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Essays on corporate risk management and optimal hedging

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Document Version

Publisher's PDF, also known as Version of record

Publication date:

2006

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Oosterhof, C. M. (2006). *Essays on corporate risk management and optimal hedging*. s.n.

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Chapter 2

AN OVERVIEW OF THE LITERATURE ON CORPORATE RISK MANAGEMENT*

2.1 INTRODUCTION: MOTIVES FOR CORPORATE RISK MANAGEMENT

Financial risk analysis and corporate risk management are important activities within financial as well as non-financial corporations. Firms are exposed to different sources of business and financial risks (risk exposures), which can affect the value of the firm. Business risks relate to the firm's investments as well as its investment opportunities, whereas financial risks relate to the way these investments are funded. As introduced in Chapter 1, corporate risk management is defined as the process of trying to influence the effect of these risk exposures on firm value. Managing risk can come in two forms: hedging a risk exposure is the process of trying to reduce the dependence of firm value on this risk exposure, whereas speculation means increasing the dependence on a risk exposure. In this chapter, we will review the literature on the use of derivative securities to alter different risk exposures of a firm, like exposures from exchange rate risk, interest rate risk, or commodity price risk.^{15,16} A study by

* An earlier version of this chapter has been published under the same title as a *SOM Research Report* in 2001.

¹⁵ Overall derivatives usage has increased tremendously in recent years. Data obtained from the Bank for International Settlements show that the outstanding amount of OTC-derivatives has increased with 70% from June 2001 till June 2003. The total notional amount outstanding approximately equals \$ 170 trillion in 2003.

¹⁶ As argued in Chapter 1, the focus of this chapter is on non-financial corporations. Financial institutions are both users and providers of financial derivatives and could, therefore, face other factors affecting its risk management strategy. For an analysis on the relationship between

Rawls and Smithson (1990) shows that financial executives rank corporate risk management as one of their most important objectives, just behind minimizing borrowing costs and maintaining or improving the firm's credit rating. As this chapter shows, these three objectives are linked.

Despite the growing popularity of corporate risk management, there is a broad discussion within the academic literature with respect to the possible contribution of corporate risk management to shareholder value. Under the assumptions of the seminal work by Modigliani and Miller (1958), in which they assume a perfect capital market, financial decisions have no impact on the value of a firm. Firm value is created by making profitable investments and the way these investments are financed (i.e., by issuing debt or equity) is completely irrelevant. The financing policy only defines the way in which value is distributed among the different claimants.

Central in the Modigliani-Miller framework is the idea that some well-defined assumptions hold. Given perfect capital markets without information asymmetries, absence of taxes (or – alternatively – absence of discriminatory corporate and personal taxes) as well as non-existence of transaction costs, individual investors are always able to perfectly replicate the financial decisions made by the firm (in the case of Modigliani and Miller (1958): the firm's debt/equity decisions). This causes the financial decisions undertaken at the firm level to be completely irrelevant, since individual investors can achieve the same profile by replication, so-called home-made leverage. These irrelevance propositions can be extended to all financing decisions,

corporate risk management and firm value for financial institutions, see e.g., Allen and Santomero (1998).

like a firm's dividend or risk management policy.¹⁷ Given the same underlying stringent assumptions, then, based on arbitrage arguments, there is no use for corporate risk management in the idealized Modigliani-Miller world. If shareholders want to alter their personal exposure towards certain risks, they can do it on their own, since all financial claims can be replicated perfectly by other financial instruments. Individual investors can therefore achieve the same risk-return profile by so-called home-made hedging.

Within the field of corporate finance, it has been recognized from the beginning that the assumptions of the idealized Modigliani-Miller framework are not met in practice. Over the last three decades, many papers have been written about possible motives for risk management practices to be undertaken at the firm level. The rationale behind the existence of corporate risk management is, in the first place, that it adds value to the firm in ways shareholders cannot achieve on their own. If capital markets are perfect in the sense of Fama and Miller (1972, p 177), in which 1) there are no transactions costs, 2) there is equal access to financial opportunities by firms and individuals, and 3) investors perceive that there are always [perfect – CMO] substitutes for any securities of a firm, then individual investors can always replicate the financial decisions undertaken by the firm. Any failure of the critical “equal access assumption” can lead to a preference for risk management at the firm level over risk management by individuals, implying that the rationale for corporate risk management can be motivated by market imperfections. Relaxing the assumptions made by Modigliani and Miller, therefore, leads to the possible motives for the

¹⁷ See e.g., Miller and Modigliani (1961) on the irrelevance of a firm's dividend policy.

existence of derivatives within corporate risk management programs since, given these relaxations, individuals cannot replicate the firm's financial decisions. For instance, Mayers and Smith (1982), Smith and Stulz (1985), Smith (1995), and Stulz (1996) show that hedging can increase firm value for three reasons: 1) hedging may add value in case a firm faces a progressive tax rate, 2) hedging may be beneficial when there are expected costs from financial distress, and 3) hedging can effectively mitigate agency problems. These three motives can all be seen in the framework of shareholder value maximization. This implies that, when the underlying market frictions exist, hedging may be a value-increasing strategy for a corporation. As will be shown in this chapter, individual investors cannot achieve these cost reductions themselves leading to a rational reason for risk management to be undertaken at the firm level. A fourth motive for the existence of corporate risk management is of a somewhat different category. Among others, Smith and Stulz (1985), Stulz (1996), Tufano (1996), and Hentschel and Kothari (2001) argue that the risk attitude of managers may also explain the use of derivatives within the risk management program of a firm, if a manager's personal wealth depends on firm value. As will be shown in this chapter, when managerial expected utility is a concave function of firm value, managers will be inclined to reduce financial risks by hedging if their future wealth is a linear function of firm value. However, if a manager's future wealth is a convex function of firm value (e.g., when he is rewarded with call options on future firm value), this manager may be inclined to relatively higher risk-taking behavior (less hedging), because a larger volatility of the value of a firm increases his personal wealth.

The value of a firm can be influenced by, for instance, changes in exchange rates, interest rates, or commodity prices. Therefore, a corporate risk manager must understand how the overall risk exposure of a firm is related to the different types of manageable risks. It is very important that the exposures are quantified correctly, otherwise the hedge will lead to an inappropriate result.¹⁸ After the exposures are quantified, the possible hedging instruments must be chosen. In order to hedge the different kinds of risk, firms can rely on a number of derivative instruments like, for instance, forwards, futures, swaps, over-the-counter options, exchange-traded options, structured derivatives, and hybrid debt. As Smith, Smithson, and Wilford (1990) show, these so-called building blocks can be combined to construct any desired position which implies that, in theory, any risk exposure can be managed. However, this is only possible under perfect capital markets with rational agents, which is, in practice, not the case. So, in “the real world” it will be impossible to perfectly hedge every exposure. Nevertheless, as this chapter will show, the motives for corporate risk management still hold.

The purpose of this chapter is to give a critical review of the theoretical motives and determinants for the use of derivative instruments by non-financial corporations. Furthermore, we discuss the empirical findings regarding some important studies. The findings of this chapter will help to determine whether the theoretical motives are indeed observed in practice. The remainder of this chapter is organized as follows. In Section 2.2 it is shown that hedging can increase firm value if firms face a progressive

¹⁸ See Stulz and Williamson (1997) for an analysis of the identification and quantification of risk exposures.

tax function. Section 2.3 relates to the benefits of hedging in situations of expected costs of financial distress. In addition, Section 2.4 deals with the motive that the corporate use of derivatives can be used to mitigate suboptimal investment policies. The possibility that the risk attitude of managers may explain the use of derivatives in the risk management policy of a firm is analyzed in Section 2.5, after which Section 2.6 contains an overview of some important empirical evidence on corporate risk management. Section 2.7, finally, concludes with a summary.

2.2 FIRST MOTIVE: REDUCTION OF EXPECTED TAXES

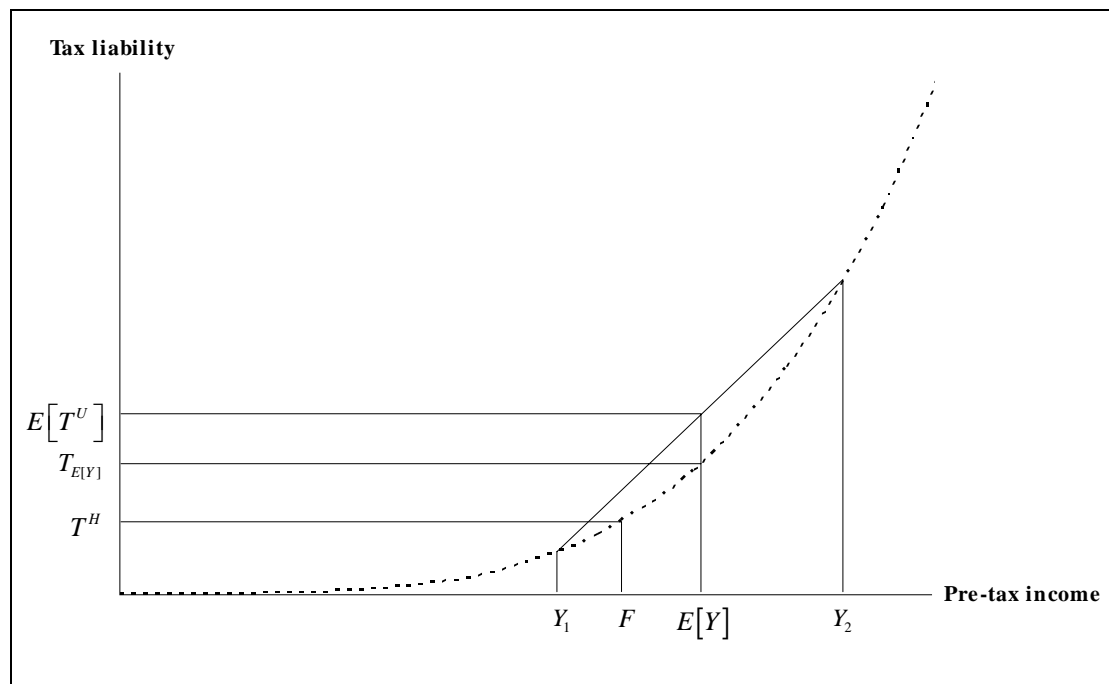
2.2.1 Theory

Among many others, Mayers and Smith (1982), Smith and Stulz (1985), Rawls and Smithson (1990), and Stulz (1996) argue that hedging pre-tax income can increase firm value. The line of reasoning is that this will only happen if the firm under consideration is liable to a progressive effective marginal tax rate (implying a convex tax function).¹⁹ The remainder of this section will show that, from the viewpoint of value maximization, hedging can reduce the firm's expected tax liability by decreasing the volatility of its pre-tax income. As a consequence, lowering the expected tax payments increases the present value of the firm.

¹⁹ Another tax motive for hedging (at the investor's level) may lie in discrepancies between personal and corporate tax levels (See e.g., Farrar and Selwyn (1967) and Brennan (1970) for an analysis on the relevance of a firm's dividend policy). In this section, however, we focus on the value-enhancing possibilities of hedging at the level of the firm and abstract from the individual investor who may attempt to maximize his income after taxes.

To illustrate the possible benefits of hedging earnings before taxes, we follow Smith and Stulz (1985), and assume a highly stylized one-period model in which there are only two possible future states of the world. The firm's pre-tax income in these two states of the world is given by either Y_1 or Y_2 . Furthermore, for now assume that the firm is an all-equity financed firm.²⁰ The tax-consequences of hedging for the two possible states of the world are depicted in Figure 2.1. The possible states of the world are ordered from "bad" states to "good" states.

Figure 2.1: The effect of hedging on the expected tax payments



In Figure 2.1, Y_1 represents the firm's pre-tax income at time 1 if state 1 occurs, whereas Y_2 implies pre-tax income at time 1, given state 2. The expected income for

²⁰ If the firm is an all-equity financed firm, we can abstract from tax deductions from financing. Tax deductions complicate the analysis, but do not change the result of the advantages of hedging pre-tax income. See e.g., Smith and Stulz (1985).

the firm is given by $E[Y]$. The possible corporate tax liabilities are given by the convex dotted line, exhibiting a strictly progressive tax rate. Since the firm is obliged to pay corporate taxes, the expected time-1 tax liability, given the fact that the firm does not engage in a risk-management policy, is given by $E[T^U]$, which is the probability-weighted average of the taxes given state 1 and the taxes given state 2. Because the tax schedule is strictly convex the corporate tax amount regarding expected pre-tax income $T_{E[Y]} < E[T^U]$. The expected corporate taxes are therefore higher than the taxes regarding expected income.

Since the effective corporate tax payments, for the case that the firm does not hedge, are a strictly convex function of pre-tax income, the tax payments disproportionately increase in pre-tax earnings. Therefore, a higher volatility of pre-tax earnings implies higher expected tax payments. To explain this, consider the following situation. If the firm does not hedge, its expected tax liability equals $E[T^U]$, which is the probability-weighted average of the taxes in state 1 and state 2. In the standard literature of finance, the world is usually assumed to be risk-neutral, implying that the prices of derivative instruments are unbiased. Given the possibility of perfect hedging, the manager of a firm can make sure that pre-tax income is equal to $E[Y]$ since future income equals expected income given unbiasedness.²¹ As a consequence, the (certain) tax liability for this situation equals $T_{E[Y]}$. Because of the convexity of the tax schedule $T_{E[Y]} < E[T^U]$,²² and firm value increases by the present value of the savings on the tax payments. However, a more realistic view of the

²¹ Unbiasedness of the forward price occurs under risk-neutrality or if restrictions on the probability distribution are assumed. See Benninga and Oosterhof (2004); see also Chapter 3 of this dissertation.

²² This can easily be shown applying Jensen's inequality.

world makes this argument even stronger. If we assume a world of risk-aversion, future certainty-equivalent income will be less than the expected income, that is, $F < E[Y]$. If the firm can make sure that its future income equals F , the certain tax liability will be T^H , which is even less than under the assumption of unbiasedness.²³ Summarizing, by hedging the pre-tax income perfectly, firm value will increase by the present value of the reduction in the expected tax liability.

Suppose we now turn to a more realistic setting, in which more than two states of the world can occur. Within this setting, if the firm does not hedge, the present value of the expected tax payments $E[T^U]$ will be equal to $\sum_{j=1}^N q_j \cdot \tau_j \cdot Y_j$, in which

$\tilde{q} = \{q_1, q_2, \dots, q_N\}$ is a vector of Arrow-Debreu state prices regarding state j , with $j = \{1, 2, \dots, N\}$.²⁴ τ_j is a vector of corporate tax rates regarding pre-tax income in

state j . If the firm is able to create a perfect hedge (i.e., the forward price is unbiased and future income equals $E[Y]$), the present value of the tax payments T^H equals

$\sum_{j=1}^N q_j \cdot \tau_j \cdot \bar{Y}_j$, where \bar{Y}_j is a vector of (certain) income before taxes in case of a perfect

hedge. Since this hedge is perfect $\bar{Y}_j = \bar{Y}$ ²⁵ and, consequently,

$$T^H = \bar{Y} \cdot \bar{\tau} \cdot \sum_{j=1}^N q_j = \frac{\bar{\tau} \cdot \bar{Y}}{1 + r_f}, \text{ where } r_f = \frac{1}{\sum_{j=1}^N q_j} \text{ is defined as the risk-free rate of interest.}$$

Since $\bar{Y} = \left(\sum_{j=1}^N q_j \cdot Y_j \right) \cdot (1 + r_f)$, it follows that $\frac{\bar{\tau} \cdot \bar{Y}}{1 + r_f} = \bar{\tau} \cdot \sum_{j=1}^N q_j \cdot Y_j$. The difference

²³ Note that in the standard literature, unbiasedness goes along with risk-neutrality. In Chapter 3 of this dissertation, we will show that this assumption is too restrictive and, restricting the probability distribution, suffices for unbiasedness (see also Benninga and Oosterhof, 2004).

²⁴ The state price regarding state j , q_j , can be defined as “the price today, of receiving one currency of payoff in the future, if and only if state j occurs”. Thus, a state price can be seen as a risk-adjusted discount factor.

²⁵ Henceforth, a bar will be used to denote a non-random parameter.

between the value of a hedged and an unhedged firm therefore equals $\sum_{j=1}^N q_j \cdot \tau_j \cdot Y_j - \bar{\tau} \cdot \sum_{j=1}^N q_j \cdot Y_j$, which is positive.²⁶ This implies that, if hedging is perfect

and costless, firm value increases by the present value of the reduction in the expected taxes, i.e., $\sum_{j=1}^N q_j \cdot \tau_j \cdot Y_j - \bar{\tau} \cdot \sum_{j=1}^N q_j \cdot Y_j$. If hedging is not costless, the difference

between the value of a hedged and an unhedged firm will be the maximum amount shareholders are willing to pay for hedging. It should be noted that the hedge does not necessarily have to be perfect in order to increase firm value (i.e., if the hedge is less than perfect, firm value will also increase but less than for the case of a perfect hedge).²⁷ In this case, the present value of the expected tax liability equals $\sum_{j=1}^N q_j \cdot \tau_j \cdot \tilde{Y}_j$, in which \tilde{Y}_j is a vector of pre-tax incomes when the firm engages in an

imperfect hedge. Because hedging reduces uncertainty, \tilde{Y}_j is less volatile than Y_j and, as a consequence, the expected tax payments will be lower. Therefore, firm value increases by $\sum_{j=1}^N q_j \cdot \tau_j \cdot Y_j - \sum_{j=1}^N q_j \cdot \tau_j \cdot \tilde{Y}_j$. Thus, given the convexity of the tax

schedule and costless hedging, the expected value of the tax liabilities depends on the effectiveness of the hedge, and lies somewhere in between the perfect hedge and the no-hedge case.

Given the analysis above, it should be clear that hedging can raise firm value if it is possible to reduce the expected amount of tax liabilities. Then the next question might be: “How much should a firm hedge?”. The preceding analysis implies that, if

²⁶ This is implied by the definition of a concave function. See also footnote 22.

²⁷ In an imperfect hedge, cash flows are still uncertain, but they are less volatile than without hedging.

costless hedging is possible, firms facing a strictly convex tax schedule should hedge all the risk of pre-tax income. This is not necessarily the case when hedging is costly. If the present value of the expected tax reduction is larger than the costs of hedging, firms should also hedge all the risk of pre-tax income. If this is not the case, firms have to look at the marginal trade-off between the reduction in expected taxes and the costs of hedging. Of course, the optimal hedge ratio is calculated by the point where marginal benefits of hedging equal the marginal costs. Thus, if the use of derivatives is not costless, firms' hedge ratios should vary between zero and 100%.

2.2.2 Empirical implications

The possible advantages of hedging pre-tax income rely on a number of factors. First of all, the more convex the effective marginal tax schedule, the greater the possible benefits from hedging pre-tax earnings. The convexity of the tax schedule is extended by tax preference items such as investment tax credits, tax loss carrybacks, and tax loss carryforwards. Investment tax credits (ITC's) offset a stated maximum fraction of a corporation's tax liability. The major effect of ITC's is to shift the effective tax structure down to reflect the value of the tax credit. Tax loss carrybacks and tax loss forwards decrease the tax liability because profits in one year can be offset by losses in another year. This induces the marginal tax schedule to become convex over a larger region, which increases the potential benefits of hedging. Firms with more tax preference items are therefore more likely to hedge their pre-tax income. A second rationale for hedging is that the more volatile the pre-tax income stream, the greater the possible advantages of hedging. Finally, hedging pre-tax income is induced by the probability of encountering in the convex part of the tax schedule. Because small

firms are expected to have lower earnings before taxes, they are more likely to be in the progressive region of the tax schedule. As a consequence, small firms are more likely to hedge pre-tax income. Therefore, it is hypothesized that small firms with tax preference items and a relatively high volatility of income-before-taxes, can be expected to gain most from hedging pre-tax income.

With respect to the size of the firm, however, it can be argued that, if the expected gain from hedging pre-tax income depends on transaction costs, larger firms are expected to gain more from hedging because transaction costs usually exhibit economies of scale. Furthermore, and maybe even more important, larger firms are probably in a better position of bearing the costs of setting up a risk management program and contracting capable employees. In this case, larger firms can be expected to enter into hedging activities more often. Thus, theory cannot predict a clear relation between firm size and hedging activities. The empirical evidence on firm size is presented in Subsection 2.6.6.

2.3 SECOND MOTIVE: REDUCTION OF EXPECTED COSTS OF FINANCIAL DISTRESS

2.3.1 Theory

The second motive for hedging at the firm level relates to situations in which there are expected costs of financial distress. Among others, Mayers and Smith (1982), Smith and Stulz (1985), Froot, Scharfstein, and Stein (1993), and Nance, Smith, and Smithson (1993) show that hedging may increase firm value, given the possibility of financial distress with – more importantly – costs associated with financial distress.

According to Rawls and Smithson (1990), the expected costs of financial distress are driven by two factors: 1) the probability of encountering financial distress if the firm does not hedge, and 2) the costs imposed by a possible bankruptcy. These costs can be substantial, not only because of the direct costs of a bankruptcy (e.g., legal costs of lawyers) but especially because of the indirect costs. First of all, suppliers of the firm will offer less attractive payment conditions if a firm is engaged in financial problems. Secondly, signs of financial distress will lead to decreases in sales since this is an indication to customers that service and warranties may cease in the future (loss of reputation). Thirdly, (new) employees will demand higher salaries since they run the risk of losing their job and, therefore, future income.

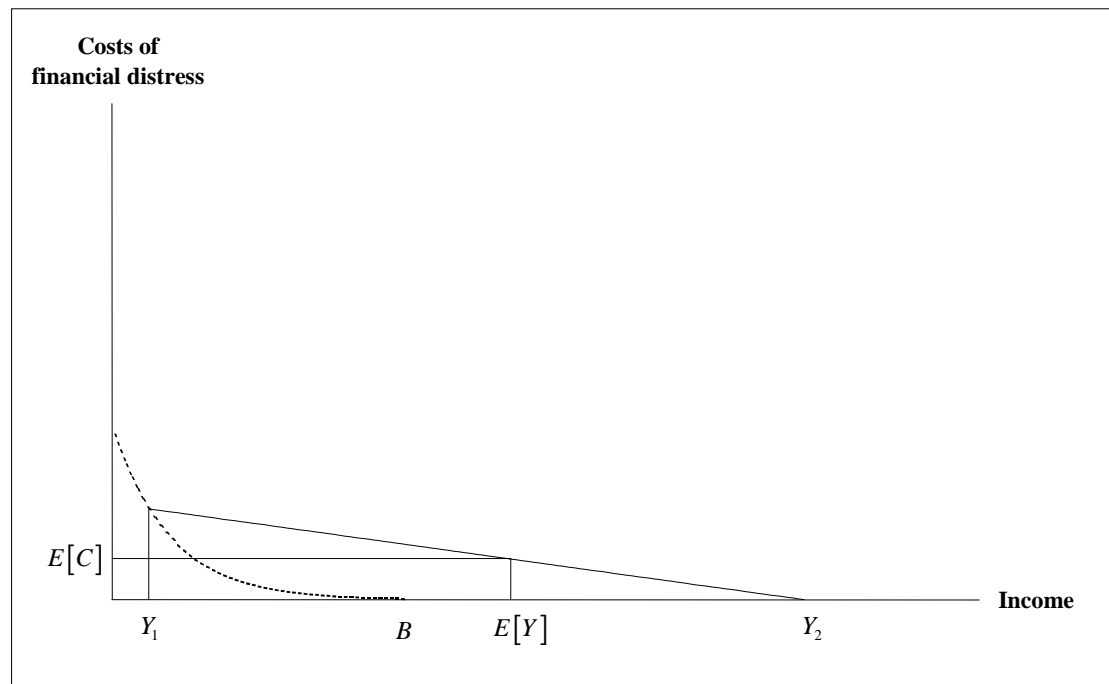
In order to analyze the value-enhancing effects of hedging with respect to a reduction in the expected costs of financial distress, we again follow Smith and Stulz (1985) and assume a one-period model in which there are two possible future states of the world. For simplicity, we abstract from corporate tax payments (i.e., we set $\tau_c = 0$).²⁸ Future income in the two states of the world is again given by Y_1 and Y_2 , in which income Y_j is assumed to be income before direct costs of financial distress.²⁹ The firm has issued a zero-coupon bond, with a principal equal to B . Furthermore, assume that this debt obligation matures at a single time 1. At time 1 all cash flows are paid to the different claimants. If income Y_j is below B , bankruptcy is declared, in which shareholders receive nothing whereas bondholders receive income minus the costs of

²⁸ If we would include taxes in the analysis it would complicate the analysis. However, the basic message will be the same. In fact, shareholder value would increase even further if the firm can, by decreasing the possibility of default, simultaneously increase its debt level. A higher level of debt increases the tax shield and thereby adds to shareholder value.

²⁹ So, the cash flow paid to the claimants will be lower in the case of financial distress, because costs of financial distress have to be paid first.

bankruptcy. If future income exceeds B , bondholders are fully repaid. Shareholders receive income minus the payment to the bondholders. Assume the states of the world are ordered such that $Y_1 < B < Y_2$, implying bankruptcy is declared if state 1 occurs. The consequences of hedging on the expected costs of financial distress are shown in Figure 2.2, in which the expected costs of financial distress are given by $E[C]$. The dotted line represents the (direct) costs of financial distress.

Figure 2.2: The effect of hedging on the expected costs of financial distress



If the firm decides not to hedge, current firm value V_0 equals $q_1 \cdot (Y_1 - C_1) + q_2 \cdot Y_2$, where q_j represents the state price regarding state j , with $j = \{1, 2\}$. As an alternative, given the possibility to engage in a perfect hedge in which future income is larger than the obligations to the bondholders, financial distress and – consequently – costs of

financial distress will be avoided. The necessary condition for not entering into financial distress is that the future income in all states of the world has to exceed the promised payment to the bondholders. Given costless and perfect hedging, firm value increases by the present value of the expected costs of financial distress, i.e., firm value increases to $\bar{V}_0 = V_0 + q_1 \cdot C_1$, where \bar{V}_0 is the current firm value in case of a perfect hedge.³⁰

If we, again, turn to a more general setting in which there are N states of the world, the present value of the expected costs of financial distress equals $\sum_{j=1}^M q_j \cdot C_j$, with M states of the world with associated costs of financial distress.³¹ If perfect

hedging can avoid bankruptcy, firm value will be equal to $\sum_{j=1}^N q_j \cdot (\bar{Y} - C_j) = \frac{\bar{Y} - C_j}{1 + r_f} = \sum_{j=1}^N q_j \cdot Y_j$, since $C_j = 0$ for all states of the world. This implies that firm value increases by $\sum_{j=1}^M q_j \cdot C_j$, which is the present value of the

expected costs of financial distress. If this perfect hedge cannot avoid bankruptcy, it may still be the best policy for the firm to hedge. As long as the present value of the costs of financial distress, $\sum_{j=1}^M q_j \cdot C_j$, is larger than its certain distress cost equivalent,

$\frac{\bar{C}}{1 + r_f}$, it will still be optimal for the firm to hedge, even though this will result in

bankruptcy.^{32, 33} The bondholders become the new owners of the firm, and some

³⁰ Note that if the firm does not hedge, there are also indirect costs of financial distress because of the current possibility of a bankruptcy. If hedging can avoid bankruptcy, the increase in firm value will be even larger since indirect costs of financial distress will also be avoided. For instance, lower contracting costs and higher sales will increase future income and, thereby, firm value.

³¹ Note that state $1 < M < N$. So, $\sum_{j=1}^M q_j < \sum_{j=1}^N q_j$.

³² Note that this is a specific situation in which the best solution is that managers act in the interest of the firm as a whole, and not in the interest of the shareholders. Since firm value is increased by a certain bankruptcy, shareholders may be compensated by the bondholders. The saved costs of

expected costs of financial distress will be avoided. If it is impossible to create a perfect hedge, the present value of the expected costs of financial distress is equal to $\sum_{j=1}^S q_j \cdot \tilde{C}_j$, where \tilde{C}_j equals the cost of financial distress regarding the hedged income \tilde{Y}_j . For this case, there are S states of the world with associated costs of financial distress. Because the hedge is not perfect, \tilde{Y}_j still exhibits some volatility, but the variation in income is less than Y_j .³⁴ Given hedging, the increase in firm value is $\sum_{j=1}^M q_j \cdot C_j - \sum_{j=1}^S q_j \cdot \tilde{C}_j$, which equals the present value of the saved expected costs of financial distress for some states of the world.

Concluding, if costless hedging can decrease the expected costs of financial distress, it will increase firm value. However, if hedging is costly, firms should, again, consider the marginal trade-off between the benefits of hedging (i.e., the reduction in expected costs of financial distress) and the costs of hedging.

2.3.2 Empirical implications

From the preceding theoretical analysis, it follows that if hedging can lower the expected costs of financial distress, it will increase firm value as long as hedging is not too expensive. Warner (1977) indicates that smaller firms deal with relatively high costs of financial distress (i.e., especially the indirect costs of financial distress

financial distress may be divided by both parties. However, agency problems complicate the situation. See Section 2.4.

³³ Note that this results also holds if a less than perfect hedge cannot avoid a bankruptcy with certainty. In this case, there is a specific subset of states of the world in which the firm goes bankrupt. See footnote 34.

³⁴ Note that there are less (i.e., $M-S+1$) states of the world with costs of financial distress. As a consequence $\sum_{j=1}^S q_j < \sum_{j=1}^M q_j < \sum_{j=1}^N q_j$.

are disproportional to firm size, implying a higher impact on smaller firms). This implies that, from a theoretical point of view, small firms are more likely to hedge. Because the possibility of a bankruptcy is larger when firms have more fixed claims, then, *ceteris paribus*, firms with higher levels of debt are also more likely to hedge. Furthermore, the probability of encountering a situation of financial distress is extended if a firm's income is highly volatile or if it has a lower credit rating. So, small firms with higher debt ratios, lower credit ratings, and a volatile income stream are expected to gain the most from hedging. However, if smaller firms face higher costs of hedging, they are less inclined to hedge. Again, like in Section 2.2, there is no clear prediction whether or not smaller firms should hedge more or less than larger firms. Empirical research should provide evidence whether the hypothesis of reductions in tax payments and costs of financial distress, or economies of scale explains hedging activities.

2.4 THIRD MOTIVE: REDUCTION OF AGENCY COSTS OF DEBT

2.4.1 Theory

Hedging can be a value-increasing strategy if it mitigates suboptimal investment policies, thereby reducing agency costs of debt. This suboptimality (i.e., the agency costs of debt) can result from adverse selection, induced by specific risk-sharing relations between financing participants in financially-distressed firms. Usually, the adverse selection problem comes in two forms.

The first one is the so-called underinvestment problem in the case of debt overhang (see e.g. Myers, 1977).³⁵ Myers shows that investment opportunities can be seen as options. The management of a firm in financial distress (acting in the interest of shareholders) may give up some of the profitable investment opportunities, because the shareholders have to pay for the investment, whereas the gains accrue primarily to the bondholders. Forgoing these investment opportunities is a rational decision if too little of the value of the potential new investment goes to the shareholders. Thus, although the investment is a project with an overall positive net present value (NPV), from the viewpoint of the shareholders the NPV may be negative, since they have to pay for the whole investment. Shareholders, acting in their own interest, will wish to forego these investment opportunities, which causes overall firm value to decline.

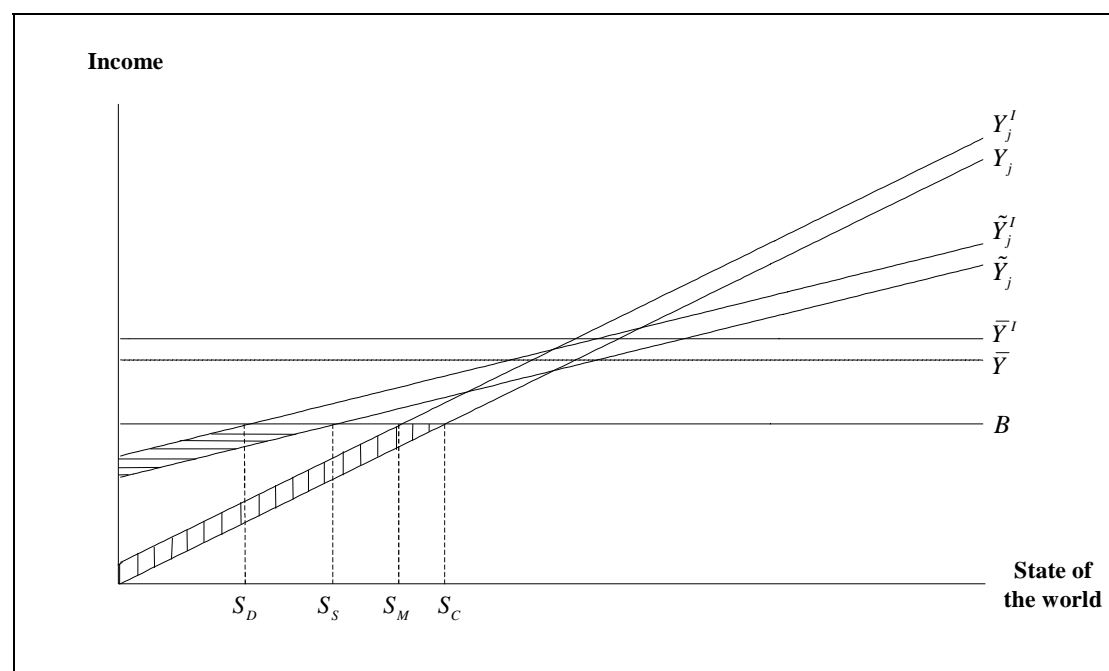
The second form of adverse selection is called the risk-shifting problem, essentially introduced by Jensen and Meckling (1976). With risk-shifting, a firm's management may engage in risky investment opportunities with a negative NPV, because potential gains accrue to the shareholders whereas the potential losses are borne by the bondholders.

Rational bondholders anticipate this opportunistic behavior, which induces them to protect themselves by increasing the required rate of return. Furthermore, bondholders can impose debt covenants, which put restrictions on the investment and financing policies. These covenants are value-reducing since the managerial degrees

³⁵ Froot, Scharfstein, and Stein (1993) provide an alternative explanation for underinvestment, in which risk management can increase shareholder value by harmonizing financing and investment policies. When raising external capital is costly (i.e., debt and equity financing is associated with agency as well as transaction costs, causing the marginal cost schedule to increase), firms may underinvest. Risk management can mitigate the underinvestment problem since it ensures the availability of more internally-generated cash, which can be used to undertake investment opportunities, even in the bad states of the world.

of freedom are decreased. If hedging can mitigate the debtholders' expected opportunities of being expropriated, it will reduce the cost of debt financing, which increases firm value. In this context, it is important that the firm has to credibly precommit on a hedging strategy in order to reduce the agency costs of debt. The effects of hedging on the agency costs of debt are shown in Figure 2.3.³⁶ The analysis is adapted from Bessembinder (1991).

Figure 2.3: The effect of hedging on the underinvestment problem



³⁶ Note that the example is based on the underinvestment and not on the risk-shifting problem. However, reducing the underinvestment problem also reduces the risk-shifting problem. If hedging shifts individual default states to non-default ones, it can increase the number of future states in which the equity-holders are the residual claimants. Therefore, a larger fraction of benefits from investing (i.e., a larger percentage of the NPV) accrues to the equityholders, which will make them less inclined to underinvest. Furthermore, a larger fraction of the costs of investing in high-risk, negative NPV projects accrues to the shareholders. Therefore, shareholders are also less likely to engage in risk-shifting behavior.

Assume the firm has issued a zero-coupon bond with a principal equal to B . Suppose this debt obligation matures at time 1. Furthermore, suppose initial income is strictly and linearly increasing in the different future states of the world and presented by the line Y_j . Bankruptcy will be declared if income is less than B , which happens for states of the world to the left of state S_C .³⁷ Suppose the firm has an investment opportunity, which results in an incremental future income I . This investment opportunity has to be financed by the shareholders. If the firm decides to invest, future state-contingent income shifts up to the line Y_j^I , where $Y_j^I = Y_j + I$. In the absence of agency costs, firm value would increase to $V_0 = \sum_{j=1}^N q_j \cdot (Y_j + I) - C_0$, where C_0 is the current cost of investing. However, part of the increase in firm value accrues to the bondholders; i.e., $\sum_{j=1}^C q_j \cdot \lambda_j \cdot I$, where λ_j is the proportion of incremental income going to the bondholders.³⁸ This value is given by the vertically-shaded area in Figure 2.3. Thus, the incremental value for the shareholders equals $\sum_{j=1}^N q_j \cdot I - \sum_{j=1}^C q_j \cdot \lambda_j \cdot I = \sum_{j=M}^N q_j \cdot (1 - \lambda_j) \cdot I$, which will be the maximum amount shareholders are willing to pay for the investment.³⁹ Because only part of the incremental value accrues to shareholders, they will be inclined to underinvest since, for them, some overall positive NPV-projects have a negative NPV. This is the case for investments for which $\sum_{j=1}^N q_j \cdot I > C_0 > \sum_{j=M}^N q_j \cdot (1 - \lambda_j) \cdot I$. Now, suppose the firm is

³⁷ The states are ordered from ‘bad’ states of the world to ‘good’ states of the world.

³⁸ For $1 \leq j \leq M$ $\lambda_j = 1$. For $M < j < C$, $0 < \lambda_j < 1$ and monotonically decreasing. For $j \geq C$, $\lambda_j = 0$.

³⁹ Remember that the shareholders have to pay for the whole investment. However, only part of the NPV $\left(\sum_{j=M}^N q_j \cdot (1 - \lambda_j) \cdot I \right)$ accrues to them.

able to hedge future income perfectly. As a consequence, assume that by hedging perfectly, future income becomes state-independent at level \bar{Y} . If the firm decides to invest, this level will shift up to \bar{Y}' . Bondholders are certain to be completely repaid implying that the full incremental value of the investment goes to the shareholders. The underinvestment as well as the risk-shifting problem disappears, which reduces the agency costs of debt to zero.⁴⁰

If it is, contrary to the previous analysis, not possible to create a perfect hedge, future income in different states of the world is assumed to be given by the line \tilde{Y}_j . The investment shifts this line up to \tilde{Y}'_j . Bondholders will be repaid in all states of the world greater than S_D . The value of the investment accruing to the bondholders now equals $\sum_{j=1}^S q_j \cdot \tilde{\lambda}_j \cdot I$, where $\tilde{\lambda}_j$ is the proportion of incremental

income for the bondholders in case of an imperfect hedge.⁴¹ In Figure 2.3, this value

is represented by the horizontally-shaded area, and is less than in the no-hedging case; i.e., $\sum_{j=1}^C q_j \cdot \lambda_j \cdot I - \sum_{j=1}^S q_j \cdot \tilde{\lambda}_j \cdot I = \sum_{j=D}^S q_j \cdot \tilde{\lambda}_j \cdot I + \sum_{j=S}^C q_j \cdot \lambda_j \cdot I > 0$. The incremental value

for the shareholders equals $\sum_{j=1}^N q_j \cdot I - \sum_{j=1}^S q_j \cdot \tilde{\lambda}_j \cdot I = \sum_{j=D}^N q_j \cdot (1 - \tilde{\lambda}_j) \cdot I$. Since

shareholders now gain more from the investment, they are more likely to invest, thereby reducing the underinvestment problem. This will induce bondholders to lower the required rate of return on their loans. Firm value is increased because agency costs are reduced.

⁴⁰ Both underinvestment as well as the risk-shifting problems are completely eliminated. See footnote 36.

⁴¹ Note that for $1 \leq j \leq D$, $\tilde{\lambda}_j = 1$. For $D < j < S$, $\tilde{\lambda}_j < 1$ and monotonically decreasing. For $j \geq S$, $\tilde{\lambda}_j = 0$.

The preceding analysis implies that reducing agency costs can only be done if hedging effectively switches some individual future default states to non-default states, thereby increasing the total number of non-default states. As a result, the number of future states in which the debtholders will not be paid is reduced, which induces the value of debt to be less sensitive to the value of incremental investments. Therefore, shareholders gain more from additional investments, which increases their willingness to provide funds for projects with a positive NPV. Furthermore, because shareholders will potentially lose more if they invest in high-risk projects, the risk-shifting problem will also be reduced. The net effect of hedging is that bondholders will require a lower rate of return, which adds value to the firm. Since, by hedging, shifting default-states to non-default states of the world can be achieved at the firm level only, shareholders cannot do this by home-made hedging (i.e., individual investors cannot replicate the firm's decisions). Given this setting, hedging only adds value if it is undertaken at the (corporate) firm level.

2.4.2 Empirical implications

Both the underinvestment as well as the risk-shifting problem is more pronounced in Myers' (1977) case of debt-overhang. As a result, firms with high financial leverage are more likely to use derivatives in order to reduce the volatility of the firm, thereby increasing firm value. Furthermore, since firms with more growth options in their investment opportunity set are more likely to suffer from agency problems, these firms have a greater incentive to undertake a hedging program to reduce the volatility of the firm's cash flow. Growth options are usually estimated by the market-to-book value. So, it can be expected that firms with a higher market-to-book ratio more

frequently use derivatives to hedge their risks. Furthermore, firms spending a relatively large amount on research and development (R&D) are expected to experience more growth in the future. Therefore, firms with higher expenditures on R&D should more frequently use derivatives to hedge the volatility of firm value. From the preceding arguments, we can hypothesize that highly-levered firms with a relative large amount of growth options are expected to gain the most from hedging, since hedging reduces their agency costs of debt.

2.5 FOURTH MOTIVE: MANAGERIAL UTILITY MAXIMIZATION

2.5.1 Theory

The three motives for corporate risk management, as discussed in the Sections 2.2 through 2.4, are based on maximizing shareholder value. The fourth argument to explain the existence of corporate risk management belongs to a different category, because it is based on managerial utility maximization.⁴² Among others, Stulz (1984), Smith and Stulz (1985), and Tufano (1996) argue that managerial risk attitude can explain the corporate use of derivatives, if a manager's expected utility depends on the distribution of future firm value. Corporate risk management changes the distribution of future firm value and, as a consequence, a manager's expected utility. This aspect is even more pronounced because managers are relatively undiversified since most of their wealth is tied to the firm. As a consequence, they may be

⁴² In the Sections 2.2 through 2.4, managers are supposed to act in the interest of shareholders. In this section, managers act in their own interest.

particularly interested in pursuing their personal preferences instead of creating shareholder value.⁴³

Following the previous sections, we assume a one-period model in which an all-equity firm's income at time 1 will be paid to the shareholders of the firm. Furthermore, assume that the firm is not obliged to pay corporate taxes, implying that τ_c is set to be zero. Finally, suppose that the manager, who is responsible for the hedging policy, is strictly risk averse such that his expected utility is a strictly concave function of his future consumption, i.e., $E[U(c_j)]$, with $U'(c_j) > 0$, and $U''(c_j) < 0$, where c_j denotes managerial consumption in state j . Suppose the manager's utility is completely tied to the value of the firm because his total wealth consists of n_s shares of stock.⁴⁴ The manager's expected consumption equals $E[c_j] = n_s \cdot \left(\sum_{j=1}^N \pi_j \cdot V_j \right)$, where π_j is the probability that state j occurs and V_j represents the according stock price of the firm. If firm value is hedged perfectly $E[c_j] = n_s \cdot \left(\sum_{j=1}^N \pi_j \cdot \bar{V} \right) = n_s \cdot \bar{V}$.

Since the utility function is strictly concave, it follows from Jensen's inequality that the utility of the expected consumption is larger than the expected utility of consumption, i.e., $U(E[c_j]) > E[U(c_j)]$. Utility will be maximized if firm value is hedged completely.⁴⁵ However, this argument only holds if the forward price is assumed to be unbiased.⁴⁶ If this is not the case, the manager has to give up some

⁴³ Note that also non-monetary items such as reputation, awards, and promotion can be important to managers. See e.g. the pathbreaking paper by Jensen and Meckling (1976) on agency costs. If managers own a fraction of the shares of the firm, this partial ownership may cause them to work less hard and consume more perquisites since the other owners bear (the biggest) part of the costs. Adequate compensation structures may mitigate these agency costs of equity.

⁴⁴ We assume that the manager is not allowed to trade company stocks in the capital market.

⁴⁵ For a formal proof, see Theorem 3.2 in Chapter 3 of this dissertation.

⁴⁶ For an analysis of unbiasedness, see Chapter 3. See also footnote 21.

future income by hedging, since the hedged consumption will be less than the expected consumption. The manager will have to make a trade-off between the loss in wealth, and the decrease in uncertainty. So, if a manager's wealth is largely and directly tied to firm value, he will be inclined to reduce financial risks by hedging and, under some circumstances, will hedge completely.

Suppose now that a manager earns a basic wage \bar{W} and is, in contradiction to stock compensation, additionally rewarded a total number of n_c call options on the future stock price of the firm. For this case, his total time-1 consumption equals $c_j = \bar{W} + n_s \cdot [V_j - X_c]^+$, where X_c is the exercise price of the call options. Being awarded call options will make the manager's payoff a convex function of firm value. As option theory shows, a higher volatility makes options more valuable,⁴⁷ which causes the manager to face a trade-off when hedging the firm's exposure. On the one hand, hedging is utility-enhancing since he is risk averse, whereas, on the other hand, hedging will make the calls less valuable since the volatility of firm value is decreased. Combining these two determinants, the manager is expected to hedge less if he obtains call options in his compensation plan as compared to being rewarded in shares of stock. More specifically, it may be in the manager's interest to increase risk since he is downside-protected by his basic wage, but profits from the upside potential by effectively exercising the call options. Therefore, even though the manager is risk averse, he will be inclined to relatively higher risk-taking behavior because a higher volatility of the firm may increase his personal utility of wealth. Of course, the degree of derivatives' use depends on a number of factors. It can be expected that managers hedge less if 1) they have a relatively large amount of call-option features in their

⁴⁷ See e.g., Black and Scholes (1973).

bonus schemes, 2) the options are at-the-money, since, in this case, they are most sensitive to changes in volatility,⁴⁸ and 3) the manager is less risk-averse.

In this section, managers act in their own interest instead of in the interest of shareholders. The previously mentioned compensation schemes will probably not cause managers to act in the interest of shareholders. Of course, managerial utility maximization can be linked to shareholder value maximization through proper management compensation schemes. By establishing an adequate compensation contract, shareholders may provide effective incentives for proper risk-taking behavior of management, which results in value-maximizing decision making. However, due to information asymmetry, incomplete contracting, and agency problems between shareholders and management, this might be a difficult, if not impossible, task (see e.g., Jensen and Meckling, 1976).

2.5.2 Empirical implications

Maximization of management utility depends on the way personal wealth is linked to firm value. If a manager owns a significant fraction of the firm, he can be expected to hedge more of the firm's risks. As a consequence, this gives an incentive for closely-held corporations to engage in hedging more frequently, since the managers/owners of these corporations do not hold well-diversified portfolios. Therefore, assuming risk aversion, they have incentives to reduce the volatility of firm value. As a

⁴⁸ Note that if the options are far in-the-money (i.e., the delta is approximately 1) and the time-to-maturity is relatively short, the manager's payoff will again be a linear function of firm value. Then, risk-averse managers will be inclined to hedge more, since the option behaves like a stock. If the options are far out-of-the-money, the manager's total payoff behaves like a zero-coupon bond, which is also insensitive to changes in volatility.

consequence, one may expect closely-held firms to engage in hedging programs. For publicly-held firms this need not be the case. The risk management program depends on the managerial incentive schemes and performance measures. If the manager is compensated in such a way that his income linearly depends on the value of the firm, one may expect the firm to hedge. However, the more call-option-like features in the incentive scheme, the less the manager is expected to hedge. As a matter of fact, it may be advantageous for managers to increase the firm's financial and business risks.

2.6 EMPIRICAL EVIDENCE ON CORPORATE RISK MANAGEMENT ACTIVITIES

2.6.1 Introduction

Several recent articles present empirical evidence on corporate risk management activities undertaken by non-financial corporations. In attempting to identify the importance of the various explanations for corporate risk management, three approaches have been used: survey analysis, regression analysis, as well as simulation analysis.

Survey analysis can greatly contribute to the understanding of empirical firm behavior, in particular when it comes to its qualitative dimensions. The goal of survey analysis is to provide a detailed description of derivatives usage and the motives for engaging into risk management practices. However, a potential problem with survey analysis is that some firms might view the information requested in the survey as proprietary. Furthermore, management might, for example, be reluctant to admit in a survey that it employs derivatives to speculate rather than for hedging

purposes. Some of these expected biases might be circumvented through sophisticated use of regression analysis. However, regression models do have some inherent explanatory limitations. A potential weakness of cross-section regression analysis stems from the fact that it might require the selection and specification of intervening variables or proxies for relevant firm characteristics. Furthermore, the derived regression coefficients are based on past information and may not hold for the firm (or the set of firms) in the future. In case there are several risk factors acting simultaneously, one needs to obtain the joint distribution of these factors, incorporating their covariation. If the relationship between firm value and the different risk factors can be analyzed, it is possible to use this analysis in a Monte Carlo simulation. An advantage of simulation analysis is that it does not assume the future to be similar to the past, and it can deal with any kind of non-linearity and path-dependency.

This section gives an overview of some evidence about corporate risk management by survey, regression, and (Monte Carlo) scenario analyses. The empirical findings regarding scenario analysis, however, are rather limited. To date, only a paper by Graham and Smith (1999) and one by Graham and Rogers (2002) discuss the tax advantages of hedging. The results from regression analysis are summarized in Table 2.1. Most studies concern firms from the U.S. and focus on exchange-rate, interest-rate, and commodity price risk. These results, as well as the results from survey and Monte Carlo analysis, are discussed in the following subsections. The different survey studies that will be discussed are presented in Table 2.2.

Table 2.1: Empirical evidence for regression studies on corporate risk management

Variable	Expected sign	Sign found and level of significance							
		NSS ¹	Mian ²	BB ³	Tufano ⁴	FCC ⁵	GMS ⁶	HH ⁷	AO ⁸
<i>Expected taxes</i>									
Tax loss carryforwards	+	-	***	**	+	-**	+	+	+
Tax credits	+	+	***			***			+
Income in progressive region	+	+	**	-***				+	**
<i>Costs of financial distress</i>									
Leverage	+	-		***	+	+	+	*	***
Interest coverage ratio	-	-		-			*	-	
<i>Agency costs</i>									
R&D-to-value or sales	+	+	**				+	*	***
Market-to-book value	+	-	-	**			-	+	***
Earnings-to-price	-			***	+				
Asset growth-to-cash flow	+			-					
PPE-to-size	-							**	-
<i>Managerial utility</i>									
Managerial option ownership	?				-	+		***	-
Managerial share ownership	+			-	-	+	*	+	
<i>Firm size</i>									
Market value	?	+	***	+	***	+	+	***	***
Total assets	?							***	+
Sales	?							***	+

*, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

¹ Empirical evidence by Nance, Smith, and Smithson (1993) for 169 US corporations.

² Empirical evidence by Mian (1996) for 3,022 US corporations.

³ Empirical evidence by Berkman and Bradbury (1996) for 116 New Zealand corporations.

⁴ Empirical evidence by Tufano (1996) for 48 US gold-mining corporations. The first column shows the results between mediocre users (i.e., with a delta smaller than 40%) and non-users. The second column shows the results between heavy users (i.e., with a delta larger than 40%) and mediocre users.

⁵ Empirical evidence by Fok, Carroll, and Chiou (1997) for 369 US corporations.

⁶ Empirical evidence by Géckzy, Minton, and Schrand (1997) for 372 US corporations.

⁷ Empirical evidence by Haushalter (2000) for 100 US oil and gas producers.

⁸ Empirical evidence by Allayannis and Ofek (2001) for 323 US corporations.

Table 2.2: Summary data for surveys on corporate risk management

Study	Year	Country	Response rate	Observations
Bodnar, Hayt, Marston, and Smithson	1994	USA	26%	530
Bodnar, Hayt, and Marston	1995	USA	18%	350
Alkeböck and Hagelin	1996	Sweden	77%	163
Berkman, Bradbury, and Magan	1996	New Zealand	64%	79
Bodnar, Hayt, and Marston	1997	USA	21%	399
De Ceuster, Durinck, Laveren, and Lodewijckx	1997	Belgium	22%	73
Mallin, Ow-Yong, and Reynolds	1997	UK	29%	231
Bodnar and Gebhardt	1997	Germany	34%	126
Bodnar, De Jong, and Macrae	1998	The Netherlands	50%	84
Pramborg	2003	Sweden - Korea	41%-16%	103-60
Saito and Schiozer	2004	Brazil	20%	57

2.6.2 Evidence regarding expected taxes

In Section 2.2 it is argued that firms are more likely to hedge if they 1) are in the progressive region of the marginal tax schedule and 2) have more tax preference items. Hedging decreases the expected tax liability by reducing the variability of pre-tax income. The existing empirical literature, as presented in Table 2.1, has developed different methods to measure the convexity of the corporate tax schedule and test the tax hypothesis, like tax loss carry forwards, investment and foreign tax credits⁴⁹, as well as the likelihood that pre-tax income falls in the progressive region of the tax code. Of these measures, the most popular variable is based on reported tax loss carry forwards or a dummy variable indicating the presence of such an item on the balance sheet.⁵⁰ However, as presented in Table 2.1, evidence from regression

⁴⁹ Note that, instead of measuring tax function convexity, the existence of foreign tax credits could also proxy the presence of foreign operations and, therefore, exposure to currency risk. Furthermore, investment tax credits may indicate that the firm faces more investment opportunities (i.e., there may be agency costs involved).

⁵⁰ Variables based on the tax loss carry forward implicitly assume that firms with such tax shields face a convex tax function, which need not be true. Graham and Rogers (2002) find no correlation between the existence of tax loss carry forwards and convexity. Furthermore, existing tax loss carry forwards may provide a disincentive to hedge because hedging reduces the possibility of higher income and therefore the chance to use the tax loss carry forwards.

analysis is mixed. Only regarding the existence of tax credits, empirical evidence seems to support the hypothesis that firms use derivative instruments in order to reduce the expected tax payments. This is consistent with the finding presented by Brown (2001), who argues that corporate risk managers indicate that tax reduction is not a motivation for hedging.

The variables within regression analyses try to measure the convexity of the tax schedule, thereby providing information about the possible existence of a tax advantage. The level of this possible advantage, however, cannot be quantified. Graham and Smith (1999) apply a Monte Carlo simulation approach to derive the possible quantitative benefits of hedging pre-tax income. Using Compustat data, they simulate tax savings for a large number of listed American firms. Their analysis indicates that tax savings from hedging can be substantial, in some extreme cases approaching as much as 50% of total taxes for a reduction of 5% in the volatility of earnings before taxes. These tax savings can be worth millions of dollars. This analysis is extended by Graham and Rogers (2002), who indicate that firms do not hedge in response to tax schedule convexity. However, by hedging, firms do increase their debt capacity, thereby increasing the tax shields of debt and, therefore, firm value.⁵¹ So, if applied correctly, hedging pre-tax income can lead to substantial increases in firm value.

⁵¹ The average increase in firm value equals 1.1%, implying an incremental tax benefit of approximately \$32 million.

In addition to regression and simulation analysis, some other researchers have performed survey analyses to investigate whether firms hedge in order to minimize expected tax payments. Bodnar *et al.* (1995, 1996, 1998) conduct different follow-up surveys among non-financial U.S. listed firms. According to these firms, their most important objective for hedging is managing cash flows, which is, according to Bodnar *et al.* consistent with the standard economic explanations of the potential benefits of hedging, like reducing expected taxes. Since managers may be reluctant to give the real reason for hedging this, as an alternative to shareholder value maximization, might also show that this reduction in cash flow volatility is for reasons of risk aversion (i.e., managerial utility maximization). The latter argument may even be more reasonable as managers do not explicitly state that they actively manage pre-tax income in order to reduce the expected tax payments. Similar studies have been conducted by Berkman, Bradbury, and Magan (1997) in New Zealand, Bodnar and Gebhardt (1999) in Germany, Alkeback and Hagelin (1999) for Swedish corporations, De Ceuster *et al.* (2000) in Belgium, Mallin, Ow-Yong, and Reynolds (2001) in the UK, Bodnar, De Jong, and Macrae (2003) for the Netherlands, and Alkeback, Hagelin, and Pramborg (2006) in Sweden.⁵² The results from these surveys are similar to the pioneering surveys in the US: none of the recipients argue that they use derivatives to minimize expected tax payments.

⁵² There are more studies performed on the use of derivative instruments by non-financial firms (see e.g., Block and Gallagher (1986), Dolde (1993), Phillips (1995), Grant and Marshall (1997), Hakkarainen *et al.* (1998) and Loderer and Pichler (2000)). These studies, however, focus on different sets of questionnaires, which makes them less suitable for comparison.

Overall, empirical evidence about hedging in order to reduce tax obligations is mixed, although Graham and Smith (1999) show that hedging earnings before taxes can have a substantial impact on firm value. A variable that has not been used in the previous analyses is the volatility of pre-tax income. As shown in Section 2.1, firms with a higher volatility of pre-tax income are more likely to hedge. However, a problem with applying this volatility as a variable is the interrelation between hedging and volatility. Because hedging decreases the volatility of pre-tax income it is probably difficult to find an empirical relation between the level of hedging and the volatility of the pre-tax income. It seems that the only way to deal with this problem is applying a simulation approach like Graham and Smith (1999).

2.6.3 Evidence regarding expected costs of financial distress

In Section 2.3, it is shown that firm value can be increased if hedging can lower the expected costs of financial distress. Therefore, most empirical studies use proxies for the probability of encountering in financial distress. Within these studies, the two preferred measures are the level of leverage and the interest cover ratio. From a theoretical point of view, the value of hedging is greater for firms facing higher levels of debt and lower interest cover ratios.⁵³ Higher leverage implies a greater probability of facing financial distress, whereas firms with a lower interest cover ratio might not generate enough cash from their operations to honor the promised payments on their debt. The results presented in Table 2.1 show that empirical evidence regarding costs of financial distress is not very strong. Five studies find the expected positive relation

⁵³ Smaller firms are also expected to have a higher probability of encountering in financial problems. The effect of firm size, however, is examined in Subsection 2.6.6.

between hedging and leverage. The level of significance, however, is not very strong. However, as Nance, Smith, and Smithson (1993) remark, this lack of significance might be explained by possible interrelations between leverage and growth opportunities (i.e., firms with more growth opportunities have less leverage and should hedge more).⁵⁴ Furthermore, consistent with theory, in all papers a negative relation between hedging and the interest coverage ratio is found. Nevertheless, only Fok, Carroll, and Chiou (1997) find a significant negative relation.⁵⁵ Summarizing, empirical evidence suggests that firms with a higher leverage and a lower interest coverage ratio hedge more, although the empirical relations are not very strong.

As has been mentioned in the previous subsection, Bodnar *et al.* (1995, 1996, 1998) conclude from their surveys that US non-financial firms most often use derivatives in order to manage cash flow volatility. Bodnar, De Jong, and Macrae (2003) present similar results for the Netherlands. They conclude that this is consistent with minimizing costs of financial distress. Berkman, Bradbury, and Magan (1997) find that non-financial corporations from New Zealand most often engage in risk management practices to reduce the volatility of accounting earnings, followed by managing cash flows and firm value.⁵⁶ Although it is not mentioned by Berkman, Bradbury, and Magan, this could be seen as trying to reduce expected costs of

⁵⁴ Another point of concern is that the costs of financial distress are assumed to be constant across firms. This approach fails to look at the interrelation between capital structure and costs of financial distress. Firms with high exogenous costs of financial distress might choose a low level of debt and vice versa.

⁵⁵ However, if firms have large internal cash buffers to pay their obligations, a low interest coverage ratio is not a good indication for the possibility of encountering financial distress.

⁵⁶ Similar results can be found for surveys in Germany by Bodnar and Gebhardt (1999), Sweden: Alkeback and Hagelin (1999), Belgium: De Ceuster *et al.* (2000), UK: Mallin, Ow-Yong, and Reynolds (2001), and Alkeback, Hagelin and Pramborg for Sweden (2006).

financial distress.⁵⁷ However, in none of the studies, managers explicitly state that they hedge in order to avoid certain costs of financial distress. As mentioned in the previous subsection, managing cash flow or accounting earnings can also be seen in the light of maximizing managerial utility: by reducing the volatility of cash flow or accounting earnings, managers may pursue their own goals (i.e., they maximize their own expected utility of wealth).⁵⁸

It can be concluded that empirical evidence does not provide very strong results for the hypothesis that corporate managers try to increase firm value by hedging, in order to minimize the expected costs of financial distress. One of the problems of regression analysis may be that the variables used do not capture the expected costs of financial distress.⁵⁹ An alternative variable that may be used is Altman's Z-score (1968) to proxy changes in the probability of financial distress. A modified Z-score has been used by MacKie-Mason (1990) and Graham, Lemmon, and Schallheim (1998). Furthermore, a variable relating the variability of the firm's earnings (i.e., an approximation for the possibility of default) with asset intangibility (i.e., an approximation for the loss of firm value at default) can be used. However, again, the problem of the interrelation between the volatility of the firm's earnings and hedging appears. Finally, credit ratings can be used to proxy for the possibility of encountering financial distress.

⁵⁷ Of course, managing cash flow volatility is different from managing earnings volatility. However, it can be expected that the two are reasonably well correlated, such that similar conclusions may be drawn from the management of both kinds of volatility.

⁵⁸ In a study performed by Rawles and Smithson (1990), corporate risk managers argue that improving a firm's credit rating is one of the most important objectives of hedging company cash flow. If managers do hedge to improve the credit rating, this can be seen as reducing the costs of financial distress.

⁵⁹ See e.g. footnote 54 and 55.

2.6.4 Evidence regarding agency costs of debt

In Section 2.4, it was shown that hedging can increase firm value if it can decrease the agency costs of debt. It can be argued that agency costs are more pronounced when 1) a firm has a higher level of financial leverage, and 2) a firm has more growth or investment opportunities. The most commonly used proxies for investment opportunities have been a firm's market-to-book ratio and (scaled versions of) R&D.⁶⁰ The rationale for using the market-to-book value is that the market value of the firm represents the value of the assets in place and the value of the investment opportunities the firm faces. Expenditures on R&D, as an alternative, should provide information about the development of future projects. As can be derived from Table 2.1, the only significant variable is the scaled version of R&D. All three regression analyses including this variable show that there is a significant positive relation between hedging and activities on R&D. For the other variables trying to capture possible growth opportunities, the evidence is less convincing.⁶¹ Furthermore, as shown in Subsection 2.4.3, the evidence regarding leverage is also mixed. Summarizing, the empirical evidence on the agency costs of debt leads to the conclusion that firms facing more growth opportunities (as measured by expenditures on R&D) seem to hedge in order to minimize these agency costs of debt.

⁶⁰ Froot, Scharfstein, and Stein (1993) argue that expenditures on R&D could also be a proxy for the extent of information asymmetry about the quality of the firm's projects or the financial constraints it faces. The lack of guarantees makes it harder for these firms to get external financing. This may also lead to underinvestment (see footnote 35). Furthermore, Gay and Nam (1998) argue that "bad" managers may hide their quality by spending more on R&D or by mimicking hedging strategies pursued by "good" managers.

⁶¹ In contrast to the studies as presented in Table 2.1, Deschmukh and Vogt (2005) test a single explanation for risk management rather than trying to distinguish among the different explanations. Their results indicate that investment spending is less sensitive to cash flow for firms that hedge. Similar evidence is found by Allayanis and Mozumdar (2000). Minton and Schrand (1999) find that cash flow volatility is associated with lower rates of investment and higher costs of external capital, supporting the argument in footnote 35.

Within the different surveys on corporate risk management, Bodnar *et al.* (1995, 1996, 1998), among others,⁶² argue that U.S. non-financial firms use derivatives in order to reduce the agency costs of debt. However, since the explicit argument is not stated by the corporate managers, it might also imply that managerial risk aversion can be the driving factor behind reducing the company cash flow or earnings. Furthermore, if hedging activities are indeed applied correctly (i.e., to enhance shareholder value), it will be hard to conclude whether this is done in the light of reducing tax payments, costs of financial distress, and/or agency costs of debt.

In conclusion, it can be stated that empirical evidence reasonably supports the hypotheses regarding reducing agency costs of debt. From the evidence presented above, it seems that firms with more growth opportunities and low accessibility to external financial capital are more likely to hedge cash flows in order to reduce agency costs of debt.⁶³

2.6.5 Evidence regarding managerial utility maximization

Section 2.5 suggests that managers can use derivatives in order to maximize their own expected utility of wealth. This can be the case because they have a large proportion of their wealth invested in the firm, which might induce them to hedge more. However, when managers' compensation contracts contain a relatively large proportion of call-option-like features, they may be inclined to hedge less, or even

⁶² Again, similar conclusions are drawn for other countries. See also footnote 56.

⁶³ In a study by Rawles and Smithson (1990), risk managers state that minimizing borrowing costs is one of the objectives of hedging. This is in line with the hypothesis of reducing agency costs of debt.

speculate. As shown in Table 2.1, empirical evidence regarding managerial option ownership is mixed. Tufano (1996) and Géckzy, Minton, and Schrand (1997) find a significant positive relation between managerial option ownership and the use of derivative instruments.⁶⁴ However, it remains unclear whether these derivatives are used for hedging or for speculation purposes. Empirical evidence on the relation between managerial share ownership and the use of derivatives is also not very conclusive. Tufano (1996) finds a significant positive relation,⁶⁵ whereas Fok, Carroll, and Chiou (1997) find a negative relation.

Overall, we can conclude that empirical evidence regarding management utility maximization is not very conclusive. A big problem, however, is that the precise composition of managerial compensation schemes is unknown. The exact sensitivity of managerial wealth to changes in firm volatility is needed to be able to draw any conclusions in the direction of whether or not derivatives are used to enhance or maximize the expected utility of management.⁶⁶

2.6.6 Evidence regarding firm size

From the theoretical arguments in the Sections 2.2 through 2.4, it is impossible to predict a clear relation between firm size and corporate risk management activities. Smaller firms are more likely to be in the progressive region of the marginal tax schedule, which makes the potential tax advantages by hedging most pronounced for

⁶⁴ Note that Tufano only finds a significant positive relation for part of the sample. See Table 2.1.

⁶⁵ A more recent study by Petersen and Thiagarajan (2000) confirms the managerial-utility maximization hypothesis for the gold mining industry in the U.S.

⁶⁶ Next to the compensation structure, it will be a hard, if not impossible, task to get information on the exact details of managerial utility functions.

relatively small firms.⁶⁷ Furthermore, smaller firms face relatively high costs of financial distress. This also supports the hypothesis that smaller firms should gain more from hedging than larger firms.⁶⁸ However, because smaller firms probably face substantially higher transaction costs of hedging, it also possible that larger firms are more likely to use derivative instruments in their risk management programs. From Table 2.1, it can be concluded that the theory of transaction costs dominates the motives for reducing expected taxes and costs of financial distress. In almost all papers, a significant positive relation between firm size and the use of derivative instruments is found. Larger firms are probably in a better position to set up a risk management program and contract specialized employees.

The previous results are confirmed by findings from survey analyses. Bodnar *et al.* (1995, 1996, 1998) show that the use of derivatives is most common among large firms, followed by medium and small firms. These findings are confirmed for all of the other survey analyses presented in Table 2.2. The survey results corroborate the suggestion that initiating and maintaining a risk management program is associated with significant fixed costs. Because of economies of scale, these costs may make derivatives usage uneconomical for smaller firms, despite the potential larger benefits. Especially the costs of setting up a risk management program and contracting specialized and highly-qualified employees may outweigh the theoretical benefits of hedging for smaller firms.

⁶⁷ See Section 2.2.

⁶⁸ See Section 2.3.

Therefore, we can conclude that from all the possible determinants of corporate risk management, firm size gives the most pronounced explanation for the corporate use of derivatives.

2.7 CONCLUSIONS

This chapter gives a theoretical and empirical overview of the motives for corporate hedging. From a theoretical point of view, hedging can increase firm value if it reduces the expected tax liability, expected costs of financial distress, and agency costs of debt. These beneficial reductions can only be achieved by the firm itself, since the relevant value-increasing hedging decisions cannot be replicated by individual investors. Furthermore, utility maximization by the manager/owner of a firm can explain the corporate use of derivatives for hedging purposes. If managerial wealth depends on future firm value, then hedging decisions by the management of the firm can be applied to increase their personal expected utility of wealth.

Empirical evidence, given regression and survey analysis, regarding tax hypothesis is mixed. Graham and Smith (1999) and Graham and Rogers (2002), who apply a Monte-Carlo simulation approach, however, show that the potential gains of hedging pre-tax income can be substantial. Empirical evidence regarding a reduction in the expected costs of financial distress is also rather inconclusive. Empirical evidence for reducing the agency costs of debt is more supportive. Firms with more growth opportunities, as measured by R&D, and limited access to external financial capital seem to hedge cash flows in order to reduce the agency costs of debt. Evidence for the use of derivatives in order to maximize managers' expected utility is

also mixed. Only Tufano (1996), studying the gold-mining industry, does find evidence that managers use derivatives in order to maximize their own expected utility of wealth. Evidence regarding firm size, finally, is very convincing. Large firms, as compared to small firms, make far greater use of derivatives. This evidence is confirmed by both regression as well as survey analysis. This may show that transaction costs of hedging play an important role in explaining the corporate use of derivatives. Larger firms are in a better position of bearing the large initial costs of setting up a risk management program, and contracting specialized employees. However, it may be the case that many firms are simply not sufficiently acquainted with the potential benefits of hedging, like minimizing expected tax payments and costs of financial distress. As shown in this chapter, these benefits can be large.

