THE UNDERINVESTMENT PROBLEM, BOND COVENANTS AND INSURANCE

by

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ABSTRACT

This article complements the earlier work by Mayers and Smith (1987) and Schnabel and Roumi (1989) which showed that a property insurance contract could be used to bond subsequent corporate investment decisions. Although these models suggest one possible approach to solving the underinvestment problem, neither model explicitly specifies the economic mechanism(s) required to guarantee that current shareholders receive the maximum possible benefits from solving this problem. We propose a financing-constrained model that not only eliminates underinvestment but also ensures that current shareholders capture the entire agency cost (net of loading) as an increase in value.

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The underinvestment problem has been well known in finance since the appearance of Myers' (1977) seminal work on “The Determinants of Corporate Borrowing.” Myers considers a situation in which the firm has an outstanding bond issue now and may invest in a positive net present value project then.[1] The payoff on the investment project is risky now but not when the decision is made then. The underinvestment occurs because there are realized project payoffs that cover the investment expenditure then but not the investment expenditure and the promised payment on the bond issue. If the firm did invest in the project under these circumstances then all the net proceeds would go to bondholders. Hence, no management acting in the interest of its shareholders makes such an investment decision. It should also be noted that, given rational expectations, the stock market value of the firm is larger now because of management’s decision then not to invest under the conditions just described.

The Mayers and Smith (1987) (henceforth M&S) article, “Corporate Insurance and the Underinvestment Problem,” builds on Myers’ work. M&S have provided an interesting and intuitively appealing discussion of the role played by insurance in bonding the corporate investment decision. M&S have shown that an insurance contract can be constructed now which commits the firm to make the investment decision then. Schnabel and Roumi (1989) (henceforth S&R) have extended the model proposed by M&S to a consideration of the effect of a safety, or premium loading.

Although M&S assert that the gains associated with resolving the underinvestment problem are enjoyed by shareholders, their analysis does not explicitly provide the mechanism to show how this is accomplished.[2] This article provides two routes out of this difficulty. Because

[1]The terms now and then are used to refer to dates zero and one, respectively.

[2]MacMinn (1987) also considers the underinvestment problem but in a different and more general setting that includes random revenue as well as random losses. Unlike Myers and M&S, the investment decision in that model is made before the payoff on the investment is known. Like Myers, it was assumed that the bonds were issued previously. The existence of risky debt was shown to motivate an underinvestment problem. The analysis showed that if the previously issued bonds had been issued with an insurance covenant then the underinvestment could be eliminated and the stock and bond values could be increased relative to the case with no covenant. Although the

the M&S and S&R models do not allow the promised debt payment to change after insurance is introduced, it follows that the debt issue raises more money with the insurance covenant than without it. Hence, current shareholders get the additional value if the manager sets a dividend payment now equal to the difference between the debt values with and without the insurance covenant net of the insurance premium. We will refer to this later as the "*cum* dividend" interpretation of the M&S and S&R models. However, rather than confound financing and dividend decisions unnecessarily, we propose an alternative solution that requires the imposition of a financing condition. This allows us to show that an insurance deductible may be chosen that enables the manager to also reduce the promised debt payment and restore full value for the current shareholders.

Our analysis explicitly shows that an insurance covenant can be designed which allows current shareholders to capture the gain in value and that the gain in value equals the agency cost of the underinvestment problem. We believe that the introduction of a financing condition rather than a dividend policy is more instructive, since it allows us to focus attention more neatly on the structure of the bond\insurance financing package. This difference becomes particularly important when premium loading is introduced because the ability to adjust the promised debt payment allows the manager to reduce the cost due to premium loading.

The Underinvestment Problem

Although limited liability confers a number of important economic benefits, it also has its costs (see Easterbrook and Fischel, 1985). By creating an asymmetry between the costs and benefits of risky activities, limited liability causes bondholders and shareholders to have incompatible incentives whenever the corporation's debt is subject to the risk of bankruptcy. M&S identify a situation in which the conflict of interests is so severe that an underinvestment problem is created. In their model, underinvestment occurs in the sense that shareholders choose

analysis demonstrated an increase in stock value, it did not demonstrate that the stockholders captured all the gains from solving the underinvestment problem. Therefore, the work here also represents a basis for clarifying and extending the analysis in that more general setting.

to forego a positive net present value investment that, in the absence of bankruptcy risk, would be undertaken. In order to focus their analysis on the role of insurance in resolving this problem, M&S assume that the only source of uncertainty for the firm is whether it will suffer a property loss.

To reconstruct the M&S model, suppose the financial markets are complete, let s denote a state of nature and let $[0, \bar{s}]$ denote the set of states then. Property losses are sustained over the interval $[0, s^l)$, whereas no losses occur over $[s^l, \bar{s}]$. Let p(s) denote the price of a financial asset that pays one dollar if state s occurs and zero otherwise; p(s) may be equivalently interpreted as a risk-adjusted discount factor. A financial asset with this payoff structure will be referred to as a basis stock. Let Π denote the value of the asset then, I(s) the investment in state s required to reconstitute the asset, and L(s) the property loss in state s. I(s) and L(s) decrease over the loss interval $[0, s^l)$. Furthermore, $L(s) > I(s) > 0$ for $s \in [0, s^l)$; i.e., rebuilding is assumed to always have a positive value. In the no loss interval $[s^l, \bar{s}]$, $L(s) = I(s) = 0$. Note that the investment decision is made after state s is revealed.

To motivate the underinvestment problem, suppose the firm had issued bonds with a promised payment of B^u dollars.[3] In the absence of any covenants, the manager chooses not to reconstitute the asset in the event $U \in [0, s^u)$, since bondholders would gain all the benefits while shareholders would bear all the costs. The boundary s^u of the underinvestment event is implicitly defined by the condition $\Pi - I(s^u) = B^u$. Therefore, a manager acting on behalf of shareholders does not invest in the event U. Rational bondholders and shareholders understand these incentives and so the value of the corporation now reflects less than the full risk-adjusted present value that could be achieved if the investment decision had been assured.

The loss in corporate value would be absorbed in its entirety by myopic bondholders. Bondholders, however, are rational in anticipating the underinvestment incentive and so would

[3] The word "had" is used advisedly here because the M&S model does not allow for any change in the promised payment to bondholders after the insurance covenant is introduced.

have required a promised payment sufficiently large to make the bond issue a zero (risk-adjusted) net present value investment. Hence, the market value of the debt issue now is D^u, where

$$D^u = \int_0^{s^u} p(s) \left[\Pi - L(s)\right] ds + \int_{s^u}^{\bar{s}} p(s)\ B^u\ ds\,. \tag{1}$$

Similarly, the stock market value S^u of the current shareholders is

$$S^u = \int_{s^u}^{s^l} p(s) \left[\Pi - I(s) - B^u\right] ds + \int_{s^l}^{\bar{s}} p(s)\ [\Pi - B^u]\ ds\,, \tag{2}$$

and the corporate value, given the underinvestment problem, is V^u, where

$$V^u \equiv D^u + S^u = \int_0^{s^u} p(s)\ [\Pi - L(s)]\ ds + \int_{s^u}^{s^l} p(s)\ [\Pi - I(s)]\ ds + \int_{s^l}^{\bar{s}} p(s)\ \Pi\ ds\,. \tag{3}$$

The agency cost c^u of this underinvestment problem is the difference between the corporate value if the firm always invests to reconstitute the asset then and the corporate value given the underinvestment problem. Let V^i denote the corporate value given a certain investment to reconstitute the asset. Then

$$V^i = \int_0^{s^l} p(s)\ [\Pi - I(s)]\ ds + \int_{s^l}^{\bar{s}} p(s)\ \Pi\ ds,$$

and the agency cost is $c^u = V^i - V^u$, or equivalently

$$c^u = \int_0^{s^u} p(s) \left[L(s) - I(s)\right] ds > 0\,. \tag{4}$$

This agency cost is positive for any promised payment such that $B^u > \Pi - I(0)$. The agency cost is a deadweight loss and is represented by the risk-adjusted present value of shaded area in figure one.[4]

[4]To justify this description and those that follow, note that by the Mean Value Theorem of the Integral Calculus there exists a state $\hat{s} \in (0,\ s^u)$ such that

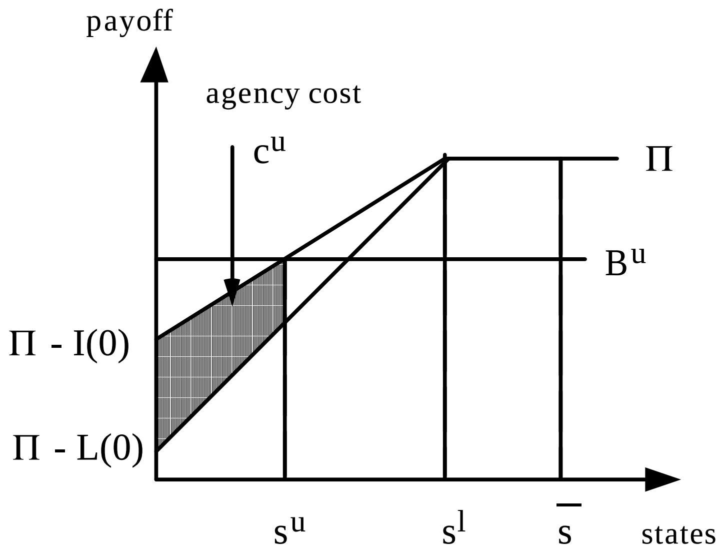

Figure 1: The Agency Cost

Insurance Covenants with No Premium Loading

The underinvestment problem may be solved by purchasing an appropriately structured insurance policy. M&S note that the net payoff then must at least cover the promised payment on the bond issue, i.e., Π - I(s) $\geq$ B. By purchasing a property insurance policy with a deductible of d = I(s^u) dollars, the corporate payoff then is guaranteed to at least cover the promised debt payment. The payoff on the insurance policy is max{0, I(s) - d}. Let *U* denote the underinvestment event and let *N* denote the complement of that event relative to [0, $\bar{s}$], i.e., *N* = [0, $\bar{s}$]*U*. Note that the corporate payoff with the insurance is Π - I(s) + max{0, I(s) - I(s^u)}; equivalently, the corporate payoff is B in the event *U* and Π - I(s) in the event *N*. Given a competitive insurance market, the premium p^i is the risk-adjusted present value of the policy payoff, i.e.,

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$$\int_0^{s^u} p(s)\,[L(s) - I(s)]\,ds = p(\hat{s}) \int_0^{s^u} [L(s) - I(s)]\,ds\,.$$

The integral on the right hand side represents the shaded area in figure one and $p(\hat{s})$ represents the risk adjusted discount factor. Hence, the shaded area is proportional to the risk adjusted present value. See Bartle (1964, p. 303) for a statement of this theorem. The agency cost may also be interpreted as part of the net present value of the investment.

$$p^i = \int_0^{s^u} p(s)\,[I(s) - I(s^u)]\,ds. \quad (5)$$

Figure two provides two equivalent graphical representations of the insurance premium; i.e., the value of the shaded areas in both represent the insurance premium required to make the debt issue with a promised payment B^u safe. The left panel of figure two gives the standard representation for the payoff on a property insurance policy with a deductible d = $I(s^u)$, whereas the right panel represents the insurance payoff as part of the total corporate payoff structure. The purchase of such a policy yields a payoff then for current shareholders of

$$\Pi - I(s) + \max\{0, I(s) - I(s^u)\} - B = \begin{cases} 0 & s \in U \\ \Pi - I(s) - B & s \in N \end{cases}. \quad (6)$$

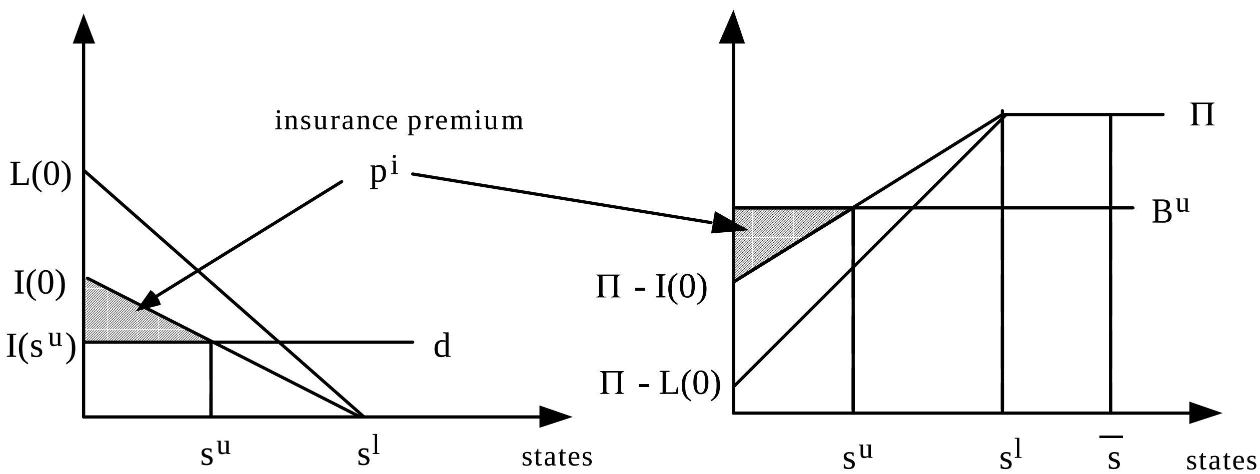

Figure 2: The Insurance Premium

By limiting the current shareholders' net payoff in the underinvestment event to zero, the insurance policy enables shareholders to guarantee that bondholders are repaid B^u dollars in all states of the world without triggering bankruptcy. Therefore, the risky debt/insurance decision is essentially a reformulation of the "safe debt" decision.[5] There are, however, some very important yet subtle differences.

By insuring against bankruptcy, the debt becomes safe; hence, the current market value of debt given the insurance is D^i, where

$$D^i = \int_0^{\bar{s}} p(s)\ B^u\, ds = \rho\ B^u, \tag{7}$$

and ρ is the sum of the basis stock prices, or equivalently, the price now of a safe asset which pays \$1 then. Comparing the insured with the uninsured debt value it may be noted that the market value of debt increases, i.e.,

$$D^i - D^u = \int_0^{s^u} p(s)\ [B^u - (\Pi - L(s))]\ ds = \int_0^{s^u} p(s)\ [(\Pi - I(s^u)) - (\Pi - L(s))]\ ds$$

$$= \int_0^{s^u} p(s)\ \left\{L(s) - I(s) + [I(s) - I(s^u)]\right\}\ ds\ = c^u + p^i. \tag{8}$$

The agency cost and insurance premium are represented in figures one and two, respectively.

In the M&S model, the firm issues bonds with an insurance covenant attached, but does not alter the promised payment on the debt issue from that B^u that was necessary in the uninsured case. Since B^u must have raised the required funds in the uninsured case, it follows that the debt issue with the insurance covenant must raise more. The missing link in the M&S model is a specification of where those excess funds go. Suppose part of the excess is paid to current shareholders now as a dividend. Since the insurance premium is paid now, let the dividend be the excess funds from the debt issue net of the insurance premium; i.e., $(D^i - D^u) - p^i$. Hence, from (8) it follows that the dividend paid now to current shareholders is c^u and so current shareholder value equals $c^u + S^u$. In this case, current shareholders enjoy the gains associated with resolving

[5] The "safe debt" decision involves choosing a promised payment $B^* \in [0, P-I(0))$. The risky debt/insurance decision is a reformulation of the safe debt decision in the sense that it provides a contractual mechanism whereby bankruptcy can be avoided in spite of the fact that debt would otherwise be risky.

the underinvestment problem. This, however, constitutes a somewhat artificial supplement to the M&S model that confounds the dividend and financing decisions unnecessarily. Alternatively, it is possible to introduce a financing condition explicitly and show that the insurance covenant enables the manager to reduce the debt payment and restore full value for the current shareholders.

Next, consider the introduction of a financing condition that allows the firm to adjust the promised payment to the bondholders. Suppose that the bonds are issued with a covenant requiring insurance and suppose that B^c is the promised payment. Since the covenant makes the debt safe it follows that an appropriately structured covenant yields a promised payment $B^c < B^u$. The insurance policy attached to the bond issue must be structured so that the bonds are safe. Let the payoff on the insurance policy be max{0, I(s) - I(s^c)}, where I(s^c) is the deductible. This deductible is selected so that Π - I(s^c) = B^c, as shown in figure three, where this condition implicitly defines the state s^c. Let p^c denote the premium for such a policy. In the previous case of a risky uninsured debt issue, the promised payment of B^u dollars raised D(B^u) dollars now and this amount must have been enough to cover the firm's investment expenditure. Suppose that the bond package with an insurance covenant is structured so that it raises the required D(B^u) dollars plus enough to cover the insurance premium. The insurance covenant provides the necessary linkage between promised payments. When the firm finances with a debt issue it must also purchase an insurance policy and link it to the bonds so that in the event that the firm cannot cover the bond payment, the insurance payoff makes up the deficit. The payoff on the bond with an appropriately structured insurance covenant is B^c for all $s \in [0, \bar{s}]$. Since this covenant guarantees that the asset will be reconstituted, the bond payoff may be expressed in terms of the payoff on the straight debt portion of the contract plus the insurance payoff as follows:

$$B^c = \begin{cases} \Pi - I(s) + [I(s) - I(s^c)] & 0 < s < s^c \\ \\ B^c & s^c < s < \bar{s} \end{cases}.$$

Of course, the equality holds because the deductible $I(s^c)$ is selected so that it equals Π - B^c. Such a contractual arrangement guarantees that the asset will be reconstituted in all states. It is also possible to specify the value of the debt and insurance portions of the contract separately. Let $D(B^c)$ denote the value of the bond\covenant scheme and let p^c denote the value of the insurance component of this scheme. Then $D(B^c) = \rho\ B^c$; this is the value of a safe debt issue, or equivalently, the risk-adjusted present value of the payment B^c. The promised payment B^c is implicitly defined by the financing condition

$$D(B^u) - [D(B^c) - p^c] = 0. \tag{9}$$

This condition simply says that the payment B^c must be selected so that it raises all that the other bond issue raised plus enough to cover the insurance premium. Let the state s^d be implicitly defined by the condition Π - $L(s^d) = B^c$. Then equation (9) may be equivalently expressed as

$$\begin{aligned}&\int_{\min\{s^d,\ s^u\}}^{s^u} p(s)\left[\Pi - L(s) - B^c\right] ds + \int_{s^u}^{\bar{s}} p(s)\left[B^u - B^c\right] ds \\ &= \int_0^{\min\{s^d,\ s^u\}} p(s)\left[\min\left\{\Pi - I(s),\ B^c\right\} - \left(\Pi - L(s)\right)\right] ds. \end{aligned} \tag{10}$$

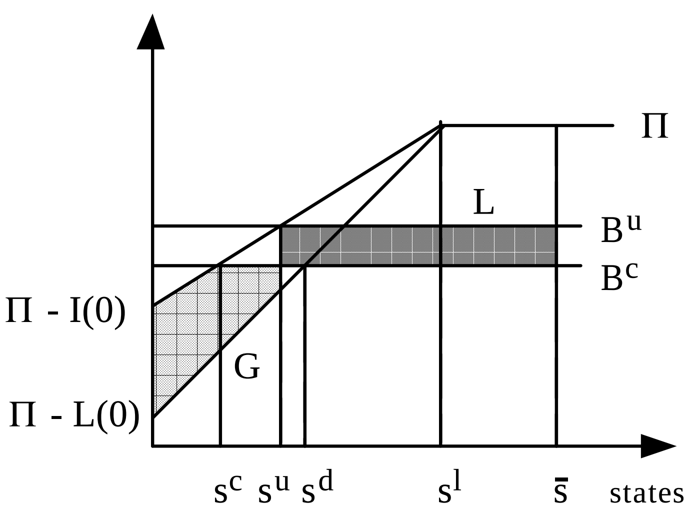

Figure 3: The Financing Condition

The promised payment B^c must satisfy (10) but such a $B^c < B^u$ always exists. The value of the area labeled L in figure three, or equivalently, the left hand side of (10) represents what bondholders lose by reducing the promised payment from B^u to B^c. The value of the area labeled G in figure three, or equivalently, the right hand side of (10) represents what the bondholders gain from the new contract structure.[6] Equation (10) expresses the notion that a new contract can be written which raises p^c dollars more than the old contract <u>and</u> guarantees reinvestment. Equation (10) is just the condition that the risk-adjusted present value of L equals that of G. Therefore, it is feasible to include a bond covenant requiring insurance such that the bond issue raises enough to cover the insurance premium as well as the other monies necessary.

A bond\covenant scheme is only beneficial if the current shareholders stand to gain. Note the payoff to current shareholders then is

$$\begin{cases} 0 & 0 < s < s^c \\ \Pi - I(s) - B^c & s^c < s < s^l \\ \Pi - B^c & s^l < s < \bar{s} \end{cases}.$$

It follows that the current shareholders' stock market value is S^c, where

$$S^c = \int_{s^c}^{s^l} p(s)\,[\Pi - I(s) - B^c]\,ds + \int_{s^l}^{\bar{s}} p(s)\,[\Pi - B^c]\,ds. \tag{11}$$

Finally, this financing package is beneficial if it ensures investment in all states and it increases current shareholder value, i.e., $S^c \geq S^u$. The difference in current shareholder value is

$$S^c - S^u = \int_{s^c}^{s^u} p(s)\,[\Pi - I(s) - B^c]\,ds + \int_{s^u}^{\bar{s}} p(s)[B^u - B^c]\,ds$$

[6]The case $s^u < s^d$ is shown in the figures but the analysis allows for either $s^u < s^d$ or $s^u > s^d$.

$$= \int_{s^c}^{s^u} p(s)\left[\Pi - I(s) - \max\left\{\Pi - L(s),\, B^c\right\}\right] ds + \int_{\min\{s^d,\, s^u\}}^{s^u} p(s)\left[\left(\Pi - L(s)\right) - B^c\right] ds + \int_{s^u}^{\bar{s}} p(s)\left[B^u - B^c\right] ds$$

$$= \int_{s^c}^{s^u} p(s)\left[\Pi - I(s) - \max\left\{\Pi - L(s),\, B^c\right\}\right] ds + \int_{0}^{\min\{s^d,\, s^u\}} p(s)\left[\min\left\{\Pi - I(s), B^c\right\} - \left(\Pi - L(s)\right)\right] ds$$

$$= \int_{0}^{s^u} p(s)\left[L(s) - I(s)\right] ds = c^u > 0. \qquad (12)$$

Note that the third equality in (12) follows from (10). The difference S^c - S^u is the value of the sum of the shaded areas labeled L and H in figure four. The value of the sum of the shaded areas labeled G and H represent the agency cost of the underinvestment problem c^u. By equation (10) and figure three, it follows that the value of the sum of the L and H areas is equal to the value of value of the sum of the G and H areas. Therefore, the bond\covenant package not only increases current shareholder value, but also entirely eliminates the agency cost of underinvestment.

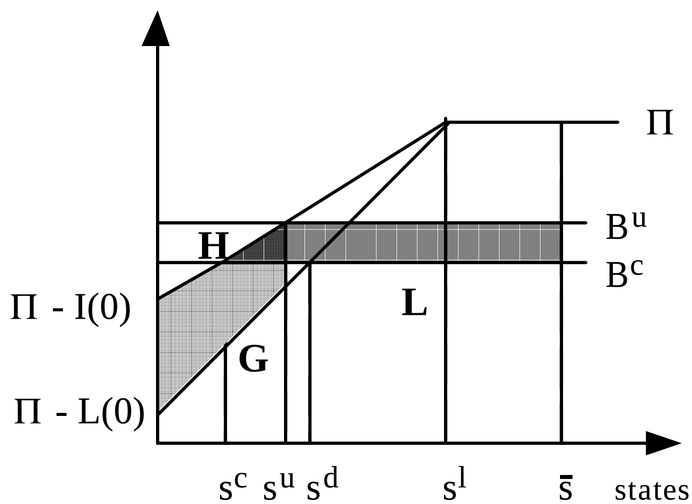

Figure 4

Insurance Covenants with Premium Loading

Now suppose that the insurance purchase includes some premium loading. Let λ denote the loading proportion and let p^l denote the pure premium. The cost of the insurance with the premium loading is (1 + λ) p^l. In this case, the financing condition must be modified so that the promised payment on the debt is sufficient to cover the loading. As in (9), the financing condition here is

$$D(B^u) - [D(B^l) - (1 + \lambda)\, p^l] = 0. \qquad (13)$$

It may be noted that the promised payment on the debt contract must be larger than it was in the no loading case. The insurance covenant is structured so that the debt issue is safe, i.e., $D(B^l) = \rho\, B^l$. The increase in the promised payment necessitates a reduction in the deductible on the insurance covenant. Using (9) and (13), the difference in the debt values may be expressed as $D(B^l) - D(B^c) = p^l - p^c + \lambda\, p^l > 0$. The difference in debt values is represented in figure five.

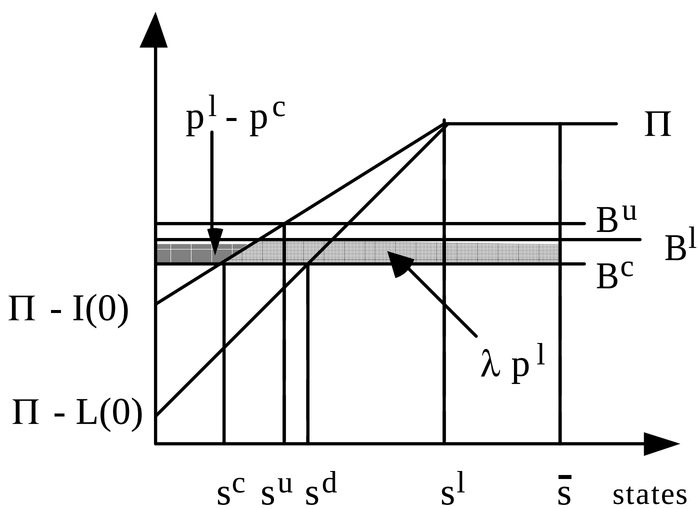

Figure 5: Premium Loading

Note that $S^c - S^l = \lambda\, p^l$. It follows that the difference between the stock value in the loading case and the stock value in the underinvestment case is $S^l - S^u = (S^c - S^u) - (S^c - S^l) = c^u - \lambda\, p^l$. It follows that even with premium loading the corporation demands insurance if the agency cost of the underinvestment problem exceeds the premium loading. Of course, for a sufficiently small agency cost there is no demand for insurance. This result is qualitatively the same as that of S&R; the difference is that the insurance covenant implied by our model allows current shareholders to increase their value by the difference between the agency cost and the premium loading whenever it is positive, i.e., by $c^u - \lambda p^l$. The introduction of the financing condition in equation (13) allows the promised payment to bondholders to be reduced. Reducing this payment also allows a smaller deductible to be chosen, thereby reducing the insurance premium and associated loading cost.

Therefore, when loading is considered, we find that our financing-constrained model has different net value implications than a *cum* dividend interpretation of S&R. Although a *cum* dividend interpretation of M&S has the same net value implications for current shareholders as our model, the story changes once loading costs are considered. Specifically, we find that the net value of the current shareholders' claim in the presence of loading is higher under our financing-constrained model compared to a *cum* dividend interpretation of S&R.[7] This result derives from the fact that loading creates an incentive to reduce the deductible as much as possible. Hence, rather than raise more debt than is needed to finance the asset and pay out the excess to current shareholders as a dividend now, it makes more sense to minimize the required insurance purchase by raising only the amount of debt needed to finance the asset and pay for the insurance; i.e., by also reducing the promised debt payment.

Concluding Remarks

This analysis demonstrates how an insurance covenant can be structured to eliminate the corporation's underinvestment problem and allow current shareholders to capture the entire risk-adjusted net present value of the investment. The analysis also shows that the underinvestment problem can be eliminated even in the presence of premium loading if the agency cost of the underinvestment problem exceeds the loading. The insurance contract is equivalent in structure to a put option and it ensures that the investment decision will be made then. Hence, the insurance covenant bonds the discretionary investment behavior of the corporation.

The model and so the analysis presented here is concerned with one decision that the corporation makes in the future. The conclusions, however, ought to be more robust. The

[7]An earlier version of this paper presents an appendix which compares and contrasts the models developed here with those of M&S and S&R by specializing the analysis to a simple two state numerical example. Interested readers should contact either of the authors for a copy of the working paper.

conclusion here is that by appropriately linking the provisions of the insurance and bond contracts, it is possible to eliminate the moral hazard problem faced by corporate management. The contract linkage eliminates the moral hazard problem and restores efficiency. More generally, it ought to be the case that whenever corporate management faces a moral hazard problem due to property or liability losses, some appropriately linked financing and insurance packages exist that eliminate the moral hazard problem. Such a generalization of the results here would not only show one source of the demand for corporate insurance but also that insurance plays a positive role in promoting the efficient allocation of risk and resources.

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