Corporate Insurance Purchases and Taxes

Brian G. M. Main

ABSTRACT

An examination of the economics of Corporate purchases of insurance indicates that one strong motivation for insurance purchase lies in the tax laws as they affect insured losses. After a theoretical examination of this point, the analogy is made between the decision to insure or not insure and the decision to lease or not lease. A numerical example is provided by way of illustration. In this way corporate purchases of insurance can be viewed as a tax minimization method of financing losses that arise from insurable risks.

1. Introduction

To date, the conventional approach to modeling a corporation's decision to purchase insurance has been to assume some corporate utility function that displays risk aversion.[1] The development of the capital asset pricing model by Sharpe (19), Litner (10), and Mossin (14), has raised a cloud over this traditional view of the corporation's insurance purchasing activity. The capital asset pricing model dichotomizes risk into specific risk, or risk unique to that corporation, and systematic risk, or risks common to all economic agents. As any investor is free to hold a diversified portfolio, it is a relatively simple matter to eliminate all specific risks from a portfolio. Through the Law of Large Numbers the investor has essentially written his or her own insurance policy against specific risks, or perils, such as fire, liability, and so on. Even if insurance premiums were actuarially fair, corporate purchases of insurance against such hazards will not improve the welfare of the diversified investor.[2]

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Helpful discussions with David Babbel, Julian Franks, and Hayne Leland are gratefully acknowledged. Thanks are also due to two anonymous referees of this Journal for constructive and useful comments.

[1] It is never made clear exactly how the parameters of this utility function are set. For an example of this approach, see Doherty (4) who speaks of "the individual or the firm" throughout. A more careful distinction is made by Mossin (15) who appeals to work by Borch (1) on the utility function of an insurer.

[2] This point was well known to Frank Knight (9, especially p. 254) writing as long ago as 1921.

On the other hand, if the corporation cedes some of its systematic risk through the purchase of insurance, the insurer will, in effect, end up holding a financial instrument whose return is correlated with the market return. By their definition the insurer cannot reduce such risks by diversification. It has been demonstrated elsewhere (see Main (12)) that consideration of the opportunity cost of capital should lead to an insurance premium that exceeds the actuarially fair odds by an amount sufficient to justify holding such undiversifiable risk. This extra charge[3] will reflect the "market price of risk" and, again, make insurance a matter of no concern to the corporate investor.

Theory seems to predict, then, that corporations will have no motivation to insure against specific risks, and that insurance premiums charged for any available insurance against systematic risks will be high enough to deter corporate purchases. This prediction is obviously at odds with established theory (see Cummins (3) and Main (12)) and with the facts. Corporations are major purchasers of property and liability insurance.[4] In addition, premiums charged on such business frequently include a loading, or allowance for expenses over and above claims paid, of 30 percent to 40 percent of the premium.[5] The list of factors that could lead corporations to purchase insurance includes costs of financial distress, human capital, informational asymmetries, and taxation. These factors were reviewed in Main (11) where it appeared that taxation presented the clearest-cut motivation for corporations to purchase insurance. The purpose of this paper is to investigate the tax-shielding aspects of insurance purchases in some detail. In Section 2 the institutional details affecting the demand and supply of corporate insurance are discussed. Section 3 presents a detailed discussion of the conditions under which tax shields will lead corporations to purchase insurance. Section 4 introduces the analogy of corporate insurance as a state dependent financial lease, and Section 5 presents the paper's conclusions.

2. The Institutional Framework

A most lucid statement of how the Internal Revenue Code effectively encourages the purchase of insurance by corporations was presented by the

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[3] It is possible, of course, that the insurer will charge a lower price, for holding the risk, than that demanded by the market. This seems to have occurred when Lloyd's agreed to insure U.S. computer leasing companies, such as Itel and Federal Leasing, against losses from early cancellation of computer leases. IBM's new 1977 product line made many of the leased 370s obsolete and resulted in claims expected to reach $700 million on $1 billion of computer leasing cover. *See Business Week* December 24, 1979, p. 48 and *Institutional Investor* March 1980, pp. 103-111. Such events must be regarded as disequilibrium phenomena.

[4] The extent of corporate insurance purchasing has been documented in surveys by Goshay (8) and *Fortune* (6). These surveys are in broad agreement. *Fortune* found that 86 percent of the top 500 industrial corporations purchased insurance against at least 75 percent of their perceived total loss exposure.

[5] Such ratios are typical of those reported in Best's *Property/Casualty Aggregates and Averages*, annual. Also see evidence by Bob A. Hedges in *The Insurance Industry* (20, pp. 1108-1117).

Oil Insurance Association in a brochure entitled, "To Insure or Not to Insure. . . ."[6] This brochure argued that self-insured property damage losses are tax deductible only to the extent of the tax base, or book value, of the destroyed asset. Income from insurance claims, on the other hand, is tax free as long as it is used to repair or replace the destroyed asset. If the income from the insurance claim is not used for some other purpose, a capital gains tax is levied on the difference between the book value of the destroyed asset and the settlemet paid by the insurer. A capital gains tax is also levied if there is seen to be an 'undue delay' before replacing the asset, or if the renewed or replaced asset is restated on the corporation's books at its now higher value. The tax is levied on the difference between the book value of the destroyed asset and the higher value at which the replacement appears on the books. To date, the tax code has not been changed to invalidate this statement.

It seems intuitive that when the capital gains tax is less than the corporate profit tax and/or when accounting depreciation for tax purposes is more accelerated than economic depreciation, or the true wear and tear on the asset, purchasing insurance at something approaching actuarial odds will be advantageous. The Oil Insurance Association gave an example of a loss experience where the market purchase of insurance was clearly more advantageous than any form of self-insurance. When this discussion was reviewed by Goshay (8) it was criticized and dismissed as being too particular. While the actual numerical example presented by the Oil Insurance Association was, by necessity, particular, it will be shown in the following sections that their argument is in fact valid, even in a general sense.

3. Conditions under which Insurance is Purchased by the Corporation

A. No Taxation

Consider a purely equity financed corporation. Many considerations are involved in the decision making of such a firm, not the least of which is a concern with liquidity or current cash flow.[7] But the generally accepted long run objective is that of maximising the present value of the corporation's profit stream, or, in other words, to maximise the discounted cash flow. If the net present value of the enterprise has been maximised no further improvement in the welfare of the equity holders is possible. In the presence of uncertain income and cost streams, however, it is necessary to choose a risk-adjusted discount rate by which to compute the net present value. Obviously the greater the uncertainty attached to a stream of cash flows, the higher should be the risk-adjusted discount rate. No attempt is made here to probe the complexities involved in this issue and the interested reader is referred to Robicheck and Myers (18) and Myers and Turnbull (17). To shed the maximum light on

[6] Reproduced in Hearings before the Subcommittee on Antitrust and Monopoly (20, Part 5, pp. 2955-2959).

[7] For a complete discussion of this issue see Fama and Miller (5) or Brealey and Myers (2).

insurance decision *per se*, it will be assumed that an appropriate risk-adjusted discount rate can be found.

The present value of the corporation can then be written

$$PV = \sum_{t=1}^{T} \frac{E(x_t - c_t - c_t')}{(1 + R)^t} \tag{1}$$

where

c_t is a random variable describing the stream of costs arising out of what will be regarded as the insurable risks faced by the corporation

c_t' is a random variable describing the stream of all other costs faced by the firm

x_t is a random variable describing the stream of revenues enjoyed by the firm

E is the expectation operator

R is the appropriate risk-adjusted discount rate

As c_t arises from the presence of insurable risks, e.g., the possible loss of the corporation's productive assets due to some irreducible but random hazard (fire, say), the possibility of insurance arises. Consider the effect of an insurance premium, I, which fully indemnifies the corporation against such losses. The insurance cover will certainly be demanded if it raises the expected discounted profits of the corporation, i.e., if

$$\sum_{t=1}^{T} \frac{E(x_t - c_t') - I}{(1 + R)^t} \geq \sum_{t=1}^{T} \frac{E(x_t - c_t - c_t')}{(1 + R)^t} \tag{2}$$

or, if

$$I \leq E(c_t)$$

i.e., if insurance is available at actuarial, or "fair", odds or better.

From the insurer's viewpoint, the expected profit from underwriting such risks can be written

$$E(NI - Nc_t) = N(I - E(c_t)) \tag{3}$$

where N is the (large) number of such identical risks underwritten by the insurer.

Thus, the expected profit[8] will be positive if and only if

$$I \geq E(c_t)$$

[8] The variance on the insurer's profits per policy will tend to zero as the number of policies, or the number of identical and independent risks underwritten, N, tends to infinity. This is a result, of course, of the Law of Large Numbers.

By considering both sides of the market, it appears that under these simple conditions, the only possible insurance premium is one that reflects the actuarial loss, i.e., a "fair game". And at these odds the corporation will be indifferent between insuring and not insuring.

B. Corporate Taxes and Full Deductibility of Loss

The simple model introduced above is now extended to include corporate profit taxes, at some marginal rate, τ. It will be assumed that insurance premiums are tax deductible, and that the settlement of an insurance claim, arising out of some loss experience, goes untaxed. In the case of an uninsured loss, it is assumed that the loss may be written off against taxes. If the corporation were levered by having corporate debt, the introduction of corporate taxes would require the use of a different risk-adjusted discount rate. This complication can be avoided by staying within the framework of a totally equity financed corporation.

The present value of the expected profit of an uninsured corporation can then be written[9]

$$PV = \sum_{t=1}^{T} \frac{E[(1-\tau)(x_t - c_t - c_t')]}{(1+R)^t} \tag{4}$$

In the case of the insured corporation, the same present value is written

$$PV = \sum_{t=1}^{T} \frac{E[(1-\tau)(x_t - c_t' - I)]}{(1+R)^t} \tag{5}$$

Thus, for the corporation, insurance cover is now attractive if

$$I \leq E(c_t)$$

which is exactly the same condition that held above. Further, the existence of corporate tax does not affect the conditions for the minimum premium, which is, again, the actuarial odds or fair-game premium. It is then a matter of indifference to the corporation whether insurance cover is purchased or not.

C. Depreciating Assets and Market-Value Insurance

To date the analysis has ignored the fact that assets depreciate, and the market value of their loss consequently declines with the passing of time. To simplify the analysis, assume that there is only one insurable risk in question, namely the loss of the corporation's only asset — its production plant, say. Whereas the period by period depreciation of this asset would appear with other non-insurable expenses in c_t', the possible loss of the asset would constitute the insurable risk cost stream previously written as c_t. In reality the corporation faces a large number of independent loss exposures of this nature, but there is no loss of generality here by reducing the analysis to only one hazard.

[9]The possibility of net revenue being negative is discussed in section 3F, after taxes have been fully introduced.

Assuming that the probability of loss is constant over time, and that the loss is either total or does not occur, the present value of the expected profit of the noninsured firm can be written

$$PV = E\left\{ \sum_{t=1}^{T} \frac{(1-\tau)(x_t - c'_t - pb(t))}{(1+R)^t} + (1-\tau)\frac{b(T)}{(1+R)^T} \right\} \quad (6)$$

where

- $b(t)$ is the book value, and in this case, market value of the asset at time t. Given that an asset lost at age t is always replaced by an asset of the same age and, therefore, market value, $b(t) = K - tD$
- D is the fixed depreciation of the asset per period, i.e., straight line depreciation is assumed
- K is the cost of the asset, and in the absence of appreciation or inflation, the market value of the asset as new
- P is the probability of total loss of the asset per period.

The last term in parentheses in (6) gives the scrap (or market) present value of the asset after T years, i.e. at the end of the period under consideration.

In a similar manner, the expected present value of the insured firm can be written

$$PV = E\left\{ \sum_{t=1}^{T} \frac{(1-\tau)(x_t - c'_t - I(t))}{(1+R)^t} + (1-\tau)\frac{b(T)}{(1+R)^T} \right\} \quad (7)$$

where

$I(t)$ is the insurance premium in period t.

The insurance premium, $I(t)$, will vary with time as the market value of the depreciating asset varies with time. Because replacement of any destroyed asset is assumed to be by one of the same vintage, the time profile of insurance premiums is known with certainty. The insurance premium can be written as a multiple, d, of the market value of the insured asset (the cover), $b(t)$

$$I(t) = db(t) \quad (8)$$

If the insurer is to write such a policy

$$I(t) \geq pb(t) \quad (9)$$

$$d \geq p$$

or

For the corporation to find insurance attractive

$$I(t) \leq pb(t) \quad (10)$$

Again, the only terms under which there will be a demand and supply of insurance is at actuarial odds where the premium is set equal to the expected loss. Even at these odds, the corporation is indifferent between market purchases of insurance and self-insurance.

D. Depreciating Assets and Replacement Value Insurance

The analysis can be further complicated by considering insurance policies that offer "new for old" or the indemnifying of the loss of a depreciated asset by the current market value of a new asset. Insurance premiums will, of course, be higher than would have been the case were insurance cover restricted to current market value of the asset. In recent years insurers have become increasingly willing to write this form of insurance. It is also true, however, that issues of moral hazard and the principle of indemnity are likely to restrict the availability of such coverage. For this reason, the assumption of "new for old" cover will be made in this section only. Once it has served to highlight the role played by tax considerations, it will be discarded and a more general assumption of "actual cash value" coverage will be used. The additional features of inflation and accounting depreciation will also be incorporated at that time.

The reader is, then, asked to suspend temporarily his or her incredulity and enter a world in which all insurers will write "new for old" cover. Assume, however, that insurance contracts must run for many periods and cannot simply be invoked when short run considerations make them attractive. Ignoring taxes for a second, it is obvious that, once again, only a premium less than or equal to the expected value of the cover (the probability of loss times the replacement value of the asset) will appeal to the corporation. In the same way the premium will have to be at least as great as this actuarial value for the insurer to sell such a policy.

The matter becomes more interesting, however, when some approximations to current tax law regarding insurance and write-off allowances are incorporated into the analysis. The main complicating factor here is that the market value of the asset at time t, b(t), will now depend on the loss experience of the corporation up to time t. For example, had the asset been totally destroyed in period t - 1, then at time t the market value of the asset will be that of a one-year-old asset — quite different from the case where there had been no loss for the t years of operation. It is a simple matter [10] to calculate the

[10]

$$
\begin{aligned}
E(b(t)) = {} & (K - D) \cdot (\text{probability lost last period}) \\
& + (K - 2D) \cdot (\text{probability lost 2 periods ago/not lost last period}) \\
& \cdot \\
& \cdot \\
& + (K - (t-1)D) \cdot (\text{probability lost } t \text{ periods ago/not lost in any subsequent period}) \\
& + (K - tD) \cdot (\text{probability not lost in } t \text{ periods}) \\
= {} & \sum_{a=1}^{t} p(1-p)^{a-1}(K - aD) + (1 - p)^{t} (K - tD)
\end{aligned}
$$

Note,

$$\sum_{a=1}^{t} p(1-p)^{a-1} + (1-p)^{t} = 1$$

i.e., the above expected value is simply a weighted average of all possible book values.

expected value of b(t)

$$E(b(t)) = \left[\sum_{a=1}^{t} p(1-p)^{a-1}(K - aD)\right] + (1-p)^{t}(K - tD) \qquad (11)$$

Without insurance, any firm that suffers the loss of an asset necessitating its replacement by a new asset is allowed to deduct from earnings, before tax computation, the relevant book value of the asset at the time of the loss. The difference between the book value and the market value of a new asset must be met from after-tax income.

In contrast to such treatment of the uninsured firm, any firm with insurance on the asset can receive full payment for a new asset from the insurance company and be exempt from corporate profit tax on this income. When the asset is entered on the books at the new, higher value, however, capital gains tax is payable on the difference (this being judged an "involuntary conversion"). As always, insurance premiums are tax deductible.

If, for the moment, accounting practices are assumed to be such that book values always reflect the contemporaneous actual cash value of the asset at market prices, b(t), the expected present value of the uninsured corporation becomes

$$PV = E\left\{\sum_{t=1}^{T} \frac{(1-\tau)(x_t - c'_t - pb(t))}{(1+R)^{t}} - \sum_{t=1}^{T} \frac{p(K-b(t))}{(1+R)^{t}} + (1-\tau)\frac{b(T)}{(1+R)^{T}}\right\} \qquad (12)$$

where the second term gives the expected value of that part of the expense of replacing destroyed assets with new assets, namely the difference between the market value of the new asset and the book value (or tax allowance) on the destroyed asset.

This can be contrasted to the expected present value of the insured corporation

$$PV = E\left\{\sum_{t=1}^{T} \frac{(1-\tau)(x_t - c'_t - I)}{(1+R)^{t}} - \sum_{t=1}^{T} \frac{pG(K-b(t))}{(1+R)^{t}} + (1-\tau)\frac{b(T)}{(1+R)^{T}}\right\} \qquad (13)$$

where

G is the capital gains tax rate.

The second term gives the expected value of capital gains tax payments. The insurance premium, I, is taken as constant over time as, in the absence of inflation or appreciation, the sum insured is constant over time — at the price of a new asset. Now the condition under which insurance will be attractive to the corporation appears as

$$(1-\tau)I \leq E\{(1-\tau)pb(t) + p(K-b(t)) - pG(K-b(t))\} \qquad (14)$$

or

$$(1-\tau)I \leq E\{pK - \tau pb(t) - pG(K-b(t))\} \qquad (15)$$

i.e., the expected cost of insuring the risk (the insurance premium plus the expected capital gains tax liability resulting from a claim) must be less than the expected cost of assuming the risk (the expected loss, adjusted by the tax saving resulting from writing-off the lost asset).

The insurer will only underwrite the risk if

$$I \geq pK$$

From this simple analysis it is now possible to find favorable insurance policies for the corporation, i.e., such that

$$pK \leq I \leq \frac{1}{1-\tau} E\{(pK - \tau pb(t) - pG(K-b(t))\} \tag{16}$$

Initially, as book value, b(t) is equal to replacement value, K, the insurance would only be attractive at actuarial odds. But, with the passing of time, the book value lies below the replacement value. Although penalized by capital gains tax, the firm is more than compensated by exemption from corporate profit tax (generally higher) on the replacement value. This can be seen more clearly by rewriting the above expression

$$pK \leq I \leq pK + \frac{1}{1-\tau} E\{p\tau(K-b(t)) - pG(K-b(t))\} \tag{17}$$

Thus, it is not so much the tax exemption of insurance premiums that makes market purchase of insurance attractive to the corporation, as the exemption from corporate profit tax of the replacement of assets long since depreciated. Market purchase of insurance can only enhance the tax shields of the corporation. Institutional constraints prevent all corporate tax liabilities from being converted to the lower capital gains rate. Insurance payments are contingent on the occurrence of some hazard, and cover is limited to an assessment of the loss suffered[11]. If moral hazard is a serious consideration then it would be necessary to restrict the cover offered to the market value of the lost asset, i.e., "actual cash value".

E. Accounting versus Economic Depreciation

Further reflection reveals that, under current tax law, even insurance based on the market value of the insured asset can allow enhanced tax shields when accounting depreciation leads to a faster write-off of the asset than is merited by its market value or economic depreciation. In general, the faster the rate at which the asset can be depreciated for accounting purposes, the higher the present value of the tax shields generated. This fact, *ceteris paribus*, leads accountants to choose the fastest rate of depreciation allowed under tax law. With little loss of generality, then, it can be assumed that the accounting book value of an asset is always less than the market value of the asset. As above, however, only the book value may be written off against tax in the case of a

[11] In fact, much of the difference between gambling and insurance is dictated by concerns over moral hazard. In principle, the insurer's function of pooling risks is little different from that of the bookmaker accepting bets.

loss. The expected present value of the asset is

$$PV = E\{ \sum_{t=1}^{T} \frac{(1-\tau)(x_t - c_t' - pb(t))}{(1+R)^t} - \sum_{t=1}^{T} \frac{p(m(t)-b(t))}{(1+R)^t} + (1-\tau)\frac{m(T)}{(1+R)^T} \} \quad (18)$$

where

m(t) represents the economic value of the asset which will depend on the past loss experience

$$E(m(t)) = \left[\sum_{a=1}^{t-1} p(1-b)^{a-1}(K-aU) \right] + (1-p)^{t-1}(K-tU) \quad (19)$$

where

U measures the loss of market value per period, i.e. economic depreciation.

This can be contrasted with the expected present value of the insured corporation

$$PV = E\{ \sum_{t=1}^{T} \frac{(1-\tau)(x_t - c_t' - I(t))}{(1+R)^t} - \sum_{t=1}^{T} \frac{pG(m(t)-b(t))}{(1+R)^t} + (1-\tau)\frac{m(T)}{(1+R)^T} \} \quad (20)$$

As in section 3C, above, the insurance premium will vary with the market value of the asset insured. If the insurer is to write such a policy

$$I(t) \geq pm(t)$$

and if the present value of the insured firm is to be higher than that of the uninsured

$$(1-\tau)I(t) \leq E\{(1-\tau)pb(t) + p(m(t) - b(t)) - pG(m(t) - b(t))\} \quad (21)$$

Thus for insurance to be demanded and supplied the premium I(t) must lie in the range

$$pm(t) \leq I(t) \leq pm(t) + \frac{1}{1-\tau}\{p\tau(m(t)-b(t)) - pG(m(t) - b(t))\} \quad (22)$$

Again, insurance increases the expected tax shield in the case of a loss, and this increase in the tax shield will outweigh the capital gains tax as long as the capital gains tax rate, G, is less than the corporate profit tax rate, τ. Obviously, the further the book value deviates from market value, the greater the incentive to insure.

F. Loss-Making Corporations

When the corporation ceases to earn profits, the effective tax rate, τ, goes to zero and the incentive to purchase insurance seems to disappear. In general, however, losses can be taken back for three years or spread forward for fifteen years. This may allow any loss to be written off against yesterday's or tomorrow's taxes — the tax shield of the loss is reduced but still present. As it is also possible to carry operating losses forward and back in this manner, an insurance premium might also earn some tax relief even if no profit were earned that particular year.

Although the details of the situation would seem to be necessary before anything definite can be said, considerations of the costs of financial distress

would also apparently increase the attractiveness of insurance to a loss-making corporation. When a firm approaches bankruptcy, capital markets suddenly appear less than perfect. A significant asymmetry of information exists between those running the firm and the capital market[12]. The possibility of a fire or similar hazard placing a drain on the corporation's already reduced liquidity will provide a substantial incentive for such a corporation to insure.

G. Inflation

Inflation and appreciating replacement costs will significantly increase the incentive to insure, as this drives a wedge between the book value and the market value or the replacement value. The use of accelerated depreciation in the presence of inflation will further add to the tax shield offered by insurance.

H. Moral Hazard

To date it has been assumed that, whether or not the asset in question is covered by the market purchase of insurance, the probability of loss is invariant. When moral hazard is admitted as a consideration, however, it is possible that the probability of loss will be lower for the uninsured corporation than for the insured corporation, thereby reducing the incentive to insure.

4. A Unified Approach. Insurance Viewed as a Lease

If there were no uncertainty concerning the loss of an asset insurance could be viewed as one particular method of financing that loss. The loss, of calculable value and occurring in a known period, could equally well be financed by the corporation making provision for loss in a reserve and/or borrowing with a repayment schedule. The corporation could be expected to choose whichever method had the effect of increasing its present value.

The decision is similar to that faced by a corporation deciding whether or not to lease an asset. Given that the investment has a positive net present value, the leasing decision concerns only the method of financing the asset. Franks and Hodges (7) have proposed a simple interpretation of the lease valuation formula of Myers, Dill, and Bautista (16). Franks and Hodges arrange the firm's self-financing of the asset such that the net cash outflow in every future period is identical to that offered by the lease. If such an arrangement results in a net outflow in the current period, the lease is superior and should be used.

By analogy, consider an asset of current value $600 which will be depreciated in a straight-line fashion over two years although its economic life is three years. If there is a probability of one-third that the asset will be destroyed at the end of each period, the distribution of possible loss experience is as displayed in Figure 1. In order to compare the advantage (or disadvantage) of insuring with the advantage of retaining the risk, it is necessary to investigate the appropriate self-financing strategy that results in identical cash outflows in

[12] See Warner (21) for a discussion of bankruptcy costs, and Main (11) for a detailed discussion of how such considerations might affect the insurance purchasing behaviour of the corporation.

each of the future periods under consideration as would insurance cover. If the self-financing strategy requires an immediate outflow of cash, the market purchase of insurance is obviously preferable. In the example of Figure 1, the finding for the loss experience corresponding to each of the nine states must be weighted by the probability of being in that state. With a large number of identical hazards this probability, of course, approximates the relative frequency of each type of experience.

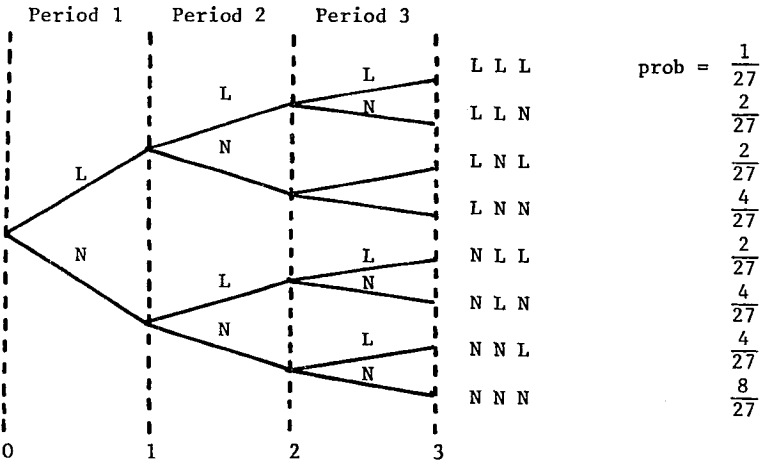
The situation can be further complicated by allowing for a 10 percent rate of inflation, a corporate income tax of 46 percent, and a capital gains tax of 28 percent. Assume that only the book value of the destroyed asset can be written off against tax, and that insurance-indemnified losses (at "actual cash value") are always restated on the books at current market price, thus incurring capital gains tax. Losses in the uninsured state are always assumed to be replaced by assets of identical vintage, thus allowing direct comparison with the replacement policy in the insured state. Tables 1(1) through 1(8) display the details of such an arrangement. Each of the eight parts of this table correspond to one of the possible loss experiences outlined in Figure 1. The first line describes the loss experience in terms of the market value of the destroyed asset. Insurance premiums are shown based on the actuarial odds of loss and on the loss exposure (the market value of the asset). Loading factors and transaction costs are, for the moment, ignored. Tax savings show the effect of insurance premiums being tax deductible. When a loss occurs and the market value (and hence, insurance settlement) exceeds the book value, a capital gains tax arises from the involuntary conversion if the replaced asset is restated at its market value. Although under no compunction to restate the value of the asset on its books, it is assumed that the extra tax shields so earned will lead the corporation to such action. This assumption also allows the comparison with the "no-insurance case" to be exact. The first set of net cash flow figures then show the position of the insured corporation.

The remainder of the table is given to the computation of the financing arrangements necessary for an uninsured corporation to enjoy an equivalent cash flow experience in each of the three periods. The purchase cost line shows the loss experience. This expense must now be met from after tax earnings, but the book value of the lost asset can be written-off against tax and so result in the depreciation tax savings shown on the next line. As the example assumes straight line depreciation over two years, the book value of the lost asset will not correspond to the market value of the loss. All the subsequent lines in the table show the loss provision measures that are necessary to ensure that the net cash flow position is identical to that in the insured case. This is the essence of the test. By making the net cash flow identical in all three periods the one payment at the beginning of the three periods summarises the advantage (or disadvantage) of insurance.

The loss provision account represents provision made within the corporation itself to finance losses. It is necessary to work backwards, i.e. from the end of the third period to the beginning of the first period to ensure that the net cash flow is identical with that of the insured case.

FIGURE 1

PROBABILITY DISTRIBUTION OF LOSS EXPERIENCE



Borrowings necessary to affect the desired cash outflow in any period will lead to interest charges which are shown as negative entries in the ''interest on loss provision account'' line. Interest charges are tax deductible and this leads to the ''interest tax savings'' line. When the loss provision account is in surplus it is assumed to be earning interest in which case there will be corresponding entries in the ''interest on loss provision account'' and ''interest tax savings'' lines but of reverse sign to those discussed above.

The balance in the ''provision account'' is arranged to be zero by the end of the third period, and the necessary initial period payment is then the consequence of financing the loss experience such that the ''net cash flow'' out of the corporation in each of the three periods is identical to what it would be in the insured case. Each of the eight possible loss experience states results in different patterns of net cash flow from the corporation and these are summarised in the eight component parts of Table 1. Weighting each state by its probability of occurrence gives the expected advantage of market purchase insurance as,

$$\frac{1}{27}\{\$523.79 + 2x\$268.25 + 2x\$210.90 + 4x\$56.89 + 2x\$217.85 - 4x\$37.69 - 4x\$111.29 - 8x\$111.29\} = \$24.41$$

TABLE 1

PROVISION AGAINST LOSS IN THE EIGHT POSSIBLE STATE DEPENDENT LOSS EXPERIENCES

(10% inflation, 46% corporate income tax, 28% capital gains tax, straight-line depreciation (over two years), real interest rate at 4%

(1) L-L-L

End of Period	0	1	2	3
Loss History		440.00	484.00	532.40
Insurance: Cash Flows				
Premiums		-146.67	-161.33	-177.46
-Tax saving on premiums		67.47	74.21	81.63
Capital gains tax		-39.20	-43.12	-47.43
Net cash flow		-118.40	-130.24	-143.26
Purchase: Cash Flows				
Purchase cost		-440.00	-484.00	-532.40
+Depreciation tax savings		138.00	151.80	166.98
- Loss provision account repayment	-523.79	144.00	173.25	206.54
- Interest on loss provision account		73.33	53.17	28.92
+ Interest tax savings		-33.73	-24.46	-13.30
Net cash flow	-523.79	-118.40	-130.24	-143.26
Provision Account				
Previous balance	0.0	523.79	379.79	206.54
- Repayment	523.79	-144.00	-173.25	-206.54
New balance	523.79	379.79	206.54	0.0
Advantage (disadvantage) to insurance difference in cash flow	523.79			

TABLE 1 (Continued)

(2) L-L-N

End of Period	0	1	2	3
Loss History		440.00	484.00	0.00
Insurance: Cash Flows				
Premiums		-146.67	-161.33	-177.46
- Tax savings on premiums		67.47	74.21	81.63
Capital gains tax		-39.20	-43.12	0.00
Net cash flow		-118.40	-130.24	-95.83
Purchase: Cash Flows				
Purchase cost		-440.00	-484.00	0.00
+ Depreciation tax savings		138.00	151.80	0.00
- Loss provision account repayment		163.32	194.03	-89.10
- Interest on loss provision account		37.55	14.69	-12.47
+ Interest tax savings		-17.27	-6.76	5.74
Net cash flow	-268.25	-118.40	-130.24	-95.83
Provision Account				
Previous balance	0.0	268.25	104.93	-89.10
- Repayment	268.25	-163.32	-194.03	89.10
New balance	268.25	104.93	-89.10	0.0
Advantage (disadvantage) to insurance				
difference in cash flow	268.25			

TABLE 1 (Continued)

(3) L-N-L

End of Period	0	1	2	3
Loss History		440.00	0.00	266.20
Insurance: Cash Flows				
Premiums		-146.67	-161.33	-88.74
- Tax savings on premiums		67.47	74.21	40.82
Capital gains tax		-39.20		-74.54
Net cash flow		-118.40	-87.12	-122.46
Purchase: Cash Flows				
Purchase cost		-440.00	0.00	-266.20
+ Depreciation tax savings		138.00	0.00	0.00
- Loss provision account repayment	-210.90	167.65	-90.39	133.64
- Interest on loss provision account		29.53	6.06	18.71
+ Interest tax savings		-13.58	-2.79	-8.61
Net cash flow	-210.90	-118.40	-87.12	-122.46
Provision Account				
Previous balance	0.00	210.90	43.25	133.64
- Repayment	210.90	-167.65	90.39	-133.64
New balance	210.90	43.25	133.64	0.0
Advantage (disadvantage) to insurance difference in cash flow	210.90			

TABLE 1 (Continued)

(4) L-N-N				
End of Period	0	1	2	3
Loss History		440.00	0.00	0.00
Insurance: Cash Flows				
Premiums		-146.67	-161.33	-88.74
- Tax savings on premiums		67.47	74.21	40.82
Capital gains tax		-39.20		
Net cash flow		-118.40	-87.12	-47.92
Purchase: Cash Flows				
Purchase cost		-440.00	0.00	0.00
+ Depreciation tax savings		138.00	0.00	0.00
- Loss provision account repayment	-56.89	179.30	-77.87	-44.54
- Interest on loss provision account		7.96	-17.14	-6.24
+ Interest tax savings		-3.66	7.89	2.86
Net cash flow	-56.89	-118.40	-87.12	-47.92
Provision Account				
Previous balance	0.00	56.89	-122.41	-44.54
-Repayment	56.89	-179.30	77.87	44.54
New balance	56.89	-122.41	-44.54	0.00
Advantage (disadvantage) to insurance difference in cash flow	56.89			

TABLE 1 (Continued)

(5) N-L-L				
End of Period	0	1	2	3
Loss History			242.00	532.40
Insurance: Cash Flows				
Premiums		-146.67	-80.67	-177.46
- Tax savings on premiums		67.47	37.11	81.63
Capital gains tax			-67.76	-47.43
Net cash flows		-79.20	-111.32	-143.26
Purchase: Cash Flows				
Purchase cost		0.00	-242.00	-532.40
+ Depreciation tax savings		0.00	0.00	166.98
- Loss provision account repayment	-217.85	-95.67	106.98	206.54
- Interest on loss provision account		30.50	43.89	28.92
+ Interest tax savings		-14.03	-20.19	-13.30
Net cash flow	-217.85	-79.20	-111.32	-143.26
Provision Account				
Previous balance	0.00	217.85	313.52	206.54
- Repayment	217.85	95.67	-106.98	-206.54
New Balance	217.85	313.52	206.54	0.00
Advantage (disadvantage) to insurance difference in cash flow	217.85			

TABLE 1 (Continued)

(6) N-L-N

End of Period	0	1	2	3
Loss History		0.00	242.00	0.00
Insurance: Cash Flows				
Premiums		-146.67	-80.67	-177.46
- Tax savings on premiums		67.47	37.11	81.63
Capital gains tax			-67.76	
Net cash flow		-79.20	-111.32	-95.83
Purchase: Cash Flow				
Purchase cost		0.00	-242.00	0.00
+ Depreciation tax savings		0.00	0.00	0.00
- Loss provision account repayment	37.69	-76.35	127.76	-89.10
- Interest on loss provision account		-5.28	5.41	-12.47
+ Interest tax savings		2.43	-2.49	5.74
Net cash flow	37.69	-79.20	-111.32	-95.83
Provision Account				
Previous balance	0.00	-37.69	38.66	-89.10
- Repayment	-37.69	76.35	-127.76	89.10
New Balance	-37.69	38.66	-89.10	0.00
Advantage (disadvantage) to insurance differences in cash flow	-37.69			

TABLE 1 (Continued)

(7) N-N-L

End of Period	0	1	2	3*
Loss History		0.00	0.00	0.00
Insurance: Cash Flows				
Premiums		-146.67	-80.67	0.00
- Tax savings on premiums		67.47	37.11	0.00
Capital gains tax		0.00	0.00	0.00
Net cash flow		-79.20	-43.56	0.00
Purchase: Cash Flows				
Purchase cost		0.00	0.00	0.00
+ Depreciation tax savings		0.00	0.00	0.00
- Loss provision account repayment	111.29	-70.79	-40.50	0.00
- Interest on loss provision account		-15.58	-5.67	0.00
+ Interest tax savings		7.17	2.61	0.00
Net cash flow	111.29	-79.20	-43.56	0.00
Provision Account				
Previous balance	0.00	-111.29	-40.50	0.00
- Repayment	-111.29	70.79	40.50	0.00
New balance	-111.29	-40.50	0.00	0.00

Advantage (disadvantage) to insurance difference in cash flow	-111.29

*In this case the asset has reached the end of its economic life by the end of the third period. This fact plus the use of discrete time periods causes column 3 to be blank in this particular numerical example.

TABLE 1 (Continued)

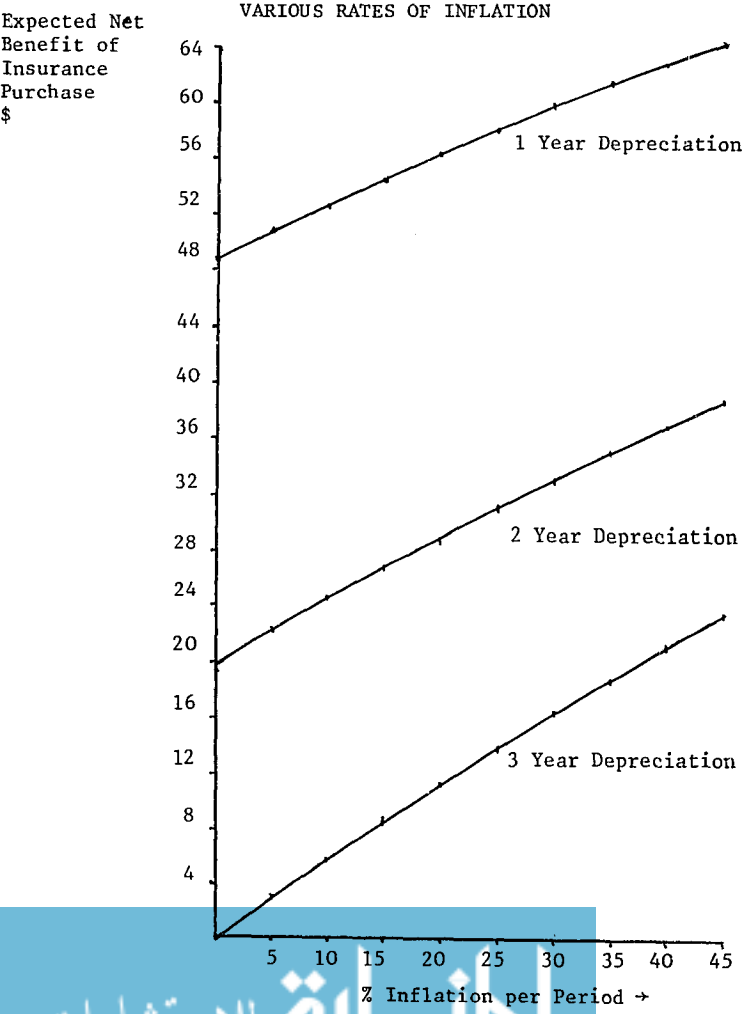
(8) N-N-N				
End of Period	0	1	2	3*
Loss History		0.00	0.00	0.00
Insurance: Cash Flows				
Premiums		-146.67	-80.67	0.00
- Tax savings on premiums		67.47	37.11	0.00
Capital gains tax				
Net cash flow		-79.20	-43.56	0.00
Purchase: Cash Flows				
Purchase cost				
+ Depreciation tax savings				
- Loss provision account repayment	111.29	-70.79	-40.50	0.00
- Interest on loss provision account		-15.58	-5.67	0.00
+ Interest tax savings		7.17	2.61	0.00
Net cash flow	111.29	-79.20	-43.56	0.00
Provision Account				
Previous balance	0.00	-111.29	-40.50	0.00
- Repayment	-111.29	70.79	40.50	0.00
New balance	-111.29	-40.50	0.00	0.00
Advantage (disadvantage) to insurance difference in cash flow	-111.29			

*See the footnote to Table 1, part (7)

In the above case the corporation can be expected to purchase insurance against loss of the asset. Further, the gains to insurance increase the more rapid is the rate of inflation, and the more rapid is the accounting depreciation of the asset. This is illustrated in Figure 2, where results of analysis similar to that described above are reported for three rates of accounting depreciation

FIGURE 2

BENEFIT OF INSURANCE PURCHASE AT VARIOUS RATES OF INFLATION



(over three years, two years, and one year, respectively), and several rates of inflation (0 percent to 45 percent per annum). If capital gains tax is set equal to corporate income tax, and accounting depreciation equals economic depreciation, the corporation is indifferent between the market purchase of insurance and self-insurance. Also, under this analysis, the use of a captive insurer has no particular advantage over the market purchase of insurance. Dealing with a captive is subject to the same tax laws as dealing with an independent insurer. The possible advantages of captive insurers, such as lower "loading factors" *per se* can, however, be included.

In the real world, a substantial "loading factor" is included in insurance premiums to cover the cost of writing and administering insurance. Figure 3 illustrates the decline in the benefit of insurance to the corporation as this loading factor mounts. A zero rate of inflation is assumed, but the same three rates of accounting depreciation from Figure 2 are employed. It is seen that, when the asset is depreciated over one year, insurance remains attractive even when the loading factor approaches 36 percent of the actual premium. As mentioned earlier, loading factors in the real world frequently exceed this level. In this context the above analysis may represent only a partial analysis of why large corporations find property insurance attractive. Alternatively, perhaps accounting depreciation and economic depreciation differ even more drastically than displayed in these examples.

Conclusion

The above approach is consistent with an Arrow-Debreu world in which all assets have values depending on the different states of nature that arise. Facing an expected loss that is non-zero, the tax treatment of insurance settlements allows the corporation to minimize the after-tax cost of casualty losses, i.e., losses due to sudden, unusual, or unpredictable causes.

As indemnity under insurance contracts is contingent on loss, the corporation cannot transmute its corporate profits tax liability into a (lower) capital gains tax liability. In the case of a self-insured loss, the tax authorities may be thought of as paying that part of the loss amounting to the book value times the corporate profit tax. In the case of a loss covered by insurance the tax authorities provide an additional amount equal to the market or insured value of the asset less its book value times the difference between the corporate profit tax and the corporate capital gains tax[13]. The limit to which tax shields

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[13] If P is the expected loss per period, and therefore also the actuarial insurance premium, and if α represents the book value as a proportion of market or replacement value ($\therefore 0 \leq \alpha \leq 1$), the expected "subsidy" from the tax authorities is

$$P[\tau - G(1-\alpha)]$$

where G is the capital gains tax rate and τ the corporate profit tax rate faced by the corporation is

$$P[\alpha\tau + (1-\alpha)(\tau-t)]$$

($\alpha\tau$: write-off of book value; $(1-\alpha)(\tau-t)$: extra subsidy with market purchase of insurance)

can be increased in this manner is determined by the loss probability faced by the corporation. And as the destruction of $1 of an asset leads tax shields to be raised by only a fraction of a dollar, there is no hint here of any "money machine".

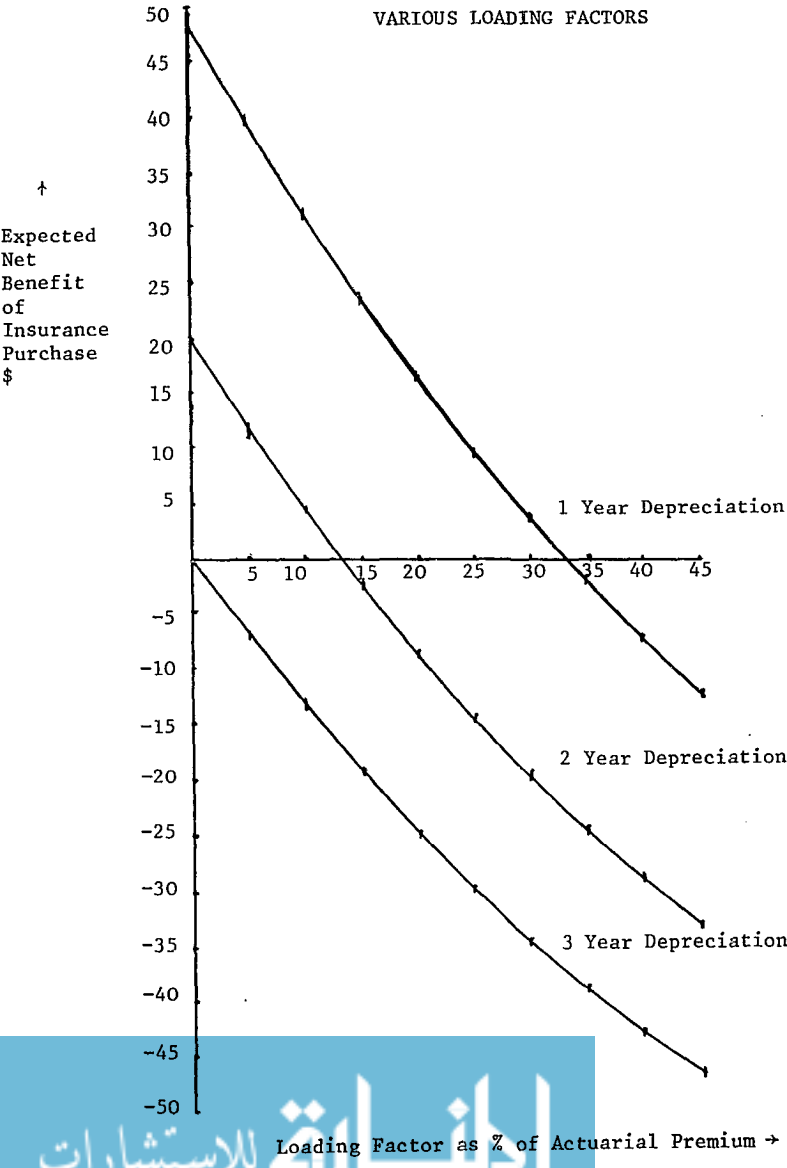
Consideration of the tax liability of the profit-making corporation has led to an understanding of when it might be in the interest of stockholders for the corporation to make market purchases of insurance. Although a well-diversified investor is not exposed to any of the specific risks faced by a corporation, when the corporation insures against such risks and in so doing reduces its tax liability, the investor clearly benefits. On the supply side of the relationship, the insurer incurs substantial costs in pricing insurance and policing the insured. In some circumstances these costs will rise sufficiently to deter corporate purchasers of insurance. It is not surprising, therefore, to find corporations insuring some of their loss exposures in the market place, and self-insuring or retaining the remainder.

If moral hazard will lead to more frequent losses on insured hazards, potentially substantial social losses are involved in encouraging corporations to insure. In addition to tax advantages, however, the insured corporation also benefits from a reduced exposure to the costs of financial distress and from reduced agency costs between equity holders and debt holders, between equity holders and management, and so forth. Thus, it is not possible to say that corporate purchases of insurance are unambiguously socially wasteful. There does, however, seem to be scope for future research in this area.

At first blush the tax minimizing argument developed here, depending as it does on the difference between corporate profit tax and capaital gains tax, seems to have little relevance to the corporate purchase of liability insurance. However, a recent and important paper by Mayers and Smith (13) has illustrated that where an uninsured liability loss would reduce the corporation, effectively, to a lower corporate profit tax bracket than normal, the difference between the two tax brackets assumes a role similar to the difference between the corporate profit tax and the capital gains tax introduced above. Again it is possible to view insurance as a tax minimizing method of financing prospective losses. Additional arguments investigated by Mayers and Smith for corporate purchases of insurances essentially concur with those raised in Main (11). From the viewpoint of tax minimization, however, the above approach has the advantage of rendering the insured versus non-insured states as stochastically equivalent in terms of cash flow in all future time periods. The advantage or disadvantage of insurance purchase then appears as an intuitively comprehensible cash flow in the current period. The decision rule offered by Mayers and Smith is, of course, no less valid for being different.

FIGURE 3

BENEFIT OF INSURANCE PURCHASE WITH VARIOUS LOADING FACTORS



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