exchange rate, the payoff from the forward exchange contracts purchased (less the cost of borrowing) and the change in the value of all other assets that belong to the firm. The manager

maximises his or her wealth subject to a budget constraint. The optimal level of risk management is thus derived. The risk management takes place at firm level as Stultz claims that the firm has a comparative advantage therein and can thus undertake it at a lower cost than managers can on their own account. Consequently Stultz predicts a positive relation between managerial wealth invested in the firm in the form of an equity stake and risk management.

### **A.2. Smith and Stultz (1985)**

Smith and Stultz (1985) develop the above theory by focusing on the form of the investment which managers hold in the firm.

#### *i. The model*

The model is a two-period model that once again positively links a manager's wealth with the value of the firm. The firm holds a hedge portfolio and consequently the manager's utility is dependant upon the value of the firm and the value of the hedge portfolio at the end of the period. The optimal hedge portfolio is thus derived. Smith and Stultz enunciate three implications of their model. In all three cases the manager's expected utility is a concave function of his or her end-of-period wealth. If the majority of the manager's wealth comprises an equity stake in the firm (as opposed to holding options), the model suggests that the optimal risk management strategy is to hedge as completely as possible. Shares provide linear payoffs and consequently a managers' wealth is a concave function of the firms' value. The manager's expected income (which is a part of wealth) is maximised when the firm is completely hedged. This concurs with Stultz's model.

If the manager's wealth is composed primarily of options to buy equity (as opposed to equity), their wealth would be a convex function of firm value as options result in income payoffs which are convex. This implies that a manager's expected value is highest if the firm does not hedge at all. The third case is a hybrid which suggests that some (as opposed to total or none) risk management is optimal. The comparative advantage in risk management that the firm allegedly enjoys means that the risk management activity occurs at the firm level.

Smith and Stultz predict a positive relation between risk management and managerial wealth invested in the firm in the form of an equity stake; and a negative relationship between the level of managerial option holdings and risk management.

For the theory to hold the transaction costs are zero assumption (A.3.) and the assumption of no principal-agent problems (A.7.) are relaxed. In addition, risk aversion changes the nature of managerial decisions and therefore the fixed investment schedule assumption (A.9.) has to be relaxed.

### **A.3. Empirical findings**

Tufano (1996b) measures the officers' and directors' share ownership as the log of the value of common shares owned (excluding options) at the average annual share price. The hypothesised relationship between the officers' and directors' share ownership and the portfolio delta is positive. This is because the theories predict that firms whose managers hold greater equity stakes, as a fraction of their private wealth, are more inclined to manage gold price risk. The variable representing the officers' and directors' option holdings is the number of options outstanding which are held by officers and directors. Financial literature suggests that firms whose managers hold

options might be less inclined to manage gold price risk, therefore a negative relationship between the officers' and directors' option holdings and the portfolio delta is assumed.

Tufano's results indicate that managerial risk aversion has an important influence on corporate risk management. Both of Smith and Stultz's predictions are supported. Firms whose managers own more stock options, manage less gold price risk. Those whose managers have more wealth invested in common stock manage more gold price risk.

Berkman and Bradbury's (1996) findings are ambiguous. Managerial share ownership is proxied by the proportion of shares held by directors. The univariate non-parametric test indicates that the proportion of shares held by directors is lower for companies that use derivatives, as opposed to those that do not. However, the tobit model results suggest that managers do employ derivatives if they hold an equity stake in the firm.

The measure for managerial share ownership used by Géczy, Minton, and Schrand (1996) is managerial wealth. This is defined as the log of the market value of the common shares beneficially owned (excluding options) by officers and directors. Managerial ownership of options is the log of the market value of the shares obtainable by exercising outstanding options. Univariate tests suggest that users of derivatives are not statistically different from non-users with respect to managerial wealth. The results of the logit regression analysis show that neither managerial wealth nor managerial ownership of options is statistically significant.

The variables chosen by Géczy, Minton, and Schrand (1996) examine a different aspect from those used in Berkman and Bradbury's research. Managerial wealth is an absolute figure rather than the proportional one that is scaled by total

issued shares as used by Berkman and Bradbury. Therefore, Géczy, *et al*'s research does not examine the effective control that managers exert over the organisation. It does, however, gauge and therefore compare the absolute level of managerial wealth invested in firms. The figure for outstanding options includes only those that are exercisable within 60 days of the year end. This is a limited and in many cases very small portion of the total number of outstanding managerial options.

#### A.4. Criticism

The objective of both models is to derive optimal hedging portfolios, given the risk aversion of managers. The more fundamental issue of whether the investor or the firm should undertake the risk management is not explicitly dealt with in the conceptual models. It is assumed that risk management will occur at a firm level because of the firms' alleged comparative advantage.

There is an internal inconsistency in Smith's (1984) theory. The 'no transaction costs' assumption is employed to justify shareholder indifference as to the firms' risk management policies. This assumption is then discarded to account for managers' preference for conducting risk management at the firm level. This inconsistency can be illustrated by the following extracts from Smith (1984).

*As, by assumption, shareholders want managers to maximise the value of the firm, they do not care about managers' choice of (number of foreign currency forwards) as long as hedging is costless and the investment policy is not affected by hedging. (131)*

*If the manager must pay some transaction costs when he or she purchases foreign default free bonds or enters into forward contracts, he or*

*she will choose the cheapest way of hedging and hence will hedge through the firm rather than on his or her personal account. In general, it is realistic to assume the firm has a comparative advantage in trading bonds or forward contracts. (131 - 132)*

A similar problem arises in Smith and Stultz (1985).

*To simplify, we assume that ... the firm incurs no transaction costs when it purchases or sells financial assets. (399)*

*The combination of transaction costs, economies of scale, and the large number of managers within any firm make this comparative advantage likely. If there is a single manager, scale economies can still induce the manager to hedge through the firm. (401)*

## **B. CONCLUSIONS AND AREAS FOR FUTURE RESEARCH**

The models are designed to determine optimal risk management levels given managerial risk aversion. They assume that risk management occurs at a firm level. The empirical research does suggest that the relationships predicted by the model hold. However, these models are not strictly relevant to the conceptual debate which is whether risk management should take place on a company or investor level. In future, the models can be adapted to explicitly include transaction costs. This would address the issue of where risk management should take place.

In his research into whether managerial motives influence firm risk reduction strategies, May (1995) employs the following proxies for CEO motives: years with the firm; proportion of personal wealth vested in firm equity; asset specific expertise; and

the firm's recent performance. This research is discussed in the section on principal-agent problems (Section VIII). It may be appropriate for future research to utilise these proxies to investigate whether there exists a relationship between them and the financial risk management strategies employed by a firm.

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## **X. EMPIRICAL ANALYSIS OF THE DETERMINANTS OF CORPORATE RISK MANAGEMENT USING SOUTH AFRICAN DATA**

An empirical analysis of the determinants of corporate risk management using South African data is performed. The investigation is based on significant international empirical works that have been seminal in the development of this particular subject area within financial academia. The basis of the study is primarily Berkman and Bradbury (1996) and Géczy, Minton, and Schrand (1996), however, where appropriate facets of the other two international papers have been incorporated. Furthermore, the peculiarities of the South African environment and accounting practices have necessitated certain adaptations and changes to the international research. This is the first research to investigate the motives for hedging in a South African context. The results of the research are presented in the following section.

### **A. CONSTRUCTION OF THE SAMPLE**

The sample consists of firms that were listed in the Industrial Sector of the Johannesburg Stock Exchange on 15 December 1996. The industrial sector of the main board of the Johannesburg Stock Exchange was chosen to ensure homogenous results. The conditions faced by the other sectors lead to fundamentally different financial disclosures. Predictions surmised from a sample consisting of firms from all the sectors of the Johannesburg Stock Exchange would probably be redundant. Mining companies are required to follow financial reporting standards that are unique to the South

African mining industry. The disclosure of mining companies' results is therefore intrinsically different from other South African companies. Given the research that Tufano (1996) has performed on North American mining companies, it is suggested that South African gold mining firms be investigated as a separate industry in future research. The characteristics and derivatives use of firms in the financial sector are crucially different from corporations in the industrial sector. The financial sector was excluded from the sample.

The development and venture capital markets were not included in the sample because of their more 'speculatory' nature. The listing requirements are more lenient than those of the main board of the Johannesburg Stock Exchange. Therefore smaller companies with a shorter or weaker financial history list on the development or venture capital boards. Additionally, these shares are generally very illiquid.

This sample was further restricted by eliminating investment holding companies. The activities of each company were determined from the 'Nature of Business' entry in *The Stock Exchange Handbook: July 96 - Dec 96* (Alexander and Oldert: 1996). Of the remaining firms, those whose results are not reported in South African Rand or a Rand equivalent<sup>1</sup> are eliminated.

The final sample consists of 146 firms of which 115 (79%) firms hedged and 31 (21%) did not hedge. The firms in the final sample come from a broad range of sectors. Most are from the electronics sector (21); the clothing sector (19); engineering sector (15); and building, beverages, food, and stores sectors (each 12). The data set was obtained from McGregor's Online Database (McGregor's Information Services (Pty) Ltd: 1996). This information was verified and, where necessary, supplemented by information from annual financial statements and Alexander and Oldert (1996). The

appendix contains detailed definitions of the variables and data sources for each variable. The full sample is also included in the appendix.

## **B. DEPENDANT VARIABLE**

The dependant variable in this research is whether South African firms manage risk as part of their financial operations. The ideal measure of risk management is the hedge ratio of the contracts used to manage risk (Berkman and Bradbury: 1996). Brealy and Myers (1991: G5) define the hedge ratio as the number of units of an asset that should be bought to hedge one unit of a liability. South African Generally Accepted Accounting Practice (GAAP), which governs the presentation of and disclosures required in companies' annual financial statements, currently requires minimal disclosure of derivatives usage. Indeed, the only GAAP statement requiring disclosure relating to derivative instruments is AC112 'Changes in Foreign Currency Exchange Rates'. This statement specifies that the premium or discount that arises because a forward exchange contract has been used to cover a transaction, be disclosed. It is therefore necessary for a firm to acknowledge that they are using derivative instruments to hedge their foreign exchange exposures. The dependant variable is thus defined as 1 (one) if there is evidence of the translation of foreign assets, liabilities or transactions at a forward rate in the notes to the financial statements. An example of a note to the financial statements which indicates risk management is:

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<sup>1</sup> The Namibian Dollar is linked to the rand.

**Foreign currency note**

Assets and liabilities in foreign currencies are translated at rates of exchange ruling at the year end or at *rates applicable in forward exchange contracts*.

When fluctuations in exchange rates *have been hedged*, the balances are adjusted to reflect the unrealised gain and loss on the hedge at the year end.

Gains and losses arising from other currency related transactions during the year are included in the earnings. (Tongaat Hulett Ltd, 1996 Annual Financial Statements) (emphasis added)

Alternatively:

**Foreign Exchange Cover**

The group adopts the policy of obtaining *forward cover* on all foreign exchange transactions. (Sterling Clothing Ltd, 1996 Annual Financial Statements) (emphasis added)

Where no evidence of a note indicating hedging is found, the dependant variable is 0 (zero). This occurs where either no foreign currency note is disclosed or the note specifies that spot rates are used for all translations. The following is an example of the latter.

**Translation of foreign currencies**

Trading transactions within the group in foreign currencies are translated at the rates of exchange ruling at the transaction date. Exchange differences are recognised in the results for the year.

All assets and liabilities of foreign entity subsidiaries are translated at the closing rate. Income statement items are translated at an appropriate weighted average exchange rate for the year. Exchange differences are taken directly to

the foreign currency translation reserve. (Protea Furnishers: 1996 Annual Financial Statement)

### **B.1. Advantage of the risk management variable**

One of the limitations of Berkman and Bradbury (1996) and Géczy, Minton, and Schrand's (1996) research, is that the dependant variable as defined does not *a priori* limit the use of derivatives to hedging. This may result in a misspecified model.<sup>2</sup> Defining the dependant variable in terms of AC112 disclosures ensures that firms classified as managing risk are using derivatives for hedging and not speculative purposes. The results obtained will therefore relate solely to risk management which uses derivatives for hedging purposes.

### **B.2. Limitations of the risk management variable**

Generally, the higher the measurement scale of the data used for statistical analyses, the richer the information content of the results. Consequently, the binary nature of the dependant variable used in this research limits the informational content of the conclusions. Given that there is no other source of publicly available information on risk management undertaken by South African companies, the limitations of the binary nature of the dependant variable have to be accepted. International empirical studies, including Nance, Smith, and Smithson (1993), and Géczy, Minton, and Schrand (1996), have also employed a categorical dependant variable for the same reasons.

Basing the dependant variable on AC112 disclosures limits risk management to derivatives usage for foreign currency transactions. Yet, South African GAAP does not consider any other purpose for using derivatives. AC112 disclosures are therefore the only publicly available information on a company's use of derivative instruments. This is the same limitation that is experienced in some of the international research. Géczy, Minton, and Schrand (1996) limit their definition of derivatives usage to those used in foreign currency transactions.

AC112 does not consider non-linear derivative instruments; for example, options. If firms follow the requirements of AC112 strictly, the effects of using options for hedging purposes would remain off balance sheet. However, one of the fundamental principles of GAAP is 'substance over form'. The substance of the use of options for hedging foreign currency transactions is the same as that of using futures. Thus it can be assumed that the use of options or other non-linear derivative instruments for the purpose of protecting the firm against movements in foreign currencies must be disclosed under AC112.

Some companies may not include information on hedging foreign currency transactions in their financial statements as South African GAAP is currently not mandatory and legally binding. Moreover, the requirements for firms listed on the Johannesburg Stock Exchange are based on Schedule 4 of the Companies Act No 61 of 1973, as amended. Disclosure of any information relating to transactions utilising derivatives is not required by this schedule. Additional disclosures are required by the JSE, however, derivatives transactions are not considered (KPMG Corporate Financial Services: 1997). Nevertheless, an audit report states that 'In our opinion these financial

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<sup>2</sup> Géczy, Minton, and Schrand (1996) consider this weakness and conclude that, on average, the firms examined are not speculating with currency derivatives. Their justification is the consistency of their

statements fairly present the financial position of the company ... in conformity with generally accepted accounting practice and in the manner required by the Companies Act.' (Appendix to AU321 (Revised) para .02.) Thus it is assumed that all companies using derivatives to hedge foreign transactions have disclosed this fact.

## C. INDEPENDANT VARIABLES

The independent variables tested are categorised according to the hypotheses which are being tested. Three main postulates are considered: the shareholder-debtholder conflict, capital market imperfections and the risk aversion of managers. The definitions, constructions and data sources for all variables are detailed in the appendix.

### C.1. Shareholder - Debtholder Conflict

Three variables were used to test the validity of the shareholder-debtholder conflict hypothesis. Measures that proxy the probability of the firm experiencing financial distress are the long term debt ratio, interest cover and firm size.

#### FIRM SIZE

The effect of firm size on risk management activities is complex. There are alternative arguments depending on which assumptions are relaxed. (Nance, Smith, and Smithson: 1993, and Géczy, Minton, and Schrand: 1996). An inverse relationship between firm size and bankruptcy costs suggests that small firms should undertake a

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results with the models of optimal hedging behaviour.

greater degree of risk management. This holds if there is a less than proportional relationship between bankruptcy costs and firm size (Warner 1977 and Smith and Stultz: 1985). In this instance, the reduction in expected bankruptcy costs is greater for the smaller firm. Smaller firms are therefore more likely to undertake risk management. If smaller firms face a greater degree of information asymmetries, theory suggests a negative relationship: larger firms should hedge less. (Géczy, Minton, and Schrand: 1996) A positive relationship is expected in the following circumstances. Nance, Smith, and Smithson (1993) claim that larger firms are more likely to employ people skilled in the management of risk. Additionally, hedging programmes exhibit informational scale economies. Thus it is more likely that firms employing these risk managers (the larger firms) will hedge. This is supported when the assumption of no transaction costs is relaxed. The economies of scale generated by the larger firm's risk management programmes will encourage hedging.

Firm size is determined by the natural logarithm<sup>3</sup> of the market value of the firm. The market value is determined by multiplying the share price at year end by the number of shares in issue at year end.

#### INTEREST COVER

Firms which have relatively high interest cover ratios face a lower probability of experiencing financial distress. Theory predicts that the relationship between interest cover and risk management is negative. Interest cover is defined as the log of income

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<sup>3</sup> Henceforth, the term 'log' implies 'the natural logarithm'.

before interest and tax divided by the interest expense.<sup>4</sup> (Berkman and Bradbury: 1996, and Géczy, Minton, and Schrand: 1996)

## LEVERAGE

Financial theory predicts that firms with healthier (lower) debt ratios, are less likely to experience financial distress. There is a negative relationship between risk management and the debt ratio. The debt ratio used is termed 'leverage'. Leverage is measured as the book value of debt over the market value of the firm. (Berkman and Bradbury: 1996)

## C.2. Capital Market Imperfections

Underinvestment costs are a direct consequence of capital market imperfections. A positive relationship between underinvestment costs and risk management activities is suggested. Underinvestment costs are dependant upon two factors: the investment activities that could potentially be disrupted if there are not sufficient internally generated funds and the availability of internally generated funds.

### *i. Investment Opportunities*

The investment opportunities are proxied by the earnings price ratio and the book to market ratio.

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<sup>4</sup> Following Berkman and Bradbury (1996), income before interest and tax is set equal to one (1) if it is negative and interest is set equal to one (1) if the firm has no debt.

#### EARNINGS-PRICE RATIO

The price-earnings ratio is a traditional indicator of the growth potential of a company: the higher the ratio, the higher the market's perception of that company's potential for growth. In this research the ratio is inverted to eliminate an outlier problem introduced by small earnings in relation to price (Berkman and Bradbury: 1996). The hypothesised relationship between this ratio and the extent of risk management is negative.

#### BOOK-TO-MARKET RATIO

The market-to-book ratio has similar implications *viz. a viz.* the firm's growth potential to the price-earnings ratio. The inverse of the market-to-book relationship is utilised so that there is a positive relationship between all the investment opportunity proxies and risk management. (Géczy, Minton, and Schrand: 1996, Berkman and Bradbury: 1996)

#### CAPITAL INVESTMENT RATIO

Géczy, Minton, and Schrand (1996) introduce this ratio which investigates the intensity of capital investment. It is defined as the ratio of property, plant and equipment<sup>5</sup> at year end to firm size.

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<sup>5</sup> Property, plant and equipment is the recently introduced term for what has traditionally been labelled fixed assets.

*ii. Availability of Internally Generated Funds*

The availability of internally generated funds is proxied by the quick ratio and the short term asset growth ratio.

## QUICK RATIO

The quick ratio is an indicator of liquidity. Theory suggests that the level of risk management increases as firms face tighter liquidity positions (a negative relationship). The quick ratio is defined as the ratio of current assets less inventory to current liabilities. (Berkman and Bradbury: 1996, and Géczy, Minton, and Schrand: 1996) This ratio is a more stringent indicator of short term liquidity than the liquidity ratio utilised by Nance, Smith, and Smithson (1993).

## ASSET GROWTH RATIO

The proxy introduced by Berkman and Bradbury (1996) to determine a firm's ability to generate enough cash to finance current investment programmes is the asset growth ratio. This short term measure is the log of current year's change in tangible net assets plus depreciation divided by net income plus depreciation.<sup>6</sup>

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<sup>6</sup> If the denominator (the change in fixed assets plus depreciation) is negative, it is set equal to 0.00001. If the numerator (net income plus depreciation) is negative, it is set equal to one. (Berkman and Bradbury: 1996)

### C.3. Risk Aversion of Managers

Financial theory suggests that, given risk adversity, the greater the proportion of a manager's total wealth that is held in the firm, the greater the extent of risk management undertaken by that manager.

#### DIRECTORS' SHARE OWNERSHIP

The total level of managers' wealth (including income from sources outside the firm) is not publicly available. Therefore, the proxy that is used is the log of the market value of ordinary shares that managers had a beneficial interest in, directly or indirectly, at the balance sheet date. (Géczy, Minton, and Schrand: 1996, Tufano: 1996<sup>7</sup>) This is not entirely representative as it assumes a constant level of wealth across all managers in all firms and that the size of the management team is constant. The hypothesised relationship between managerial share ownership and risk management is positive. Géczy, Minton, and Schrand (1996) also consider the relationship between managers' unexercised options holdings and hedging. South African Generally Accepted Accounting Practice does not require the disclosure of the options held by directors, thus this variable cannot be empirically tested.

## D. UNIVARIATE ANALYSIS

The statistical significance of a result is an estimated measure of the degree to which the result is representative of the population. The measure of statistical significance used in this research is the p-value. This term was introduced by K

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<sup>7</sup> Tufano calculates the market value using the average annual share price.

Brownlee in 1960<sup>8</sup>. The p-value represents the probability of error associated with rejecting the hypothesis of no difference between the two groups in the population when, in fact, the hypothesis is true. In other words, the p-value is the probability of obtaining a value of the test statistic as extreme or more extreme (in the appropriate direction) than that actually obtained given that the tested null hypothesis is true. It is also the smallest level of significance at which  $H_0$  can be rejected. (Daniel: 1995) The advantage of reporting a p-value is that the reader can set their own criteria for accepting or rejecting the null hypothesis. The reader is thus able to make an independent decision as to the significance of the results. The amount of the p-value represents a decreasing index of the reliability of a result. The higher the p-value, the less reliance can be placed on the observed relation between variables in the sample being representative of the relationship between the respective variables in the population. For example, a p-value of 0.05 (this equates to 1 out of every 20) indicates that there is a 5% probability that the relation found between the variables in the sample is merely a coincidence. A p-value of 0.05 is generally regarded as the largest acceptable error level. Statistically significant results have p-values of less than 0.01. P-values of less than 0.005 or 0.001 represent highly significant results.

Differences between the means of the firms that used derivatives and those that did not, are tested for significance using the Mann Whitney U-test. This is a non-parametric test which assumes that the dependant variable is measured on at least an ordinal scale. The interpretation of the test is essentially identical to the interpretation of the results of a t-test for independent samples, except that the U-test is computed

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<sup>8</sup> Brownlee K. A. (1960), *Statistical Theory and Methodology in Science and Engineering*, New York, John Wiley.

based on rank sums rather than on means. The U-test is the most powerful non-parametric alternative to the t-test for independent samples. (Statsoft: 1996)

## E. MULTIVARIATE ANALYSIS

When attempting to establish determinants of corporate risk management analytically, certain fundamental statistical problems are raised by the qualitative nature of the dependant variable. Ordinary least squares regression cannot be used as the assumption of homoskedasticity is violated by the estimation of the dependant variable. This estimation necessitates the use of a dummy binary variable, which in this research is whether the firms use derivatives to manage risk (1) or not (0). Until recently a number of disparate techniques were needed to model a binary dependant variable as a function of a set of explanatory variables. These techniques ranged from the repetitious elaboration of two-way cross tabulations at fixed levels of the other predictors, to ordinary least squares regression or discriminate analysis for a binary dependant variable, to discriminate analysis for a polytomous dependant variable with continuous predictors, to non-parametric techniques for the case in which the dependant variable was ordinal. (Demaris: 1992). The multivariate analysis of categorical data has been transformed by a particular form of the general loglinear model, namely logit analysis. The above is illustrated by a quotation by Michael S Lewis-Beck in Demaris (1992: iii):

*'Logit modelling represents a breakthrough in the methodology of social science research because it offers ways to more efficient estimation of models with multiple, categorical variables'*

### E.1. Logit Analysis

Logit analysis transforms the problem of predicting probabilities within a (0,1) interval to the problem of predicting the odds of an event occurring within the range of a real line. The logit model is based on the cumulative logistic probability function.  $Z_i$  and is assumed to be a theoretical continuous index which is determined by the explanatory variable  $X$ . Thus

$$Z_i = \alpha + \beta X_i$$

Individual  $Z_i$  cannot be observed. The only available data is whether observations fall into one category (high values of  $Z_i$ ) or a second category (low values of  $Z_i$ ). Logit analysis solves the problem of how to obtain estimates for the parameters of  $\alpha$  and  $\beta$  while at the same time obtaining information about the underlying index  $Z$ . The derivation is taken from Pindyck and Rubinfeld (1991: 258 - 259; 280 - 281). They specify the logit model as:

$$P_i = F(Z_i) = F(\alpha + \beta X_i) = \frac{1}{1 + e^{-Z_i}} = \frac{1}{1 + e^{-(\alpha + \beta X_i)}}$$

(Eq. XI.1)

where

$e$  = base of natural logarithms  $\approx 2.718$

$P_i$  = probability that an individual will make a certain choice given  $X_i$

Multiplying both sides of this equation by  $1 + e^{-Z_i}$ , the following is obtained:

$$(1 + e^{-Z_i}) P_i = 1$$

Dividing by  $P_i$  and then subtracting 1 leads to:

$$e^{-Z_i} = \frac{1 - 1}{P_i} = \frac{1 - P_i}{P_i}$$

By definition  $e^{-Z_i} = \frac{1}{e^{Z_i}}$ , therefore:

$$e^{-Z_i} = \frac{P_i}{1 - P_i}$$

Taking the natural logarithm of both sides:

$$Z_i = \log \frac{P_i}{1 - P_i}$$

Thus Eq. XI. 1 can be estimated by:

$$\log \frac{P_i}{1 - P_i} = Z_i = \alpha + \beta X_i$$

(Eq. XI.2)

This is the 'logit' itself. It can be interpreted as the natural logarithm of the odds or the 'log odds'. This indicates the relative probability of falling into one of the two categories being investigated.

Least squares estimation cannot be used to estimate the parameters of the model when the dependant variable is binary and the explanatory variables are continuous. Therefore it is necessary to estimate a logit model in which only one choice is associated with each set of independent variables (Pindyck and Rubinfeld: 1991). This is achieved by using a maximum likelihood estimation procedure. The parameters of the logit model (below) need to be estimated:

$$P_i = \frac{1}{1 + e^{-(\alpha + \beta X_i)}}$$

(Eq. XI.3)

Individual  $P_i$  are not observed, the only available information is which of the binary choices ( $Y_i = 0$  or  $Y_i = 1$ ) was made. The objective is to find parameter estimates for  $\alpha$  and  $\beta$  which make it most likely that the choices in the sample *would have* occurred. Assuming that 1 is chosen  $n_1$  times and 0  $n_2$  times ( $n_1 + n_2 = N$ ) and that the data is arranged such that the first  $n_1$  observations relate to 1, then the likelihood function has the form:

$$L = \text{Prob}(Y_1, \dots, Y_N) = \text{Prob}(Y_1) \dots \text{Prob}(Y_N)$$

The probability of 0 being chosen is equal to one minus the probability of 1 being chosen. If  $\Pi$  is used to represent the product of a number of factors, the likelihood function becomes:

$$L = P_1 \dots P_{n_1} (1 - P_{n_1+1}) \dots (1 - P_N) = \prod_{i=1}^{n_1} P_i \prod_{i=n_1+1}^N (1 - P_i) = \prod_{i=1}^N P_i^{Y_i} (1 - P_i)^{(1-Y_i)}$$

The latter expression follows because the observations have been ordered such that  $Y_i$  equals 1 for the first  $n_1$  observations and 0 for the last  $n_2$  observations. The logarithm of  $L$  is maximised by substituting the logistic probability function from Eq. XI.3. The following is obtained (note there are two steps to the derivation).

$$\begin{aligned} 1 - P_i &= 1 - \frac{1}{1 + e^{-(\alpha + \beta X_i)}} = \frac{1 + e^{-(\alpha + \beta X_i)} - 1}{1 + e^{-(\alpha + \beta X_i)}} \\ &= \frac{e^{-(\alpha + \beta X_i)}}{1 + e^{-(\alpha + \beta X_i)}} = \frac{1}{1 + (1/e^{-(\alpha + \beta X_i)})} = \frac{1}{1 + e^{\alpha + \beta X_i}} \end{aligned}$$

$$\log L = \sum_{i=1}^{n_1} \log P_i + \sum_{i=n_1+1}^N \log (1 - P_i)$$

The slope estimators of  $\hat{\alpha}$  and  $\hat{\beta}$  are obtained by differentiating  $\log L$  with respect to  $\alpha$  and  $\beta$ , setting it equal to zero and solving the resultant equation.

$$\frac{\partial(\log L)}{\partial \beta} = \sum_{i=1}^n \frac{\partial P_i / \partial \alpha}{P_i} - \sum_{i=n+1}^N \frac{\partial P_i / \partial \alpha}{1 - P_i} = 0$$

$$\frac{\partial(\log L)}{\partial \beta} = \sum_{i=1}^n \frac{\partial P_i / \partial \beta}{P_i} - \sum_{i=n+1}^N \frac{\partial P_i / \partial \beta}{1 - P_i} = 0$$

(Eq. XI.4)

If the analysis involved constant and multiple independent variables, a series of simultaneous Eq. XI.4 would have to be solved for the unique values of the constant and all the coefficients. This procedure has been automated by a number of statistical computer programmes. Statistica (v5) (Statsoft: 1995) was used to analyse the data in this research.

## **XI. EMPIRICAL EVIDENCE OF THE DETERMINANTS OF CORPORATE RISK MANGEMENT IN SOUTH AFRICAN FIRMS**

The results of the empirical investigation into the determinants of corporate risk management using South African data are presented in this section. The methodology and discussion of variables used are considered in Section X.

### **A. UNIVARIATE NON-PARAMETRIC RESULTS**

The descriptive statistics of the independent variables: the mean; standard deviation; median; minimum and maximum; are listed in Table XI.1:

Table XI.1. Descriptive Statistics of Independent Variables

Hypothesis	Variable	Mean	Standard Deviation	Median	Minimum	Maximum
Financial Distress	Interest Cover	2.179	3.505	1.660	-11.243	12.990
	Firm Size	19.377	1.914	19.430	14.557	24.343
	Leverage	0.185	0.568	0.053	0.000	4.900
Investment Opportunities	Earnings-price ratio	0.094	0.148	0.082	-0.651	1.163
	Book-to-market ratio	1.026	1.116	0.695	0.092	6.685
	Capital investment	0.522	0.651	0.319	0.000	4.391
Availability of Internal Funds	Quick Ratio	1.405	4.030	0.935	0.212	49.255
	Asset Growth	-0.617	3.370	-0.445	-11.513	12.106
Risk Aversion	Directors' share ownership	13.570	7.318	15.834	-9.210	21.190

Table XI.1. shows selected summary statistics for the managerial and financial characteristics of all the firms included in the study. The sample contains 146 firms listed on the industrial sector of the Johannesburg Stock Exchange in 1996.

Firm size is measured by the log of the market value of the corporation on balance sheet date. Interest cover is denoted by the log of earnings before interest and tax divided by the interest expense. The debt ratio, defined as the book value of debt over the market value of the firm, measures the degree of leverage. Outlier problems that arise because firm's have small earnings are avoided by the inversion of the price earnings ratio. The book to market ratio is the inverse of the standard market to book ratio. Capital investment is defined as the ratio of property, plant and equipment divided by firm size. Liquidity is measured by the quick ratio: current assets less inventory over current liabilities. Asset growth is the log of the current year's change in fixed assets plus depreciation divided by net income plus depreciation. Directors' share ownership is the log of the market value of ordinary shares held, directly and indirectly, by the company's directors.

To test the significance of the differences in the medians between firms that manage risk and those that do not, a Mann Whitney U-test was performed.<sup>1</sup> Table XI.2 reports the means and medians for the firms that hedge and those that do not. The results of the Mann Whitney U-test are also summarised in Table XI.2.

<sup>1</sup> For an explanation of the Mann Whitney U-test and reasons for performing the test see section X.D.

Table XI.2. Univariate Non-Parametric Tests

Hypothesis	Variable	Firms which do not hedge N=31		Firms which do hedge N=115		Z-statistic	p-value
		Mean	Median	Mean	Median		
Financial Distress	Interest Cover	1.344	1.254	2.403	1.866	-2.472	0.013
	Firm Size	18.273	18.435	19.674	19.693	-3.357	0.001
	Leverage	0.341	0.076	0.143	0.039	2.007	0.045
Investment Opportunities	Earnings-price ratio	0.098	0.082	0.093	0.082	-0.273	0.785
	Book-to-market ratio	1.228	0.727	0.971	0.675	0.916	0.359
	Capital investment	0.567	0.414	0.510	0.281	1.299	0.194
Availability of Internal Funds	Quick Ratio	2.721	0.942	1.050	0.930	0.462	0.644
	Asset Growth	-0.914	-0.391	-0.536	-0.445	0.170	0.865
Risk Aversion	Directors' share ownership	11.322	15.328	14.176	15.840	0.847	0.397

Table XI.2. shows selected summary statistics for the managerial and financial characteristics of the firms which manage risk and those that do not. Of the total of 146 firms included in the sample, 115 hedged and 31 did not. The Z-statistic is the result of the non-parametric Mann-Whitney U-test. This technique assesses the differences in the medians between the group of firms that hedge and those that do not. The related p-values are listed adjacent to the Z-statistics.

Firm size is measured by the log of the market value of the corporation on balance sheet date. Interest cover is denoted by the log of earnings before interest and tax divided by the interest expense. The debt ratio, defined as the book value of debt over the market value of the firm, measures the degree of leverage. Outlier problems that arise because firm's have small earnings are avoided by the inversion of the price earnings ratio. The book to market ratio is the inverse of the standard market to book ratio. Capital investment is defined as the ratio of property, plant and equipment divided by firm size. Liquidity is measured by the quick ratio: current assets less inventory over current liabilities. Asset growth is the log of the current year's change in fixed assets plus depreciation divided by net income plus depreciation. Directors' share ownership is the log of the market value of ordinary shares held, directly and indirectly, by the company's directors.

Table XI.2 indicates strong support for theories which predict a greater degree of risk management in companies facing financial distress. A firm is more likely to face bankruptcy costs if it has a lower interest cover (p-value is 0.013) and is more highly levered (p-value is 0.045). Although the leverage result is not significant, it does fall within the largest acceptable error level. Theory predicts that firms in this position manage risk to reduce the expected costs of financial distress.

The most significant finding is a negative relationship between firm size and hedging (p-value is 0.001). This is highly significant and therefore interesting given the conflicting hypotheses about firm size. The relationship between bankruptcy cost and firm size suggested by Warner (1977) and Smith and Stultz (1985) is supported by the above result. Their model predicts that the reduction in expected bankruptcy costs, due to hedging, is greater for the small firm given that bankruptcy costs are less than proportional to firm size. Thus smaller firms are more likely to hedge. Géczy, Minton, and Schrand (1996) suggest that if information asymmetries exist, the relationship between firm size and risk management is negative. This theory is supported by the significant negative relationship found. However, the result is contrary to the postulate that larger firms are more likely to hedge because they experience economies of scale and informational economies when managing risk.

Firms which hedge have a higher capital investment ratio (p-value is 0.194). Although this is the most significant result among the variables testing the investment opportunities hypothesis, it is not statistically significant. The earnings-price ratios of firms employing derivatives is higher than firms who do not but, with a p-value of 0.785, the relationship is not significant. An insignificant negative relationship, with a p-value of 0.359, between the book-to-market ratio and risk management is found: this is contrary to financial theory.

Neither the availability of internal funds nor the directors' share ownership are found to be notable explanatory variables.

Correlation is a measure of the relation between two or more variables. The terminology and concepts of correlation were introduced by Galton in 1888. The correlation coefficient measures the strength of the linear relationship between two or more variables. It is not dependant on the specific measurement units of the variables.

Correlation coefficients can range from -1.00 to +1.00. The value of -1.00 represents a perfect negative correlation while a value of +1.00 represents a perfect positive correlation. A value of 0.00 represents a lack of correlation. The significance of a correlation coefficient will change depending on the size of the sample from which it was computed. The most widely-used type of correlation coefficient is Pearson's  $r^2$  which is also called linear or product-moment correlation.

Of the 45 Pearson correlation coefficients reported in Table XI.3., 15 are statistically different from zero at  $p\text{-value} < 0.05$ . These are italicised in Table XI.3. This suggests that multicollinearity is present in the data. Given these correlations among the different firm characteristics, the univariate tests cannot be expected to reveal significant differences in firm traits, holding other attributes constant. The smallest correlation is 0.00008 between the book-to-market and quick ratios. The largest is 0.855 between the book to market ratio and the capital investment ratio.

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<sup>2</sup> The original reference is Pearson K, (1896), Regression, heredity, and panmixia, *Philosophical Transactions of the Royal Society of London*, Ser. A, 187.

Table XI.3. Pearson Correlation Matrix Independent Variables

	Interest Cover	Firm Size	Leverage	Earnings-price Ratio	Book-to-Market Ratio	Asset Growth Ratio	Capital Ratio	Quick Ratio	Directors' share ownership
Interest Cover	1.000								
Firm Size	0.156	1.000							
Leverage	-0.149	<i>-0.246</i>	1.000						
Earnings-price Ratio	<i>0.340</i>	-0.107	0.137	1.000					
Book-to-Market Ratio	-0.058	<i>-0.390</i>	<i>0.701</i>	<i>0.504</i>	1.000				
Asset Growth Ratio	<i>-0.218</i>	0.066	-0.115	-0.081	-0.107	1.000			
Capital Ratio	-0.038	<i>-0.244</i>	<i>0.451</i>	<i>0.504</i>	<i>0.855</i>	0.107	1.000		
Quick Ratio	0.077	<i>-0.170</i>	-0.033	-0.030	0.000	<i>-0.292</i>	-0.090	1.000	
Directors' share ownership	-0.118	0.036	0.054	-0.017	0.059	0.068	0.062	<i>-0.263</i>	1.000

Table XI.3. lists the Pearson correlation coefficients for explanatory variables used in the Mann Whitney U-test and the logit analysis. The italicised correlation coefficients are significant at  $p < 0.05$ .

Firm size is measured by the log of the market value of the corporation on balance sheet date. Interest cover is denoted by the log of earnings before interest and tax divided by the interest expense. The debt ratio, defined as the book value of debt over the market value of the firm, measures the degree of leverage. Outlier problems that arise because firm's have small earnings are avoided by the inversion of the price earnings ratio. The book to market ratio is the inverse of the standard market to book ratio. Capital investment is defined as the ratio of property, plant and equipment divided by firm size. Liquidity is measured by the quick ratio: current assets less inventory over current liabilities. Asset growth is the log of the current year's change in fixed assets plus depreciation divided by net income plus depreciation. Directors' share ownership is the log of the market value of ordinary shares held, directly and indirectly, by the company's directors.

Statistically significant results in the univariate analysis of means are only found for variables testing the financial distress hypotheses. These results suggest that firms who hedge have a lower interest cover ratio, are smaller and are leveraged to a greater extent than firms who do not hedge.

## B. RESULTS OF THE LOGIT ANALYSIS

Logit regression analysis is a statistical technique which facilitates the multivariate analysis of categorical data<sup>3</sup>. The overall chi<sup>2</sup> value for the analysis (with 9 degrees of freedom) is 24.292. With a p-value<sup>4</sup> of 0.00387, this is a highly significant result and suggests that risk management practices in South African firms are associated with the firm and managerial characteristics tested.

Maximum likelihood estimates of the logit regression are reported in Table XI.4. The predicted sign registers the direction of the relationship which is suggested by financial theory. The sign of the coefficient estimate indicates whether the relationship between the variables is found to be positive or negative. The p-value is a measure of statistical significance of the value of the coefficient estimate. The p-value is derived from the relevant t-statistic with 136 degrees of freedom. The t-statistic and standard error are not central to understanding the results of the analysis and have been included for interest.

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<sup>3</sup> The logit regression model is discussed and derived in Section X.E.

<sup>4</sup> For further discussion on p-values see Section X.D.

Table XI.4. Logit Estimates of the Determinants of the Corporate Use of Derivatives

Hypothesis	Variable	Predicted Sign	Coefficient Estimate	p-value	t-statistic (136)	Standard error
	Constant		-7.960	0.009	2.991	-2.661
Financial Distress	Interest Cover	-	0.130	0.117	1.577	0.082
	Firm Size	?	0.463	0.002	3.081	0.150
	Leverage	+	-1.012	0.108	-1.618	0.625
Investment Opportunities	Earnings-price ratio	-	-1.872	0.330	-0.978	1.914
	Book-to-market ratio	-	0.947	0.139	1.489	0.636
	Capital investment	+	-0.707	0.386	-0.869	0.814
Availability of Internal Funds	Quick Ratio	-	-0.553	0.161	-1.410	0.392
	Asset Growth	+	0.019	0.781	0.278	0.068
Risk Aversion	Directors' share ownership	+	0.052	0.066	1.851	0.028

Logit regression estimates of the relationship between the likelihood of a firm which manage risk and the variables listed below are shown in Table XI.4. The p-value, t-statistic and standard error associated with each estimate are included.

Firm size is measured by the log of the market value of the corporation on balance sheet date. Interest cover is denoted by the log of earnings before interest and tax divided by the interest expense. The debt ratio, defined as the book value of debt over the market value of the firm, measures the degree of leverage. Outlier problems that arise because firm's have small earnings are avoided by the inversion of the price earnings ratio. The book to market ratio is the inverse of the standard market to book ratio. Capital investment is defined as the ratio of property, plant and equipment divided by firm size. Liquidity is measured by the quick ratio: current assets less inventory over current liabilities. Asset growth is the log of the current year's change in fixed assets plus depreciation divided by net income plus depreciation. Directors' share ownership is the log of the market value of ordinary shares held, directly and indirectly, by the company's directors.

The logit analysis yields two significant results: larger firms are more likely to undertake risk management, and the likelihood of a firm hedging increases with the size of the directors' ownership therein.

As with the univariate study, the variables concerned with the hypothesis of financial distress are found to be the most significant. However, these results are unexpected. The proposed positive relationship between risk management and leverage is not supported. Firms which manage risk are more likely to have a lower degree of leverage. This outcome is significant just beyond the 10% level (the p value is 0.108).

A similar discrepancy occurs with the interest cover ratio. Firms with higher interest cover ratios undertake risk management. However, the p-value is 0.117 and therefore, this relationship is not significant. Contrary to the results of the Mann Whitney U-test, a highly significant *positive* relationship (p-value of 0.002) between firm size and risk management, exists. Larger firms are more likely to undertake risk management. The theories which propose that larger firms experience scale and informational advantages in risk management and are thus more likely to hedge, are supported by this result. The literature which predicts a negative relationship because corporations attempt to lower the expected costs of bankruptcy through risk management, is not upheld by the findings of the logit analysis. The relationship between firm size and risk management is the most significant relationship found by the analysis.

A statistically significant relationship exists between the directors' share ownership and risk management (p-value of 0.066). The larger the level of the directors' investment in a company, the more likely that firm is to hedge. When the assumption of no principal-agent problems is lifted, the possibility of the managers having a risk averse profile is introduced. Risk averse managers prefer to reduce the risk to which they are exposed. Managers who have a large proportion of their personal wealth invested in the firm and whose wealth is therefore affected by changes in the value of the firm, can achieve this by reducing the variance of the firm's returns. Corporate risk management is asserted on the basis of managers' risk aversion. The relationship predicted by the literature is supported by the results of the logit analysis.

None of investment opportunities variables yield statistically significant logit estimators. Although the hypothesised negative relationship of the earnings-price ratio with risk management holds (p-value of 0.33), the direction of the book-to-market ratio is positive (p-value of 0.139). With a p-value of 0.386, the capital investment

ratio is not significant. The availability of internally generated funds, as measured by the quick and asset growth ratios does not impact on firms' decision to manage risk. Neither result is statistically significant (the p-value relating to the quick ratio is 0.161 and that relating to the asset growth ratio is 0.781). These results imply that the theories justifying risk management on the basis of costly external financing affecting investment activity are not strongly supported.

The fact that only two statistically significant results are found is expected given that a number of the variables are correlated. The Pearson correlation coefficients are reported in Table XI.3. Of the 45 reported, 15 are statistically different from zero. This suggests that multicollinearity is present in the data.

The logit analysis suggests that larger firms hedge and that the directors of the firms that hedge own a larger proportion of the company. These two variables are significant determinants of corporate risk management activities. The hypothesis that the costs of financial distress are reduced by risk management is not supported by the results of the logit analysis. The predictions of financial theory in respect of capital market imperfections are not representative of the characteristics of firms listed on the industrial sector of the Johannesburg Stock Exchange.

### **C. COMPARISON WITH INTERNATIONAL STUDIES AND AREAS FOR FUTURE RESEARCH**

A comparison of the results of the few empirical studies is useful as it highlights which hypotheses are supported by real world data. The studies are performed in different countries across a range of firms.

The most significant relationship in the research presented here, that firm size is positively related to hedging, is also found by Nance, Smith, and Smithson (1993) and Berkman and Bradbury (1996). Directors' share ownership, which tests the risk aversion hypothesis, is found to have a notable positive relationship with risk management in this study, as well as Berkman and Bradbury (1996) and Tufano (1996b). The theory, which posits that risk management is undertaken to reduce the costs of financial distress, is supported by the results of the univariate study in this research, Géczy, Minton, and Schrand (1996) and Berkman and Bradbury (1996). The capital market imperfections hypothesis has found mixed support in the various studies. Nance, Smith, and Smithson (1993) and Géczy, Minton, and Schrand (1996) find that the research and development variable is significant. The quick variable is also noted in Géczy *et al.* Berkman and Bradbury (1996), however, observe a relationship between the earnings-price ratio and hedging. There is no evidence to substantiate the capital market imperfections theory in this study. Further research should be conducted into the risk aversity and scale advantages hypotheses as these have the most empirical support.

Interestingly, the findings of this research and those of Berkman and Bradbury (1996) are similar. Firm size is the variable which yields the most significant result and in both cases it is positive with a p-value of 0.002. Directors' share ownership is significant just beyond the 10% level in Berkman and Bradbury and is significant in this research. Interest cover, which is significant in the New Zealand research is, however, not significant in South Africa. In both papers, the asset growth variable exhibits the weakest relationship with risk management.

### XIII. CONCLUSION

This paper analysed the determinants of corporate risk management activity and presents exploratory research on this subject in a South African context. Traditional financial theory based on the Modigliani-Miller indifference paradigm suggests that under certain assumptions, a firm's financial policy is irrelevant, *i.e.* it has no impact on firm valuation. Corporate risk management, as a major aspect of overall financial policy, is therefore also irrelevant. However, this conclusion is contradicted by observation of company practices. The use of derivatives, particularly for hedging, is widespread.

The apparent conflict between the predictions of financial theory and what is observed in practice has recently begun receiving attention from international financial researchers. A number of hypotheses which attempt to explain why risk management takes place at a corporate level have been presented. In order to evaluate the strength of the underlying theory, this paper began with a formalised process of identifying the assumptions underlying the various hypotheses. The assumptions discussed were those at the core of the indifference framework: all markets are perfectly competitive and efficient; information is perfect and costless; transactions costs are zero; no taxes exist; all individuals undertake maximising behaviour; the objective of the firm is to maximise shareholder value; no principal-agent problems exist; risk neutrality; and the firm faces a fixed investment schedule.

The hypotheses which attempt to justify the relevance of corporate risk management were derived by relaxing one or more of these basic assumptions. The theories discussed in the existing literature were classified according to which assumptions were altered. Relaxation of various sets of assumptions yielded situations

where corporate risk management may increase firm or shareholder value. These situations were created by capital market imperfections, informational asymmetries, convexity of the tax schedule, principal-agent problems, including shareholder-manager and shareholder-debtholder conflicts, and risk averse participants. A limited number of empirical tests of these postulates have been performed. Four of the more significant international studies were discussed in the paper. The results are varied, and each shows support for different hypotheses.

For the first time an empirical investigation into the determinants of corporate risk management in a South African context was conducted. The most important result of the univariate analysis indicated that companies undertake risk management to reduce the expected costs of financial distress. There was a highly significant negative relationship between firm size and risk management, suggesting that the reduction in expected bankruptcy costs, due to hedging, is greater for the small firm given that bankruptcy costs are less than proportional to firm size. An alternative hypothesis that is upheld by the result is that if information asymmetries exist, the relationship between firm size and risk management is negative.

The logit regression analysis yielded a highly significant overall result, which suggests that risk management practices are related to company and managerial characteristics. Two variables, director's share ownership and firm size, were significant. Larger firms undertake more risk management. This result is consistent with the hypothesis that firms experience scale and informational advantages in risk management. The univariate analysis found contradictory evidence of a negative relationship between firm size and risk management. However, the logit regression is a more reliable indicator of the relationship between variables as it controls for the other variables included in the study. The larger the level of the directors' investment in a

company, the more likely that firm is to hedge. Corporate risk management is asserted on the basis of managerial risk aversion.

Given that the investigation into this subject is in its infancy, there are several areas for future research. Subsequent work might increase the power of the test by using a continuous measure of risk management activity. ED107 'Financial instruments: Disclosure and Presentation' was released in September 1996. This statement requires the disclosure of information about the extent and nature of financial instruments utilised by a company. These disclosures are more onerous than AC112, and would facilitate the use of a 'fair value' variable such as that employed by Berkman and Bradbury (1996). The subject of information asymmetries is receiving increasing attention in the economic sciences. The theories developed should be investigated and, if relevant, adapted to increase the understanding of corporate risk management.

An additional area for further research is the South African gold mining industry. An analysis similar to that performed by Tufano (1996b) could be conducted. Given the current disclosures made by the South African mining industry, it may not be possible to reconstruct Tufano's portfolio delta percentage. However, this may be possible in the future as the South African standards for disclosure are brought in line with international norms.

Corporate risk management is likely to become increasingly prevalent as the sophistication of the tools to manage risk develop and the level of education about the subject grows. The reasons for hedging at a company level is an area that has only recently begun receiving attention from financial academics. Further research must be undertaken to increase the understanding of the determinants of corporate risk management.

*... finance theory has had ...less clear cut guidance to offer on the logically prior question of hedging strategy: What sort of risks should be hedged? Should they be hedged partially or fully? ... It is not that there are no stories to explain why firms might wish to hedge. ... However, it seems fair to say that there is not yet a single, accepted framework which can be used to guide hedging strategies. (Froot, Scharfstein and Stein: 1993: 1629 - 1630)*

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## APPENDICES

### APPENDIX 1. DATA SOURCE

#### A. DEPENDANT VARIABLE

Variable	Data used to determine variable	Source
1 (the firm hedges) or 0 (the firm does not hedge)	Foreign Currency Note to Financial Statements	AFS

#### B. INDEPENDENT VARIABLES

Hypothesis	Variable	Data description	Data used to calculate variables	McGregor's # (from 'financials')
Financial Distress	Interest Cover	Log of income before interest and tax divided by the interest expense	Operating income Interest paid	63 66
		Firm Size	Log of the market value of the firm	Number of shares Share price at year end

<b>Hypothesis</b>	<b>Variable</b>	<b>Data description</b>	<b>Data used to calculate variables</b>	<b>McGregor's # (from 'financials')</b>
	Leverage	Book value of debt over the market value of the firm.	Book value debt Firm Size	16 Calculated above
Investment Opportunities	Earnings Price ratio	Inverse of the price earnings ratio	Price Earnings ratio	McGregor's section on ratios
	Book - Market ratio	Inverse of the market to book ratio	Capital employed Firm size	21 Calculated above
	Capital investment	Ratio of fixed assets to firm size	Fixed assets Firm Size	23 Calculated above
Availability of Internal Funds	Quick Ratio	Current assets less inventory divided by current liabilities	Current assets Current liabilities Inventories	34 41 35

<b>Hypothesis</b>	<b>Variable</b>	<b>Data description</b>	<b>Data used to calculate variables</b>	<b>McGregor's # (from 'financials')</b>
	Asset Growth	Current years' change in	Fixed assets - current year	23
		fixed assets plus	Fixed assets - prior year	23
		depreciation divided by	Depreciation	104
		net income plus depreciation	Net income	81
Risk Aversion	Directors' share ownership	Log of the market value	# shares held by directors	AFS
		of shares held by directors	Share price at year end	107

**NOTE:**

AFS = Annual Financial Statements

**APPENDIX 2. DATA**

Firm	Risk Management	Interest cover	Firm size	Leverage	Earnings-price ratio	Book-to-Market ratio	Asset Growth	Capital ratio	Quick ratio	Directors' share ownership
1	0	2.015	17.606	0.000	0.130	1.315	-1.497	0.319	3.465	17.376
2	0	3.984	18.873	0.004	0.749	1.358	-0.019	0.816	2.216	16.741
3	1	1.371	20.778	0.132	0.088	0.826	-0.050	0.638	0.587	14.959
4	1	1.598	20.830	0.171	0.063	0.795	0.122	0.437	1.586	10.692
5	0	2.082	20.739	0.064	0.098	0.775	-0.653	0.545	0.849	11.939
6	0	0.267	20.269	0.041	0.001	0.092	1.465	0.071	0.906	-9.210
7	0	1.154	18.846	0.071	0.130	0.727	-0.164	0.519	0.515	-9.210
8	0	1.084	17.351	0.298	0.120	2.183	-0.059	1.978	0.942	10.556
9	0	3.134	19.841	0.015	0.091	0.309	-0.834	0.214	0.579	15.965
10	1	-11.243	20.340	0.275	-0.235	0.992	10.282	1.345	0.255	19.614
11	1	5.085	20.010	0.003	0.100	0.432	-1.306	0.166	2.083	-9.210
12	1	12.990	22.431	0.003	0.061	0.500	-2.348	0.319	1.451	18.008
13	1	0.681	19.738	0.643	0.113	1.774	-11.513	0.131	2.766	13.941
14	1	2.598	20.611	0.018	0.067	0.595	-0.659	0.203	1.270	15.558
15	1	1.210	21.621	0.212	0.061	0.689	-1.607	0.043	2.875	19.022
16	1	1.440	17.841	0.471	0.056	0.511	1.482	0.248	0.911	16.988
17	0	1.701	19.791	0.057	0.082	0.433	-1.374	0.044	1.667	6.194
18	1	3.945	19.410	0.000	0.218	2.119	-0.772	1.022	1.644	14.699
19	1	-0.131	16.352	0.180	-0.025	0.704	7.028	0.333	0.690	15.840
20	1	2.192	19.693	0.028	0.124	0.746	-0.777	0.412	0.692	17.788
21	1	1.566	20.987	0.203	0.149	1.471	-0.389	0.719	0.465	20.332
22	0	0.307	15.703	0.540	0.135	2.041	-0.224	1.213	0.268	15.101
23	0	0.307	15.703	0.540	0.110	1.978	-0.061	1.213	0.268	15.101
24	1	3.439	17.437	0.014	0.105	0.421	-1.441	0.122	2.207	16.733
25	1	1.450	18.286	0.171	0.067	0.459	0.883	0.384	1.232	17.593
26	1	2.810	18.593	0.003	0.122	0.735	-0.622	0.340	0.707	13.261
27	1	1.456	21.741	0.194	0.083	0.571	-0.189	0.407	0.721	16.698
28	1	1.651	19.247	0.028	0.058	0.353	-0.376	0.222	1.334	15.022
29	1	1.866	21.273	0.050	0.070	0.501	-0.259	0.327	0.766	18.466
30	1	0.839	16.514	0.172	0.111	0.971	0.338	0.549	0.954	16.213
31	1	12.148	21.454	0.000	0.064	0.229	-1.890	0.102	1.387	16.846
32	1	1.174	18.944	0.010	0.040	0.256	-0.920	0.029	1.049	9.895
33	1	12.124	21.717	0.003	0.053	0.250	-2.629	0.039	2.988	21.190
34	0	1.880	19.309	0.076	0.073	0.612	-0.344	0.394	1.792	19.061
35	1	1.299	23.109	0.665	0.084	1.419	-0.445	1.238	0.921	17.971
36	1	2.131	21.391	0.085	0.066	0.453	12.106	0.245	0.869	16.830
37	0	0.780	16.617	0.555	0.131	1.762	-1.123	0.673	0.991	16.222
38	0	2.444	20.518	0.106	0.072	0.462	-0.391	0.347	0.847	-9.210
39	1	2.351	17.966	0.027	0.109	0.599	-0.373	0.344	1.092	17.025
40	1	1.600	17.686	0.053	0.061	0.553	-0.919	0.223	1.996	11.877
41	1	4.089	20.458	0.005	0.078	0.232	-0.924	0.049	0.899	13.805
42	1	2.614	20.532	0.099	0.211	0.700	-0.256	0.402	1.402	10.583
43	1	4.316	21.545	0.328	0.089	1.171	0.492	0.997	0.603	-9.210
44	1	1.551	22.820	0.112	0.076	1.275	-0.105	0.864	1.060	16.510
45	1	1.973	19.718	0.042	0.076	0.347	-0.023	0.164	0.456	17.953

Firm	Risk Management	Interest cover	Firm size	Leverage	Earnings-price ratio	Book-to-Market ratio	Asset Growth	Capital ratio	Quick ratio	Directors' share ownership
46	1	7.436	18.334	0.072	0.020	0.721	0.441	0.548	0.212	16.088
47	0	-6.767	17.605	0.199	0.031	0.720	-11.513	0.414	0.599	16.443
48	1	2.953	16.182	0.091	0.053	0.675	-2.470	0.063	1.662	13.354
49	1	3.798	18.875	0.000	0.083	0.522	-1.454	0.341	0.350	14.452
50	1	0.790	18.317	0.012	0.154	0.832	-1.734	0.113	0.831	15.046
51	1	1.383	19.636	0.043	0.080	0.594	-0.445	0.109	1.523	18.914
52	1	1.326	21.464	0.037	0.058	0.381	-0.187	0.109	0.397	19.540
53	1	2.644	22.530	0.019	0.058	0.327	-0.370	0.202	0.739	18.083
54	1	1.431	21.530	0.195	0.082	0.670	-1.855	0.093	0.695	12.320
55	1	2.283	20.397	0.001	0.061	0.460	-0.530	0.091	0.940	18.208
56	0	1.083	20.915	0.114	0.047	0.509	0.731	0.208	1.113	15.328
57	1	1.185	17.959	0.237	0.123	1.595	0.519	1.593	0.907	17.527
58	1	9.597	18.594	0.172	0.097	2.067	1.216	2.062	0.574	16.556
59	0	0.804	16.929	0.324	0.067	0.650	0.599	0.583	0.278	10.965
60	1	4.324	21.398	0.003	0.061	0.342	-0.250	0.189	1.209	13.922
61	0	1.418	20.585	0.134	0.039	0.310	-0.680	0.224	1.089	19.220
62	1	4.644	20.422	0.006	0.070	0.232	-1.348	0.187	0.841	16.072
63	0	0.618	19.335	0.173	0.020	1.018	1.514	1.044	0.248	18.167
64	0	1.668	18.914	0.148	0.013	0.965	0.138	0.380	2.183	17.774
65	1	2.120	21.671	0.033	0.036	0.670	0.421	0.102	1.226	14.719
66	1	1.592	24.343	0.065	0.045	0.294	-0.225	0.227	0.697	19.043
67	0	7.058	19.310	0.011	0.063	0.108	-2.102	0.025	1.467	17.997
68	1	4.118	20.932	0.019	0.082	0.702	-0.173	0.378	0.816	13.919
69	0	2.711	21.355	0.018	0.058	0.549	-3.060	0.096	0.930	19.583
70	1	-9.874	19.562	0.081	-0.156	0.472	2.108	0.090	0.505	16.690
71	1	2.260	22.042	0.000	0.092	1.050	-1.016	0.741	0.869	12.673
72	1	3.649	20.240	0.154	0.377	3.098	-0.077	2.381	1.030	15.337
73	0	-2.747	18.161	0.043	-0.111	0.375	9.745	0.460	0.468	10.938
74	1	0.469	20.046	-0.015	0.031	0.442	1.169	0.190	0.622	15.648
75	1	6.256	18.333	0.031	0.160	1.071	0.244	0.943	0.994	17.941
76	1	1.868	19.451	0.054	0.103	0.578	-0.316	0.237	0.530	14.996
77	1	1.240	19.800	0.046	0.090	1.151	-0.203	0.800	0.765	8.243
78	1	1.416	20.342	0.010	0.070	0.416	0.203	0.424	0.606	-9.210
79	1	9.940	18.625	0.004	0.105	0.754	-0.426	0.522	1.039	11.495
80	1	6.303	18.935	0.000	0.110	0.181	-1.757	0.063	1.417	9.012
81	1	3.409	18.947	0.173	1.163	5.849	-0.630	4.391	1.089	12.396
82	1	-9.386	17.623	0.436	-0.240	1.648	10.086	1.269	0.294	16.853
83	1	0.649	20.128	0.362	0.100	1.112	-0.444	0.433	0.513	18.473
84	1	1.018	21.948	0.188	0.116	1.062	-0.124	0.727	0.554	11.333
85	1	2.138	20.123	0.012	0.079	0.364	-0.455	0.171	0.652	13.581
86	1	0.283	22.014	0.325	0.039	1.247	0.080	0.885	0.983	15.940
87	1	5.229	17.489	0.000	0.083	0.449	-0.868	0.126	2.261	14.862
88	1	0.643	20.497	0.060	0.079	0.496	-0.311	0.298	0.635	13.120
89	1	1.596	22.177	0.087	0.083	0.335	-0.154	0.281	0.692	12.177
90	1	2.591	24.057	0.073	0.088	0.518	-0.654	0.412	1.325	16.063
91	1	0.776	21.624	0.295	0.103	1.176	0.588	0.620	0.862	16.414
92	1	1.971	15.774	0.287	0.260	1.533	0.511	0.709	1.179	15.522

Firm	Risk Management	Interest cover	Firm size	Leverage	Earnings-price ratio	Book-to-Market ratio	Asset Growth	Capital ratio	Quick ratio	Directors' share ownership
93	1	2.219	17.560	0.060	0.178	0.823	-1.231	0.281	1.166	10.977
94	0	1.621	17.504	0.009	0.141	2.009	-1.301	0.673	1.443	16.217
95	0	0.197	14.557	1.790	0.104	5.092	0.836	2.075	0.634	11.889
96	0	0.000	18.435	0.017	-0.022	0.258	8.896	0.072	3.070	15.288
97	1	1.751	19.483	0.076	0.132	0.917	-0.767	0.291	1.417	15.607
98	1	5.470	19.213	0.000	0.162	3.071	-0.360	1.811	1.407	15.399
99	1	3.820	18.846	0.000	0.193	1.726	-0.832	0.610	1.826	-9.210
100	1	5.466	18.939	0.000	0.163	4.110	-0.135	2.383	1.500	18.104
101	1	1.013	17.008	0.353	0.256	2.131	0.543	1.643	0.636	16.063
102	1	1.711	17.787	0.177	0.202	1.868	-0.215	0.638	1.129	17.270
103	1	1.114	16.013	0.174	0.258	1.583	-1.037	0.438	0.797	15.469
104	0	3.738	15.540	0.000	-0.001	1.044	-11.513	0.000	49.255	-9.210
105	1	4.314	18.733	0.002	0.077	0.893	-0.847	0.141	2.221	18.130
106	1	10.422	19.293	0.000	0.127	1.059	-11.513	0.548	1.216	12.486
107	1	1.737	18.318	0.181	0.136	1.159	-0.218	0.614	0.891	17.011
108	1	1.493	18.951	4.372	0.271	6.685	1.608	3.358	1.077	17.442
109	1	0.058	15.576	0.147	0.023	2.231	0.492	0.307	0.917	13.672
110	1	1.294	15.339	1.001	0.478	4.983	-1.112	2.164	0.930	14.571
111	1	11.494	20.690	0.001	0.005	0.673	-0.590	0.143	1.183	-9.210
112	1	0.672	18.731	0.001	0.017	0.345	-2.266	0.147	1.669	11.276
113	1	1.024	18.592	0.011	0.032	0.384	-0.876	0.052	0.944	13.476
114	1	0.742	19.100	0.056	0.012	0.204	0.565	0.032	0.969	18.356
115	1	2.884	20.255	0.008	0.062	0.305	-1.385	0.114	1.056	15.786
116	1	-8.217	17.329	0.129	-0.651	0.945	-11.513	0.823	0.594	16.652
117	1	2.450	20.591	0.000	0.062	0.216	-1.655	0.031	0.755	13.658
118	1	2.531	20.493	0.027	0.174	1.355	-1.888	0.082	1.132	13.137
119	1	2.102	21.354	0.004	0.054	0.096	-0.908	0.041	0.917	15.828
120	1	9.325	18.794	0.000	0.054	0.136	-0.968	0.075	1.038	17.552
121	1	4.147	16.707	-0.000	0.172	0.922	-1.831	0.389	1.913	16.666
122	1	1.035	18.654	0.079	0.043	0.339	-0.057	0.137	0.883	18.107
123	1	-7.812	17.693	0.648	-0.121	0.577	5.808	0.046	0.762	14.740
124	1	1.489	21.870	0.000	0.025	0.137	-1.529	0.010	0.725	20.446
125	1	1.642	20.906	0.003	0.043	0.270	0.400	0.087	0.846	16.814
126	1	1.586	21.182	0.001	0.038	0.356	-0.886	0.158	0.780	13.365
127	1	2.460	22.097	0.006	0.051	0.257	-0.574	0.121	0.690	16.224
128	1	2.843	20.970	0.003	0.169	0.745	-3.997	0.019	1.102	15.608
129	1	0.337	17.922	0.039	0.102	0.776	-2.097	0.138	1.122	17.101
130	1	2.171	19.275	0.001	0.134	0.214	-2.333	0.092	1.052	-9.210
131	1	2.019	20.956	0.168	0.073	0.628	-1.385	0.209	1.360	18.319
132	1	1.495	22.036	0.054	0.041	0.322	-0.162	0.323	0.619	17.395
133	1	1.052	19.666	0.192	0.073	0.731	-1.069	0.225	0.717	19.326
134	1	0.107	19.872	0.029	0.089	1.471	-11.513	0.038	1.283	18.563
135	1	1.168	17.489	0.008	0.133	2.168	-0.781	1.363	0.790	11.005
136	1	6.844	19.205	0.001	0.085	0.413	-0.199	0.201	1.413	-9.210
137	0	0.657	16.173	0.060	0.093	2.239	-2.083	0.597	0.819	16.062

<b>Firm</b>	<b>Risk Management</b>	<b>Interest cover</b>	<b>Firm size</b>	<b>Leverage</b>	<b>Earnings-price ratio</b>	<b>Book-to-Market ratio</b>	<b>Asset Growth</b>	<b>Capital ratio</b>	<b>Quick ratio</b>	<b>Directors' share ownership</b>
138	1	1.094	19.451	0.005	0.015	0.818	-0.250	0.192	0.823	18.630
139	1	1.584	20.199	0.013	0.120	1.220	-0.852	0.684	0.951	14.530
140	1	2.072	20.456	0.035	0.065	0.351	-1.282	0.077	0.902	17.701
141	0	0.650	15.624	4.900	0.230	6.259	-11.513	1.436	1.286	13.504
142	0	1.254	19.626	0.065	0.073	0.455	-0.058	0.151	2.133	-9.210
143	1	2.025	17.464	0.246	0.136	0.582	-0.329	0.293	1.181	16.829
144	0	1.378	17.702	0.099	0.115	0.509	-1.074	0.420	0.791	17.015
145	0	5.194	17.034	0.087	0.160	0.955	-0.621	0.373	1.254	16.396
146	1	9.905	18.054	0.034	0.154	0.778	-0.706	0.898	0.476	16.978

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