How Insurance Solves the Underinvestment Problem

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This note compares and contrasts the models developed in Garven and MacMinn (1993) by presenting a simple numerical example based upon two discrete (rather than a continuum of) future possible states of the world. The terms *now* and *then* are used to refer to the beginning and end of the period. Shareholders are assumed to have made an initial investment *now* and are considering different financing alternatives. This decision is modeled assuming that 1) only two states of the world (no loss and loss) may occur *then* with equal probabilities, 2) investors are risk neutral, and 3) the interest rate is zero.[1] The firm will be worth $1,000 in the no loss state and $200 in the loss state. However, the firm may invest $600 in the loss state to rebuild the asset. Since rebuilding reduces loss costs from $800 to $600, the net present value *now* of rebuilding *then* is (.5)($800 - $600) = $100.

Our numerical example considers the effects of leverage, insurance, and loading costs under three financing alternatives: 1) the unlevered, uninsured firm, 2) the levered, uninsured firm, and 3) the levered, insured firm. Table 1 shows the prospective payoffs associated with the decision to rebuild for the unlevered, uninsured firm. Since the value of the firm *now* is $100 greater if the asset is rebuilt *then*; i.e., $V^r = \mathrm{E}(V^r(s)) = \$700 > \$600 = \mathrm{E}(V^u(s)) = V^u$, the firm will optimally rebuild.[2]

Table 1

The Unlevered, Uninsured Firm

state	Pr(s)	Π	$L(s)$	$V^u(s) = \Pi - L(s)$	$I(s)$	$V^r(s) = \Pi - I(s)$
no loss	50%	$1000	$0	$1000	$0	$1000
loss	50%	$1000	$800	$200	$600	$400
value now		$1000	$400	$600	$300	$700

Next, consider the decision faced by a levered, uninsured firm. Suppose the firm wants to issue risky debt *now* with a promised payment *then* of B = $700. Without insurance, this firm will face the payoff schedule shown in Table 2. If the firm does not rebuild, total corporate value will decline by the amount of the underinvestment cost; i.e., V^r - V^u = $700 - $600 = $100

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[1]Note that, given these assumptions, market value is equal to the expected value of cash flow.

[2]Note that since the firm is unlevered, total firm value equals stock market value; i.e., $V^r = S^r > S^u = V^u$.

= c^u.[3] The market value of debt under this "underinvestment" scenario (D^u) is \$450, whereas current shareholder value (S^u) is \$150. If the firm rebuilds, total market value is restored to $V^r = D^r + S^r =$ \$550 + \$150 = \$700. Although shareholders are indifferent about rebuilding (since $S^r = S^u =$ \$150), it is important to note that if the asset is rebuilt, the underinvestment cost is completely appropriated by bondholders; i.e., $D^r = D^u + c^u$= \$450 + \$100 = \$550.

Table 2

The Levered, Uninsured Firm (B = \$700)

state	$Pr(s)$	Π	$L(s)$	$D^u(s)$	$S^u(s)$	$I(s)$	$D^r(s)$	$S^r(s)$
no loss	50%	\$1000	\$0	\$700	\$300	\$0	\$700	\$300
loss	50%	\$1000	\$800	\$200	\$0	\$600	\$400	\$0
value now		\$1000	\$400	\$450	\$150	\$300	\$550	\$150

Shareholders would not be indifferent about rebuilding if they could somehow convince bondholders that rebuilding will occur then, collect higher proceeds *now* from issuing bonds, and renege *then* on their commitment. However, rational bondholders recognize the incentives for shareholders to employ such a tactic. Unless shareholders can credibly assure bondholders that the investment will actually be made *then*, bonds will be priced *now* based upon the expectation that underinvestment will occur *then*.

Garven and MacMinn propose a "financing constrained" solution of the underinvestment problem. Essentially, this involves jointly choosing debt and deductible levels such that the proceeds generated by the insured bond issue (D^c) equal the proceeds generated by the uninsured bond issue (D^u), plus enough to cover the insurance premium (p^c) (see Garven and MacMinn's equation (9) and figure 3 for the details). As Table 2 above indicates, uninsured bonds with a promised payment of \$700 have a market value *now* of D^u = \$450. The promised payment and deductible combination that jointly satisfy the financing condition given in equation (9) are B^c = \$500 and d = \$500. Table 3 below summarizes the payoffs that would occur *then* if the firm implemented the financing constrained solution to the underinvestment problem.

As Table 3 indicates, the financing-constrained solution generates current shareholder value of S^c = \$250, representing a \$100 increase over the value of uninsured shares (as indicated in Table 2). Since S^c - S^u = c^u = \$100, we find that not only is the underinvestment problem solved; current shareholders capture the entire agency cost as an increase in value *now* of the stock payoff *then*. By making bonds safe, insurance increases bond value *now* from \$450 to \$500, which just covers the \$50 insurance premium.

[3]Generally, $c^u < npv$. However, since the present example assumes that there are only two states of the world, the underinvestment cost equals the project *npv*.

Table 3

The Levered, Insured Firm (B^c = \$500 and d=\$500)

state	$Pr(s)$	Π	$L(s)$	$I(s)$	$p^c(s)$ = max($I(s)$-d,0)	Π^*= Π-$I(s)$+$p^c(s)$	$D^c(s)$	$S^c(s)$
no loss	50%	\$1,000	\$0	\$0	\$0	\$1,000	\$500	\$500
loss	50%	\$1,000	\$800	\$600	\$100	\$500	\$500	\$0
value now		\$1,000	\$400	\$300	\$50	\$750	\$500	\$250

Next, we introduce loading costs. Given a premium loading factor λ = 50%, the promised payment B^l and deductible d that jointly satisfy the financing condition (see Garven and MacMinn's equation (13) and figure 4 for the details) are B^l = \$600 and d = \$400. Table 4 below summarizes the payoffs that occur *then* when there are loading costs and the firm implements the financing-constrained solution to the underinvestment problem:

Table 4

The Levered, Insured Firm (B^l = \$600 and d=\$400)

state	$Pr(s)$	Π	$L(s)$	$I(s)$	$p^l(s)$ = max($I(s)$-d,0)	Π^*= Π-$I(s)$+$p^l(s)$	$D^l(s)$	$S^l(s)$
no loss	50%	\$1,000	\$0	\$0	\$0	\$1,000	\$600	\$400
Loss	50%	\$1,000	\$800	\$600	\$200	\$600	\$600	\$0
value now		\$1,000	\$400	\$300	\$100	\$800	\$600	\$200

As Table 4 indicates, when λ = 50%, loading costs (λp^l) total \$50, since the pure premium p^l= \$100. Note that insurance increases bond value now from \$450 to \$600, which just covers the \$150 insurance premium. Also note that the increase in current shareholder value, S^l - S^u = \$200 - \$150 = \$50, which corresponds to the difference between the agency cost and the premium loading; i.e., c^u - λp^l = \$100 - \$50 = \$50. Hence, by raising only the amount of debt needed to finance the asset and pay for the insurance, the financing-constrained solution proposed here provides the mechanism required to maximize current shareholder value. Simultaneously solving the underinvestment problem and minimizing loading costs accomplish this.

References

Garven, James R., and Richard D. MacMinn. 1993. "The Underinvestment Problem, Bond Covenants, and Insurance." *The Journal of Risk and Insurance* 60(4): 635-646.