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Article abstract

Traditionally, the term "risk management" has been used to refer to the management of the downside risk that is usually associated with insurance. During the 1960's and 1970's, it became popular for corporate insurance buyers to frame the insurance decision as part of a wider process of managing risk. Many financial instruments have then emerged. The success of insurers in staving off competition from capital markets will rest on how effectively they reduce transaction costs. Certainly, unboundling allows insurers to target firms according to their particular needs. For firms that are large and publicly traded, the risk reduction offered by insurance is modest and expensive and the ancillary services provided by insurers are of limited value. However, there is a large demand for conventional insurance products from small firms, for whom the hedging and ancillary services of insurance will continue to be of value.

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CORPORATE INSURANCE: COMPETITION FROM CAPITAL MARKETS AND FINANCIAL INSTITUTIONS

by **Neil A. Doherty**

RÉSUMÉ

Traditionnellement, le terme «gestion des risques» a été limité aux risques couverts par l'assurance. Durant les années 1960 et 1970, il est devenu populaire, pour les responsables de portefeuille d'assurances, d'analyser les décisions d'assurance comme faisant partie d'un processus de gestion des risques plus large. Plusieurs instruments financiers ont été développés durant la même période. Le succès des assureurs contre la concurrence des marchés financiers est intimement lié à leur efficacité à réduire les coûts de transaction. Les assureurs se doivent de cibler les entreprises selon leurs besoins particuliers. Pour les grandes entreprises ayant des portefeuilles publics, la réduction des risques offerte par les assureurs est faible et coûteuse et les services spécialisés offerts par les assureurs sont de valeur limitée. Par contre, il existe une grande demande pour les assurances traditionnelles dédiées aux petites entreprises, pour lesquelles les possibilités de diversification des risques sont plus faibles et les services spécialisés des assureurs continuent d'avoir une valeur positive.

Mots clés : Assurance d'entreprise, marchés financiers, institutions financières, coûts de transaction.

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ABSTRACT

Traditionally, the term "risk management" has been used to refer to the management of the downside risk that is usually associated with insurance. During the 1960's and 1970's, it became popular for corporate insurance buyers to frame the insurance decision as part of a wider process of managing risk. Many financial instruments have then emerged. The success of insurers in staving off competition from capital markets will rest on how effectively they reduce transaction costs. Certainly, unboundling allows insurers to target firms according to their particular needs. For firms that are large and publicly traded, the risk reduction offered by insurance is modest and expensive and the ancillary services provided by insurers are of limited value. However, there is a large demand for conventional insurance products from small firms, for whom the hedging and ancillary services of insurance will continue to be of value.

Keywords: *Corporate insurance, capital markets, financial institution, transactions coasts.*

I. INTRODUCTION: INSURANCE AND THE TWO FACES OF RISK MANAGEMENT

The 1980's saw systematic changes in the way many corporations handed insurable risk. Traditionally, such risks have been insured. But over this decade there was a rapid growth in captive insurance firms, industry pools, and in contractual arrangements that more closely resembled financing plans than risk transfers. Partly, this may have been due to insurance availability problems: indeed there was a severe crisis of availability and pricing of liability insurance in the early and mid 1980's. The crisis forced firms to find alternatives to liability insurance, at least on a temporary basis. But the growth of alternative risk management strategies cannot be explained completely by this crisis. The growth of captive insurance companies and other risk management strategies both preceded this crisis and has continued after the crisis. Rather, the challenges to traditional insurance strategies come from the availability of new instruments in capital markets and from a new paradigm on why risk is costly to firms. My purpose is to explore the implications of this development for the insurance industry.

The 1980's also witnessed dramatic changes in capital markets. The growth in markets for new financial instruments led to the emergence of financial engineering to create investment strategies with almost any desired risk profile. These strategies can be used in investment management to exploit pricing anomalies, or they can

be used to hedge risk from existing investment positions. For example, banks and insurance firms have been users of these concepts to derive investment strategies to hedge their liability risk. Similarly, other corporations now have the means to hedge the risks arising from changes in commodity prices, interest rates, or foreign exchange rates that de-stabilize their earnings. Even more broadly, firms can hedge the effects of shifts in demand at the level of the economy or industry.

The new focus on managing corporate risk is not entirely due to the availability of hedging instruments. It derives in part from changes in the intellectual climate. Prior to the Capital Asset Pricing Model, the conventional wisdom was that risk was costly to the firm's owners (and to other stakeholders) and, given risk aversion, it was held that its removal was beneficial. This climate boded well for insurance: it followed routinely that insuring risk would enhance firm value. But CAPM's message was that investors can diversify, thus there was no advantage to a firm hedging risk, when investors could achieve the same results in the management of their portfolios. This caused a re-evaluation as to why firms still displayed a marked aversion to risk, even when it was diversifiable. Under the new paradigm, risk is costly because it reduces the *expected value* of cash flows (e.g., it enhances incentive conflicts between the firm's stakeholders, because it increases the costs of financial distress and because it can increase taxes when tax functions are non-linear). Finally, a further stimulus to concern with corporate risk was that the 1980's was a period of volatility. It was a period of recession, boom and recession of greater magnitude than recent decades and this was echoed in violent movement in financial series including interest rates and stock prices.

Armed with these new concepts of risk costs, and the availability of new financial instruments, firms have started to develop a new interest in risk management, that focuses not only insurable risk, but on a wide array of financial and economic risks which affect a firm's performance. How will insurance fare in this new climate? What new products, or financial strategies offer competition for corporate insurance markets? It is helpful to set the stage by looking at the concept of "risk management".

Traditionally, the term "risk management" has been used to refer to the management of the downside risk that is usually associated with insurance. During the 1960's and 1970's, it became popular for corporate insurance buyers to frame the insurance decision as part of a wider process of managing risk. Many financial instruments have then emerged. This process was aided by academics

who structured insurance in a vertical process in which risk exposure was identified, measured and then "managed".[1] Management could involve either transfer to an external risk bearer (insurance) or retention (self insurance). Over the years, more elaborate instruments have emerged which blur the distinction between retention and transfer. These include insurance rating formulas which share risk, risk pools which resemble historical mutual insurers, captive insurance companies, and financing devices such as finite risk plans, which embody modest risk transfer but aim to smooth the impact of insurable losses over time. From its insurance roots, traditional risk management (TRM) has preserved its conceptual and institutional links with insurance. TRM has continued to be defined around insurance and, institutionally, the products that are traded represent an expansion of the insurance industry.

In the 1980's the term risk management has come to be applied to the management of a different set of risks affecting corporations. These risk exposures are wide and include the risk from movements in product prices, interest rates, foreign exchange rates, the payoffs from R&D and from movements in aggregate or industry demand. This form of risk management may be called financial risk management (FRM) because the strategies derived for dealing with this risk involve the use of financial instruments.

The two practices of risk management have largely been conducted in parallel with little coordination. But this may now be changing. A recent article in Business Week reveals how many firms are developing comprehensive (across the company and across sources of risk) risk management strategies.[2] At the insurer level, many firms are now actively practicing asset liability management and in doing so are developing more comprehensive postures on risk that will likely affect the demand for reinsurance. And, in their turn, reinsurers are now having to face a new form of competition in the form of catastrophe futures and options on these futures.

In section II, I will briefly summarize the basic costs which risk imposes on firms and will classify the broad strategies that are available for dealing with insurable, financial and economic risk. These strategies form two generic groups; those that reduce the risk itself (hedges) and strategies which leave the risk but reduce its cost to the firm. In Section III, I will examine the inefficiencies in insurance markets that cause insurance to be a less than perfect hedge for risks which are inherently insurable. These inefficiencies trigger potential competition from other instruments and strategies for the commercial insurers' business. I will discuss some potential remedies

that will help protect the market share of insurers. In Section IV, I will discuss non-insurance strategies for managing insurance risk. Mostly, I will be concerned with cost reducing strategies such as leverage management but some derivative based hedges can be envisaged. Finally, in section V, I will address issues of unbundling the services that constitute an insurance contract and how this will affect the ability of insurers to compete with alternative risk management products.

■ II. AN OVERVIEW OF RISK MANAGEMENT STRATEGIES

☐ II(i). Why is Risk Costly to Firms?

Risk is costly to firms either because it triggers agency cost and/or because they face non-linearities in prices or obligations.[3] One simple cost of risk arises from non-linearities in tax schedules. The combined effects of progressivity in tax schedules, availability of tax shelters, and the provisions of carry forwards and carry backwards, often create convex tax schedules. Jensen's inequality implies that expected taxes will be reduced if the riskiness of earnings is reduced. It follows that the after tax value of the firm will rise if the firm hedges earnings risk. But hedging is not the only risk management strategy. Firms can address this problem by reducing the vulnerability of the firm to risk, rather than by reducing the risk itself. There is a quasi market for firms to "trade" tax shields. The most well known aspect of this market is that for leasing which is driven largely by the lessor retaining ownership of an asset and exploiting its comparative advantage over the lessee in depreciating the asset.

More complex aspects of risk management arise from the effects of risk on optimal contract design. Many stakeholders, such as managers, may hold an undiversified position in the firm's value. Consequently, the efficient management compensation contract involves a trade off between risk sharing and efficiency. Risk sharing considerations favor payment of flat salary to managers since shareholders have a comparative advantage in diversifying. The flat salary avoids payment of a risk premium to risk averse and undiversified managers. However, efficiency considerations demand that compensation align the interests of shareholders and managers, thus pointing to performance related compensation. The purest alignment is one in which compensation is related to share value, but

this clearly exposes managers to risk and requires the inclusion of a risk premium. This trade off between efficiency and risk sharing can be mitigated by alternative risk management strategies. The first is to hedge the risk in the firm's value. The second strategy is to link managerial compensation to alternative (accounting) performance measures that are purged of risk. Ideally such measures should carry a strong signal of management performance, but should have little extraneous noise; i.e., they should have a low noise to signal ratio.

A similar dual strategy set is available to address a third risk cost to firms. All firms face a probability that they will become insolvent. This probability is jointly determined by the riskiness of the firm's earnings and its level of debt. Insolvency presents the firm with a number of possible transaction costs, including the costs of "out of court" settlements (workouts), costs of administering bankruptcy and lost investment opportunities during re-organization or liquidation. Under absolute priority rules,[4] bankruptcy costs are borne by creditors and will be reflected ex ante, in the price of bonds and in the terms of credit.

Financial distress also can impose *ex ante* costs. The non-linear nature of claims held by shareholders and bondholders creates incentive conflicts; shareholders will tend to over-value high risk investment projects since part of the downside risk is "put" to the bondholders. This implies that, either the firm will loose value as it fails to select value maximizing investment projects, or that resolution of the agency conflict requires costly controls that limit the discretionary power of managers.[5]

☐ II(ii). The Dual Risk Management Strategy Set

The foregoing examples as to why risk is costly illustrate that there are two generic types of risk management strategy:

- **STRATEGY 1.** Hedge the risk (which I will call "*reduce risk*")
- **STRATEGY 2.** Reduce the cost of given risk to the firm (which I will simply refer to as "*reduce cost*")

The risk exposures facing a firm include insurable risk, interest rate risk, price changes for commodities sold or bought, risk of shifting demand for industry products, and risk arising from a change in the overall level of demand of the economy. For each of these forms of risk, a focussed hedge can be available. Insurance can be used to hedge insurable risk, interest rate futures/caps or

swaps &c. can be used to hedge interest rate risk, for some commodities (oil, wheat, pork bellies, etc.) forward or futures markets are available, industry risk can be hedged by taking derivative positions in industry stocks, and risk of economy wide fluctuations in economic activity can be hedged by index futures, etc. These various hedges are specific to the risk exposure, though some generality is sometimes possible. For example, if options are traded on the firm's stocks, then positions in such options can be used to hedge any and all sources of risk to the firm. Thus, a shareholder of a firm having a portfolio of hedges for each specific risk should be able to more or less duplicate this position by trading in derivatives on the firm's stocks.

In contrast to risk reducing strategies, cost reducing strategies are not risk source specific. Changing leverage reduces the expected cost of bankruptcy, and leads to more efficient project selection independently of the source of the risk. Similarly, a strategy to linearize tax schedules, will reduce the risk cost associated with variable earnings, regardless of the source of the risk. And the trade off between risk sharing and efficiency can be mitigated by use of performance measures that lower the noise to signal ratio, whatever the source of the risk. Finally, to the extent that risks from various sources are less than perfectly correlated, they are sub additive. Thus, a totally passive strategy, in which no corporate risks are hedged, will achieve some degree of natural diversification.

The source specificity of hedges versus the broad sweep of cost reducing strategies is illustrated in Table 1. This distinction becomes important when looking at the effects of risk management on insurance products and markets. It follows immediately that cost reducing risk management strategies provide a substitute (not necessarily perfect) for insurance.

■ III. INSURANCE HEDGES: INEFFICIENCIES AND RE-DESIGNS

□ III(i). Moral Hazard and Adverse Selection

It is tautological that, if risk is costly, then the firm will gain value if costless insurance hedges are purchased. But insurance invariably does encounter transaction costs. Indeed the growth of

TABLE I
RISK REDUCING AND COST REDUCING RISK MANAGEMENT STRATEGIES

RISK STRATEGY	Insurable Risk	Interest Rate Risk	Foreign Exchange Risk	Commodity Price Risk	Industry Demand	Economy Risk
HEDGE						
Insurance	X					
Int. rate swap		X				
F.E. future			X			
Comm. Future				X		
Index option					X	
Market option						X
LOWER COST						
Leverage	X	X	X	X	X	X
Signal/noise	X	X	X	X	X	X
Tax shield	X	X	X	X	X	X
Diversification	X	X	X	X	X	X

KEY: X = Domain of Strategy

non insurance risk management strategies can be attributed to the presence of transaction costs.

To the extent that insurance contracts fail to resolve adverse selection, policyholders with lower than average expected accident costs will subsidize those having higher than average costs. A common complaint of corporate risk managers is that insurance forces them to subsidize competitors with poorer loss control.

Insurance encounters moral hazard problems. This increases the cost of insurance to the extent that this is not addressed in contract design. The increase in costs will be borne, *ex post* by insurers who must pay losses. *Ex ante*, the increased insurer costs will be anticipated in insurance premiums and will fall on policyholders.

These inefficiencies can be addressed by reducing the information gap or in contract design. The most direct weapon available lies in inspection and auditing of risks, and it is routine for insurers to do this for all but the smallest risks. The use of inspections closes information asymmetries but also provides valuable information to insureds to condition investments in safety and loss control. To the

extent that information problems remain, further contractual devices are available to insurers. Deductibles can be used to combat moral hazard (see Winter 1992 for survey) and rationing and experience rating can be used as signalling device to mitigate adverse selection (see Dionne and Doherty 1992 for survey). While there is some limited evidence (Dionne and Doherty 1994 and Pueltz and Snow 1994) to show that signalling devices are being used to redress adverse selection, the interesting fact is how little evidence there is to confirm the application of such devices.

☐ III(ii). Acute Inefficiencies: Implicit Correlation and Liability Insurance Crises

A second class of inefficiencies may have contributed more to the search for non insurance risk management techniques over the past decade, notably in liability insurance. Insurance has always worked most effectively when the insurer can write a portfolio comprising a large number of independent policies. This permits the insurer to diversify away most risk. The most obvious failure of the independence condition arises in insuring catastrophes such as storm or earthquake damage. However, a more subtle failure has arisen in liability markets. The combination of precedent setting court judgements, sometimes of immense magnitude and often with retroactive effect, violates the independence axiom (see Priest 1987 and Winter, 1991). A new court precedent can create a new liability that did not exist when the policy was written. All existing policies will have their coverage extended by this precedent, despite the fact that the policies could not have been priced with this coverage in mind. Clearly, the problem is most severe for "occurrence" policies.

Legislative initiatives can have similar effect; the most dramatic has been "Superfund". In 1980, Superfund created a new liability on polluting firms for the cleanup costs. This liability is retroactive and applies to all past pollution of designated sites. There is vigorous dispute about whether old policies cover such cleanup costs, but some courts have nevertheless determined that coverage does exist. Such legislative initiatives cause further implicit correlation by "creating" coverage for the existing portfolio of policies, that could not have been priced when these policies were issued (see Doherty, Kleindorfer and Kunreuther 1990).

The impact of judicial and legislative activism on liability insurance markets has been profound. Medical malpractice insurance markets exhibited severe crises in the 1970's and in the 1980's, the liability insurance crisis led to widespread rationing of

coverage (or total unavailability) together with massive price increases. The 1980s liability insurance crisis severely affected product liability, most commercial liability, and Directors and Officers' insurance. But the most dramatic effect was on the market for pollution insurance which has all but disappeared. These crises have forced firms to re-examine their risk management strategies and many have come up with solutions that include captives, pools, risk retention groups, retention, and various hybrid risk transfer/loss financing strategies.

☐ III(iii). Implicit Correlation and the Mutuality Principle

I have suggested that the biggest spur to the creation of alternative risk management strategies has been the implicit correlation induced by judicial and legislative initiatives that re-define liability and insurance coverage. This creates an issue of how to design an optimal contract (or even designing the marketplace) when faced with undiversifiable risk. I will spend some more time on this issue, partly because of its central importance and partly, because the relevant theory does not seem to be well understood in the marketplace.

The basic concept is what has become known as the "mutuality principle". The idea was derived by Karl Borch and special cases of this idea are the asset pricing models such as Capital Asset Pricing Model which have become paradigms in investment finance.[6,7] The fundamental idea is that when risk averse parties contract in a market in which there is some undiversifiable risk, the optimal form of risk sharing would have all parties having shares on aggregate wealth (in CAPM terms, all investors would hold the market portfolio). Borch showed that this implies that only that risk which is correlated with the market would be priced (the special case of CAPM is apparent).

The implications of this idea for designing insurance organizations and insurance contracts have been addressed by Marshall 1974, and Doherty and Dionne 1993. According to the mutuality principle, risk can be decomposed into diversifiable and undiversifiable. Absent other transaction costs, the optimal insurance contract is one in which diversifiable risk is fully transferred to the insurer (is pooled amongst those commonly exposed to such risk) and the undiversifiable risk is shared between the insurer and the policyholders. There are several ways in which this risk allocation can be achieved; by mutualization of the insurance firm, by a stock firm issuing participating contracts or by policyholders simulating the effects of mutualization by simultaneously buying policies and

equity shares of a stock insurer. The de-composition of risk occurs because, on first pass, the insurer can fully insure all the risk of each policyholder. However, the insurer then pays a dividend based on portfolio loss experience which reflects undiversified risk. In this way, insureds pass on all diversifiable risk to the insurer, but undiversified risk is retained by insureds in the form of the dividend. Apart from achieving mutuality by mutualizing the insurer, or selling participating policies, the effect can be approximated by other devices. For example, Doherty 1991 has shown that the switch from "occurrence" to "claims made" policies has had similar effects.[8] These devices ensure that the inability to diversify completely does not result in a collapse of the insurance market, and that risk which is diversifiable is indeed fully diversified.

To some extent, markets have responded to crises of diversifiability in the manner predicted by the mutuality principle. The medical malpractice crisis of the 1970 was followed by a significant increase in the market share of mutual insurers (Danzon 1985) and the general liability insurance crisis in the 1980's also was followed by the emergence of new mutuals and insurance pools including risk retention groups and the Ace and Excel companies (Doherty and Dionne 1992). Moreover, many liability policies were re-issued on a claims made basis.

While the predictions of the mutuality model have been roughly affirmed, many policies still seem to be sub optimal in their design, and the effect may well be to limit the capacity of the market to insure that part of the risk which is indeed diversifiable. Despite it intellectual foundation in insurance, the message of risk decomposition (almost a mantra in capital markets) has not been fully absorbed in insurance markets. The failure to decompose risk, seems to lead insurers to find methods to limit the overall degree of (undifferentiated) risk they insure. For example, it is common practice for commercial liability insurance to limit risk by retrospective rating. Retrospective rating does mitigate moral hazard; but it does so at the sacrifice of diversification. Since the retroactive premium adjustment is based on the insured's own loss experience, this device simply passes back to the insured much risk that diversifiable.[9] Moreover, it has been noted by Smith and Stultzer (1990) that mutual or participating policies can be used to address moral hazard and adverse selection. Thus, it would seem it possible to have rather more of the best of both worlds with mutual policies;

optimal risk sharing together with mitigation of moral hazard and adverse selection.

It is also likely that the insurance markets further limit ability for diversification by imposing strict limits on the amount of insurance offered to each policyholder. For example, it rare for any insured to be offered coverage for more than $0.5 billion for any loss or accumulation of losses in the policy period. Resistance to higher levels of coverage would be less severe if insurers were able to pass poor portfolio loss experience back to insureds by reducing policyholder dividends (or increasing assessments which are negative dividends).

☐ III(iv). Insurers as "Deep Pockets"

The second and related acute stimulus to alternative risk management also has occurred in liability insurance markets. Courts are sometimes thought to be willing to create coverage under policies where no coverage is believed to exist. Consider again the pollution cleanups under Superfund and the language in policies which contain a «pollution exclusion» clause. A view which is held widely in the insurance industry and is echoed by some outsiders is that "... judicial misconstruction of the pollution exclusion has caused enormous problems for insurers..." and that courts have "... ignored the meaning of the word "sudden" and interpreted the pollution exclusion clause out of existence" (Rosenkrantz, 1986, p 1300). Insurers, it seems have become deep pockets in the courts' search for sources of funds to cleanup the environment and to compensate victims.

Clearly, a pattern of unfaithful interpretation of policy wordings creates harm to insurance markets, but even with more benign judicial environment, insurance can increase the costs of managing risk. For uninsured firms, the potential liability for lawsuits is constrained by net worth. This implies that restriction of net worth becomes a risk management strategy since it can reduce the expected *internal* costs of accidents.[10] Indeed there is some evidence that this strategy is widely used. Ringleb and Wiggins, 1990, have shown that there is a disproportionate tendency for firms involved in high risk activities, to have low net worth. Buying liability insurance clearly undermines this strategy and increases expected costs. Moreover, it has been shown that the demand for insurance is indeed sensitive to net worth (see Shavell 1986). This shows in yet another way that management of capital structure offers a substitute for insurance.

☐ III(v). Use of Option Models to Price Insurance and Reinsurance

The state of the art in writing and pricing reinsurance contracts has hardly changed over the decades. Prices are usually set with respect to historical experience and relationships (implicit contracts) are set over long time periods so that premiums can be adjusted to reflect actual loss experience. The long term relationship also redresses the moral hazard that arises from this relationship. This structure permits two ways to characterize the reinsurance contract. First, it can be viewed as what is purports to be; a mechanism for spreading risk across many primary insurers (cross sectional diversification). On this view, reinsurance is conceptually a pure insurance mechanism, but structured on a long term basis because the prevailing pricing mechanisms betray uncertainty and indecision (parties feel the need for the long term relationship to correct mistakes in year to year pricing). The second way reinsurance can be viewed is as a mechanism which is inherently long term; the contract is intended to be self financing over a number years and the ceding firm's liabilities are smoothed (inter-temporal diversification for the ceding insurer). I will return to inter-temporal smoothing later under in section V. For now I will consider the efficiency of reinsurance as a mechanism for cross sectional diversification.

As currently structured, reinsurance is expensive. The long term, self financing nature of the relationship relies heavily on personal relationships, with reinsurance brokers acting as intermediaries. Moreover, reinsurers will often reinsure backwards (called retrocession) with other insurers resulting in further broking charges. The intermediary costs are in addition to broking fees incurred between the policyholder and the primary insurer. Thus, the accumulation of transaction costs incurred before risk spreading comes to rest can be enormous. The intense personal contact in this market facilitates "good faith" relationships[11] based on reputation. The use of reputation to control behavior ensures the duration of relationships and permits them to be self financing. At issue is whether improvements in pricing technology can reduce transaction costs.

Reinsurance policies are essentially options written on the liability portfolios of direct or ceding) insurance firms. One form, the quota share, is a proportionate sharing of the ceding firm's losses with the reinsurer. Another typical form is a stop loss contract which is similar to a normal insurance policy with a deductible. The reinsurer pays the excess of the insurer's aggregate portfolio losses

over some trigger (effectively the striking price). An alternativcharacterization of a reinsurance contract is as an option on the asset portfolio of the reinsurer, in which the striking price (the ceding company's aggregate loss) is random, and this claim is held alongside all other reinsurance contracts written by the same reinsurer. The resemblance between insurance and options is well known, (see Cummins 1988 and Doherty and Garven 1986) and it has become increasingly applied to reinsurance transactions (Doherty 1988, Kun Ock Lew 1990, Garven and Louberge 1994) and has become a major thrust of research in actuarial profession.

The application of option pricing techniques to reinsurance is not trivial. There are several problems. Insurers' loss distributions do not follow the usual forms assumed for capital assets (e.g. log normal), and the underlying asset on which the option is written (normally the ceding firm's loss portfolio) is not traded. Consequently, it is not feasible to maintain a continuous hedge, and there is an embedded moral hazard problem since the ceding firm can influence the realization of its own aggregate loss by its underwriting and claim settlement practices. Some of these problems will yield to enquiry. For example, Cummins 1988 model addresses many of the distributional issues and uses jump process to address the discontinuities found in insurance series. Moreover, the use of discrete time models offers a potential resolution of the continuous trading issue, but discrete models impose their own restrictions on distributional forms used.

The potential for option pricing strategies to change the way in which reinsurers conduct their business is enormous. It represents a potential to substitute technology for the expensive labor inputs necessary to maintain "good faith" relationships. The potential for savings in transaction costs are significant. This in turn will improve the competitive edge of reinsurance over rival strategies (e.g., catastrophe futures discussed below) and will help maintain a healthy supply of capital into insurance markets.

■ IV. NON INSURANCE STRATEGIES FOR MANAGING INSURABLE RISK

□ IV(i). Capital Structure Strategies

In Section II, various cost reduction strategies were mentioned, including reduction of tax convexities and purging performance

measures used in compensate managers for random noise as well as reducing the leverage of the firm. Each of these strategies can act as a substitute for insurance in managing insurable risks. But the benefits of cost reducing strategies are not specific to the source of risk; rather they provide a substitute for the comprehensive hedging strategy in which all sources of risk are hedged or are reduced by passive diversification. If insurable risk is not hedged, then its cost can be reduced by leverage management. Leverage strategies can reduce the cost of risk in several ways.

- Reducing leverage reduces the probability of insolvency and thereby reduces expected cost of bankruptcy. Since bankruptcy costs are borne *ex post* by creditors (assuming application of the absolute priority rule), then *ex ante*, the anticipated expected value will be netted out of the issue price of bonds. It follows that reducing risk or reducing leverage, will reduce the expected value of these transaction costs.

- Reducing leverage lowers incentive conflicts between stockholders and creditors in selecting investment projects. Limited liability creates a put option for the firm's shareholders; i.e., the option to put the firm to the bondholders in the case of insolvency. In selecting projects, shareholders will tend to underestimate the NPV by the value of this put. Or, in other words, shareholders will tend to ignore the downside in project selection since this is transferred to creditors. This leads to distortions in project selection and a general failure of the firm to maximize value (see Jensen and Meckling 1976 and Myers 1977). The loss of value increases with the level of leverage and with the risk of the firm's cash flows. It follows that reduction in risk or reduction in leverage will lead to improved project selection and higher firm value.

- Reducing the net worth of the firm externalizes costs to involuntary creditors (accident victims with valid lawsuits against the firm). Given the value of the firm, higher leverage will transfer the anticipated cost of liability suits from shareholders to voluntary creditors (e.g. bondholders) since accident victims will other compete with creditors for the proceeds of a bankrupt firm. To the extent that this transfer is reflected in the issue price of new debt, there will be no gain in firm value. However, the firm can gain value by

spinning off high risk activities as suggested by Ringleb and Wiggins' analysis discussed above.

- Uninsured losses present the firm with an investment opportunity; i.e., to replace the assets that have been destroyed. This investment opportunity competes with new projects for available funds (e.g., retained earning or lines of credit). Consequently, funding the uninsured loss either means that other investment opportunities are foregone or that new capital must raised with its attendant issue costs. The "pecking order hypothesis" (Myers and Majluff 1984) asserts that internal funds are less costly than external funds, and that external debt is less costly than external equity. When an uninsured loss occurs, the firms is then faced with the choice of diverting internal funds from new investment project or, raising new capital, so that both the loss and new investment projects can be funded. A study by Fazzarri, Hubbard and Petersen (1988) has shown that, for every dollar of loss of earnings, firms reduce capital expenditures by about 35 cents. Using this reasoning, Froot, Scharfstein and Stein (1994) have argued that hedging risk adds value by protecting the firm's ability to undertake all value enhancing investment opportunities. However, similar reasoning might suggest that the firm plan its capital structure with an equity buffer; i.e., maintaining low levels of leverage to protect the borrowing capacity of the firm so that it can fund new investment projects and unhedged losses without having to resort to costly new equity issues. Naturally, the borrowing capacity will be consumed after a loss. But this allows the firm time to restore its desired leverage gradually by debt retirement, dividend policy and other methods which are less costly than new equity issues.

Leverage reduction strategies take various forms. A simple strategy is to reduce the level of debt. This reduces the probability of bankruptcy thereby reducing the expected bankruptcy costs and the distortions in project selection. This strategy is illustrated in Appendix A. An example is constructed to show that with conventional debt (i.e., non convertible debt or NCD), the firm will have an incentive to choose a high risk, negative NPV project over a low risk positive NPV project. However, when leverage or risk is reduced, the firm chooses the "correct" project and this enhances firm value.

☐ IV(ii). Insurance and Leveraging Strategies as Sources of Financing for Insurable Loss

One can pay for uninsured losses with debt or equity, or one can view insurance as a source of capital to pay for these losses. Here I will compare insurance with more conventional sources of capital. First, I will look at the implications for capital structure. Second, I will look information costs associated with these alternative sources of capital.

Insurance is a leverage neutral loss financing strategy. To see this, consider first paying for losses with debt or equity. When an uninsured loss occurs, the impact is borne primarily by shareholders and one would expect the price of equity to fall. Large losses, such as the GPU's Three Mile Island, Union Carbide's Bhopal, Exxon's Valdez, all are associated with a sudden fall in stock price. The closer the firm is to insolvency, the greater the impact of the loss on the firm's creditors. But mostly, the loss will reduce the value of equity relative to debt, i.e., it will increase the firm's leverage. If, prior to the loss, the firm was near its optimal capital structure, then the loss will leave the firm over-levered and it is natural to consider equity financing to pay for the reinvestment. Assuming the reinvestment to have positive NPV (otherwise it would not be worth undertaking) the main beneficiaries of reinvestment are shareholders and a equity funded reinvestment will repair the firm to its optimal capital structure. The problem with this scenario is that equity funding might be expensive if external markets are used. If debt financing is used to pay for reinvestment, the leveraging effects of the loss will not be redressed by raising further debt[12]. Thus, the choices are between equity financing and (absent sufficient retained earnings) high transaction costs of new issues versus debt financing which likely will knock the firm off its optimal capital structure.

Now consider insurance as a source of financing for losses. Payment of premiums is regular cost which can be budgeted as other costs of doing business. When a loss occurs, reinvestment will restore operations, hopefully, to their pre-loss levels. However, since the loss can be paid for without new equity or debt, insurance preserves capital structure from sudden shocks; insurance is leverage neutral. Consequently, insurance avoids the trade off between over-leverage and costly new equity issues mentioned in the previous paragraph. But insurance also has its costs and the choice

between insurance and conventional sources of financing rests partly on the comparison of the respective transaction costs.

Essentially the transaction costs of insurance arises because of risk transfer and pre-payment. The insurer pays for losses and recovers prospectively in the form of premiums calculated from estimated expected losses. Much of the transaction cost comes in the form of estimating expected losses for each insured. The cost is enhanced by the fact that large losses are infrequent or rare, and are not easily estimated from the insurer's statistical records[13]. Moreover, the risk transfer creates the usual moral hazard problems. These features demand a large degree of monitoring to estimate the expected loss and to ensure continuing risk control. The costs are high largely because they must be incurred by the whole population at risk, not simply those who have a loss. In contrast, if debt financing is used, then the transaction cost is largely one of estimating credit risk. First consider whether it is cheaper for a bank to estimate and control credit risk than it is for an insurer to estimate expected losses and control moral hazard. But this captures only part of the comparison. Note that the cost of estimating credit risk is incurred only for those having a loss; thus prospectively this cost must be discounted by the probability of a loss occurring. Similarly, if equity financing is used, the prospective cost is diminished by the probability that no loss will occur, and the transaction cost is mainly one of writing incentive compatible contracts as discussed in Sections II and III.(i) above.

The transaction cost for conventional sources of finance is the product of the expected value of loss and the cost of capital plus the expected value of issue costs. In contrast the transaction cost for insurance is the difference between the premium (plus any other costs of securing insurance) and the present value of any expected claims payments made to the policyholder. For the reasons expressed in the previous paragraph, one would normally expect insurance to be more expensive prospectively than debt or equity, and this would certainly bias choice against insurance. However, as discussed in Section V, insurance does bundle insurance with other services and, if these are of value to the policyholder, they become part of the calculus.

☐ IV(iii). Convertible and Reverse Convertible Debt

A more sophisticated approach to leverage management is to retain the debt but add a conversion option. Normally such options allow the bondholder to convert debt into a given number of shares

of stock. This option will be "in the money" when the stock price rises such that the shares obtained on conversion have higher value than the debt. Green (1984) has shown that this conversion feature can reduce the distortions in project selection by "straightening out" the payout function such that payouts to different stakeholders are more nearly aligned.

Convertible debt mitigates incentive conflict by partly unlevering, i.e., unlevering in those states in which the firm performs well. Intuitively, it would appear that the best time to unlever is not when it is performing well, but when leverage becomes a burden, i.e., when the firm approaches insolvency.[14] In this light it would seem that incentive conflicts could be dealt with more efficiently by issuing convertible debt in which the option is granted to the firm, rather than to bondholders. I will call this Reverse Convertible Debt (RCD).

With RCD, it is to the advantage of the firm's owners to convert the debt to equity when the equity price falls sufficiently that the shares offered have lower value than the debt which is replaced. The advantages of this arrangement are twofold. First, it can be shown to be effective in mitigating the project selection problem, while retaining the leverage of the firm should it do well. The incentive conflict is mitigated since the shareholders retain a stake in very low realization of firm value (conversion dilutes equity but it does not expire worthless as it would with conventional debt). Thus, shareholders pay attention to downside risk in selecting investment projects. With RCD improved project selection can be secured without having to unlever the healthy firm and thereby loosing the various advantages of debt (tax advantages, lower transaction costs, etc.). Second, the exercise of the conversion option triggers an automatic unlevering when the firm is distressed. Consequently, the probability of insolvency is reduced (in the limit to zero when all debt has this feature) with a consequent savings in bankruptcy costs. An example is shown in the Appendix B in which the issue of reverse convertible debt not only leads to "correct" project selection, and saving in bankruptcy costs, but also the gains to bondholders are so great that the reverse convertible debt is actually MORE valuable than non convertible debt (despite the fact that bondholders have given away the conversion option).[15,16] The reverse convertible debt example shows that financial engineering strategies might be formulated which provide alternatives to conventional insurance strategies.

☐ IV(iv). Derivative Strategies

Derivatives have come to be used extensively in the management of financial risk (e.g., interest rate futures/caps/swaps, index options) and in the management of certain economic risk (e.g., commodity futures and options). However, they may have a role to play in the management of insurable risk. I will give two examples. The first shows that derivatives, which are a direct substitute for insurance, are actually being traded. The second is a more speculative example, and is meant to illustrate that there are potentially other uses for derivatives that could undermine the demand for conventional corporate insurance policies.

In 1992 the Chicago Board of trade opened a market in catastrophe futures and the following year trade began in options on these futures. The basic contract is written on an index of the catastrophe losses of 26 U.S. insurers. The index is compiled quarterly and contracts come in a standard size. The ability to write futures and options on this index provides a good, though not perfect, catastrophe hedge (the perfect hedge would be written on the actual loss experience of the individual insurer). While any one insurer's catastrophic loss experience may not be perfectly correlated with the index, there is likely to be a high correlation. Stated in these terms, these catastrophe futures seem to be an imperfect substitute for conventional reinsurance which pays according to the ceding firm's actual loss experience (rather than an index of market experience). However, the futures and options offer some compensating advantages over conventional reinsurance. First, they partly resolve the moral hazard problem; no one insurer has much influence of the index (non index insurers have no control and index insurers contribute, one average, 1/26 of the experience). Second, and not unrelated to the moral hazard issue, the transaction costs are much lower than for reinsurance. Growth of this market in its first two years has been fairly modest and this seems to have given rise to some complacency in insurance circles that it does not pose serious competition for reinsurance. This complacency is probably misguided. The success of all derivative markets has been constrained by the availability of a proper pricing formula, and considerable progress is now being been made on this front.[17] Second, the volume of Chicago Board trades may well severely underestimate the actual growth of these types of instruments; trades in the "over the counter" market have been reported on a much larger scale.[18]

My second example of the use of derivatives to compete with insurance is indeed more speculative. Insurance reduces risk. In so doing, insurance protects the earnings and share value of the firm

from the cost of rebuilding destroyed property, the payment of liability suits, or from the loss of earnings that may result from the destruction of productive assets. One way of characterizing the insurance process, is that the insurer pools the risks of policyholders with similar characteristics; e.g., those in the same industry. Industry pooling is explicit in many risk retention groups or other insurance pools which confine entry to a single industry. A good example would be O.I.L. which is a group captive comprising oil companies. Industry pooling is implicit in standard insurance arrangement with conventional stock insurers. The implicit nature of pooling stems from the fact that insurers typically use the statistical loss record of similar exposures to set and adjust premiums. Thus, industry insurance portfolios are self financing as the losses of one firm are spread over the industry pool. In this view, insurance is essentially guaranteeing that a sudden loss to one firm will not cause its share value to fall relative to its competitors. However, it is not difficult to envision other risk management strategies that would protect a firm's share value relative to its competitors. Such a strategy could be assembled from shares and derivatives of the firm and its competitors. It is true that this strategy would not isolate changes in value caused solely by insurable events, as would insurance. In this sense, such a derivative strategy would not be a perfect substitute for insurance. But is this really a deficiency? On the contrary, the lack of risk specificity could be an advantage given that many risk managers are stressing the comprehensive impact of risk on corporate performance.

■ V. INSURANCE AND UNBUNDLED STRATEGIES

□ V(i). Insurance as a Risk Management Bundle

A traditional insurance contract provides a bundle of services, notably:

- The insurer estimates the cost of insurable exposures and this is fixed as the premium. Fixing the cost of risk permits the insured to price its products and to improve estimation of the NPV of investment projects.
- Second, insurers often inspect the premises and operations of the insured. While the insurer's main interest is in acquiring information for underwriting and pricing, this information is

useful to policyholders in identifying opportunities to reduce risk.

- Third, insurers settle claims. At a minimum, the claims settlement services relieves the insured of an administrative burden. But externalizing claims settlement can help to mitigate losses. For example, insurers accumulate skills in settling liability claims which ultimately can accrue to the insured in lower premiums.
- Fourth, insurance provides a hedge with the corresponding benefits of risk reduction discussed at length here.
- Finally, insurance provides a source of funding for losses which avoids recourse to other sources of capital.

Insurers clearly have a comparative advantage over policyholders and other financial institutions in providing this bundled product. However, the bundle is costly. The high transaction costs often associated with insurance to some extent reflect the additional services provided in the insurance bundle. But these high costs are not necessarily deadweight costs of buying insurance. For example, the high costs of reducing information asymmetry between the policyholder and insurer do provide a common information base so that contracts can be written. In addition, the information provided to the insurer has value to the insured as noted in the first and second points above. To the extent that these services are of value to the insured, it would be misleading to make a direct comparison between the typically high costs of financing losses by insurance versus the typically lower cost of drawing on a line of credit. Contrary, to the extent that the bundled services offer little or no value to the insured, the real transaction cost of insurance will increase.

Consider an example of a large publicly traded firm making products which require a high level of technical expertise. Examples would be manufacturers of drugs, chemicals, aircraft and oil companies. For such firms, the insurer would be unlikely to have a comparative advantage over the firm in estimating losses or in providing loss prevention services. Such firms have specialized "in house" expertise which is unlikely to be replicated by insurers. Moreover, since the firm is large, the capacity limits of the industry (insurers rarely offer coverage for over $500 million per loss of for accumulations of losses in a year) are unlikely to offer significant risk reduction. Indeed the only losses that pose any serious risk to multi-billion dollar firms are typically those multi-billion dollar liability losses (e.g. Exxon's $9 billion and counting) which are well

beyond the capacity of the insurance industry anyway. For such a firm, the main risk management need is probably to find an orderly way of funding losses, without leaving the firm short of funds for new projects and without resort to expensive new debt issues. How might such contingent financing be acquired? One set of possibilities already has been discussed. The leverage management strategies discussed in Section IV, represent an unbundled risk management product; they contain neither risk transfer nor the other ancillary services provided with insurance. Clearly capital markets and banks are well suited to provide such funding and they can, and do, compete with insurers for loss financing. However, insurers still have some comparative advantage to exploit in selling a "stripped down" loss financing service instead of a full insurance bundle. Finite risk plans provide such a vehicle.

☐ V(ii). Finite Risk Plans

Finite risk plans defy a very precise definition since they vary in their structure. However, they have in common the provision of loss financing with some measure of risk transfer. A typical plan allows for the payment of premiums over a fixed period (say five years). The projected terminal value of the premiums plus investment income, assuming no loss payment, becomes the limit on coverage. Any losses occurring within the five year period are paid up to the coverage limit. Finally, the plan will usually return part of the unpaid balance (premium account minus paid losses) on termination. Essentially such a plan is one of smoothing the costs of financing losses, within defined value and time limits. The degree of risk transfer varies. In some plans there is little risk transfer other than that the insurer assumes the risk that the insured will become insolvent after payment of a loss and will be unable to pay any remaining premiums. In other plans, there is more risk transfer. For example, the plan might limit the payment of any single loss to the sum of premiums plus investment income but will allow multiple losses. The *quid pro quo* would be that less premium would be returned if losses turn out to be lower than premiums.

While pans differ in their risk transfer component, their common feature is that they provide a smoothing of losses over the contract horizon. Moreover, in restricting the risk transfer, the monitoring cost is changed. The underwriting risk is lowered and it is not necessary to undertake expensive inspections and controls to redress adverse selection and moral hazard. Instead the insurer's risk is more of a credit risk nature. Consequently, finite risk plans can be seen as the insurance industries attempt to forestall actual, or potential,

competition from banks and the capital market, for financing insurable losses. But the other side of this coin is that they define a region for banks to compete directly with insurers in the management of insurable risk.

□ V(iii). Financial Reinsurance

Financial reinsurance, like finite risk plans, come in various forms. However, it is essentially similar to finite risk plans in its general structure and objective. These plans explicity address the function of inter-temporal diversification, since they smooth losses over a definite finite horizon. Like finite risk plans, their value lies in the possibility for reducing transaction costs by substituting credit risk for underwriting risk.

■ CONCLUSION

Competition for conventional insurance products can be roughly divided into two forms. First, there are hedging products offered by the capital market. This form of competition is still in embryo, though it should be taken seriously by insurers. While catastrophe futures and options may not be perfect substitutes for conventional reinsurance products, they do offer an attractive trade off to primary insurers. The payoffs may be less than perfectly correlated with the purchasing insurer's actual catastrophe loss experience, but the redress of moral hazard promises a significant lowering of transaction costs. Perhaps the best defense against the growth of these products for reinsurers lies in the use of pricing technology (e.g., option pricing) to lower the transaction costs and to permit these products to be sold in less costly and less labor intensive fashion. Forecasting other uses of derivative as substitutes for primary corporate insurance is quite speculative. However, it is not at all difficult to identify possibilities. This becomes apparent when one considers that the ultimate protection offered by corporate insurance is that against a fall in stock price. Derivatives are traded constantly with such hedging motives in mind. One can only expect that, as traditional risk management and financial risk management are merged, such strategies will be increasingly recognized as substitutes for risk specific hedges such as insurance.

The second form of competition lies in the adoption of strategies to render risk less costly. The most apparent of these is leverage management, notably the use of alternative financing strategies.

The insurance market has always been affected by this form of competition to some extent. Uninsured losses, or underinsured losses, have always created demands on retained earnings, or called for new debt or even new equity. Whether this has always been part of a comprehensive risk management strategy may be questioned; and the risk management literature has only recently come to view risk management as a holistic corporate activity in which insurable risk is only one element. Competition for insurance from debt and equity defines opportunities for other financial institutions. Certainly, if credit risk is less costly to monitor than insurance risk, then lending institutions are well placed to compete with insurers to finance insurable losses. Perhaps the best defense for insurers lies in expanding its list of products to include some which more closely resemble financing, than hedging, instruments. The insurance industry appears to be showing some signs of doing just that. Finite risk plans and financial reinsurance are responses to this threat. To meet this competition successfully will require that insurers unbundle the usual package of loss services and develop these and related financing products that have transaction costs closer to those associated with the monitoring of credit risk than insurance risk.

The success of insurers in staving off competition will rest on how effectively they reduce transaction costs. Certainly, unbundling allows insurers to target firms according to their particular needs. For firms that are large and publicly traded, the risk reduction offered by insurance is modest and expensive and the ancillary services provided by insurers are of limited value. Probably such firms are more interested in orderly financing of losses and this can best be provided unencumbered by the high transaction costs associated with hedging and its ancillary services. However, there is a large demand for conventional insurance products from small firms, for whom the hedging and ancillary services of insurance will continue to be of value. Some of this market is reasonable secure for insurers. For example, property insurance usually comes close to satisfying most of the criteria of insurability and usually can be written with moderate transaction costs. Liability insurance is more problematic. To retain this market, insurers must be more successful in dealing with crises caused by implicit correlation. To succeed requires that they effectually "mutualize" the nature of the contracts they sell by defining risk pools within their larger portfolio and issuing participating policies within each pool.

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APPENDIX A

Consider a firm in which existing operations are risky, future earnings have an expected present value of either 100 or 200 each with a 0.5 probability. The firm has 100 existing shares and existing senior debt with a face value of 100. Since the debt is covered in all states of the world, its value is 100 and the value of equity is 50. We assume all risk is diversifiable.

PROJECT SELECTION WITH NON-CONVERTIBLE DEBT

The firm now faces the following project choice:

	Capital cost	PV of earnings	E(NPV)
Project A	200	220	20
Project B	200	20; probability 0.5 or 310; probability 0.5	-35

The earnings from the projects are independent of those from existing operations. The firm issues new (junior) debt with a face value of 200 prior to making its project selection with a (dubious) hope of financing the project which has a cost of 200. Finally, we assume that the transaction cost in the event of bankruptcy is 100.

We now value the firm's claims bearing in mind the permutations of earnings that can arise from existing operations and from whichever new project is chosen. We also net out bankruptcy cost where total value of earnings is insufficient to pay both senior and junior debt.

Value of the firm if project A is chosen

Value of the firm	0.5(320 + 420)	= 370
Old Debt	0.5(100 + 100)	= 100
New Debt	0.5(200 + 200)	= 200
Equity	0.5(20 + 120)	= 70

Value of the firm if project B is chosen

Value of the firm	0.25(20 + 120 + 410 + 510)	= 260
Old Debt	0.25(20 + 100 + 100 + 100)	= 80
New Debt	0.25(0 + 20 + 200 + 200)	= 105
Equity	0.25(0 + 0 + 110 + 210)	= 80

This illustrates the classic under-investment problem. Since project selection is made after debt has been issued, shareholders favor project B which offers an equity value of 80 compared with 70 for A. If bondholders anticipate this choice, then debt is valued only at 105, thus the debt issue will not command a sufficient price to fund the project. In this example, there is insufficient gain to shareholders to make good the remaining 95, (i.e., 200 - 105), required to fund project B, since the value of equity is 50 with neither project and is only 80 if B is undertaken. Unless the firm can credibly signal to bondholders a commitment to undertake A, the firm is snookered and will accept neither project.

Now, the problem can be solved in either of two ways. First, if the new project were to be financed with equity, there would be no problem; project A would be chosen. This follows since the total debt is now only 100 (old debt) and there is no chance that firm value would fall below this value. Since the probability of bankruptcy is zero, shareholders bear all risk with either project and will select that with the higher NPV. Alternatively suppose that the risk in project B can be hedged. With a costless hedge, the firm could replace a lottery of 10 and 310 with a certain value of 165. It is straightforward to show that the shareholders would never select a certain project with cost 200 and certain PV 165 over an alternative with cost 200 and certain PV of 220.

■ APPENDIX B

PROJECT SELECTION WITH REVERSE-CONVERTIBLE DEBT

The advantages of RCD can be illustrated using the same example but changing the debt to reverse convertible. We will show that RCD will reduce the distortion, in this case leading to the value maximizing decision. Moreover, we will show that the benefit to bondholders can be sufficiently large, that reverse convertible debt can actually have a higher value than non convertible debt, despite the fact that with RCD the option is exercised against the bondholders. In

effect, the conversion option can have negative value. This gain in value stems from the fact that RCD reduces or removes, expected bankruptcy costs and from the real effects of project choice on the value of the conversion put.

Now the new debt is assumed to contain an option for the firm to convert the debt into equity; the option being held by shareholders. The face value of the debt is the same, and the conversion ratio will permit the exchange of the bonds for 200 shares of stock. Thus, after conversion, the number of shares will rise from 100 to 300. The old senior debt is still assumed to be non-convertible. First, we need to establish the values of the firm at which the conversion option will be exercised. Since the option is held by shareholders, it will be exercised at values for which the value of equity issued on conversion (which will then amount to two thirds of total equity) is less than the non converted obligation of 200; i.e.

Convert if:	(Value of firm – Senior Debt) < 200
or if:	Value of firm < 400

Since the firm will unlever its junior debt for all firm values less than 400, it can become bankrupt only if it is unable to pay the senior debt of 100. No matter which of the new projects is selected, there is always sufficient value from existing operations and from the project to pay the senior debt. Thus, there is no bankruptcy cost to consider.

Value of the firm if project A is chosen

Value of the firm	0.5(320 + 420)	= 370
Old Debt	0.5(100 + 100)	= 100
New Debt	0.5{(320-100) + 200}	= 173
Equity	0.5{(320-100) + 120}	= 97

Value of the firm if B is chosen

Value of the firm	0.25(120 + 220 + 410 + 510)	= 315
Old Debt	0.25(100 + 100 + 100 + 100)	= 100
New Debt	0.25{(120-100)+(220-100)+200+200}	= 123
Equity	0.25{(120-100)+(220-100)+110+210}	= 92

Now there is clear incentive to undertake project A since the value of equity is higher than for B. Moreover, in anticipating the choice of A, bondholders will be willing to pay 173 for the new reverse convertible debt. Notice that, for non convertible debt, bondholders would only have paid 105. Thus, despite the fact that the conversion option is held by shareholders, RCD is much more valuable than NCD. The source of the gain in value is twofold. First bankruptcy costs which would have been borne by bondholders, are avoided with RCD. Second, because RCD disciplines the choice of project A, the conversion put under RCD has a much smaller value than the default put under NCD. Finally, it remains to show that the choice of A is feasible and will

be funded. While project A costs 200, investors will subscribe only 173 for the new RCD. Thus, a remaining 27 needs to found from equity. Bearing in mind that the value of equity if neither project is undertaken is 50, and this increases to 97 if project A is undertaken, the increase in equity value will permit the issue of new equity (to fund the remaining 27) and still leave old shareholders better off.

This example shows that RCD can discipline the firm to take the positive NPV project and, in doing so, the gain in value can be captured by the firm's current shareholders. To see this, notice that, if neither project is undertaken, equity is worth 50. If RCD is issued and A is chosen, then existing equity is worth 70 (97 minus the 27 needed to supplement debt of 173 in funding the project). The gain in the value of existing equity is exactly equal to the NPV of project A.

The capacity of the insurance market to offer insurance on large risks, depends mainly on the supply of capital to the reinsurance industry and to surplus lines insurers. Reinsurance capacity has been acutely sensitive to market conditions and to realizations of losses. For example, withdrawal of reinsurer has been identified as a major factor in the 1980's liability insurance crisis (Winter 1991) and lack of capacity often seems to follow natural disasters which severely affect reinsurers and deplete their surplus. Capacity problems are enhanced by the difficulties in pricing reinsurance contracts.

This structure is precarious for at least two important reasons. First, since the reinsurer usually writes the losses in the tail of the distribution for which the relative variance (variance to expected loss) is unusually high. This means that reinsurers and surplus lines insurers often have a high probability of ruin and periods of catastrophic loss experience do seem to have been followed by failures of such insurers. This problem arises from insufficient diversification amongst reinsurers. This usually requires a wide spread of risk across lines of business and geographically.

Notes

1. Notable were Mehr and Hedges, 1963 and 1974.

2. Managing Risk, Business Week, October 31, 1994.

3. For explanations of the cost of risk see Mayers and Smith 1982, Shapiro and Titman 1985, Froot, Scharfstein and Stein, 1994.

4. Though, I will argue later that deviations from absolute priority are important in formulating risk management strategies.

5. See Jensen and Meckling, 1976 and Myers, 1977.

6. It is also interesting to note that Borch's derivation of the mutuality principle preceded the publication of the CAPM by Sharpe, Mossin and Lintner and, although Borch expressed his model in terms of reinsurance market, he carefully explained in the introduction that it applied, *inter alia*, to capital markets. Thus, there is a case for arguing credit for CAPM rightly belongs to Borch. A clue to why he did not receive this recognition is given by Kihlstrom and Pauly, 1971, who suggested that he was somewhat skeptical about his predictions and failed to foresee the profound implications of his model.

7. A good summary of the mutuality principle is given by Gollier 1992.

8. Jointly, the observations that (a) the mutuality principle is efficient when faced with undiversifiable risk and (b) claims made policies (but not occurrence policies) achieve the mutuality effect, carries interesting implications for the widely publicized lawsuits against the insurance industry. The Attorneys General of various states recently sued several insurers and the Insurance Services Office for conspiring to force the claims made policy form on policyholders. Part of the basis for this suit was that claims made represented a degradation of coverage. This seems to totally ignore the aspect of undiversifiable risk that had become apparent in the liability marketplace. It seems somewhat ludicrous that the industry was being accused of forcing a policy form, which can be shown to be efficient, on the public.

9. Note the contrast with participating policies which allow for dividends to policyholders based on the *portfolio* loss experience.

10. One would expect that limiting capital would reduce costs to the extent that accident victims were not contracting with the firm (e.g. customers and employees) and therefore could not extract an ex ante risk premium for such risk.

11. The good faith code is sufficiently strong that many actors keep scant records of transactions, relying on brokers and primary insurers for complete evidence of contracts which are still sometimes sealed orally.

12. The effects of paying for uninsured losses with debt on capital structure are broadly as follows. The initial effects of the loss of productive assets are to reduce earnings and, since fixed income claims are not forgiven, leverage will increase. Raising new debt to pay for the cost of reinvestment will increase leverage even further. However, the double whammy on leverage will be partly offset by the value created by reinvestment. Investing in a positive NPV reinvestment project (re-building the plant) will create value for residual claimants and will partly restore the value of equity. Nonetheless, the firm will end up with more debt and higher leverage than before the loss.

13. Doherty and Smith 1993 have argued that the transaction costs for insuring large losses are likely to be large also because the market exhibits more monopoly power at this level, and also because insurers are more likely to dispute large losses such that costs of enforcing the insurance contract rise. Naturally, the expected value of such enforcement costs will be embedded in the insurance premium.

14. See Frierman and Visawanath 1994 for a justification of this proposition.

15. The example is taken from Doherty and Harrington 1995.

16. Another spin on the concept of RCD is offered by Frierman and Viswanath 1994. They show that, when faced with the project selection problem, the Pareto optimal form of capital structure is one which resembles RCD in that the shareholders participate in *all* possible realizations of firm value. They then argue (incorrectly, see Doherty and Harrington 1995) that RCD would not be sustainable because investors would separate out the conversion option and this would deprive the firm of the efficiency gain. However, they do argue (correctly) that even without building the conversion option into debt, much the same effect is achieved *ex post* by bankruptcy courts. Courts often deviate from the absolute priority rule and in so doing, they do allow the shareholders to retain some value even though the firm is insolvent. If actors anticipate that courts will act in this way, then the incentive conflicts that lead to poor project selection will be mitigated. Simple recognition of this fact means that the cost of risk is somewhat lower than one might otherwise have thought, and the need for insurance, or other hedges, is not so strong.

17. See D'Arcy and Grace, 1992, Niehaus and Mann 1992, and Cox and Schwebach 1992 for a discussion of these instruments, their uses and some thoughts on pricing. At least one of these papers is a little pessimistic about the prospects for the futures. However, this paper was written before trade began and, perhaps due to some refinements in the basic contracts, there has been some growth of the market.

18. See Economist, Insurance Survey, 3rd December, 1994, page 18.