CHAPTER 7
WHY IS RISK COSTLY TO FIRMS?

RISK AND SHAREHOLDER DIVERSIFICATION

Risk is diversifiable in the capital market.
Risk is not diversifiable in the capital market.

WHY IS RISK COSTLY TO FIRMS?

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CHAPTER 7
WHY IS RISK COSTLY TO FIRMS?

Finance theory leaves us with a risk management puzzle for it seems to imply that reducing or removing risk (especially insurable risk) has no value for the publicly traded firm. The story can be told in various ways. Suppose a firm faces the prospect of an uninsured or unhedged loss. This introduces risk to the firm's value. However, this risk is spread over the firm's shareholders, each of whom will bear only a small part of the risk. Moreover, many shareholders (especially institutional shareholders) are highly diversified. Thus, the effect of the risk from the uninsured firm on the portfolio risk of each shareholder, is minimal. This is especially true if the uninsured risk is uncorrelated with the remaining risk in the shareholders' portfolios. The risk of loss to a single firm is essentially diversified across the capital market. In effect, it is insured by the capital market. Just as insurance spreads the effect of loss across a population of policyholders similarly exposed to risk, public ownership spread corporate loss across investors, who each assume a small portion of the risk of each firm. But the story gets better. Normally uninsured losses are tax deductible. With a 34% tax rate, the loss is deductible and is diversified across all the nation's taxpayers. Thus, an uninsured or unhedged loss is diversified in a very complete sense; one third is diversified across all taxpayers, and the other third is diversified throughout the capital market. Surely no insurance market could achieve a better spreading of the effects of risk.

The capital asset pricing model tells the story in a more precise way. Suppose first that the unhedged loss is uncorrelated with aggregate wealth or the market portfolio, i.e., the risk has zero beta. In this case, the risk can be borne effectively at no cost by shareholders who can diversify the unhedged risk simply by their choice of investment portfolio. Accordingly, hedging the risk has no value to shareholders and will not affect the stock price *ex ante*. Shareholders will not reward management for hedging a risk that they could hedge themselves at little or no cost. Now consider that the unhedged risk is correlated with the market portfolio. In this case, leaving the risk unhedged does affect the investor's portfolio risk and will command a price. Leaving the risk unhedged will change the firm's beta which will affect the equilibrium price of its stock. However, selling the risk to a risk bearer, such as an insurer, will normally command a risk premium related to the beta of the transferred risk. Thus, when the firm hedges the risk, the effect on the investor is two fold; first the risk of the investor's portfolio is reduced, and second the earnings of the investor will fall by the risk premium paid to the insurer. It is identical to the effect that could have been achieved by the investor simply by switching a little of her portfolio between stocks

with different betas. Again, why would the shareholders wish to reward the firm's management for hedging when they could achieve the same effect simply by re-adjusting their portfolio.

It seems we have something of a conundrum. Shareholders, apparently should have no interest in managing risk according to conventional finance theory. The purpose of this chapter is to tell a different story about why risk is costly. The basic message of this story is rather surprising. It turns out that risk is important to shareholders, not because the risk *per se* is a problem to the firm's owner's, but because risk can have indirect effects that will reduce *expected* shareholder income. Moreover, we need to understand these disruptive effects of risk since appropriate risk management strategies can be formed effectively only if we understand the precise effects of risk. Indeed some risk management strategies need to target the precise disruptions caused by risk. In the remainder of this chapter we examine why risk is costly to firms. We explore a set of ideas that have gained currency since the early 1980's. We will show that unhedged risk can increase expected taxes; it can cause agency conflicts between various classes of corporate stakeholders that result in dysfunctional investment decisions; it can deprive the firm of funding for new investments and it can interfere with the design of effective compensation plans for managers. But first, we will examine in more detail the counter case that risk can be handled simply be shareholders and that its retention has little direct cost to the firm's owners.

RISK AND SHAREHOLDER DIVERSIFICATION

Before considering the *why* risk is costly to firms, first consider the *why not*. Consider the following rationale for corporate risk management. *Investors typically do not like risk; therefore value will be created for shareholders if the firm hedges risk*. Two levels of argument will be made. The first address the question under the assumption that the risk is diversifiable to investors; in capital asset pricing model terms, the earnings have a zero beta. The subsequent argument addresses the question when the beta is not zero.

Risk is diversifiable in the capital market.

Consider insurable events such as fires and liability suits. Most insurable losses appear to have little of no correlation with capital market indices. Does it matter to investors whether firms insure such risks or not? To pursue this, take an investor that has \$1000 invested and this is allocated in equal weight, w_i , over 10 different

assets (so $w_i = 0.1$) each having an expected return, $E(r_i)$, of 0.1 and a standard deviation, $\sigma(r_i)$, of 0.1. Each of the firms has purchased some insurance and the remaining risk is simply unhedged. The risks of the firm are uncorrelated. Clearly, the overall expected return for the investor is 0.1 and the investor's risk is calculated by the following formula:

$$\sigma(r) = \sqrt{\sum_i w_i^2 \sigma^2(r_i) + \sum\sum_{i \neq j} w_i w_j r_{ij} \sigma(r_i) \sigma(r_j)}$$

$$\sigma(r) = \sqrt{(10)\left(\frac{1}{10}\right)^2 (0.1)^2} = 0.032$$

Now, suppose one of the firms (firm # 10) cancels its insurance policy. This increases the standard deviation of that firm's return from 0.1 to 0.3. However, since the insurable risk was independent of market risk, this will not affect the typical correlation between this firm's return, and those of other firms. The correlations remain the same; in this case zero. But ask what the cancellation of the insurance will do to the expected return. Under our assumptions, the insurable risk would not have commanded a risk premium from the insurers (the insurer's shareholders could easily diversify this zero beta risk so they would not demand a risk premium). So, apart from any transaction costs in the insurance premium, firm 10's expected earnings would remain unchanged and so would its expected rate of return. The risk to the shareholders who has invested 1/10th of his capital in this firm has now increased as follows:

$$\sigma(r) = \sqrt{(9)\left(\frac{1}{10}\right)^2 (0.1)^2 + \left(\frac{1}{10}\right)^2 (0.3)^2} = 0.0424$$

However, suppose the investor accommodates this change in risk in firm # 10, simply by increasing the number of securities in his portfolio from 10 to 15; (each has a weight of 1/15)

$$\sigma(r) \quad = \quad \sqrt{(14)\left(\frac{1}{15}\right)^2(0.1)^2 \quad + \quad \left(\frac{1}{15}\right)^2(0.3)^2} \quad = \quad 0.032$$

which, ignoring some minor rounding error, is the same level of risk as he had before the tenth firm canceled its insurance.

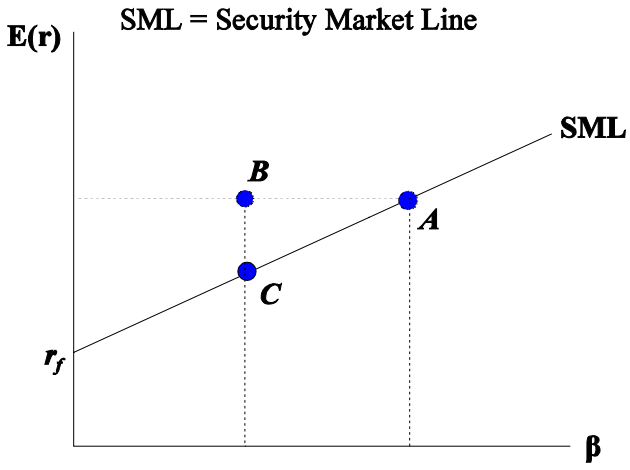
The point of this exercise is to show that, while firms can change their level of risk by hedging, so investors can change their level of risk in the choice of the portfolio. If there were no transaction costs either for the firm to buy insurance of for investors to buy and sell assets, then it would make no difference to owners whether firm bought insurance or not. If firms do hedge, investors can achieve desired risk-return levels by holding fairly small portfolios. If firms do not hedge, investors can achieve the same risk-return level simply by holding more assets. Investor diversification is a substitute for corporate hedging and insurance. One would not expect the capital market to reward those firms buying hedges by bidding up the values of their stocks.

We did ignore transaction costs which become relevant at two points. First, insurance will attract some transaction costs. This will include administration costs, and costs of settling claims, as well as frictional costs that arise from moral hazard. But it is also costly for investors to diversify. First, transaction costs tend to increase as a given capital sum is sub-divided over more securities; costs on smaller lots being proportionately higher. Thus, the issue of hedging seems to rest on which transaction costs are higher; will the saving of insurance transaction costs, outweigh the additional costs to investors of adjusting their portfolios to contain more securities?

But the second issue is probably more important. In the example given, the investor need not adjust to the cancellation of the insurance by holding more assets in his portfolio; he could simply sell shares in firm 10 and purchase shares in other firms with lower risk profiles (i.e. similar to that of firm 10 before it canceled its insurance). This argument speaks more to *changes* in hedging behavior than in the optimal *levels* of those hedges. If the firms choose *stable* risk management strategies, investors can structure their portfolios once and do not have to incur transaction costs in adjusting

their personal portfolios to offset changes in corporate risk profiles.

Figure Hedging a Systemmatic Risk



Risk is not diversifiable in the capital market.

Consider Figure 1 which shows the Capital Asset Pricing Model. A firm's stock is valued according to expected earnings and systematic risk (β), thus yielding the relationship between expected return and β. This firm's beta and expected return are shown at point A. Now the firm buys insurance. In this case, assume that insurable losses are less likely when the market index is high. Since losses are cash outflows, including such losses in a diversified portfolio will tend to increase systematic risk (holding a negative beta liability has the same effect on portfolio risk as holding a positive beta asset). Thus, when the firm insures this risk, it is like ridding itself of a positive beta asset and the firm's beta will fall. If the insurer were naive enough to sell this insurance for a premium equal to the expected value of loss, then the policyholder firm's expected income would not change, but its beta would be lowered. This is shown as position "B" in the Diagram. Clearly this is an attractive position for any investor; beta has been lowered without giving up any expected return. The stock is now underpriced. This stock would be in high demand, bidding its price up and therefore, the expected return would fall to position "C". This rise in price would be a capital gain to existing shareholders and would signal a reward for insuring the risk.

Now consider where the reward comes from. The firm rids itself of a negative beta liability (like a positive beta asset) and it was assumed the insurance firm did not charge a risk premium (over expected loss) for insuring the beta risk. Naturally, the insurance company's beta will be affected by this transaction; as the insuring firm's beta falls, so the insurance company's beta will rise. So the insurer's shareholders would naturally want this additional systematic risk to be priced in the insurance premium. If this is the case, the insurance transaction simply shifts the policyholder firm from "A" to "C" in the diagram. The firm's shareholders would find the firm correctly priced before the transaction given the initial beta. The insurance policy would reduce expected earnings (since now the insurer demands a risk premium) and

reduces the beta so that they are once again in balance. Just let me contrast the two situations.

> If insurers do not charge a risk premium; insurance reduces the firm's beta without reducing expected earnings. Consequently, the stock is under-priced and the price rises yielding a capital gain to shareholders.
>
> Insurer do charge a risk premium; insurance reduces the beta and reduces expected earnings. Thus the stock is still correctly priced and no price adjustment occurs in the firm's stock

So, back to the question, does hedging risk benefit shareholders? Then answer is no, if the party assuming the hedge prices it correctly. Of course shareholders can benefit if the insurer under-prices the insurance policy. But this is hardly a justification for risk management, it is a justification for buying under-priced assets. It is really no different from the firm buying a building, or machine, or license, for less than its market value. We can generalize this argument from the simple capital asset pricing model to later generation pricing models that also assume that diversifiable risk is not priced in the capital market.

Having argued why risk should not be a problem for publicly held firms, we now address why risk is a problem.

WHY IS RISK COSTLY TO FIRMS?

1. Tax effects - risk reduction and convex tax schedules[1]

The tax functions facing firms typically are convex. Higher levels of corporate earnings usually encounter higher rates of marginal taxation. The convexity may not be uniform, but nevertheless this is a typical pattern in many countries. To some degree, this convexity is built into the tax schedule; initial corporate earnings, like the first dollars of individual earnings, are untaxed at the Federal level. Above this threshold, earnings pass through several marginal rates, settling on a constant rate. But convexity also arises from other features of the tax code. Firms are allowed deductions for certain expenditures such as depreciation and loss carry backs. The effects of such deductions is to increase the range of income which attracts a zero marginal rate. The effects are graphed in Figure 2.

This non linearity in tax functions gives rise to a interesting relationship between risk and expected tax liability. The intuition is straightforward. Consider a firm with expected earnings of $B. If it earns exactly B dollars, then the firm's tax liability can be read straight off the tax schedule as illustrated in Figure 2. The tax liability for this firm is shown as T(B) (read this notation as the tax, T, appropriate to income B). Now consider a second firm which also has possible earnings of A or C as shown in Figure 2. If there is a 50% chance of either A or C, then the expected earnings are B (the same as for the first firm). This firm will either incur a tax liability of T(A) or T(C) each with a 50% chance. The expected tax is the weighted average of T(A) and T(B) shown as "E(tax)". Notice that the expected tax for the second firm is considerable higher than for the firm with certain income of B, despite the fact that the expected earnings of the two firms was identical at B.

Now this story can be translated into one of risk management. Starting with the second firm whose risky income can be either A or C. For example, C is the earnings of the uninsured firm if it does not suffer loss. A loss of assets or an uninsured liability could reduce income to A. The probability of this loss is say 50%. The expected earnings of the firm are at point B (B=0.5C+0.5A). If an insurance firms were to sell a policy covering a loss of AC with a 0.5 probability, it would have to charge a premium at least equal to the expected loss. Now an insurance policy

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[1]For ideas presented in this sub section see Smith and Stulz (1984), Scholes, Wilson and Wolfson 1990), and others.

bought at a premium of BC (the expected value of the loss which is 0.5 times AC), would give the firm a certain income of B. [2] Consider the tax effect of the insurance. If insurance is purchased, the firm's certain income is B and it will pay an appropriate tax of T(B). If the firm does not insure, it will have a tax liability of T(C) if it has no loss and a tax of T(A), if it does have a loss. The firm's expected tax is E(tax) as shown in Figure 2. The level E(T) is calculated as the (0.5)T(A)+(0.5)T(C). Thus, the expected tax is higher without insurance. Insurance reduces expected tax from E(tax) to T(B).

Consider a simple example. A firm has earnings that follow the distribution.

EARNINGS	***PROBABILITY***
0	*0.2*
100	*0.3*
200	*0.3*
300	*0.2*

EXPECTED VALUE = 150

The firm faces a 34% marginal tax rate but, due to progressivity of the code, and to tax shelters such as depreciation, the first 120 of earnings is free of tax. The firm's expected after tax income is (E denotes before tax earnings and S denotes the value of the earnings shielded):

[2] The insurance premium normally will be somewhat higher than BC, and the certain income of the firm will be slightly lower than point B, when transaction costs such as profit allowance, reserves and commissions are also factored into the premium.

E - MAX{0.34(E-S); 0}	***AFTER TAX EARNINGS***
0 - 0	*= 0*
100 - 0	*= 100*
200 - 0.34(200 - 120)	*= 172.8*
300 - 0.34(300 - 120)	*= 238.8*

EXPECTED VALUE = 129.6

Now consider that the firm can hedge this risk by a derivative instrument that will replace the risky earnings stream by its expected value which is 150. The firm's after tax income will be:

150 - 0.34(150 - 120) = 139.8

Which represents a gain of 10.2, without any change in the expected value of before tax earnings.

The representation of the tax code above is rather simple. One important omission is the ability of the firm to "carry forward" losses to future tax periods; i.e. negative income this year, can be used as a deduction against future earnings. Suppose, that the firm could carry forward each dollar of losses with interest, and the firm was absolutely certain that it would have sufficient future income to avail itself of the deductibility. The *expected present value* of each $1 carried forward would be a tax relief of (a negative tax liability is a tax benefit or refund):

$$-\frac{\$1(1+r)}{1+r} = -\$1$$

With this assumption, all income is either taxed at the marginal rate, or is forgiven at the marginal rate. Thus, the tax function would not be convex (kinked) as shown in figure 2, but would just be a straight line (shown as a short dashed line in Figure 3). Expected tax of positive and negative income would be symmetric with this linear tax function, and there would be no gain from hedging.

Now suppose that the probability that future earnings will be sufficient to use the carry forward is "p" which is less than unity, and that the loss cannot be carried

forward with interest. The expected present value of each $1 of carry forward would be:

$$- \frac{(p)\times\$1}{1+r}$$

which is a benefit of less than $1. This situation is depicted in Figure 3, as the wide dashed line. Notice that this line is convex and this implies that the expected tax liability from hedging, T(B), is lower than that for the unhedged position, E(tax). Thus, even with carry forwards, there is still a tax advantage to reducing the riskiness of earnings.

The tax gain described above, and illustrated with insurance, is not a specific tax preferences built into the tax code for insurance (e.g. a specific deductibility for insurance premiums). Rather it is a general tax benefit that can be secured by reducing the riskiness of earnings, whatever the source of the risk and whatever the nature of the hedge used. Finally, notice that the tax advantage from hedging is jurisdictional. The gain comes about be reducing the riskiness of earnings within a given tax jurisdiction, not necessarily from reducing the risk of global corporate earnings.

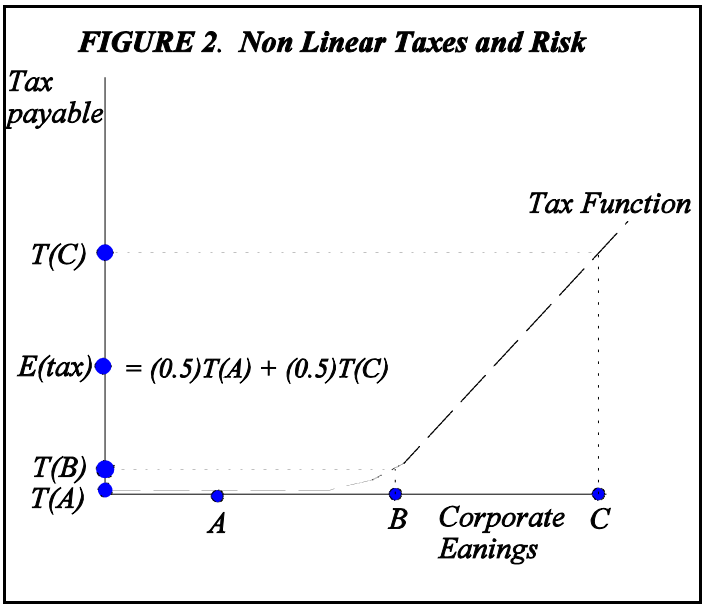


FIGURE 2. Non Linear Taxes and Risk
Tax payable
Tax Function
T(C)
E(tax)
= (0.5)T(A) + (0.5)T(C)
T(B)
T(A)
A
B
Corporate Eanings
C

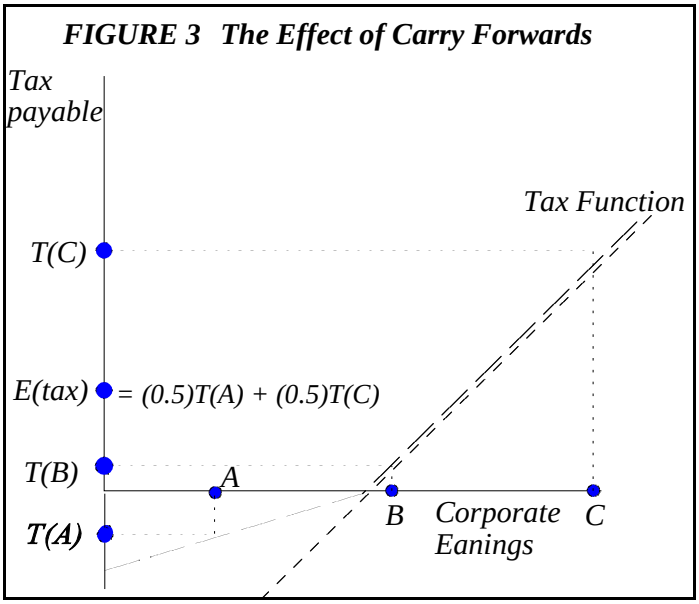


FIGURE 3 The Effect of Carry Forwards
Tax payable
Tax Function
T(C)
E(tax)
= (0.5)T(A) + (0.5)T(C)
T(B)
T(A)
A
B
Corporate Eanings
C

2. Risk management and the costs of financial distress

a. Direct Costs of Financial Distress

If a firm becomes bankrupt then, according to the absolute priority rule, shares expire worthless and the firm transfers to the creditors. Consequently, any transaction costs, such as legal fees, court fees, accounting costs, will be borne *ex post*, by the creditors. In addition to direct costs of bankruptcy, there may be indirect costs, or opportunity costs, which also will fall on creditors. For example, when a firm is administered by the court, the normal incentive structure which leads managers to perform efficiently may be disturbed. This may happen in two ways. Most directly, there are contracts written with managers, agents, employees and others which often have rewards and penalties associated with performance. During a bankruptcy, these contracts are sometimes challenged especially if they seem retroactively generous given the firm's current plight. Moreover, new contracts written during such a period are written under court influence. Will these contracts written under court supervision, carry the same incentive provisions as contracts written during a normal period under which the firm is monitored continuously by the capital market? To the extent that incentive compatibility is sacrificed during bankruptcy, the performance of the firm will suffer. The foregone value will be lost to the creditors who now "own" the firm. Similarly, value may be lost if the selection of investment projects is affected by court supervision. For example, during solvent operations, and capital market accountability, the firm may be aggressive in its project selection and earn the appropriate premium associated with such entrepreneurial activity. If the bankrupt firm is less entrepreneurial in its project selection, any loss of value will fall on the creditors.

The various transaction costs of bankruptcy (known simply as "bankruptcy costs") theoretically fall *ex post* upon the creditors since equity claims expire worthless. In practice, distressed firms may not be re-organized according to the absolute priority rule. Many distressed firms are re-organized in out-of-court settlements or "workouts". These settlements invariably, leave the shareholders with some value and the usually lower transaction costs associated with workouts will fall jointly (according to negotiation) on both classes of stakeholder. Thus, the transaction costs associated with bankruptcy fall, *ex post*, on the principle stakeholders. *Ex ante*, these costs will be anticipated in the value of the bonds (and perhaps the stocks). The discount in bond values will reflect investor expectations as

to the prospective size of the bankruptcy costs, together with investor expectations about the probability of bankruptcy. Accordingly, any strategy which reduces the probability of bankruptcy (or persuades investors that the probability has been reduced) will enhance the value of the firms bonds.

The value of a firm, V(F) is the capitalized value of its expected future cash flows, CF discounted at a rate r:

$$(1) \qquad V(F) = \sum_t \frac{E(CF_t)}{(1+r)^t}$$

This value is divided between the various stakeholders; i.e., the shareholders and the bondholders. To see how bankruptcy costs affect value, consider some different possibilities. First, suppose that bankruptcies do not result in liquidation and consequently, the firm can potentially have multiple bankruptcies over its future lifetime. Equation 2, gives an idea of how the firm value will be reduced. In this equation P_t is the probability the firm will become bankrupt in year "t" and BC is the associated bankruptcy cost. Notice that the second term in equation 2 did not appear in equation 1, and it is this second term that captures the expected value of the bankruptcy cost. Under the absolute priority rule, this loss of value would fall wholly on creditors.

$$(2) \qquad V(F) = \sum_t \frac{E(CF_t) - (P_t)(BC)}{(1+r)^t}$$

Now consider that bankruptcy results in liquidation of the firm. In this case, the loss due to bankruptcy includes not only the transaction costs of the bankruptcy as described, but also loss of future earnings as the firm ceases to operate. This is now captured in equation 3. To see this imagine that in any future year "s" there is a probability 1-P_s that the firm will survive and a corresponding probability P_s that the firm will become bankrupt and liquidate conditional on having survived to that year. We assume that bankruptcy occurs at the end of the year. Thus, if one knew that the firm would survive to year "s" and then be bankrupted and liquidated in that year, the present value of earnings would be:

$$V(F) = \sum_{t=1}^{s} \left[\frac{E(CF_t)}{(1+r)^t} \right] - \frac{(BC)}{(1+r)^s}$$

Now, bearing in mind that the probability that the firm will survive to year "t" then be liquidated is $(1-P_1)(1-P_2).....(1-P_{t-1})$, then the value of the firm becomes:

$$(3) \qquad V(F) = \sum_{t=1}^{\infty} \left[\prod_{i=1}^{t-1} (1-P_i) \left((1-P_t) \frac{E(CF_t)}{(1+r)^t} - \frac{P_t(BC)}{(1+r)^t} \right) \right]$$

Notice that in all of the above formulas, the value of the firm will increase if the probability of bankruptcy can be reduced. This will reduce the expected value for bankruptcy costs in both equations 2 and 3. Additionally, in equation 3, reducing "P" also will reduce the probability that the firm will liquidate and thereby loose access to all future revenues.

To see the risk management implications, consider Figure 4. Distribution "A" shows the distribution of *equity* value for a firm with significant risk. If the equity value falls below zero, the firm becomes insolvent and will undergo bankruptcy proceeding or some out of court settlement. The probability of bankruptcy is the area to the left of the zero, and under curve "A" as indicated by the diagonal shading. Recall that the total area under a distribution is unity, thus the area shaded will translate directly into a probability which is less than unity. If risk can be reduced as shown by the more compressed distribution "B", the probability of bankruptcy can be reduced as shown by the smaller solid shaded area to the left of zero and under curve "B".

Figure 4. Risk and the probability of Bankruptcy

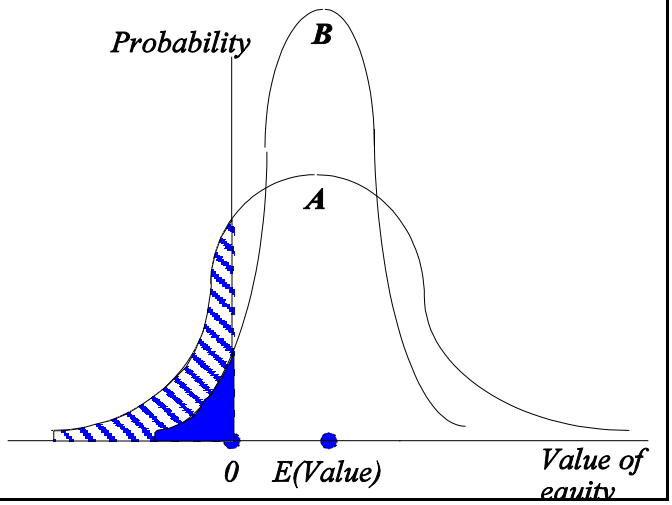
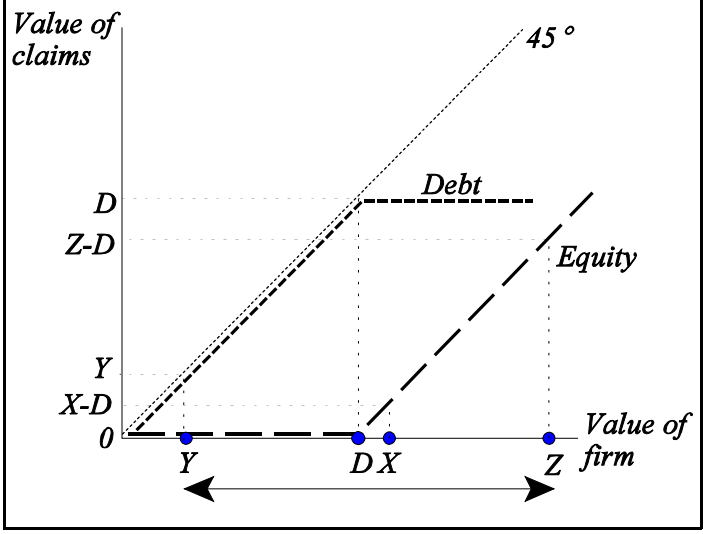


FIGURE 5. Leverage and Dysfunctional Investment



b. Agency Costs and Dysfunctional Investment: Underinvestment and Asset Substitution.

Apart from the transaction costs associated with financial distress, the prospect of future financial distress causes a number of other problems. These transaction costs are agency cost that are known as *underinvestment* and *asset substitution*.

Agency problems arise between shareholders and creditors. Shareholders have some control over the decision making processes within the firm through their ability to appoint and compensate the management team. Creditors lend their money to the firm without such control over its decision making. Thus, the shareholders are in an agency relationship with respect to the bondholders. This relationship generates opportunities for shareholders to exploit bondholders by choosing investment projects with risk characteristics that selectively favor shareholders at the expense of creditors. This exploitation arises from the different patterns of payoffs to the different classes of investors. These distortions in project selection can even cause shareholders to pass up profitable investment opportunities.

To start, consider the nature of the payoffs to shareholders and creditors and we will develop the illustrations by assuming creditors are bondholders. Bondholders receive a fixed payoff of principal and interest if the value of the firm is sufficient to cover this obligation. Shareholders receive the residual claim; they are paid dividends after interest and principal have been met and they receive the residual in a liquidation after all priority claimants have been paid. This can be represented simply in a one period setting. Figure 5 shows the value of the firm on the horizontal axis, and the vertical axis shows the values of the main classes of securities, debt and equity. We ignore taxes in this example for simplicity. The face value of the debt is "D". If the value of the firm is worth less than "D" the firm is insolvent. In this case, the equity is worthless and the debt is worth whatever remaining value is left to the firm. Thus, the debt claim is the full value of the firm (i.e., follows the 45° line) and the equity claim is zero (i.e., on the horizontal axis). If the firm value exceeds "D", the firm is solvent and the debt claim is worth its full face value "D" and the equity is worth whatever is left (i.e., the firm value, V(F) minus "D").

Now consider a firm which faces no risk and has a certain value of X as shown in Figure 5. It can now choose a new project which will have an expected value of zero, but a downside risk of X-Y together with an upside potential of Z-X. The range of risk from the project is shown by the arrowed line underneath the diagram. If the firm undertakes the new project, the firm value would be a lottery over points Y and

Z, but still have an expected value of X. With the project, the upside and downside risk are borne unequally by the shareholders and bondholders. All the upside risk benefits the shareholders whose claim increases from (X-D) to (Z-D) if the project is successful. On the other hand, if the project fails, the shareholders claim only falls from (X-D) to zero. The shareholders benefit from all the upside but bear little downside. The bondholders fare less well. If the project succeeds, they receive no additional benefit as fixed stakeholders; their value stays at D. On the other hand, if the project fails, they do not receive their promised value D but receive only the remaining value Y. Thus, the bondholders face no potential gain from the project, but they face a potential loss of D-Y. In summary, the projects offers the shareholders a chance of substantial gain, but little loss as they can deflect any loss to the bondholders. In effect, the shareholders are playing a *"heads I win, tails you lose"* game with the bondholders. Naturally such games are very attractive to the shareholders, and unattractive to bondholders.

This attraction of shareholders to high risk investment can lead to *asset substitution*. The firm raises debt, promising to undertake a low risk project. But having secured the funds, it then substitutes a high risk investment causing a wealth transfer from bondholders to shareholders. However, there is a catch for the shareholders. Bondholders anticipate that shareholders will be tempted to seek out such risky investment projects, and accordingly, when bonds are issued, they are discounted to reflect this potential expropriation. This hurts shareholders for it increases the cost of debt. Shareholders are "hoisted on their own petard"; when they secure funds from bondholders, they are tempted to risk those funds in highly uncertain ventures. This, *ex post* temptation hurts shareholders *ex ante*, since it reduces the amount bondholders are willing to pay for new debt. Prospectively, shareholders would be better off if they could send bondholders some credible signal that they would not engage in such expropriatory behavior.

Underinvestment arises also from the asymmetry in the payoffs to bondholders and shareholders. We can again use Figure 5 to begin our illustration of underinvestment. Suppose a firm already has considerable risk; for example, the value is a lottery over points Y and Z with an expected value of X. The shareholders will either get 0 (if the firm value is Y) or Z-D (if the firm value is Z). Bondholders will get either Y or D depending on whether firm value is Y or Z. If the respective probabilities of Z and Y are 0.5, then:

Value of the firm = V(F) = ½ (Y) + ½ (Z)
Value of equity = V(E) = ½ (0) + ½ (Z-D)

Value of debt = V(D) = ½ (Y) + ½ (D)

Now suppose the firm faces a new riskless investment opportunity that has a small positive NPV. The cost is C which is paid for up-front by shareholders. The present value of future cash flows from the new investment is N giving an NPV of N-C. I will assume here that the NPV is not sufficient to pull the firm out of bankruptcy (N-C < D-Y). After this investment, the values are:

NEW Value of the firm ½ (Y+N)) + ½ (Z+N) - C = V(F) + N - C
NEW Value of equity ½ (0) + ½ (Z-D+N) - C = V(E) + ½N - C
NEW Value of debt ½ (Y+N) + ½ (D) = V(D) + ½N

Although the value of the firm rises by the full NPV (N-C) this benefit is split unevenly between the stakeholders. Shareholders here pay the full cost of the project but only get back one half of the income N. The reason is that the firm was already risky and, due to limited liability, shareholders could default on debt if the firm value was Y (paying only Y instead of the full face value of debt D to bondholders). With the project, shareholders increase the amount they pay to bondholders in the event of bankruptcy from Y to Y+N. Thus, half of the benefit of the project goes to shoring up the debt should the firm default. The shareholders pay the full cost of the project but only benefit if the firm does not become bankrupt. Thus, shareholders are likely to pass up this project despite its positive NPV.

Like the asset substitution problem, underinvestment ultimately hurts shareholders. Bondholders can anticipate that the firm is likely to forego positive NPV projects when it is insolvent and this will harm bondholders. The greater the risk of the firm, the more likely that such underinvestment will occur and the less attractive are the bonds to investors. But, if the firm can lower the risk, it can make the bonds more attractive and thereby lower the cost of the firm's debt. Thus, both asset substitution and underinvestment raise the cost of debt. However, reducing risk will mitigate these distortions and thereby lower the cost of debt capital. In this way, risk management can add value to the firm and to its shareholders.

3. Costly access to capital and the "crowding out" of investment projects (or Cash Flow Hedging)

After a firm suffers a loss of assets, such as fire damage to a plant, it is presented with an investment opportunity. The firm has the opportunity to re-invest in the construction of a replacement plant. Like any other investment opportunity, reinvestment only will add value to the firm if the net present value is positive.[3] Reinvestment can be financed in two ways. Under *post loss* financing, the funds are secured (from internal or external sources) after the loss has occurred. Funds may be either debt or equity, but the opportunity cost of raising this money is met after the funds are raised. If money is borrowed it must be repaid after the loss; if equity is raised, dividends will be payable after the loss. Unless the firm is sufficiently liquid, the firm must go to external sources to secure the re-investment funds and this involves significant costs. *Pre-loss* financing occurs if the funds to reinvest in future prospective losses are secured and paid for before the loss occurs. Insurance is such a source. Premiums are paid in anticipation of possible losses, and the insurance proceeds can be used to finance re-investment. In this fashion, insurance may be seen as a source of financing for insurable losses, in much the same way as debt and equity are sources of financing.

Some financing is necessary for the firm to capture the net present value of reinvestment, and the financing source which adds most value is the preferred one. Thus, the decision to purchase insurance involves a comparison between the transaction costs associated with insurance (such as commissions, overheads, and

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[3] This decision is not trivial. Just because a firm continues to operate with productive assets, does not imply that it makes economic sense to replace those assets should they be destroyed. The decision to continue to operate with assets in place, involves a comparison between the *disposal* value of the assets in place, and the earnings that they are expected to generate. If the projected earnings capitalize to a value greater than the disposal value, it adds value to continue production. If the assets should be destroyed, then the replacement value becomes the appropriate basis for measuring the return. Only if the projected earnings capitalize to a value greater than the replacement value, does it make sense to re-invest. For example, imagine a steel mill with disposal value of 300, generating annual earnings of 80. There is an effective rate of return of 26.7%% from continuing production. But should the mill be destroyed in an explosion and cost 1000 to replace, the rate of return is only 8%. With a cost of capital of, say 12%, reinvestment would not be appropriate.

moral hazard frictions) with the transaction costs of more conventional capital sources such as debt and equity which we will discuss later. It can be seen that one of the benefits of hedging or insurance, is that it permits the firm to undertake value adding re-investment opportunities, which might be lost if post-loss financing is not forthcoming or is too costly.

The analysis of the previous two paragraphs was developed [4] to analyze insurance and reinvestment decisions. These ideas have been generalized by Froot, Scharfstein and Stein (FSS) of Harvard Business School into a broader rationale for hedging which I will call the "*crowding out*" hypothesis or what is sometimes called "*cash flow hedging*". The first element of this idea is that capital sources have different costs. FSS evoke the work of Myers and Majluf to argue that external capital is more costly than internal capital. This is obvious in the case of direct costs. External capital encounters issue costs and underwriting costs which are avoided when retained earnings are used to fund projects. More important are the costs of information asymmetry. Managers will normally have greater knowledge of their firms and its investment opportunities than external investors. This information asymmetry gives rise to the sort of expropriatory behavior we analyzed previously when discussing the "under-investment" problem. Such behavior either forces the firm to adopt costly controls (e.g. restraints included in bond issues, costly reporting and monitoring) or it is anticipated by investors and lowers the amount raised in new issues and thus increases the cost of capital. The additional costs associated with external funding, lead to the so called "pecking order" hypothesis; firms have a ranking of sources of financing with internal funds beings preferred, followed by external debt and then external equity.

The differential costs associated with capital are used by FSS to develop their rationale for hedging. First, firms derive value from identifying and undertaking new investment projects. A healthy and growing firm may be investing in research and development, developing new products and rationalizing existing operations. Such firms face a continuing need for capital to fund their investment opportunities. Given the pecking order of the costs of financing, one would expect such firms to adopt a financial strategy (e.g. a capital structure and dividend policy) to fund as much as feasible of the new investments from internal sources. Now suppose that such a firm takes a sudden loss in liquidity from an uninsured fire or liability suit, a sharp deterioration in exchange rates or an unanticipated rise in the price of a commodity

[4]See Doherty 1985.

that is used intensively in production. The loss in liquidity compromises the firm's ability to undertake its desired investment projects. Some projects which were attractive given internal funds, are not so attractive now they have to be paid for from more costly external sources. Thus, the firm may defer (until sufficient internal funds have accrued) or cancel some investment projects. This results in a real loss of value to the firm. In contrast, hedging these losses preserves internal funds so that they can be used to finance new investments in a cheap and orderly manner.

The crowding out hypothesis can be summarized as follows. In the face of costly access to external capital, hedging preserves internal funding sources and avoids the loss of positive NPV projects. This loss of value can be high. FSS quote sources that suggests that for every $1 of sudden capital loss, firms reduce their investment budget by approximately 35 cents. More direct support for this hypothesis is given in recent work by Géczy, Minton and Schrand (1995, 1996). They examine a sample of Fortune 500 non financial firms which are exposed to currency risk and find that firms that have high R&D, low quick ratios and highest foreign exchange exposure (i.e. the firms that face the highest opportunity cost from unhedged losses) are indeed the firms that are most likely to use currency hedges.

4. Managerial utility maximization and risk aversion[5]

Here, we will examine two separate but related issues. First, we are concerned with why risk is costly and how a firm can add value by avoiding risk. In this vein, we wish to see how firms can achieve more effective job performance from managers by design of their compensation. In examining this issue, a central point is whether managers bear risk and how much they need to be compensated for doing so. The second issue arises because managers actually make decisions which determine both the productivity of the firm and the amount of risk it accepts. We are facing another type of agency cost. Will managers make decisions to serve their own interests or to serve the shareholders? Moreover, if we accept that managers are self interested, then can shareholders design compensation systems to influence the risk management choices made by managers?

Typically, corporate decisions are not made by a firm's owners but by employed managers. We now show that managers may choose to adopt risk postures that are not in the interests of shareholders; this decision making depends very much on how managers are rewarded. Presently, we will show how value can be added for shareholders by adopting risk management strategies that recognize managerial utility maximization. We will start with the explanation of risk management serving manager self interest.

a. Managerial self interest and risk taking

Suppose that managers serve their own self interest which may, or may not, coincide with others such as shareholders. Further assume that managers are risk averse which we capture by the function which shows manager utility to be the square root of wealth.

$$\mathbf{U = W^{0.5}}$$ where U = utility and W = manager wealth

The manager's wealth comprises his earnings from employment and other wealth. If other wealth were very large relative to employment income, then one might suppose the risk of employment income to be of little interest. But this is not true for most managers for whom employment income is a major, or even dominant, source of wealth. For these managers, risk in employment income is important. Accordingly, if

[5] See Smith and Stultz 1985.

employment income is risky, the manager will find it distinctly less attractive

To develop the example, the firm's value (i.e., the present expected value of its future cash flows) can be either $500m or $1000m each with 0.5 probability. The risk can be hedged and, bearing in mind any transaction cost associated with the hedge and any efficiency gain from hedging,[6] value can be stabilized at $780 m. Would a manager choose such a hedge? We consider three cases.

Flat salary. First, consider a manager with a flat salary of $300,000. Assuming job security is not affected by the purchase of the hedge, the manager should be indifferent, even though shareholders gain from the hedge. The manager's utility is:

$$\mathbf{U = (300{,}000)^{0.5} = 547.72}$$

regardless of whether the hedge is purchased or not. One might suppose that the tie would be broken since the board of directors would favorably assess the manager's job performance if the hedge was purchased.

Incentive compensation. Now suppose the manager is paid some proportion "x" of the value of earnings. Such a scheme can be labeled "incentive compensation" or "performance related earnings". If there is a competitive labor market, the value of *x* should be sufficient that the manager is no worse off with incentive compensation than with flat salary (the previous case shows the manager's utility is 547.72 with flat salary). Thus, the utility of earnings with incentive compensation (either x times $500m or x times $1000m) must be no less than 547.72

$$\begin{aligned}
\mathbf{547.72} &\leq \mathbf{0.5(500{,}000{,}000x)^{0.5} + 0.5(1{,}000{,}000{,}000x)^{0.5}} \\
\mathbf{1095.45} &\leq \mathbf{(500{,}000{,}000^{0.5} + 1{,}000{,}000{,}000^{0.5})\,(x)^{0.5}} \\
\mathbf{1095.45} &\leq \mathbf{53983.46\,(x)^{0.5}} \\
\mathbf{0.02029} &\leq \mathbf{x^{0.5}} \\
\mathbf{x} &\geq \mathbf{0.000412}
\end{aligned}$$

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[6]Note that the certain value of profit with the hedge exceeds the expected value of profit without hedging. This implies that, either the transaction costs of the hedge are negative or, more likely, that transactions costs are positive but are more than offset by an efficiency gain from hedging. The efficiency gain could come from resolution of asset substitution, underinvestment of the crowding out problem.

Having established the competitive compensation level, let us know examine the manager's utility level with and without the hedge.

With the hedge

$$U = \{ 0.000412(\$780m) \}^{0.5} = 566.89$$

Without the hedge

$$U = 0.5(500{,}000{,}000 \text{ times } 0.000412)^{0.5} + 0.5(1{,}000{,}000{,}000 \text{ times } 0.000412)^{0.5} = 547.72$$

Now utility is higher with the hedge than without. Thus, the manager now has a direct monetary interest in that decision which favors shareholders; i.e. hedging.

Stock options. The third compensation system considered is a stock option plan. Suppose the manager receives neither salary nor shares of stock, but has call options on the stock. The firm's value is either \$500m or \$1000m and you now know there are 10 million shares outstanding. The firm has no debt so firm value can be divided over the number of shares; each share will be worth either \$50 or \$100. Suppose each call option is the right to purchase a share at a price of \$80 (this price is known as the exercise price or the striking price). Either, the share is worth \$50, in which case the option to buy at \$80 is worthless and the option expires; or the share is worth \$100 and the option to buy at \$80 yields a clear profit of \$20 per share. Noting that the probability of each share value is 0.5, the *expected profit* from holding one option on one stock is:

$$E(PROFIT)_{\text{per option}} = 0.5(\$0) + 0.5(\$20)$$

and the *expected utility* from holding options to purchase some number "y" shares is:

$$EU = 0.5(\$0 \text{ times } y)^{0.5} + 0.5(\$20 \text{ times } y)^{0.5}$$

Notice that the option will only be worth money if the stock price can rise above the exercise price of \$80. Thus, if the firm were to hedge and stabilize its value at \$780m, each share would be worth \$78 and the option to purchase a share at \$80 would be without value.

It should be coming clear that, if the manager is rewarded with stock options, then hedging is unattractive; the manager will receive no income. What is the good of holding options with an exercise price of \$80 on stocks that are certain to be valued

at $78?. In fact, the expected utility of the manager is the square root of zero which is zero. If, on the other hand, the manager held 60,000 stock options and the firm did not hedge, then the expected utility of the manager is

$$\mathbf{EU = 0.5(\$0 \text{ times } 60{,}000)^{0.5} + 0.5(\$20 \text{ times } 60{,}000)^{0.5} = 547.72}$$

The manager is clearly better off if the firm does not hedge. If the manager is to make the decision, he will clearly prefer not to hedge. You will notice that I have given a number of 60,000 options so that the manager receives the same utility as if he had a flat salary of $300,000 of received 0.00412 of the firm's value. Thus, I am comparing compensation systems that are comparable and competitive with each other.

The above analysis suggests that we should be able to predict what type of hedging policies are adopted by firms, by examining the compensation package offered to its managers. Firms offering incentive compensation which is directly related to value (both upside and downside) such as stock ownership plans, are very likely to hedge risk since managers will reduce their own risk and secure any efficiency gains from the hedge. Firms, that offer flat salary, may still hedge but the likelihood is weaker, Managers have no direct money interest in hedging, but may benefit indirectly if it affects job security or performance evaluation. In contrast, managers rewarded mainly with stock options are less likely to hedge since it can lower the value of their options. There is some recent evidence supporting this pattern. Peter Tufano (1996) recently examined hedging behavior in the gold mining industry. Here firms face an easily identifiable risk; that of fluctuations in gold prices. However, there is an active market in gold price hedging instruments. Tufano found clear differences in hedging patterns which seemed to be explained only by differences in management's holdings of securities of their employer. Firms whose managers held large equity holdings tended to hedge, but firms whose managers held large option positions were much less likely to hedge gold price risk.

b. Risk and the efficiency of compensation design.

Now consider a firm that faces no risk. Managers can affect productivity and thereby profitability, by their effort. High effort will lead to high (certain) profit and low effort will lead to low (certain) profit. The problem is that managers would, other things being equal, prefer not to work hard and thus there is an incentive conflict. This incentive conflict could be resolved if directors could observe the effort level of managers and simply reward them conditional on effort. But effort is not easily observable. But in this example, there is another simple solution. The firm can simply

pay the managers according to profit; high profit receives high compensation and vice versa. As long as the additional compensation for high effort (a) exceeds the manager's disutility from supplying high effort, and (b) is less than the additional profit generated by the high effort, then this compensation system will add value without making managers any worse off. Notice that profit becomes a perfect *ex post* signal of the manager's effort, thus compensation will be directly related to effort.

We can now add risk to the mix. High effort from the managers will lead to a higher likelihood of high profits and low effort will likely cause lower profits. If the manager is paid incentive compensation in the form of a proportion of profits, then it becomes likely (but not certain) that the manager will be paid more, the higher his level of effort. But the risk of the profit stream will be reflected in the manager's compensation. Since employment income typically is a large portion of the manager's wealth, this risk significantly reduces the manager's welfare. Thus, incentive compensation typically is higher than flat salary; incentive compensation has to compensate both for the disutility of high effort and for the inherent risk.

The gain from hedging risk can now be seen in two different ways. If profit risk is hedged, then incentive compensation becomes riskless and thus the level of compensation can be lowered. The firm need no longer pay managers a risk premium. Another way of viewing this issue is to address the trade-off involved in performance related earnings compared with flat salary. Performance related earnings induce higher effort but are more costly because of the risk imposed on managers. This risk usually results in managers being paid hybrid compensation; part salary and part bonus. The firm forgoes some efficiency gain in order to avoiding loading managers with too much risk. Now, if risk is hedged, the compensation scheme can focus solely on productivity and pay only bonuses. This means higher productivity. In more general terms, hedging affects the optimal mix in the compensation system; less risk will favor a higher proportion of performance related compensation.

c. Risk and signaling

A variation on the managerial utility maximization model uses risk management as a signal of managerial ability (DeMarzo and Duffie 1995 and Breeden and Viswanathan 1996). In these models, investors are unable to tell from performance measures (quarterly profit, stock price, etc) to what extent the result is due to the ability of the manager or to exogenous factors. This makes it more difficult for managers of high ability to command appropriate rewards. Consider the following simple example, a well managed airline will on average command higher profits than

a poorly managed one. The term "well managed" might encompass effective pricing policies; effective choice of routes, effective marketing, appropriate safety policies, etc. However, profits will still be adversely impacted by factors outside management control such as rising fuel prices, changes in the demand for travel or by the chance accident that occurred despite effective safety policy. So imagine that the annual profits of the well managed firm and the poorly managed firm are as follows:

PROFIT $ million	**PROBABILITY WELL MANAGED**	**PROBABILITY POORLY MANAGED**
100	01	0.4
200	0.2	0.3
300	0.3	0.2
400	0.4	0.1
Expected profit	**300**	**200**

Now investors, unfortunately, never get to see *expected* profit. They can make some estimates of what they expect profit to be for the coming year. But this will depend on how much information they have about investment opportunities, managerial practices and a whole host of other factors, and they are unlikely to have the same quality of information as the firm's own management. All the investor gets to see at the end of the year is the actual profit. Suppose this turns out to be 100. Does the investor know whether the firm is well managed or poorly managed? The investor might infer that such a low profit is more likely to be indicative of poor management than good management, but she cannot be sure. Using the table, an observation of 100 would have a 40% chance of occurring with bad management but only a 10% chance with good management. Similarly, a result of 400 would have a 40% chance with good management but only a 10% chance with bad management.

This idea is sometimes knows as a *signal to noise ratio*. Consider a radio signal: you wish to listen to the British Broadcasting Corporation on your short wave radio. A signal is transmitted from London but what you hear on your radio in Philadelphia is a combination of the broadcast signal and a lot of static interference or noise.

Reception is good when the signal is strong and the interference low; a high signal to noise ratio. Reception is poor when the signal is weak and the static loud; a low signal to noise ratio. Profit performance combines in a single measure (a) management quality (the signal) and (b) random events (the noise). What effective managers would like (though not ineffective managers) is a strong signal and low noise.

So now the good managers may wish to signal quality by removing the noise. If the risk is hedged, observed profit will be 300 (minus any transaction cost for the hedge). However, is a poorly managed firm hedges, the actual profit will turn out to be 200 (minus transaction cost). Thus, with complete hedging, the result would reveal fully the quality of management; the actual profit performance is all signal and no noise. In this way, efficient management managerial compensation could be more accurately tied to performance. Complete hedging of all corporate risk is rarely possible; but some hedging can remove risk. Thus, the game played by high quality management would now be to increase the signal to noise ratio so that actual performance is more likely to be indicative of high quality management.

5. Comparative advantage in risk bearing

Two of the stories about why risk was costly were "moral hazard" tales. Managers are agents of the firm's owners and, if left to their own devices, will make self interested decisions. Recognizing this, owners usually arrange compensation systems to align interests of shareholders and managers. One of the design choices is how to trade off risk sharing (favoring flat compensation) with efficiency (favoring performance related pay). Hedging, can lighten this trade-off by providing incentive compensation and lowering the risk premia demanded by managers. Similarly, the under-investment phenomenon arose because of the agency function of shareholders with respect to money provided by creditors. The opportunity for owners to default on debt, leads to the selection of abnormally risky projects. Anticipating such excessive risk taking leads investors to discount the value of corporate bonds. Hedging removes the advantage to shareholders of such high risk activity and can provide a credible signal that such expropriatory behavior will not be undertaken. Both these arguments suggested that the level of risk, and the potential losses the firm faces, are dependent on how the firm's value is divided between stakeholders. We introduce another argument which also shows that the level of hedged cash flows depends on how rights to earnings and value are divided.

Consider the following situation. A firm (call it the main contractor) designs and builds a telecommunications satellite. This is a complex product and the main

contractor sub contracts with other firms who supply sub systems which are then assembled into the final product. The final product is then sold to a telecommunications firm which uses the satellite for telephone communications. Of course, the satellite has to be launched by a rocket into an appropriate orbit before it can fulfil its function. Suppose something goes wrong and the customers fails to acquire a functioning satellite in the correct orbit. Who should pay? You are the main contractor and you seek advice from your corporate lawyers. No doubt they will try to persuade you that contracts should be written so that someone else (anyone else) is responsible. Is this a desirable solution?

Now consider just a sample of the things that can go wrong

The rocket can blow up during launch destroying the satellite
The satellite can be delivered to the wrong orbit
The satellite can get to the correct orbit but fails to function through an assembly fault
The satellite can get to the correct orbit but fails through a sub system failure

If the accumulation of all these risks is too high, the customer is simply going to say "@?#!$ satellites. I will use fibre optic instead because it is more reliable". So clearly, to retain your market, you will wish to offer the customer a reliable and economic product. Now the question is, who should bear the risk of losses and how does this decision affect the final price and reliability of the product?

This answer depends on an idea elaborated by Calibresi, 1970, which is to make that party responsible who can avoid the loss at least cost.[7] So, consider failures from sub system faults. Sub contractors produce these sub systems and through their effort, they can improve quality control. It makes sense to make the sub contractors liable for these type of failures. If they are not liable, they will simply pay less attention to quality control. Similarly, it is sensible to make the rocket

[7]This discussion is related to the Nobel prize winning work of Ronald Coase (1960) who explored optimal rules for property rights and legal liability accidents. Coase's contribution was to suggest that liability rules would not affect investments in safety if contracting costs were zero. Regardless of the initial allocation of liability, the parties could enter contracts or bargains, in which the person that makes the safety decision has a financial incentive to make one which is socially optimal.

manufacturer, and or the launch contractor responsible if the rocket fails to deliver the satellite to correct orbit, and the main contractor responsible for faults stemming from overall design and assembly. In this way, each party has a strong financial incentive to see that the operations over which they have control, function without hitch.

Now you may object to this reasoning and claim that everyone has an incentive to competent work anyway since, otherwise, they will obtain a poor reputation and will not be asked to do future work. Certainly reputation is important. The point here is that there is simply an additional, and more immediate, incentive to perform

CORE RISK AND INCIDENTAL RISK.

The idea that firms can have a comparative advantage or disadvantage in risk taking has recently been given a slightly different flavor. When an oil company explores for oil, it acquires risk. When an insurance company issues policies, it takes risks. When a bank lends to a startup firm, it takes risk. Firms are in the business of taking risk; indeed that is how they earn profit. Now consider these three examples. The oil company takes the risk that its exploration will not result in a finding of oil; or the finding might be small and uneconomic. What the firm is banking on is its superior exploration technology and geological knowledge, to increase the odds in its favor. This is a core competency of the firm and, in exploiting this competency, the firm expects to earn economic profit. The risk is more than compensated by the expected profit; in short, it is a positive net present value opportunity. The firm is rewarded for its particular and scarce skills. Indeed the organization of business is centered around the ability of specialist firm to identify and exploit positive NPV investment opportunities within their area of competence. Investment opportunities are, by nature, risky. Those same opportunities may not be identified, and could not be exploited at a similar profit, by others without those skill sets. Thus, the specialized firm is rewarded for adopting risk. The scarcer the skills and the greater the value created by the investment, the higher the reward to risk ratio (i.e. the higher the risk adjusted NPV).

However, in taking this risk, the oil company acquires incidental risk. Profit can be depleted if its engineers are killed in an air crash, or if the currency rate between the country of exploration and the head office domicile changes. These are risks which are not core and the firm has no special advantage in handling. Consequently, the oil company can gain no special reward in retaining these risks. Like core risks, these risks are costly. They can increase agency costs, taxes etc.. But

unlike core risks, the firm can expect no extra profit from bearing the non core risks.

The insurance firm can dichotomize its risks in a similar fashion. Assuming risk through insurance is a speciality for which the firm expects profit. The core competencies of the insurer include the ability to diversify this risk through the structure of its portfolio, the ability to underwrite successfully (i.e. discriminately accept those policyholders who are better than average), the ability to price the risk, and the ability to settle claims effectively and cheaply. However, the insurer acquires incidental risks. For a small insurer without a full investment department, this could include investment risk, risk of suits against the company's officers and the control of catastrophe risk. There are others better equipped to handle and assume these risks. A portfolio manager's core competency is to handle the investment risk and a reinsurer's is to handle the catastrophe risk. These risks might well be transferred to outsiders who have greater expertise in handling them.

The point is not to assert that an insurer's core competency does not include investment management (larger insurers would indeed claim such expertise). The point is that for any firm, there are going to be some risks that are core; and its very business is the exploitation of these risks for profit, and some risks which are incidental. How this carves up will vary from firm to firm. An important idea developed and tested by Schrand and Unal (1997)[8] concerns the composition of risk and how it might be managed. If risk is costly, then one would wish to control overall risk in a way that maximizes profit relative to the risk assumed. If one has a choice over which risk to assume, it makes sense to assume the risks with the highest reward ratio. Thus, in managing risk, the idea is to transfer the incidental risk (they use the label homogenous risk) to outsiders in order to free up capacity to assume more core risk. They call this idea "coordinated risk management".

WHICH FIRMS BENEFIT FROM MANAGING RISK?

The various explanations of why risk is costly suggest that the cost of risk will differ between firms in a predictable way. This is important when it comes to test these theories and is also important for those charged with managing risk. We will take each theory in turn and isolate the firm characteristics that determine whether risk is important and, by implication, whether hedging the risk can add value.

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[8]See also the much earlier work of Kenneth Arrow (1964, Chpt. 5) who also considered comparative advantage in risk bearing

The tax non linearity rationale rest on the firm's tax function being convex. If taxes are linear in income, then expected taxes are unrelated to the riskiness of income. The more convex the tax function, the greater expected taxes will increase with risk. But this relationship is compounded by considering the distribution of earnings. Convexity is important over the range of earnings which are most likely. Consider a firm whose tax function is convex over a low range of earnings then becomes linear as earnings increase (i.e the marginal tax rate is constant over medium to high earnings). If a firm's earnings are most likely to lie in the medium/high range, convexity in the low range has little effect on expected taxes. The issue then is whether the range of probable earnings spans the kinks in the tax schedule. Firms with high probable earnings and low investment tax credit and carry forwards are unlikely to secure much tax benefit from managing risk. Firms with higher tax shields are a high variation of earnings about the level of tax shield, can reduce their expected taxes most through hedging. Roughly, this means those firms whose tax shields are roughly equal to expected earnings.

The financial distress rationales for risk management carry a clear implication. Firms with higher leverage will bear a higher cost of risk. If two firms have the same level of risk, the higher leverage firm will have a higher probability of bankruptcy and therefore the higher expected bankruptcy costs. Moreover, the indirect agency problems also will be higher for the more leveraged firm. The indirect cost of financial distress model also relies on the firm having opportunities for growth; it is in the selection of new investment projects that principal-agent distortions can occur. Leveraged firms with available investment opportunities will gravitate towards high risk projects. The anticipation of this by bondholders can increase the cost of debt and lead to underinvestment. This is not as important for firms with no growth potential. Leverage and growth also are relevant firm characteristics when considering crowding out costs. If unhedged losses crowd out new investment, it only does so for firms with investment opportunities. The greater these growth opportunities, the greater the opportunity cost of risk.

The managerial utility maximization model also has clear predictions. But these predictions are not so much about which firm's shareholders are likely to gain most from hedging. Rather, they concern which firms are likely to hedge because the managers choose to do so. Firms whose management compensation systems focus on share ownership are more likely to engage in hedging activities. Firms that make intensive use of options in rewarding managers are more likely to engage in risky activities and less likely to hedge.

FIRMS MOST LIKELY TO HEDGE

TAX NON LINEARITY	Ratio - Tax shield : E(earnings) ≈1
FINANCIAL DISTRESS -DIRECT	High leverage
FINANCIAL DISTRESS - INDIRECT	High leverage High growth High R&D
CROWDING OUT	High leverage High growth High R&D
MANAGERIAL UTILITY MAXIMIZATION	Managers hold few options/many shares
STAKEHOLDER RISK AVERSION	Creditors/warranties

SOME EVIDENCE ON THE COST OF RISK AND FIRM VALUE.

Various people have tested the theories of why risk is costly and a selection is summarized here. It would be difficult to measure the costs of risk directly and these research tests do not usually attempt to do so. Rather, they reason that the higher the cost of risk to a firm, the more it has to gain from hedging and therefore, the more likely it is to hedge. The trick is then to find the firm characteristics that indicate that risk is more or less costly. For example, with the tax non-linearity model, firms with a tax shield/expected earnings ratio close to one would gain more than firms whose range of earnings does not span different marginal tax rates. With the underinvestment model, firms with more leverage and higher growth opportunities would have most to gain from hedging. However, the crowding out model suggests that hedging behavior would be explained by similar firm characteristics. Thus, a finding that hedging behavior was positively associated with leverage and growth would be supportive of both models. It is not necessary to come up with a winner. Many academics believe that all of these models have something to say about the cost of risk.

There have been some tests of hedging of insurance firms purchase of reinsurance. Mayers and Smith (1990) take an interesting approach which tests several of the models considered. The various models presented earlier in this chapter were asking why risk was costly to a firm whose owners could diversify easily in their portfolio choices. Mayers and Smith consider this issue and argue that different ownership structures of insurance firms, present different opportunities for diversification. The greater the fraction of the owners' wealth accounted for in the insurance firm's equity, the greater the demand for reinsurance. Thus, a ranking of ownership structures according to their demand for reinsurance would be headed by Lloyds associations followed single family, closely held and widely held firms. They do find evidence consistent with this hypothesis. In addition, their results show that demand for reinsurance is negatively related to credit standing (Best's rating) which is consistent with the financial distress hypothesis. Other results concern the effects of size and, more importantly, geographical diversification. The latter result is taken to support the hypothesis that reinsurers offer real service efficiencies that are more valuable to the smaller, more geographically diversified insurer. Although not stressed by Mayers and Smith, this result also can be explained by insurers developing core competencies and being more willing to assume risk in such areas.

Another insurance result tests the cost of risk hypotheses indirectly. Kleffner and Doherty (1996) look at the supply of catastrophe insurance in California. Instead of examining whether firms off-load risk, they look at whether firms assume risk in a way that is systematically related firm characteristics that reveal the cost of risk bearing. Consider the financial distress and crowding out hypotheses, and the significant degree of undiversifiable risk assumed by insurers offering earthquake insurance. These factors suggest that insurers would be more willing to offer earthquake coverage the lower their leverage, the greater their reinsurance and the more diversified (geographically and by line of business) their portfolios. These results are consistent with costs of financial distress hypothesis. They failed to find evidence of tax motivated risk assumption though there were difficulties in finding good proxies for tax convexity.

A study of another industry, gold mining, by Peter Tufano (1996) comes up with different results. Gold mining firms can hedge their exposure to fluctuation in the price of gold using various instruments such as forward sales, loans, and put and call options. However, these instruments could be used both for risk management and speculative purposes. To separate these different uses of derivatives, he uses the concepts of *delta,* the sensitivity of the value of a portfolio to a small change in the price of an underlying asset, and *delta percentage*, the percentage of gold production

accounted for by the portfolio delta. He then tests the various hypotheses of costly risk bearing and finds strong support for the managerial utility maximization model, but little support for the other models that suggest that hedging can increase the wealth of shareholders. The variables that proxy for financial distress and tax convexity have no significant power in explaining delta percentages. However, Tufano finds that firms whose management holds more stock engage in more risk management but firms whose managers hold more stock options manage less risk. Managers of gold mines, it seems, pay more attention to their own welfare, than that of their shareholders, in managing risk.

Another empirical test by Schrand and Unal (1997) also supports the managerial utility maximization hypothesis but, in addition, does provide support for other theories. These authors look at the issue of core versus incidental risk, i.e., their "coordinated risk management" concept. This test is a little subtle since they examine firms which *increased* their levels of risk. They look at thrift institutions that differ according to organizational form; some are stock firms owned by investors and some are mutuals owned by depositors. A fundamental difference is that stocks can access new capital markets, by issuing equity, to fund new projects. The inability of mutuals to do so, implies that they are more exposed to risk. The conversion of a mutual firm to a stock form of organization, removes this constraint and effectively increases its risk bearing capacity. This enables the de-mutualized firm to assume more core risk. This can still have all the frictional costs we have identified, but since the risk is core, it can be rewarded. Their evidence does confirm that demutualizing firms tend to assume more risk. However, recall that risk is still costly and so such firms tend to switch between core and incidental risk; i.e. they hedge non rewarded incidental risk to release capacity to absorb more core risk.[9] This is what one would expect from the crowding out hypothesis (or indeed from the financial distress theories). But the story gets more interesting. Demutualization enables firms to reward managers with shares and options. Demutualizing firms that go on to focus on compensation based share ownership decrease total risk following conversion, whereas converting firms whose managers are rewarded with options increase total risk. This difference is statistically significant.

Further indirect support for the one of the theories is provided in the patterns of executive compensation. There has been an ongoing debate about whether executive pay is related to performance. Following an important paper by Jensen and

[9] Credit risk is a core activity and interest rate risk is incidental.

Murphy in 1990 various people have addressed this topic but the results on this relationship have been mixed. But a recent paper by Aggarwal and Samwick helps resolve the puzzle and bring the subject squarely into the risk management field. They find that the sensitivity of pay to performance is significantly positive if one controls for the volatility of stock prices. Firms with highly volatile stocks are least willing to offer performance related pay since it imposes large risk on managers; and the reverse is true for firms with more stable stock prices. Thus, it is difficult for firms with volatile stocks to motivate managers and one might expect that performance would suffer. However, the clear implication is that, insofar as the management of risk reduces stock price volatility, it becomes easier to write performance related compensation and thereby boost efficiency.

Some evidence to support the crowding out hypothesis also is available. Empirical evidence cited by Froot, Scarfstein and Stein, 1993 suggests that for each dollar of unhedged loss, project budgets will be cut by about 30 cents. More recent evidence from Minton and Schrand, 1999, also supports this opportunity cost. They show that capital expenditure for firms with high cash flow volatility is about 19% below the mean and expenditures for those with low volatility is about 11% above the mean. Hedging avoids this loss and protects the ability of the firm to fund its investment program.

CONCLUSION - A TRANSACTIONS COSTS EXPLANATION OF CORPORATE RISK MANAGEMENT

The various theories as to why risk affects corporate value have a common base; they all arise from the frictional costs (or, as they are known by economists, *transactions costs*) faced by a firm in doing its business. Firms have to pay taxes, and the expected value of these taxes is affected by risk. Firms bring together various stakeholders and frictions between these stakeholders affect the quality of its decisions. For example, firms typically raise money both in the form of equity and debt. But creditors and shareholders are affected differently by future risk. Insofar as shareholders control investment decisions, they are likely to favor risky projects since they can keep the upside and default on the downside. This propensity for risk taking is anticipated by creditors and it therefore increases the cost of debt capital. Firms can reduce this transaction costs, the cost of debt capital, by hedging risk.

We also saw how hedging can facilitate the financing of new investments after a loss. Firms may wish to hedge to preserve their liquidity so that new investment can be funded internally. Failure to hedge courts the possibility that a loss will absorb

internal funds and expose the firm to the costly external capital market to finance new investment. Given the higher hurdle of external capital costs, some new investment will be lost.

Another theory examined in this chapter, looked at how hedging can be used to wrote more effective compensation contract with managers. Managers are typically risk averse and relatively undiversified whereas outside shareholders are typically diversified. Thus, from a risk sharing view, it makes sense for managers to be paid flat salary and for risk to be borne by shareholders. But from an incentive view, it makes sense to align interests of shareholders and managers in the form of performance compensation. This trade-off can be largely avoided if firm risk is hedged. This permits firms to uses incentive compensation without burdening managers with risk that is outside their control.

And finally, we examined signaling theories. Insider managers can use hedging to signal private information to outsiders. This inside information can pertain to the quality of investment opportunities or to the underlying quality of the managers. For example, when a firm hedges risk that is outside the managers control, the profit of the firm is purged of noise and becomes a more pure signal of the productivity of the managers. Thus, managers of high productivity may chose to hedge in order to command higher compensation.

As risk increases these various transactions costs, so hedging or insurance reduces these costs and adds value to the firm. In the next chapter, we will return to each of these transactions costs and illustrate how hedging can create. But hedging will be only one of several risk management strategies examined in the following chapters. For each transaction costs examined, we will show that value can be created either by reducing risk, or how the firm's financial, organizational or contract structure can be re-designed so that it can tolerate the risk without imposing high cost.

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