Corporate risk management

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CORPORATE RISK MANAGEMENT: AN OVERVIEW

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SOM-theme E: Financial markets and institutions

Abstract

Corporate risk management and hedging are important activities within financial as well as non-financial corporations. Under the assumptions of Modigliani and Miller [1958], corporate risk management is a redundant activity. However, the existence of market imperfections can explain the corporate use of derivatives. Hedging can increase firm value when 1) firms face a progressive tax rate, 2) there are expected costs from financial distress, and 3) hedging can reduce agency costs of debt. Furthermore, derivatives' use can be explained by the risk attitude of managers. This paper provides a review of, and some critical notes on the theoretical and empirical literature on corporate risk management strategies. It will be stated that the empirical results for the theoretical hypotheses are mixed, even though corporate risk management can substantially increase firm value. The major determinant of derivatives' use is firm size. The mixed results indicate that corporate risk managers, willingly or unwillingly, do not behave in an optimal way. Therefore, this study may motivate corporate risk managers to use derivative instruments in order to create shareholder value, since it shows the benefits of corporate risk management and the sources of these benefits.

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Introduction

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 and investment opportunities (i.e., its real assets), whereas financial risks relate to the way these investments are funded (e.g., a higher level of debt increases the financial risk for the shareholders). Corporate risk management is the process of trying to influence the effect of these risk exposures on firm value. 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 paper, we will deal with the use of derivative securities in order to alter different risk exposures of a firm.[1] Rawls and Smithson [1990] show 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 paper shows, these three objectives are linked.

The interest for risk management from a practitioner's point of view has increased tremendously since a great number of firms revealed huge derivatives-related losses. Probably the most well-known example is the German industrial conglomerate Metallgesellschaft, which almost went bankrupt at the end of 1993 for the loss of around $1.3 billion in oil futures contracts. Other examples of great disasters leading to fear of using derivatives include Orange County, losing $1.7 billion in levered interest-rate products, and Barings, going bankrupt after the accumulated losses on Nikkei-index futures contracts reached around $1.4 billion. This fear for the use of derivative instruments is, however, probably overstated and incorrect. Often, the derivates-related losses were caused by fraud or by misunderstanding and misusing the derivative instrument, but not because the derivative itself is risky.

[1] Of course, there are alternatives to the use of derivate instruments like investing and borrowing abroad simultaneously, which provides a natural hedge against exchange rate risk. In this paper we abstract from these substitutes and solely focus on the use of derivatives.

The academic interest for corporate risk management is more positive and focuses on how derivatives could, or alternatively, should be used by corporations. Under the assumptions of Modigliani and Miller [1958], financial decisions have no impact on firm value. Value is created by making profitable investments, and the way these investments are financed is completely irrelevant. The financing policy only defines the way in which value is distributed among the different claimants. As a consequence, 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. Of course, it has been recognized from the beginning that the assumptions of this idealized world are not met in practice. In recent years, much has been written about possible motives for corporate risk management. The primary reason for corporate risk management is that it adds value to the firm, in ways shareholders cannot do on their own. This is because of market frictions that are absent in the Modigliani-Miller world, which means that corporate risk management can only be relevant if markets are imperfect. Among others, Mayers and Smith [1982], Smith and Stulz [1985], Smith [1995], and Stulz [1996] show that hedging can increase firm value when 1) a firm faces a progressive tax rate, 2) there are expected costs from financial distress, and 3) hedging can mitigate agency problems. These three motives can all be seen in the framework of shareholder value maximization. So, when these market frictions exist, hedging may be a value-increasing strategy for a corporation. A fourth motive is of a somewhat different category. Smith and Stulz [1985], Stulz [1996], Tufano [1996], and Hentschel and Kothari [1998] argue that the risk attitude of managers may explain the use of derivatives within the risk management program of different firms. As will be shown later, when managers' expected utility is a concave function of firm value, they will be inclined to reduce financial risks by hedging if their future wealth is a linear function of firm value. However, if their future payoff is a convex function of firm value, they will be inclined to relatively higher risk-taking behavior, because a larger volatility of the value of a firm increases their 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 exposure of a firm is related to the different types of hedgeable risks. It is very important that the exposures are quantified correctly, otherwise the hedge will lead to an inappropriate result.[2] After the exposures are quantified, a manager must choose the hedging instruments. In order to hedge different kinds of risk, firms can rely on forwards, futures, swaps, over-the-counter options, exchange-traded options, structured derivatives, and hybrid debt. Like Smith, Smithson, and Wilford [1990] show, these so-called building blocks can be combined to construct any desired position. So, in theory any 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 practice it will be impossible to hedge every exposure. Nevertheless, as this paper will show, the motives for corporate risk management still hold.

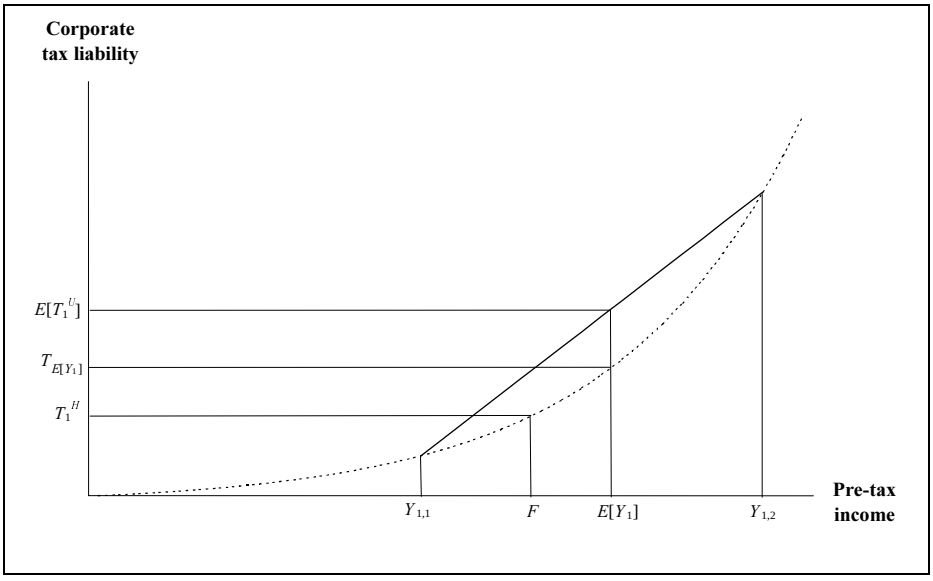
In this paper, we give a critical review of the theoretical motives and determinants for the use of derivative instruments by non-financial corporations. Furthermore, we discuss the empirical findings regarding some important studies and add some suggestions for improving empirical studies. The overview can serve as a guide for, for instance, corporate risk managers. Showing the benefits of corporate risk management and the sources of these benefits, this paper may motivate these managers to use derivative instruments in order to create shareholder value, rather than using derivatives for their own utility. The first section of the paper shows that hedging can increase firm value if firms face a progressive tax function. The second section relates to situations in which hedging lowers the expected costs of financial distress. Section three deals with the motive that the corporate use of derivatives can mitigate suboptimal investment policies. Section four shows that the risk attitude of managers can explain the use of derivatives in the risk management policy of a firm. Section five contains an overview of some empirical evidence on corporate risk management. Section six, finally, concludes with a summary and some suggestions for future research.

[2] See Stulz and Williamson [1997] for an analysis of the identification and quantification of risk exposures.

1. Reduction in expected taxes

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. This will only happen when the firm faces a progressive effective marginal tax rate (implying a convex tax function). It will be shown that, from the viewpoint of value maximization, hedging can reduce the firm's expected tax liability by reducing the volatility of pre-tax income. These lower expected tax payments increase the present value of the firm. To illustrate this, we now assume a 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 either $Y_{1,1}$ or $Y_{1,2}$.[3] Furthermore, for now assume that the firm is an all-equity firm.[4] The tax-consequences of hedging in the two possible states of the world are depicted in figure 1. Note that the states are ordered from 'bad' states to 'good' states.

Figure 1: Tax benefits from hedging



[3] Note that $Y_{t,i}$ denotes income at time t in state i.

[4] If the firm is an all-equity firm, we can abstract from tax deductions. Tax deductions complicate the analysis, but do not change the result of the advantages of hedging pre-tax income.

Where:

$Y_{1,1}$ = The firm's pre-tax income at time 1 if state 1 occurs;

$Y_{1,2}$ = The firm's pre-tax income at time 1 if state 2 occurs;

$E[Y_1]$ = The expected pre-tax income at time 1;

$E\left[T_1^U\right]$ = The expected tax liability at time 1 if the firm does not hedge;

$T_{E[Y_1]}$ = The tax liability regarding the expected pre-tax income.

F = The forward price. That is, the certain pre-tax income in a perfect hedge;

T_1^H = The tax liability at time 1 if the firm hedges perfectly.

In figure 1, the possible corporate tax liabilities are given by the convex dotted line. Since the effective corporate tax payments are a strictly convex function of pre-tax income, the tax payments disproportionally 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 $E\left[T_1^U\right]$, which is the probability-weighted average of the taxes in state 1 and state 2. In the theoretical literature, the world is usually assumed to be risk-neutral. If this is the case, the firm can make sure its pre-tax income is equal to $E[Y_1]$ since the forward price equals the expected income in a risk-neutral world. The (certain) tax liability then equals $T_{E[Y_1]}$. Because of the convexity of the tax schedule, $T_{E[Y_1]} < E\left[T_1^U\right]$[5], and firm value increases by the present value of the savings on the tax payments.

One can criticize these ideas because they are even stronger in the real world. If we assume the more realistic view of a world in which there is risk aversion, the forward price will be less than the expected income, that is, $F < E[Y_1]$. If the firm can make sure that it's certain future income equals *F*, the certain tax liability will be T_1^H, which is even less than under the assumption of risk neutrality. Therefore, by

hedging perfectly, firm value will increase by the present value of the reduction in tax payments.

Now we turn to a more general setting to see the effect of hedging pre-tax income on firm value. If we suppose there are N possible future states of the world, then in case of no hedging, the present value of the expected tax payments $E\left[T_1^U\right]$ will be equal to $\sum_{i=1}^{N} p_i \cdot \tau_{c,Y_{1,i}} \cdot Y_{1,i}$, in which p_i is a vector of Arrow-Debreu state prices[6] regarding state i, with $i=\{1,2,...,N\}$. $\tau_{c,Y_{1,i}}$ is a vector of corporate tax rates regarding pre-tax income $Y_{1,i}$. If the firm manages to create a perfect hedge, the present value of the tax payments T_1^H equals $\sum_{i=1}^{N} p_i \cdot \tau_{c,Y_{1,i}^*} \cdot Y_{1,i}^*$, where $Y_{1,i}^*$ is a vector of pre-tax income in case of a perfect hedge. Since the hedge is perfect $Y_{1,i}^* = Y_1^*$ and, consequently, $T_1^H = Y_1^* \cdot \tau_{c,Y_1^*} \sum_{i=1}^{N} p_i = \frac{\tau_{c,Y_1^*} \cdot Y_1^*}{1+r}$, where r is the discrete risk-free rate of interest for the whole period.[7] Since Y_1^* must be equal to the current forward price $Y_1^* = \left(\sum_{i=1}^{N} p_i \cdot Y_{1,i}\right) \cdot (1+r)$, it follows that $\frac{\tau_{c,Y_1^*} \cdot Y_1^*}{1+r} = \tau_{c,Y_1^*} \cdot \sum_{i=1}^{N} p_i \cdot Y_{1,i}$. Thus, the difference between the value of a hedged and an unhedged firm equals $\sum_{i=1}^{N} p_i \cdot \tau_{c,Y_{1,i}} \cdot Y_{1,i} - \tau_{c,Y_1} \cdot \sum_{i=1}^{N} p_i \cdot Y_{1,i}$, which is positive.[8] Therefore, if hedging is perfect and costless, firm value increases by present value of the reduction in the expected

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[5] This can easily be shown with Jensen's inequality.

[6] A state price regarding state i can be defined as "the price today, of receiving one currency of payoff in the future, if and only if state i occurs". Thus, a state price can be seen as a risk-adjusted discount factor.

[7] Because $\sum_{i=1}^{N} p_i$ leads to an $(N \cdot 1)$ vector that pays one dollar in every state of the world, its current price must be $(1+r)^{-1}$.

[8] This is implied by the definition of a concave function.

taxes, i.e., $\sum_{i=1}^{N} p_i \cdot \tau_{c,Y_{1,i}} \cdot Y_{1,i} - \tau_{c,Y_1} \cdot \sum_{i=1}^{N} p_i \cdot Y_{1,i}$. If hedging is not costless, this 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 with a perfect hedge.[9] In a real-world setting it will probably be the case that it is not possible to find derivative instruments that perfectly correlate with pre-tax income because markets will not be complete (i.e., there is no constant spanning of assets). In this case, the present value of the expected tax liability equals $\sum_{i=i}^{N} p_i \cdot \tau_{c,\tilde{Y}_{1,i}} \cdot \tilde{Y}_{1,i}$, in which $\tilde{Y}_{1,i}$ is a vector of pre-tax incomes when the firm engages in an imperfect hedge. Because the imperfect hedge reduces uncertainty, $\tilde{Y}_{1,i}$ is less volatile than $Y_{1,i}$ and the expected tax payments will be lower. Therefore, firm value increases by $\sum_{i=1}^{N} p_i \cdot \tau_{c,Y_{1,i}} \cdot Y_{1,i} - \sum_{i=i}^{N} p_i \cdot \tau_{c,\tilde{Y}_{1,i}} \cdot \tilde{Y}_{1,i}$. 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.

It should now 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 costless hedging is possible, firms facing a convex tax schedule should hedge all 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 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 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%.

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

Empirical implications

From the previous analysis it should be clear that the higher the convexity of effective marginal tax schedule, the greater the possible benefits from hedging. This convexity of the tax function is extended by tax preference items such as investment tax credits, tax loss carrybacks, and 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 -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. Because small firms are more likely to be in the progressive region of the tax schedule, small firms are also more likely to hedge. Furthermore, the more volatile the pre-tax income stream, the greater the advantages of hedging. Therefore, 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. However, if the expected gain from hedging pre-tax income depends on transaction costs (which is usually the case), 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. Thus, theory does not predict a clear relation between firm size and hedging activities.

2. Reduction in expected costs of financial distress

The second motive for hedging relates to situations in which there are expected costs of financial distress. Mayers and Smith [1982], Smith and Stulz [1985], Froot, Scharfstein, and Stein [1993], and Nance, Smith, and Smithson [1993] show that hedging can increase firm value, whenever there are expected costs of financial distress. According to Rawls and Smithson [1990], the expected costs of financial

distress are a positive function of 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 (e.g., higher contracting costs for new employees, loss in sales).[10]

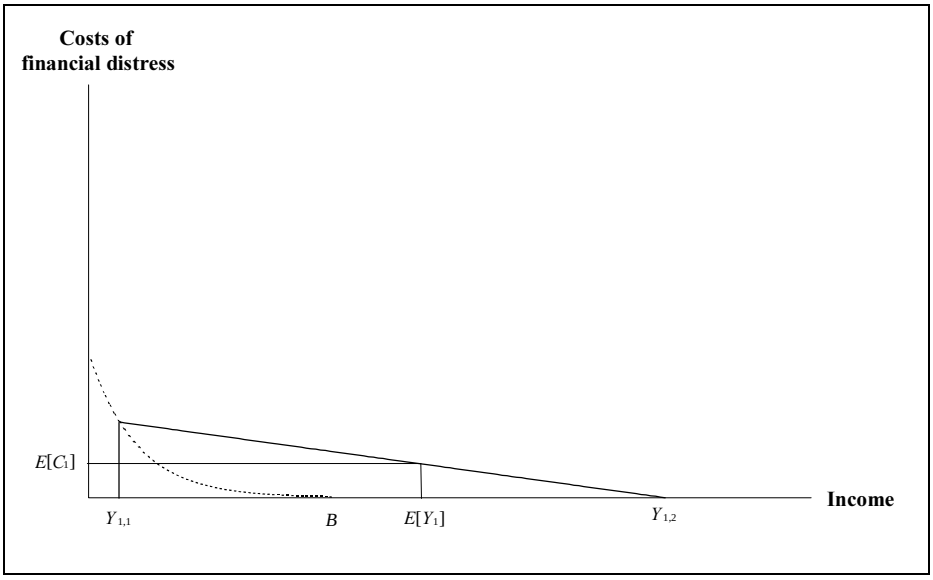
As an example, we again assume a one-period model in which there are two possible future states of the world. For simplicity, we abstract from taxes.[11] Possible future income in the two states of the world is given by $Y_{1,1}$ and $Y_{1,2}$. Income $Y_{1,i}$ is assumed to be before direct costs of financial distress.[12] The firm has zero-coupon bonds outstanding, with a principal equal to B. Furthermore, assume that all debt matures at a single time t_1. At time t_1 all cash flows are paid to the different claimants. If income $Y_{1,i}$ is below B, bankruptcy is declared. Shareholders receive nothing whereas bondholders receive income minus the costs of bankruptcy. If future income is above B, bondholders are fully repaid. Shareholders receive income minus the payment to the bondholders. Suppose that the states of the world are ordered such that $Y_{1,1} < B < Y_{1,2}$. The consequences of hedging on the expected costs of financial distress are shown in figure 2. The dotted line represents the (direct) costs of financial distress.

[10] See e.g., Warner [1977] and Altman [1984].

[11] If we would include taxes, it would complicate the analysis. However, the basic message will be the same.

[12] 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.

Figure 2: The effect of hedging on the expected costs of financial distress



Where:

$Y_{1,1}$ = The firm's income at time 1 if state 1 occurs;

$Y_{1,2}$ = The firm's income at time 1 if state 2 occurs;

B = The face value of debt;

$E[Y_1]$ = The expected income;

$E[C_1]$ = The expected costs of financial distress without hedging.

If the firm does not hedge, current firm value V_0 equals $p_1 \cdot \left(Y_{1,1} - C_{1,Y_{1,1}}\right) + p_2 \cdot Y_{1,2}$. If management can engage in a perfect hedge, and make sure future income is larger than the payment to the bondholders, financial distress, or more importantly, costs of financial distress will be avoided. The necessary condition for avoiding financial distress is that the forward price has to exceed the promised payment to the bondholders. If hedging is costless, firm value increases by the present value of the

expected costs of financial distress, i.e., $V_0^* = V_0 + p_1 \cdot C_{1,Y_{1,1}}$, where V_0^* is the current firm value in case of a perfect hedge. [13]

If we, again, turn to a more general setting, the present value of the expected costs of financial distress is equal to $\sum_{i=1}^{M} p_i \cdot C_{1,Y_{1,i}}$, with *M* states of the world with direct costs of financial distress.[14] If a perfect hedge can avoid bankruptcy, firm value will be equal to $\sum_{i=1}^{N} p_i \cdot \left(Y_1^* - C_{1,Y_1^*}\right) = \frac{Y_1^* - C_{1,Y_1^*}}{1+r} = \sum_{i=1}^{N} p_i \cdot Y_{1,i}$, since $C_{1,Y_1^*} = 0$. Thus, firm value increases by $\sum_{i=1}^{M} p_i \cdot C_{1,Y_1}$, which is the present value of the expected costs of financial distress.

What is not stated in the literature so far is that if a perfect hedge cannot avoid bankruptcy, it may still be the best policy for the firm to hedge. As long as $\sum_{i=1}^{M} p_i \cdot C_{1,Y_1}$ is larger than $\frac{C_{1,Y_1^*}}{1+r}$, it is still optimal for the firm to hedge, even though this will result in bankruptcy.[15] The bondholders become the new owners of the firm, and some 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 $\sum_{i=1}^{S} p_i \cdot C_{1,\tilde{Y}_{1,i}}$, where $\tilde{Y}_{1,i}$ is a vector of hedged

[13] 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 a 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.

[14] Note that $1 < M < N$. So, $\sum_{i=1}^{M} p_i < \sum_{i=1}^{N} p_i$.

[15] 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 financial distress may be divided by both parties. However, agency problems complicate the situation. See section 3.

future income. [16] Because the hedge is not perfect, $\tilde{Y}_{1,i}$ still exhibits some volatility, but less than $Y_{1,i}$. If the firm hedges, the increase in firm value is $\sum_{i=1}^{M} p_i \cdot C_{1,Y_{1,i}}$ - $\sum_{i=1}^{S} p_i \cdot C_{1,\tilde{Y}_{1,i}}$, 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. If hedging is costly, firms should, again consider the marginal tradeoff between the benefits of hedging (i.e., the reduction in expected costs of financial distress) and the costs of hedging.

Empirical implications

From the preceding 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. Therefore, small firms are more likely to hedge. Because the possibility of a bankruptcy is larger when firms have more fixed claims, firms with higher debt ratios are also more likely to hedge. Furthermore, a higher volatility of a firm's income stream results in a higher possibility of financial distress. Thus, the higher the volatility of income, the greater the advantages of hedging. Finally, the lower the credit rating of a firm, the higher the probability of entering into financial distress. 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 1, there is no clear prediction whether or not smaller firms should hedge more or less than larger firms. Empirical research should provide evidence whether tax reductions and costs of financial distress, or, economies of scale explains hedging activities.

[16] Note that there are less (i.e., *M*-*S*+1) states of the world with costs of financial distress.

3. Reduction in agency costs of debt

Hedging can be a value-increasing strategy if it mitigates suboptimal investment policies, thereby reducing agency costs of debt. This suboptimality 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.

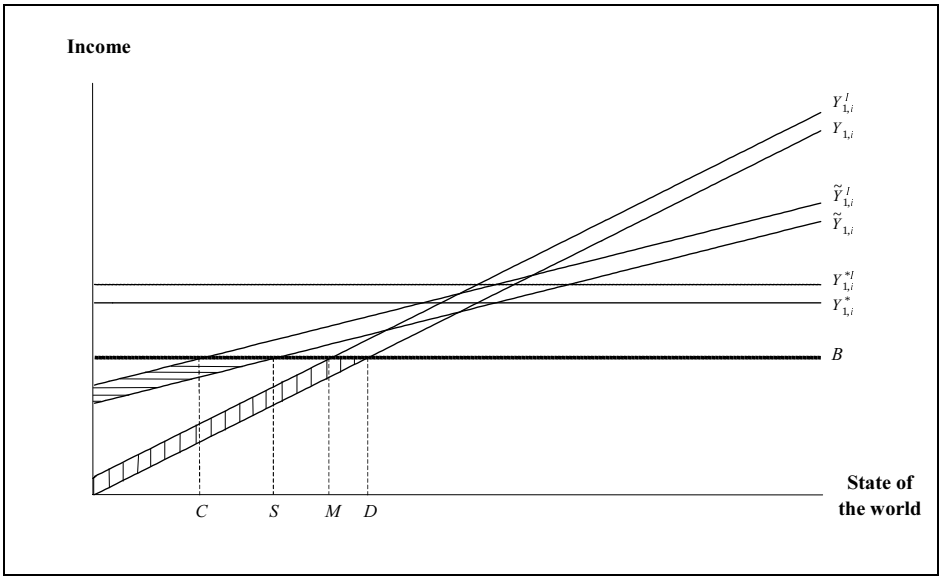
The first one is the so-called underinvestment problem in the case of debt overhang (see Myers [1977]). Myers shows that investment opportunities can be seen as options. The management of a firm in financial distress (acting in the interest of shareholders) may forgo some of the profitable investment 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 is negative. Shareholders, acting in their own interest, forgo these investment opportunities, which reduces overall firm value.

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 go 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. If hedging can mitigate the debtholders' expected opportunities of being expropriated, it will reduce the cost of debt financing, which increases firm value. The effects of hedging on the agency costs of debt are shown in figure 3.[17] The figure is adapted from Bessembinder [1991].

[17] 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 increases the number of future states in which the equity-holders are the residual claimants. Therefore, a

Figure 3: The effect of hedging on the underinvestment problem



Suppose the firm has issued zero-coupon bonds with a principal equal to B. which mature at time t_1. Initial income for the different future states of the world is given by the line $Y_{1,i}$. Bankruptcy will be declared if income is less than B, which happens for states of the world smaller than D.[18] Suppose the firm has an investment opportunity, which results in an incremental future income I_1. This investment opportunity has to be financed by the shareholders. If the firm decides to invest, future income shifts up to the line $Y^{I}_{1,i}$, where $Y^{I}_{1,i} = Y_{1,i} + I_1$. In the absence of agency costs, firm value would increase to $V_0 = \sum_{i=1}^{N} p_i \cdot (Y_{1,i} + I_1) - C_0$, where C_0 is the current cost of investing. However, part of the increase in firm value accrues to the bondholders; i.e.,

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.

[18] Note that the states are ordered from 'bad' states of the world to 'good' states of the world.

$\sum_{i=1}^{D} p_i \cdot \lambda_i \cdot I_1$, where λ_i is the proportion of incremental income going to the bondholders.[19] This value is given by the vertically shaded are in figure 3. Thus, the incremental value for the shareholders equals $\sum_{i=1}^{N} p_i \cdot I_1 - \sum_{i=1}^{D} p_i \cdot \lambda_i \cdot I_1 = \sum_{i=M}^{N} p_i \cdot (1-\lambda_i) \cdot I_1$, which will be the maximum amount shareholders are willing to pay for the investment.[20] Because only part of the incremental value accrues to shareholders, they will be inclined to underinvest since, for them, some positive NPV-projects have a negative NPV, that is, for investments for which $\sum_{i=1}^{N} p_i \cdot I_1 > C_0 > \sum_{i=M}^{N} p_i \cdot (1-\lambda_i) \cdot I_1$. Now, suppose the firm is able to hedge future income perfectly. By hedging perfectly, future income is given by the line $Y_{1,i}^{*}$. If the firm decides to invest, this line will shift up to $Y_{1,i}^{*I}$. Bondholders will surely be paid and the complete value of the investment now goes to the shareholders. The underinvestment as well as the risk-shifting problem disappears, which reduces the agency costs of debt to zero.[21] If it is not possible to create a perfect hedge, future income in the different states of the world is given by the line $\tilde{Y}_{1,i}$. The investment shifts this line up to $\tilde{Y}_{1,i}^{I}$. Bondholders will be repaid in all states of the world greater than *C*. The value of the investment accruing to the bondholders now equals $\sum_{i=1}^{S} p_i \cdot \tilde{\lambda}_i \cdot I_1$, where $\tilde{\lambda}_{ii}$ is the

[19] For $1 \le i \le M$, λ_i=1. For $M < i < D$, $0 < \lambda_i < 1$ and monotonically decreasing. For $i \ge D$, $\lambda_i = 0$.

[20] Remember that the shareholders have to pay for the whole investment. However, only part of the NPV ($\sum_{i=M}^{N} p_i \cdot (1-\lambda_i) \cdot I_1$) accrues to them.

[21] See footnote 17.

proportion of incremental income for the bondholders in case of an imperfect hedge.[22] In figure 3, this value is represented by the horizontally shaded area, and is less than in the no-hedging case; i.e., $\sum_{i=1}^{D} p_i \cdot \lambda_i \cdot I_1 - \sum_{i=1}^{S} p_i \cdot \tilde{\lambda}_i \cdot I_1 = \sum_{i=C}^{D} p_i \cdot \tilde{\lambda}_i \cdot I_1 + \sum_{i=S}^{D} p_i \cdot \lambda_i \cdot I_1 > 0$. The incremental value for the shareholders equals $\sum_{i=1}^{N} p_i \cdot I_1 - \sum_{i=1}^{S} p_i \cdot \tilde{\lambda}_i \cdot I_1 = \sum_{i=C}^{N} p_i \cdot (1 - \tilde{\lambda}_i) \cdot I_1$. 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.

So, 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 debt to be less sensitive to incremental investments. Therefore, shareholders gain more from additional investments, which increases their willingness to provide funds for positive NPV projects. Furthermore, because shareholders will potentially lose more if they engage 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. Logically, shareholders cannot do this on their own.

Empirical implications

Both the underinvestment and risk-shifting problems are more pronounced in Myers' [1977] case of debt-overhang. Thus, 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 the underinvestment

[22] Note that for $1 \leq i \leq C$ $\tilde{\lambda}_i = 1$. For $C < i < S$, $0 < \tilde{\lambda}_i < 1$ and monotonically decreasing. For $i \geq S$, $\tilde{\lambda}_i = 0$.

problem, these firms have a greater incentive to undertake a hedging program which reduces the volatility of the firm. 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 use more derivatives to hedge their risks. Furthermore, firms spending a lot on research and development (R&D) are expected to experience more growth in the future. Therefore, firms with a higher ratio of R&D to firm value should use more derivatives to hedge the volatility of firm value. Thus, highly-levered firms with a relatively large amount of growth options are expected to gain the most from hedging.

4. Risk attitude of managers

The previously mentioned three motives for corporate risk management are based on shareholder value maximization. The fourth motive belongs to a different category because it is based on managerial utility maximization.[23] Stulz [1984], Smith and Stulz [1985], and Tufano [1996] argue that management's risk attitude can explain the corporate use of derivatives, if their expected utility depends on the distribution of future firm value. Corporate risk management changes the distribution of future firm value and, thus, management's expected utility.

Again, we assume a one-period model in which an all-equity firm's income at the end of period one will be paid to the different owners of the firm. Furthermore, assume the corporation pays no corporate taxes. Finally, suppose a manager is risk-averse such that his expected utility U is a concave function of firm value, i.e., $U\left(W(Y_{1,i})\right)$, with $\frac{\partial U}{\partial W(Y_i)} > 0$, and $\frac{\partial^2 U}{\partial W(Y_{1,i})^2} < 0$. Suppose the manager's utility is completely tied to the value of the firm because his total wealth is equal to a fraction γ of the firm. Thus, $W_0 = \gamma \cdot V_0 = \gamma \cdot \left(\sum_{i=1}^{N} p_i \cdot Y_{1,i} \right)$, where the symbols used, are the same as before. The manager's expected wealth equals $E[W_1] = \gamma \cdot \left(\sum_{i=1}^{N} q_i \cdot Y_{1,i} \right)$, where q_i is

the probability that state *i* occurs. If firm value is hedged perfectly $E[W_1] = \gamma \cdot \left(\sum_{i=1}^{N} q_i \cdot Y_{1,i}^* \right) = \gamma \cdot Y_1^*$. Since the utility of wealth is strictly concave, it follows from Jensen's inequality that the utility of the expected wealth is larger than the expected utility of wealth, i.e., $U\left(E\left[W_1\right]\right) > E\left[U\left(W_1\right)\right]$. Utility will be maximized if firm value is hedged completely.

A problem with this argument is that it only holds in a world in which all financial assets have the same expected rates of return. If this is not the case, the manager will 'lose' some future income by hedging, since the hedged wealth will be less than the expected wealth. The manager will have to make a trade-off between the loss in wealth, and the decreased 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, completely.

Suppose now that a manager earns a basic wage Ψ, but can earn a relatively large amount of bonuses equal to $\alpha \cdot Max(Y_{1,i} - X, 0)$. Thus, the manager is granted a bonus if future income exceeds a certain amount *X*. Effectively, the manager owns α European call options on the firm with an exercise price equal to *X*. This will make the manager's payoff a convex function of firm value. The manager's total wealth equals $\Psi + \alpha \cdot \sum_{i=1}^{N} p_i \cdot Max(Y_{1,i} - X, 0)$. Option theory shows that an increase in volatility makes options more valuable.[24] So, if the payoff function of a manager is a strictly convex function of firm value, the manager maximizes his expected wealth if he does not hedge at all. More strongly, it can 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. Thus, even though the manager is risk averse, he will be inclined to relatively higher risk-taking behavior because a higher volatility of the firm increases his personal utility of wealth. Of course, the degree of derivatives' use depends on a number of factors. It can be expected that

[23] In the sections 1 through 3, managers are supposed to act in the interest of shareholders. In this section, managers act in their own interest.

managers hedge less if 1) they have a relatively large amount of call-option features in their bonus schemes, 2) the options are at-the-money, since, in this case, they are most sensitive to changes in volatility,[25] 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 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. This 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.

Empirical implications

Maximization of managerial utility depends on the way personal wealth is linked to firm value. If managers own a significant fraction of the firm, it can be expected that the firm will hedge more of its risks. This gives an incentive for closely-held corporations to hedge since the managers/owners do not hold well-diversified portfolios. Therefore, assuming risk aversion, they have incentives to reduce the volatility of firm value. Thus, one may expect closely-held firms to engage in hedging programs. For widely-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 firm is expected to hedge. Even

[24] See e.g., Black and Scholes [1973].

[25] Note that if the options are 'too' 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.

stronger, it may be advantageous for managers to increase the firm's financial and business risks.

5. Evidence on corporate risk management

Several recent articles give some empirical evidence on corporate risk management activities 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, and Monte Carlo simulation.

Survey analysis can greatly contribute to the understanding of empirical firm behavior, in particular when it comes to its qualitative dimensions. 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 hedge. 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 analysis. The empirical findings regarding Monte Carlo analysis, however, are rather limited. To date, only a paper by Graham and Smith [1999] discusses the tax advantages of hedging. The results from

regression analysis are summarized in table 1. These results, as well as the results from survey and Monte Carlo analysis, are discussed in the following subsections.

Table 1: Empirical evidence on corporate risk management

Variable	Expected Sign[1]	Sign found						
		NSS[2]	Mian[3]	BB[4]	Tufano[5]		FCC[6]	GMS[7]
Expected taxes								
Tax loss carryforwards	+	-	-***	+**	+	-**	+	+
Tax credits	+	+***	+***				+**	
Income in progressive region	+	+**	-***					
Costs of financial distress								
Debt-to-value	+	-		+***	+	+	+	-*
EBIT-to-interest expense	-	-		-			-*	-
Agency costs								
R&D-to-value or sales	+	+**					+*	+***
Market-to-book value	+	-	-**				-	+***
Earnings-to-price	-			+***				
Asset growth-to-cash flow	+			-				
PPE-to-size	-							-**
Managerial utility								
Managerial option ownership	?				-	+*		+***
Managerial share ownership	+			-	-	+*	-*	+
Firm size								
Market value	?	+***	+***	+***	+	+	+***	+***
Total assets	?						+***	
Sales	?						+***	

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

[1] The expected sign of the variable is defined as the mean of derivatives users minus the mean of non-users (U-NU).

[2] Empirical evidence by Nance, Smith, and Smithson [1993] for 169 US corporations.

[3] Empirical evidence by Mian [1996] for 3,022 US corporations.

[4] Empirical evidence by Berkman and Bradbury [1996] for 116 New Zealand corporations.

[5] 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.

[6] Empirical evidence by Fok, Carroll, and Chiou [1997] for 369 US corporations.

[7] Empirical evidence by Géckzy, Minton, and Schrand [1997] for 372 US corporations.

Expected taxes

As shown in section 1, firms are more likely to hedge if they 1) are in the progressive region of the marginal tax schedule and 2) they have more tax preference items. Hedging reduces the expected tax liability by reducing the variability of pre-tax income. However, as shown in table 1, evidence from regression 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.

Some other researchers have used survey analysis to investigate whether firms hedge in order to minimize expected tax payments. Bodnar, Hayt, and Marston [1996] conduct a survey among 350 non-financial US firms. According to these firms, their most important objective for hedging is managing cash flows, which is, according to Bodnar, Hayt, and Marston, consistent with the standard economic explanations of the potential benefits of hedging, like reducing expected taxes. However, managers do not explicitly state that they actively manage pre-tax income in order to reduce the expected tax payments. Berkman, Bradbury, and Magan [1997] survey 79 New Zealand corporations. Here, none of the corporations indicate that they use derivatives in order to minimize expected taxes.

Graham and Smith [1999] use a Monte Carlo approach to derive the possible benefits of hedging. 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 volatility. These tax savings can be worth millions of dollars. So, hedging pre-tax income can lead to substantial increases in firm value.

Overall, empirical evidence about hedging in order to reduce taxes is mixed, although Graham and Smith [1999] show that hedging 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 1, firms with a higher volatility of pre-tax income are more likely to hedge. However, the big 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].

Expected costs of financial distress

In section 2, it was shown that firm value can be increased, if hedging can lower the expected costs of financial distress. Theory predicts that the value of hedging is greater for smaller firms, and for firms with a higher financial leverage. As shown in table 1, empirical evidence regarding leverage is not very strong. As Nance, Smith, and Smithson remark [1993], the 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). Furthermore, consistent with theory, all researchers find a negative relation between hedging and the interest coverage ratio. Nevertheless, only Fok, Carroll, and Chiou [1997] find a significant negative relation. 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.

Bodnar, Hayt, and Marston [1996] find from their survey that US non-financial firms use derivatives in order to manage cash flows. They conclude that this is consistent with minimizing costs of financial distress. Berkman, Bradbury, and Magan [1997] find that all of the New Zealand firms use derivatives in order to reduce the volatility of 1) earnings, 2) cash flows, and 3) firm value. Although it is not mentioned by Berkman, Bradbury, and Magan, this could be seen as trying to reduce expected costs of financial distress. However, in both studies, managers do not explicitly state that they hedge in order to avoid certain costs of financial distress.

One can conclude 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. An extra variable that may be used is Altman's [1968] Z-score. A modified Z-score has been used by MacKie-Mason [1990] and Graham, Lemmon,

and Schallheim [1998]. Furthermore, we can use 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). However, again we deal with the problem of the interrelation between the volatility of the firm's earnings and hedging. Finally, credit ratings can be used to proxy for the possibility of encountering financial distress.

Agency costs of debt

In section 3, 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 opportunities. As shown in table 1, the only significant variable is R&D-to-value or -sales. All three regression analyses including this variable show that, for their database, there is a significant positive relation between hedging and R&D activities. For the other variables trying to capture possible growth opportunities, the evidence is less convincing. Furthermore, as shown before, the evidence regarding leverage is also mixed.

In their survey, Bodnar, Hayt, and Marston [1996] find that US non-financial firms use derivatives in order to reduce the agency costs of debt. Berkman and Bradbury [1997] find similar results for New Zealand corporations. However, the explicit argument is not stated by the corporate managers.

Concluding, we can say that empirical evidence reasonably supports the hypotheses regarding reducing agency costs of debt. Firms with more growth opportunities and low accessibility to external financial capital hedge cash flows in order reduce agency costs of debt.

Managerial utility

Section 4 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 will be inclined to hedge less, or even speculate. As shown in table 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.[26] These results are consistent with the hypothesis that managers may increase firm risk in order to maximize their own utility of wealth. However, it remains unclear whether derivatives are used in order to reduce or increase risk. 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, whereas Fok, Carroll, and Chiou [1997] find a negative relation.

Overall, we can conclude that empirical evidence regarding managerial utility maximization is not very supportive.

Firm size

From the previous sections, it was impossible to predict a clear relation between firm size and corporate risk management. 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 relatively small firms.[27] 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.[28] However, because smaller firms probably face substantially higher transaction costs of hedging, it may also be possible that larger firms are more likely to use derivative instruments in their risk management programs. From table 1, we can conclude that explanation of transaction costs dominates the motives for reducing expected taxes and costs of financial distress. In almost all research a significant positive relation between firm size and the use of derivative instruments is found. Larger firms are

[26] Note that Tufano only finds a significant positive relation for part of the sample. See table 1.

[27] See section 1.

[28] See section 2.

probably in a better position of setting up a risk management program and contracting specialized employees.

Thus, 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.

6. Summary

In this paper, we have given an overview on the theoretical and empirical literature on corporate risk management. Theoretically, hedging can increase firm value if it reduces the expected tax liability, expected costs of financial distress, and agency costs of debt. Furthermore, expected utility of management can explain the corporate use of derivatives. Empirical evidence regarding tax hypotheses is mixed. Graham and Smith [1999], 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 mixed. Inclusion of other variables like Altman's Z-score and credit ratings may lead to better results. Empirical evidence for reducing the agency costs of debt is more supportive. Firms with more growth opportunities, as measured by R&D, and low accessibility to external financial capital 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] finds clear evidence that managers use derivatives in order to maximize their own expected wealth. Evidence regarding firm size, finally, is very convincing. Large firms, as compared to small firms, make far greater use of derivatives. 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 paying the large initial costs of setting up a risk management program, and contracting specialized employees. However, it may be the case that lots of firms are simply not acquainted with the potential benefits of hedging, like minimizing expected tax payments and costs of financial distress. Graham and Smith [1999] shows that these benefits can be large in case of reducing the expected tax payments. Probably, the same kind of simulation approach has to be applied in order to numerize the effects of reducing the expected

costs of financial distress and the agency costs of debt. Quantifying these effects will probably be tricky since the estimation of the costs will be difficult. Another problem may be that corporate risk managers may not behave as rational as assumed in the theoretical models. Finally, the preceding analysis assumes that there are market imperfections but that the market is complete, that is, there is a constant spanning of assets. So, if a firm wants to hedge, for instance, its pre-tax income, there exist derivative instruments (or combinations of derivate instruments) to do so perfectly. In a real world setting, this is not the case and the potential benefits of hedging will decrease. In future research a lot remains to be done.

References

Altman, E.L., 1968, "Financial Ratios, Discriminant Analysis, and the Prediction of Corporate Bankruptcy", *Journal of Finance*, Vol. 23, pp. 589-609.

Altman, E.L., 1984, "A Further Empirical Investigation of the Bankruptcy Cost Question", *Journal of Finance*, Vol. 49, pp. 1067-1089.

Berkman, H., and M.E. Bradbury, 1996, "Empirical Evidence on the Corporate Use of Derivatives", *Financial Management*, Vol. 25, pp. 5-13.

Berkman, H., M.E. Bradbury, and S. Magan, 1997, "An International Comparison of Derivatives Use", *Financial Management*, Vol. 26, pp. 69-73.

Bessembinder, H., 1991, "Forward Contracts and Firm Value: Investment Incentive and Contracting Effects", *Journal of Financial and Quantitative Analysis*, Vol. 26, pp. 519-532.

Black, F., and M. Scholes, 1973, "The Pricing of Options and Corporate Liabilities", *Journal of Political Economy*, Vol. 81, pp. 637-654.

Bodnar, G.M., G.S. Hayt, and R.C. Marston, 1996, "1995 Wharton Survey of Derivatives Usage by Us Non-Financial Firms", *Financial Management*, Vol. 25, pp. 113-133.

Fok, R.C.W., C. Carroll, and M.C. Chiou, 1997, "Determinants of Corporate Hedging and Derivatives: A Revisit", *Journal of Economics and Business*, Vol. 49, pp. 569-585.

Froot, K.A., D.S. Scharfstein, and J.C. Stein, 1993, "Risk Management: Coordinating Corporate Investment and Financing Policies", *Journal of Finance*, Vol. 48, pp. 1629-1658.

Géckzy, C., B.A. Minton, and C. Schrand, 1997, "Why Firms Use Currency Derivatives", *Journal of Finance*, Vol. 52, pp. 1323-1354.

Graham, J.R., M. Lemmon, and J. Schallheim, 1998, "Debt, Leases, Taxes, and the Endogeneity of Corporate Tax Status", *Journal of Finance*, Vol. 53, pp. 131-162.

Graham, J.R., and C.W. Smith, 1999, "Tax Incentives to Hedge", *Journal of Finance*, Vol. 54, pp. 2241-2260.

Hentschel, L., and S.P. Kothari, 1998, "Are Corporations Reducing or Taking Risks with Derivatives?", *Working Paper*, University of Rochester.

Jensen, M.C., and W.H. Meckling, 1976, “Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure”, *Journal of Financial Economics*, Vol. 3, pp. 305-360.

MacKie-Mason, J., 1990, “Do Taxes Affect Corporate Finance Decisions?”, *Journal of Finance*, Vol. 45, pp. 1471-1493.

Mayers, D. and C.W. Smith, 1982, “On the Corporate Demand for Insurance, *Journal of Business*, Vol. 55, pp. 281-296.

Mian, S.L., 1996, “Evidence on Corporate Hedging Policy”, *Journal of Financial and Quantitative Analysis*, Vol. 31, pp. 419-439.

Modigliani, F., and M.H. Miller, 1958, “The Cost of Capital, Corporation Finance and the Theory of Investment”, *American Economic Review*, Vol. 48, pp. 261-297.

Myers, S.C., 1977, “Determinants of Corporate Borrowing”, *Journal of Economics*, Vol. 5, pp.147-175.

Nance, D.R., C.W. Smith, and C.W. Smithson, 1993, “On the Determinants of Corporate Hedging”, *Journal of Finance*, Vol. 48, pp. 267-284.

Rawls, S.W., and C.W. Smithson, 1990, “Strategic Risk Management”, *Journal of Applied Corporate Finance*, Vol. 3, pp. 6-18.

Smith, C.W., 1995, “Corporate Risk Management: Theory and Practice”, *Journal of Derivatives*, Summer, pp. 21-30.

Smith, C.W., C.W. Smithson, and D.S. Wilford, 1990, *Managing Financial Risk*, Harper Business, New York.

Smith, C.W., and R.M. Stulz, 1985, “The Determinants of Firms’ Hedging Policies”, *Journal of Financial and Quantitative Analysis*, Vol. 20, pp. 391-405.

Stulz, R.M., 1984, “Optimal Hedging Policies”, *Journal of Financial and Quantitative Analysis*, Vol. 19, pp. 127-140.

Stulz, R.M., 1996, “Rethinking Risk Management”, *Journal of Applied Corporate Finance*, Vol. 9, pp. 8-24.

Stulz, R.M., and R. Williamson, 1997, “Identifying and Quantifying Exposures”, in: *Financial Risk and the Corporate Treasury: New Developments in Strategy and Control*, Robert Jameson, ed., Risk Publications, London, pp. 33-51.

Tufano, P., 1996, “Who Manages Risk? An Empirical Examination of Risk Management Practices in the Gold Mining Industry”, *Journal of Finance*, Vol. 51, pp. 1097-1137.

Warner, J.B., 1977, “Bankruptcy Costs: Some Evidence”, *Journal of Finance*, Vol. 32, pp. 337-347.