On Target Debt Ratios

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Abstract

We show how target debt ratios can improve the investment incentives in firms with risky debt outstanding and with asymmetric information. While profitable investments in a firm with risky debt and/or asymmetric information can reduce the value of existing equity, new debt offsets the value loss to old shareholders. Since financing a part of investments with new debt set by target debt ratios offsets wealth transfer effects, firms will not pass up valuable investment opportunities and will make the optimal investment decisions. For the effectiveness of target debt ratios, the new debt can be issued with shelf registration and can maintain the same priority as in the old debt.

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1. Introduction

In his classic paper, "Determinants of Corporate Borrowing," Myers (1977) saw a *direct* role for target debt ratios, expressed in *book value* terms, in controlling the incentives for management to pass up positive net present value projects when debt was present. He suggested that if firms set target debt ratios in *book value* terms, it would help control the perverse incentive to underinvest which the existence of debt caused. Although never spelled out in the paper, the reason why the target debt ratios worked was that the addition of new debt marginally decreased the value of old debt, thus partially offsetting the wealth transfer to old debt holders *when profitable new projects were undertaken*.

Myers did not elaborate on how the firm would choose the proper target debt ratio leaving his analysis at the point of saying that the target debt ratio would help control the perverse incentives of debt. Presumably the target debt ratio would be one of many tools – such as debt covenants, bank borrowing, and general monitoring and bonding activities – used by management to reduce agency costs in the presence of outstanding debt.

From examination of the literature, it appears as if Myers' idea on debt ratios has laid fallow for nearly three decades.[4] Even in his presidential address to the American Finance Association Myers (1984) seems to have abandoned the idea. He discusses the target debt ratios and says that "...the static tradeoff theory would specify all target debt ratios in terms of market not book values."[5] But he then observes that if firms really did set the target in terms of book value, we would see much larger debt ratios than we do. The answer to this dilemma, according to Myers, lies in the observation that "Book asset values are proxies for the values of assets in place" and that "...firms do not set target book debt ratios because accountants certify the books."[6] Certainly this last explanation is made in jest. Certifying the debt by accountants has nothing to do with the debt level the firm will choose. But if part of market value was the value of assets in place, which closely corresponded to book value of assets in place, then there may be a close correspondence between book values and "entire" market values of the firm's assets in place and its growth options. One can infer that Myers meant that setting a target debt ratio in book value terms was not unreasonable because it was a proxy for the theoretically correct ratio which would have been expressed in market terms. The idea of expressing the target debt ratio in book value terms to facilitate the control of agency costs seems to be absent in the subsequent analysis.[7]

Myers argues that an unusually profitable firm in a slow growth industry may end up with an unusually low debt ratio compared to the average while an unprofitable firm may

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[4] Harris and Raviv (1991) examine the extant theoretical literature on capital structure. In their classification of the literature they discuss models that are agency cost based. Within that classification they further discuss models which deal with the conflict between equity holders and debt holders. These models -- Diamond (1989) and Hirschleifer and Thakor (1989) -- focus primarily on the problem of asset substitution. Underinvestment is not an issue.

[5] Myers (1984), p 586.

[6] Ibid, p.587.

[7] Myers (1989), Myers (2001), and Myers (2003).

end up with a relatively high debt ratio because of the reluctance of the firm (via the modified "pecking" order theory) to issue equity capital. Using the asymmetric information analysis of Myers and Majluf (1984) he concludes, that to control underinvestment, the profitable firm generates equity through retained earnings and the unprofitable firm must raise external capital which it chooses to do by issuing debt. The unprofitable firm will only change the debt ratio when it finds that financial distress cost scare it into adding equity. This theory seems to completely eliminate conscious selection of target debt ratios in favor of debt ratio constraints. Industry growth, which all firms tend to share, determines the mix of assets in place to growth options, thus the bias affected by using book values of assets in place of market values is the same for all firms in the industry. Firms in industries with substantial growth options will have smaller denominators (in book value terms) than firms in industries with few growth options. The amount of debt that a firm has depends on its past profitability and thus firms within the industry have different numerators. From this point of view Myers argues that there is a tendency for the debt ratio to vary from industry to industry but the debt ratio for the firm has no meaning. This explains the observation of clustering of book debt ratios by industry while at the same time ruling out their rational use by a firm.

But apparently executives attach importance to book debt ratios. Scott and Johnson (1982) found, in a survey of executives, that 89% used "some measure of leverage in arriving at their firm's debt-equity mix" and that "familiar balance sheet and income statement-based leverage ratios are widely used....." Ang (1976) studied the time series behavior of individual firm's debt ratios in book terms and found that firms seem to operate as if they had a target leverage ratio and tended to close the gap between actual and target ratios quite rapidly.[8]

It appears as if the literature subsequent to Myers (1977) has made no attempt at incorporating the target debt ratio as a help in controlling underinvestment. Rather, the costs that are avoided by selection of the debt ratio are the more traditional costs such as bankruptcy or liquidation. Titman and Wessels (1988), in an empirical study of capital structure, document regularities regarding the debt ratio firms hold. They suggest that the "uniqueness" of the firm, through its impact on liquidation costs, has a bearing on the debt ratio. They argue that the more "unique" the firm, the smaller the debt ratio. A firm which produces unique or specialized products must satisfy its customers, suppliers and workers in such a way that minimizes cost and reduces the probability that rather heavy bankruptcy or liquidation costs will be incurred. They will do this by having less debt in the capital structure. This is essentially a bankruptcy argument. Also since short term debt is negatively related to firm size, they infer that transactions costs may be significant. But since they assume that transactions cost would be generally small, they hypothesize that if empirical analysis picks up a transaction cost effect, then other leverage-related costs may not be particularly significant. Finally they speculate that since past profitability and current debt levels are negatively related to the debt ratio, the asymmetric information arguments of Myers (1984) and Myers-Majluf are supported.

Titman and Wessels seem to suggest that there is a "bankruptcy" explanation or an

[8] Ibid. p.563.

asymmetric information explanation for the capital structure of a firm. Underinvestment and wealth transfers to bond holders seem to have not "bubbled to the surface" in their empirical work. Harris and Raviv (1991) relate theoretical models coming from agency or asymmetric information bases to empirical studies. They find some support for the "asset substitution" and "management self dealing" models of leverage determination.[9] Theoretical and empirical work dealing with asymmetric information abounds. The Myers-Majluf hypothesis in which wealth transfers to and from old and new investors has received considerable theoretical and empirical attention.[10] No theoretical or empirical literature seems to have dealt with the underinvestment problem and the target debt ratio approach for dealing with it.[11]

The purpose of this paper is to examine the Myers' target debt ratio approach for dealing with the underinvestment problem resulting from risky debt and is to extend the case with asymmetric information. We illustrate the problem with the solution in numerical examples. We also recognize the limit of using target debt ratios due to the priority of new debt and find new debt with shelf registration as a partial remedy.

In section 2 we show why Myers' target debt ratio, in book value terms, and in the absence of asymmetric information, will contribute to solving the underinvestment problem. We do this by expanding Myers' model and showing both the strengths and limitations of the approach he suggested. In section 3 we discuss underinvestment related to asymmetric information. We examine further the target debt ratios in resolving the underinvestment problem in section 4. We illustrate the role of target debt ratios with numerical examples in section 5. We evaluate the effectiveness of target debt ratios with their limits in section 6. Section 7 concludes.

2. The Underinvestment Problem with Risky Debt

Consider a firm that has assets-in-place A and growth opportunities B:

$$V_t = A + B = V_E + V_D \tag{1}$$

The firm is required to make investment I to realize growth opportunities B. To interpret Myers' comment that a target debt ratio, expressed in book value terms, helps to create the proper incentives for firms to not pass up positive net present value projects, first write the value V_t^I of the firm with the undertaken investment I partially financed by new debt at time t as

[9] Harris and Raviv (1991) and Stulz (1990) have models which deal with the relationship between management and equityholders - management self dealing -- while Diamond (1989) and Hirschleifer and Thakor (1989) deal with the relationship between equityholders and debtholders - asset substitution. The empirical evidence is found in Kim and Stulz (1988), Mikkelson and Partch (1986), Masulis (1980), Millon-Cornet and Travlos (1989), Dann (1981), Vermaelen (1981), Asquith and Mullins (1986), Masulis and Korwar (1986), Schipper and Smith (1986) and Eckbo (1986).

[10] See Harris and Raviv (1991) for a review of this literature.

[11] More recent studies on target debt ratios deal with other issues such as the existence or the speed of ajustement to target debt ratios by Jong and Verwijmeren (2007) and Hovakimian and Li (2008).

$$V_t^I = V_E^I + V_D^I + V_{ND}^I \tag{2}$$

where V_E^I is the value of the equity capital invested in the firm, V_D^I is the old debt and V_{ND}^I is the new debt issued at time *t*.

Suppose that the investment made at time *t* is

$$I = I_E + I_D \tag{3}$$

where *I* is the investment in assets, I_E is the amount of funds supplied by equity, and I_D is the amount of funds supplied by new debt holders. We will also assume a fixed portion, α of new investment is financed with equity so we add the conditions that

$$I_E = \alpha I, \quad I_D = (1 - \alpha)I \tag{4}$$

and the target debt-equity ratio is

$$\frac{dI_D}{dI_E} = \frac{d}{dI_E}\left(\frac{1-\alpha}{\alpha} I_E\right) = \frac{1-\alpha}{\alpha} \tag{5}$$

Since new investors are assumed to have rational expectations, the new debt holders get a market value which is the same as their actual dollar contribution, i.e.

$$I_D = V_{ND}^I$$

The incentives are properly aligned when the stockholders get value equal to or greater than their new investment. This will occur when

$$\frac{d(V_t^I - V_{ND}^I)}{dI_E} = \frac{dV_E^I}{dI_E} \geq 1 \tag{6}$$

That is, the incentives are properly aligned when the entire increase in firm value in excess of the new debt value is greater than or equal to the increase in equity investment. Furthermore the investment should only be undertaken if the added equity value is greater than the added *equity* investment.

The value of the old debt can be written as

$$V_D^I = f(V_t, \sigma^2, I_D) \tag{7}$$

where it is understood that

$$\frac{\partial f_t}{\partial V_t^I} \geq 0, \quad \frac{\partial f_t}{\partial \sigma^2} \leq 0, \quad \frac{\partial f_t}{\partial I_D} \leq 0$$

as in Myers. The third argument in equation (7) is the new debt. Its effect is ambiguous. For example, if the new debt ranked in priority with the old debt or had a *higher priority,* then adding new debt would decrease (or not increase) the value of the old debt. But if the new debt had a *lower priority* then there would be no impact on old debt value and the equality would hold.

The formula for the left hand side of (5), using (2**)** and the value of old debt as expressed in equation (6), can be written as

$$\begin{aligned}\frac{d(V_t^I - V_{ND}^I)}{dI_E} &= \frac{dV_E^I}{dI_E} + \frac{dV_D^I}{dI_E} \\ &= \frac{dV_E^I}{dI_E} + \frac{\partial f}{\partial V_t^I}\frac{\partial V_t^I}{\partial I}\frac{\partial I}{\partial I_E} + \frac{\partial f}{\partial \sigma^2}\frac{\partial \sigma^2}{\partial I}\frac{\partial I}{\partial I_E} + \frac{\partial f}{\partial I_D}\frac{\partial I_D}{\partial I_E}\end{aligned} \tag{8}$$

With the Myers' definition on wealth transfer, $\boldsymbol{Z_t}$, from shareholders to bondholders

$$Z_t = \frac{\partial f}{\partial V_t^I}\frac{\partial V_t^I}{\partial I} + \frac{\partial f}{\partial \sigma^2}\frac{\partial \sigma^2}{\partial I} \tag{9}$$

it follows that

$$\frac{d(V_t^I - V_{ND}^I)}{dI_E} = \frac{dV_E^I}{dI_E} + Z_t\frac{\partial I}{\partial I_E} + \frac{\partial f}{\partial I_D}\frac{\partial I_D}{\partial I_E} \tag{10}$$

and because there is a target debt ratio we have

$$\frac{d(V_t^I - V_{ND}^I)}{dI_E} = \frac{dV_E^I}{dI_E} + Z_t\frac{1}{\alpha} + \frac{\partial f}{\partial I_D}\frac{1-\alpha}{\alpha} \tag{11}$$

It is now possible to complete the analysis of investment incentives provided by a target debt-equity ratio expressed in book value terms. For the incentives to be consistent with value maximization the following conditions must be satisfied:

i) All positive net present value projects must be taken;
ii) No negative net present value project should be taken;
iii) The wealth transfer to old bondholders must be smaller than growth opportunities *B.*

The third condition holds if the sum of the second and third terms in (8) is less than or equal to growth opportunities *B.* If the priority of new debt is equal or higher to that of

old debt the third term on the right hand side is negative. Thus if Z_t in the second term was positive -- meaning wealth would be transferred to old bondholders if there were no new bondholders -- the third term *may* help to offset its effect. The reason why a conditional answer must be given is that the size of the debt-equity ratio has an impact on the way the incentives work themselves out. For the two terms to completely offset one another we must have

$$Z_t \frac{1}{\alpha} + \frac{\partial f}{\partial I_D} \frac{1-\alpha}{\alpha} = 0 \Rightarrow 1-\alpha = \frac{Z_t}{-\frac{\partial f}{\partial I_D}} \tag{12}$$

That is, the ratio of the transfer of wealth to old debt (if no new debt is issued) and the transfer to equity (if no new equity is issued), must equal the fraction of investment financed by new debt if there is to be no wealth transfers. For example if 50% of the capital budget was financed by debt, then $\alpha = 0.50$ and the transfers *from* old debt to equity which are due to the new debt must be twice as large as the transfers *to* old debt from equity that arise from the (presumably value enhancing) new investment.

Note that if the target for new financing was 80% from debt and 20% from equity, the new debt would need to be much less effective in transferring value from old debt. It needs only to have 25% more impact than the investment transfer impact, Z_t. Alternatively if using 50% debt would completely offset a positive value of Z_t, it would align the incentives properly and allow the firm to take all positive NPV projects. A smaller percentage, e.g. 20%, would reduce the disincentive to invest but would not eliminate it. Some positive NPV projects would be left on the table. If 80% were adopted there would be a transfer of wealth from old bond holders to the stockholders. One could argue that it would be in the stockholders' interest to take all positive NPV projects in this case.

It should be noted that without the target debt ratio the one way to eliminate the wealth transfer to old bondholders when there was a positive NPV project was to increase the risks of new projects. This led to the perverse incentive to take negative NPV projects which reduced the value of the firm as long as they were risky enough to transfer enough wealth to stockholders to offset the reduction in the value of the firm. The use of a target debt ratio reduces this perverse incentive.

3. The Underinvestment Problem with Asymmetric Information

Myers and Majluf (1984) show how information asymmetries between the firm and the market can lead to underinvestment because managers may act in the interests of existing passive investors.[12] Their idea is that firms with risky assets in place and risky investment alternatives may find that the loss to existing shareholders from sharing of the

[12] A passive investor is one who does not adjust her portfolio in response to a firms issue-invest decisions or when the firm reallocates internal funds between cash and real investments. See Myers and Majluf (1984) p. 188.

value of existing assets-in-place with new equity investors may be insufficient to make up for the value added to existing shareholders by taking on a new positive NPV project. Therefore a firm may pass up a positive NPV project because it may not be in the short term interests of the existing shareholders.

To overcome the tendency to pass up positive NPV projects when passive investors are present, the firm holds financial slack which obviates the need for issuing securities or it issues debt which leads to a diminution of the asymmetric information problem.[13] There is no incentive to issue equity and so the analysis seems to suggest that a growing firm will have an ever increasing debt ratio if it cannot finance internally with retained earnings. Myers-Majluf also rule out the case where the firm issues equity when "managers and the market are assumed to share the same information." They argue that the managers' issuance of equity suggests that, although they do not have immediate need for funds, future projects will be such that the current stock price is an overvaluation. Share issuance, even in this case, will cause declines in the stock value. Furthermore it will cause the firm to refrain from investment in positive NPV projects when the stock is undervalued. Stock issuance is avoided "like the plague."

The prescriptions that come forth from the Myers-Majluf model must be viewed within the context of the environment in which the firm operates. If the assets in place are small relative to the NPV of the new projects, the likelihood of not issuing equity and passing up positive NPV projects is small. The potential for transferring value originating in the assets in place away from existing shareholders is small compared to the benefits that would be passed up if the positive NPV projects were not undertaken. That is, if the firm has a very high growth rate it is likely that few positive NPV projects would be passed by.

The general implications for management are simple. Limit dividends and accumulate retained earnings in order to invest in positive NPV projects as they arise. The implications for optimal capital structure are less clear. Issuing debt when outside financing is needed would lead to high debt proportions. If the debt is risky, some positive NPV projects would be ignored. But each added increment of debt would also have the potential to transfer wealth from the existing debt holders to equity. The potential of new debt holders to be expropriated in the future would be present and would most likely affect the cost of debt for the firm. An implication of the Myers-Majluf theory is likely to be high cost debt.

The use of debt, in the Myers-Majluf theory, increases the value of the firm by reducing the incidence of foregone positive NPV projects. But it also increases the cost of debt. From the stockholders' point of view it seems there is a trade-off that is operative pitting reducing the incidence of project by-pass against increases in the cost of debt. As management analyzes projects ordered in decreasing profitability, at some point taking on the incremental project may just offset the wealth transfer resulting from increased debt costs.

[13] Myers and Majluf (1984) p. 207.

The Myers-Majluf theory also suggests that slack could be used to finance projects. When slack is used to the exclusion of new debt, the proportion of equity in the capital structure will increase. Therefore wealth is transferred away from equity to existing debt holders. Thus there seems to be a disincentive to make investments even from slack. This also suggests that there is room for target debt ratios within the Myers-Majluf theory.

4. A Closer Look at Target Debt Ratios

From the points of view in both Myers (1977) and Myers-Majluf, the essence of the capital structure problem is the analysis of incentives arising from wealth transfers. Myers (1977) studies the transfers between bond holders and existing stockholders and how these wealth transfers affect the propensity to pass up positive NPV projects. Myers-Majluf study the transfers between new and existing stockholders. Again the source of the reduction in value from poor incentives is the propensity to pass up positive NPV projects. The costs or benefits of wealth transfers from existing debt holders to stockholders plays no essential role in Myers-Majluf. In Myers (1977) the potential for transferring wealth away from existing bondholders exists through the firm's ability to change the risk category of its investment (risk shifting).

A closer look at the nature of these incentives using all four participants - existing stockholders, new stockholders, existing debt holders, and new debt holders -- is now in order. The essence of the power of the *partial* financing with debt (a target debt ratio) lies in the fact that the new debt causes a transfer of wealth from the old debt to equity. Its power is in nullifying the opposite direction transfer that takes place when positive NPV projects increase the value of the firm and, at the same time, the value of the old debt. But not financing completely with debt causes wealth transfers to new stockholders. Financing entirely with debt will increase the debt in the capital structure and increase its cost thus transferring wealth away from stockholders (albeit while causing no NPV projects to be by-passed). It seems as if the managers, as agents for the stockholders, must decide to whom to transfer wealth -- to the new stockholders, to the old bondholders, or to the new and future bondholders. It also seems that there is no way to costlessly take on all positive NPV projects.

To develop this idea further we will start by ignoring the possibility of asymmetric information and ask how the appropriate debt ratio would be determined? The answer depends on the opportunity set of investments from which the firm can draw. For example, if dV_t/dI is large for small I the marginal value of Z_t would be large. As investment is increased the marginal value of Z_t would fall because the NPVs of the marginal projects would fall. On the other hand one would guess that the marginal wealth transfer from the issuance of new debt would be increasing with the investment. Thus the incentive would be to set the scale of investment where the two *marginal* effects offset each other.

For the most profitable project, the debt ratio financing it would have to be very high to offset the wealth transfer. The transfer effects of the next most profitable project could

be offset with a smaller debt ratio. This process would then continue until the marginal project would need no debt because it would provide no wealth transfer. Thus the effective debt ratio used at any point in time would be

$$1 - \alpha = \frac{\int_0^{I^*} dZ_t}{\int_0^{I^*} \frac{\partial f}{\partial I}} . \qquad (13)$$

It is clear that eliminating the disincentive is a very difficult problem in practice. It requires knowing the functional relationship between investment amount and NPV at each point in time. It also requires knowledge of the functional relationship between new debt amount and the wealth transfer which would result from adding new debt. Furthermore, for a target debt -equity ratio to be constant over time requires these two functional relationships must also be constant.

If the functional relationships are not constant over time but the target debt-equity ratio is, the effect on the incentive to invest will also be varied. But it seems that it will always move incentives in the proper direction.

We now consider some theoretical aspects of this problem. They relate to the investment alternatives that the firm faces as well as the existing debt. Suppose we first look at a new firm initially financed with only a small amount of debt. Ordinarily very profitable projects in the investment set would need to be financed with large portions of debt because of the transfer of wealth to the existing debt holders from the new, profitable projects. But if existing debt is already quite safe, its value will be little affected by taking on a new, profitable project. In addition, since we have assumed the amount of existing debt is small, there is not a great deal of latitude in transferring wealth from the existing debt holders to offset a wealth transfer which would occur because of taking on the very profitable project. This suggests that the target debt ratio will have little impact on aligning incentives.

However, the effect of asymmetric information, as in Myers-Majluf, will still prevail. If the firm were to issue equity to outsiders, there may be a transfer of wealth away from existing stockholders to new stockholders. The extent of the transfer depends on the value of assets in place and the value of new projects. The Myers-Majluf analysis suggests that one of the most important factors in determining the extent of the wealth transfer from existing to new stockholders is the relationship between the value of the assets in place and the profitability of new projects. If the new project profitability is large relative to the value of assets in place, then financing with outside equity carries a less negative signal, less wealth is transferred from old stockholders to new stockholders, and the underinvestment problem is eased. If the growth rate is substantial and new projects were quite profitable relative to existing projects, retained earnings would not be sufficient to finance new investment and the firm must obtain outside financing. The firm's existing stockholders may be better off if the projects were financed using debt. As debt is

accumulated, its value is affected by the addition of new profitable investments and the way they are financed. If outside debt is used to finance all new investments, at some point in time the value of old debt will decline and wealth will be transferred to stockholders. This will have an adverse effect on the cost of new debt. It will be advantageous for the firm to issue a mix of debt and equity that will cause the underinvestment problem to be avoided and will preserve the existing debt from being exploited. Although it will be unlikely that the dual objective can be achieved, there will be a movement toward an optimal capital structure with target debt equity ratios.

Alternatively suppose the same firm is initially financed with a substantial amount of debt. Suppose the debt is in "excess of the optimal target debt ratio." The value of this existing debt may be greatly enhanced by taking on profitable projects. This will cause an underinvestment incentive. But if the existing debt has had considerable value diminution there may be an incentive to issue equity to transfer wealth back to the bond holders, thus sending a signal to future bondholders that they will not be exploited. By issuing equity there may be a transfer from existing stockholders to new stockholders. However, if there is a profitable store of projects this transfer may be small. Once the value diminution of the existing debt is corrected, then the target debt ratio could be used to align incentives. Thus it seems as if a firm will be brought toward an equilibrium debt ratio irrespective of its starting debt position.

We might hypothesize that, for profitable and high-growth firms, the concern for under investment arising from transfers of wealth between existing and new stockholders would be quite small. The more important concern is transfers between stockholders and debt holders. There is an incentive to use debt in financing since the stockholder will acquire all of the NPV of the project and the existing debt value will not be affected. However, as debt is added, an impact on existing debt becomes more likely to occur. Thus debt will be used to the point where additional debt will result in wealth transfers. At that point the target debt ratio becomes important in aligning incentives.

Suppose that we now look at a firm which has few profitable new projects relative to assets in place. In this situation the transfers of wealth between new and existing stockholders become important. Here the incentive is to not issue equity to finance projects. Because of low profitability of projects the firm may not be able to finance all positive NPV projects out of retained earnings and will thus resort to debt to avoid the underinvestment problem due to a transfer of wealth from old stockholders to new stockholders. This suggests that each addition of debt will reduce the value of existing debt and transfer wealth to old stockholders. But such a practice would lead to high costs of debt. There seems to be a dilemma. If financing is done with equity there will be a transfer of wealth to new stockholders from old stockholders and no transfer of wealth away from bondholders to make up for the old stockholders' loss. If financing is done with debt there is a transfer away from bondholders to old stockholders with an attendant increase in debt cost.

How can the dilemma be solved? The ideal would be that old stockholders do not suffer losses and old bondholders do not suffer losses. And at the same time the firm

chooses to undertake all positive NPV projects. It appears that this may be very difficult to accomplish. One way to avoid the wealth transfer would be to pass up projects. Financing positive NPV projects with part debt and part new equity may prevent transfer of wealth from stockholders to bondholders and vice-versa but it would allow transfer from old stockholders to new stockholders.

One way to avoid the dilemma described in the previous paragraph would be to finance with subordinated debt. In this way there would be no transfer from existing shareholders and no need to use new equity. This suggests that subordinated debt is a device that can be used to control investment incentives. The analysis so far suggests that subordinated debt would be used when the firm has few highly profitable projects. In these situations the debt ratio would tend to be quite high. In situations where the firm had many highly profitable projects it is likely that no subordinated debt would be needed and the firm would finance with a mix of debt and equity.

As to the second question -- why the target debt-equity ratio can be effective in a world of rational expectations -- we are less sanguine. We have explicitly brought the rational expectations assumption into the modeling of the new debt. We have assumed that the market value of the new debt is the same as the book value. But what about the old debt? These security holders have apparently set themselves in the position where they can be exploited by the issuance of new debt which can be issued at a higher or equal priority.

If the new debt holders, knowing that they would some day be old debt holders, could be sure that the target debt-to-equity ratio would serve to exactly offset all transfers of wealth to them because of profitable investments, then proper incentives would result. But is this a reasonable assumption? Equation (13) suggests that it may not be since a single target debt-equity ratio cannot be counted upon to exactly offset the two counter effects. This suggests that the bondholder may pay a smaller amount for a debt promise than she would when a continual complete offset could be expected.

Because the debt holder would pay a smaller amount it is incumbent on the stockholders to provide an incentive to pay more. How could they do this? How about a covenant that says future debt will be lower priority? *Ceteris paribus* this would probably cause the price of the debt to rise. But then the third term on the right hand side of (8) would vanish and the target debt equity ratio would have no effect in providing the proper incentive to invest. That is, the stockholders' problem would not be solved. Acquiring new positive NPV projects would transfer wealth to old debt holders. Therefore the stockholders may resort to increasing risk to get a transfer of wealth to the stockholders. This tendency would be seen by the new debt holders thus mitigating the rise in bond price because of the more restrictive covenant.

5. Numerical Examples

We develop numerical examples which illustrate the ideas developed in the previous section. Specifically it combines the ideas in section 2 where Myers (1977) is extended to

deal with target debt ratios and the asymmetric information ideas presented in Myers-Majluf.

There are two examples in this section. The first example in section 5.1 shows how financing with equity will transfer wealth from stockholders to bond holders, providing an incentive to not take a positive NPV project. However a target debt ratio – meaning both debt and equity will be used to finance the new investment – eliminates the loss of wealth by the old stockholders and aligns the incentive. The second example in section 5.2 illustrates that financing with new outside equity will transfer wealth from old shareholders to new shareholders, providing an incentive not to take a positive NPV project. However, a target debt ratio obviates the loss of wealth to the old shareholders and restores the investment incentive to old shareholders.

5.1 Resolving the Underinvestment Problem with Risky Debt

To illustrate the Myers' underinvestment problem, we start with a firm that has assets-in-place valued $A = 1100$ at $t = 0$. Suppose the firm has a single debt issue outstanding. The face value is $P = 1000$, and the debt is coming due in 2 years at $t = 2$. The risk-free rate is 5 percent. Suppose now that the value of the firm's assets-in-place in a year will move up (State 1) by a factor of $u = 1.5$ or down (State 2) by a factor of $d = 1/u = 0.6667$. States 11 and 12 represent moving up and down during the second year, respectively. There are then four paths to three states at $t=2$. There are two moves upward, (1,1), two moves downward. (2,2), or a move up and a move down, (1,2) and (2,1). The firm also has a growth opportunity that requires an initial investment of $I = 100$ and generates NPV of 30 or 10 at $t = 1$.

The value of the assets-in-place and of the equity as a call option on the assets-in-place in 2 years will be:

State	Assets-in-place	Equity
11	$A_{11} = 1100 \times 1.5^2 = 2475,$	$E_{11} = \text{Max}(2475 - 1000, 0) = 1475,$
12, 21	$A_{12} = A_{21} = 1100 \times 1.5 \times 0.6667 = 1100,$	$E_{12} = E_{21} = \text{Max}(1100 - 1000, 0) = 100,$
22	$A_{22} = 1100 \times 0.6667^2 = 488.89,$	$E_{22} = \text{Max}(488.89 - 1000, 0) = 0.$

Using the risk-neutral probability p of moving up, we compute the current values of the equity E as 328.15 and of the debt V_D as 771.85 from the values (E_1, E_2) of equity at $t = 1$:

$p = (1.05 - 0.6667)/(1.5 - 0.6667) = 0.46;$ $\quad 1\text{-}p = 0.54,$
$E_1 = (1475 \times 0.46 + 100 \times 0.54)/1.05 = 697.62,$
$E_2 = (100 \times 0.46 + 0 \times 0.54)/1.05 = 43.81,$
$E = (697.62 \times 0.46 + 43.81 \times 0.54)/1.05 = 328.15,$
$V_D = 1100 - 328.15 = 771.85.$

The investment opportunity available to the firm requires an initial investment of $I = 100$ and the values of growth opportunity with the required investment at $t = 1$ are either

115.50 or 136.50 which provide the NPVs of either 10 (= 115.50/1.05 – 100) or 30 (= 136.50/1.05 – 100) similar to the example of Myers-Majluf. Combining with the risk neutral probabilities, we have the value of the growth opportunity at $t = 0$ as 19.20 (= 30 × 0.46 + 10 × 0.54). Once the NPVs (10, 30) of the growth opportunity is realized at $t = 1$, those values (115.50, 136.50) at $t = 1$ will behave like assets-in-place and will be B_{11} = 204.75, B_{12} = 91, B_{21} = 173.25, or B_{22} = 77 at $t = 2$ as shown in Panel B of Figure 1. The NPV of the investment opportunity can also be computed from payoffs at $t = 2$ as 19.20:

$B_1 = (204.75 \times 0.46 + 91 \times 0.54)/1.05 = 136.50,$
$B_2 = (173.25 \times 0.46 + 75 \times 0.54)/1.05 = 115.50,$
$B(PV) = (136.50 \times 0.46 + 115.50 \times 0.54)/1.05 = 119.20,$
$B = B(PV) - I = 119.20 - 100 = 19.20.$

Panel A of Figure 1 summarizes the computed values above. Its initial balance sheet with the investment opportunity is

Balance Sheet with growth opportunity at t = 0

Assets-in-place	1100.00	Value of debt	771.85
Value of growth opportunity	19.20	Value of equity	347.35
Value of firm	1119.20	Total debt and equity	1119.20

Hence, the value V_E of the equity with the investment opportunity can be broken down into the equity with and without future growth opportunities as pointed out by Myers (1977):

$V_E = E + B = 328.15 + 19.20 = 347.35,$
$V = A + B = V_E + V_D = 1119.20.$

Thus what we see here is the value of the debt and equity with the growth opportunity pending but not yet undertaken.

5.1.1 Investment with 100% equity

We now look at the case where the investment opportunity is to be financed with 100% equity. We will see that equity financing will cause the value of the investment of 100 by the shareholders to decline to less than 100 once it is undertaken. That is, the profitable project will accrue to bondholders – their investment is now safer and equity holders will lose.

If the investment is made by existing shareholders, the values of the firm and the equity in 2 years will be

State	Firm Value	Equity
11	$V_{11}^I = 2475 + 204.75 = 2679.75,$	$E_{11}^I = \text{Max}(2679.75 - 1000, 0) = 1679.75,$
12	$V_{12}^I = 1100 + 91 = 1191,$	$E_{12}^I = \text{Max}(1191 - 1000, 0) = 191,$

21 $V_{21}^I = 1100 + 173.25 = 1273.25$, $E_{21}^I = \text{Max}(1273.25 - 1000, 0) = 273.25$,

22 $V_{22}^I = 488.89 + 77 = 565.89$, $E_{22}^I = \text{Max}(565.89 - 1000, 0) = 0$.

Using the same risk-neutral probabilities, we compute the current values of the equity as $V_E^I = 426.99$ and of the debt as $V_D^I = 792.21$ with the investment:

$$V^I = V_E^I + V_D^I = A + I + NPV(B) = 1100 + 100 + 19.20 = 1219.20,$$
$$E_1^I = (1679.75 \times 0.46 + 191 \times 0.54)/1.05 = 834.12,$$
$$E_2^I = (273.25 \times 0.46 + 0 \times 0.54)/1.05 = 119.71,$$
$$V_E^I = (834.12 \times 0.46 + 119.71 \times 0.54)/1.05 = 426.99,$$
$$V_D^I = 1219.20 - 426.99 = 792.21.$$

Panel A in Figure 2 shows the value of the firm and the equity. Its balance sheet with the investment of 100% equity is

Balance Sheet with the investment of 100% equity at t = 0

Assets-in-place	1219.20	Value of debt	792.21
Value of growth opportunity	0	Value of equity	426.99
Value of firm	1219.20	Total debt and equity	1219.20

If the investment is made with shareholders' outlay $I_E = 100$, shareholders lose value by 1.16 and bondholders gain 20.36, which is the wealth transfer Z_t from shareholders to bondholders in (9):

Change in E: $V_E^I - E - I_E = 426.99 - 328.15 - 100 = -1.16$,

Change in D: $Z_t = V_D^I - D = 792.21 - 771.85 = 20.36$.

Here we see that the stockholders put in 100 and the market value of their equity did not rise by 100. It fell 1.16 short. But since the project was profitable the bondholders gained its NPV plus 1.16 more which accrued to them because the risks they were bearing were reduced. Since shareholders lose value with the investment, the firm will pass up the positive NPV project as presented by Myers (1977).

5.1.2 Investment with target debt ratios

We show that the target debt ratio has an impact on the incentive to invest. But the strength of the incentive depends on the magnitude of the target debt ratio. We first show that a small target debt ratio will have a negative effect. This is not surprising since we know from the example of complete equity financing that the project would be bypassed even though it had a positive NPV. Since any positive NPV project will add value to the firm and will be undertaken if the stockholders see an increase in their market value above the amount of their contribution to the financing, there is a minimum target debt ratio which provides an incentive. However, as the debt ratio increases the incentive gets

stronger. As we described earlier in the paper, there is a unique debt ratio for every growth opportunity in which the stockholder gets the full NPV. For debt ratios below that unique debt ratio the stockholder gets only some of the NPV with the remainder accruing to the benefit of the bond holder. For target debt ratios above that unique debt ratio the stockholder gets more than the NPV, extracting wealth from the bondholder.

If the investment $I = 100$ is partially debt financed and the new debt has the same priority as the old debt, shareholders not only eliminate losses from the investment but also retain its NPV. Setting $\alpha = 0.96$, we have a target debt ratio $1 - \alpha = 0.04$. With 4% debt financing at $I_D = 4$ shareholders will be indifferent to the investment and bondholders will retain the full NPV of 19.20:

State	Firm Value	Equity
11	$V_{11}^I = 2679.75$,	$E_{11}^I = \text{Max}(2679.75 - 1000 - 4\times1.05^2, 0) = 1675.34$,
12	$V_{12}^I = 1191$,	$E_{12}^I = \text{Max}(1191 - 1000 - 4\times1.05^2, 0) = 186.59$,
21	$V_{21}^I = 1273.25$,	$E_{21}^I = \text{Max}(1273.25 - 1000 - 4\times1.05^2, 0) = 268.34$,
22	$V_{22}^I = 565.89$,	$E_{22}^I = \text{Max}(565.89 - 1000 - 4\times1.05^2, 0) = 0$.

We compute the current values of the equity as $V_E^I = 424.15$ and of the old debt as $V_D^I = 791.05$ with the investment:

$V^I = 1219.20$ (no change),
$E_1^I = (1675.34 \times 0.46 + 186.59 \times 0.54)/1.05 = 829.92$,
$E_2^I = (268.34 \times 0.46 + 0 \times 0.54)/1.05 = 117.78$,
$V_E^I = (829.92 \times 0.46 + 117.78 \times 0.54)/1.05 = 424.15$,
$V_D^I + V_{ND} = V^I - V_E^I = 1219.20 - 424.15 = 795.05$,
$V_D^I = 795.05 - 4 = 791.05$.

Panel B in Figure 2 shows the value of the firm and the equity. Its balance sheet with the investment of 4% debt is

Balance Sheet with the investment of 4% debt at t = 0

Assets-in-place	1219.20	Value of debt	795.05
Value of growth opportunity	0	Value of equity	424.15
Value of firm	1219.20	Total debt and equity	1219.20

If the investment is made with 4% debt, shareholders do not lose value and old bondholders gain 19.20, which is the wealth transfer Z_t from shareholders to bondholders in (9):

Change in E: $V_E^I - E - I_E = 424.15 - 328.15 - 96 = 0$,
New debt: $I_D = V_{ND}^I = 4$,
Change in old debt: $Z_t = V_D^I - V_D = 791.05 - 771.85 = 19.20$.

We see from this example that the the stockholder puts in 96 and gets value of market value of 96. Thus she is indifferent to the project. If the debt ratio had been between 0 and 4% there would be no incentive to invest in the positive NPV project because of the wealth transfer to bondholders.

We now use a debt ratio that gives the stockholder the full NPV for her investment.

Setting $\alpha = 0.3016$, we have a target debt ratio $1 - \alpha = 0.6984$. With 69.84% debt financing at $I_D = 69.84$, shareholders will keep the full NPV of 19.20 and bondholders will be indifferent:

State	Firm Value	Equity
11	$V_{11}^I = 2679.75$,	$E_{11}^I = \text{Max}(2679.75 - 1000 - 69.84 \times 1.05^2, 0) = 1602.75$,
12	$V_{12}^I = 1191$,	$E_{12}^I = \text{Max}(1191 - 1000 - 69.84 \times 1.05^2, 0) = 114$,
21	$V_{21}^I = 1273.25$,	$E_{21}^I = \text{Max}(1273.25 - 1000 - 69.84 \times 1.05^2, 0) = 196.25$,
22	$V_{22}^I = 565.89$,	$E_{22}^I = \text{Max}(565.89 - 1000 - 69.84 \times 1.05^2, 0) = 0$.

We compute the current values of the equity as $V_E^I = 377.51$ and of the old debt as $V_D^I = 771.85$ with the investment:

$V^I = 1219.20$ (no change),
$E_1^I = (1602.75 \times 0.46 + 114 \times 0.54)/1.05 = 760.79$,
$E_2^I = (196.25 \times 0.46 + 0 \times 0.54)/1.05 = 85.98$,
$V_E^I = (760.79 \times 0.46 + 85.98 \times 0.54)/1.05 = 377.51$,
$V_D^I + V_{ND} = V^I - V_E^I = 1219.20 - 377.51 = 841.69$,
$V_D^I = 841.69 - 69.84 = 771.85$.

Panel C in Figure 2 shows the value of the firm and the equity. Its balance sheet with the investment of 69.84% debt is

Balance Sheet with the investment of 4% debt at t = 0

Assets-in-place	1219.20	Value of debt	841.69
Value of growth opportunity	0	Value of equity	377.51
Value of firm	1219.20	Total debt and equity	1219.20

If the investment is made with 69.84% debt, shareholders gain $B = 19.20$ and old bondholders gain nothing:

Change in E: $V_E^I - E - I_E = 377.51 - 328.15 - 30.16 = 19.20$,
New debt: $I_D = 69.84$,
Change in old debt: $Z_t = V_D^I - V_D = 771.85 - 771.85 = 0$.

Hence, if the investment I is partially debt financed between 4% and 69.84%, both shareholders and bondholders do not lose value and the firm will not pass up the positive NPV project.

It follows that any target debt ratio above 69.84% will net the stockholder more than the NPV for the growth opportunity. So what we have seen is that the as the target debt ratio increases beyond 4% there is an increase in the benefits to the stockholder holding the debt rate constant. But clearly, over time, the debtholder would catch on to the exploitation that is taking place and demand a higher rate to compensate for it.

We now move on to the second example involving the asymmetric information case emphasized in Myers-Mjluf.

5.2 Resolving the Underinvestment Problem with Asymmetric Information

Following the asymmetric information in Myers-Majluf, we assume that the true state is revealed to management at t = 0 and to investors at t = 1 in the same example as above. The asset values at $t = 0$ are:

$A(1) = A_1/(1 + r_f) = 1650/1.05 = 1571.43$
$A(2) = A_2/(1 + r_f) = 733.33/1.05 = 698.41$
$B(1) = B_1/(1 + r_f) - I = 136.50/1.05 - 100 = 130 - 100 = 30,$
$B(2) = B_2/(1 + r_f) - I = 115.50/1.05 - 100 = 115.50 - 100 = 10,$

Asset values at $t = 0$

	State 1	State 2
Assets-in-place	$A(1)$ =1571.43	$A(2)$ = 698.41
Investment Opportunity	$B(1)$ = 30	$B(2)$ = 10

5.2.1 Investment with 100% new equity

If the firm issues stock to raise $I = 100$ and invests regardless of which state occurs, the decision to sell new equity tells investors nothing about the true state. However, there are three problems with the investment. First, there is a wealth transfer to bondholders. The wealth transfer $Z_t = 20.36$ from shareholders to bondholders makes the total equity with the investment less valuable than the equity with growth opportunities:

Total equity: $V_E^I = 426.99$ (Panel A of Figure 2),
Total debt: $V_D^I = V^I + B(I) - V_E^I = 1100 + 19.20 - 426.99 = 792.21,$
Change in equity: $V_E^I - (V_E + I) = 426.99 - (347.35 + 100) = -20.36,$
Change in debt: $Z_t = V_D^I - D = 792.21 - 771.85 = 20.36.$

Second, new shareholders do not get what they pay for, while existing shareholders are better off with the investment:

$E^I_{Old} = V^I_E \times V_E/(V_E + I)$
$= 426.99 \times 347.35/(347.35 + 100) = 331.54,$
$E^I_{New} = V^I_E \times I/(V_E + I)$
$= 426.99 \times 100/(347.35 + 100) = 95.45,$
Change in old equity: $E^I_{Old} - E = 331.54 - 328.15 = 3.39,$
Change in new equity: $E^I_{New} - I_E = 95.45 - 100 = -4.55.$

Third, issuing equity and investing regardless of true states is not the equilibrium solution. The payoffs to both old and new shareholders in State 1 are:

$V^I_E = E^I_1/(1 + r_f) = 834.12/1.05 = 794.40$
$E^I_{Old} = 794.40 \times (328.15 + 30)/(328.15 + 30 + 100) = 621.01,$
$E^I_{New} = 794.40 \times (100)/(328.15 + 30 + 100) = 173.39.$

The payoffs to both old and new shareholders in State 2 are:

$V^I_E = E^I_1/(1 + r_f) = 119.71/1.05 = 114.01,$
$E^I_{Old} = 114.01 \times (328.15 + 10)/(328.15 + 10 + 100) = 87.99,$
$E^I_{New} = 114.01 \times (100)/(328.15 + 10 + 100) = 26.02.$

Panels A and B of Figure 3 show the value of the firm and the equity with the investment. The payoffs E^I_{Old} to existing shareholders with the investment can be compared to those E_{Old} without the investment as in Panels C and D of Figure 3:

State	Issue and invest	No investment
1	$E^I_{Old} = 621.01$	$E_{Old} = E_1/(1 + r_f) = 697.62/1.05 = 664.40$
2	$E^I_{Old} = 87.99$	$E_{Old} = E_2/(1 + r_f) = 43.81/1.05 = 41.72.$

Since the value of old equity is lower when shares are issued in State 1, the optimal strategy is to issue and invest only in State 2. However, this strategy signals State 2 and $E^I_{Old} = 87.99$. The equilibrium payoffs are

State	Issue and invest	No investment
1	–	$E_{Old} = 664.40$
2	$E^I_{Old} = 87.99$	–

Hence, the firm passes up a profitable investment project in State 1. The value of the equity at $t = 0$ will be 336.32:

V_E = (664.40 × 0.46 + 87.99 × 0.54)/(1 + 0.05) = 336.32.

There is a loss of 11.03 in ex-ante equity value from V_E = 347.35 to V_E = 336.32.

5.2.2 Investment with target debt ratios

If the investment *I = 100* is financed with debt and new equity and the new debt has the same priority as the old debt, management will invest regardless of which state occurs. Setting α = 0.3508, we have a target debt ratio 1 – α = 0.6492. With 64.92% debt financing at I_D = 64.92, the values of the firm and the equity in State 1 at *t = 2* will be:

State	Firm Value	Equity
11	V_{11}^I = 2679.75,	E_{11}^I = Max(2679.75 – 1000 – 64.92×1.05^2, 0) = 1608.18,
12	V_{12}^I = 1191,	E_{12}^I = Max(1191 – 1000 – 64.92×1.05^2, 0) = 119.43,

And the values of the firm and the equity in State 1 at *t = 1* will be:

V_1^I = (2679.75 × 0.46 + 1191 × 0.54)/1.05 = 1786.50,
E_1^I = (1608.18 × 0.46 + 119.43 × 0.54)/1.05 = 765.96.

Thus, the values of the firm and the equity in State 1 at *t = 0* will be:

V^I = 1786.50/1.05 = 1701.43,
V_E^I = 765.96/1.05 = 729.48.

Finally, the values to both old and new shareholders in State 1 are E_{Old}^I = 664.40 and E_{New}^I = 65.08 as shown in Panel A of Figure 4:

$E_{Old}^I = V_E^I \times (E + B)/(E + B + I)$
= 729.48 × (328.15 + 30)/(328.15 + 30 + 35.08) = 664.40,
$E_{New}^I = V_E^I \times (I)/(E + B + I)$
= 729.48 × (35.08)/(328.15 + 30 + 35.08) = 65.08.

Since the total debt is 971.95, the value of old debt becomes 907.03:

$V_D^I + V_{ND} = V^I - V_E^I$ = 1701.43 – 729.48 = 971.95,
V_D^I = 971.95 – 64.92 = 907.03.

The value E_{Old} of the old equity remains unchanged and the value of new equity increases by 30 when shares are issued in State 1:

Change in E: $V_E^I - E - I_E = 729.48 - 664.40 - 35.08 = 30$,
Change in old equity: $E_{Old}^I - E_{Old} = 664.40 - 664.40 = 0$,
Change in new equity: $E_{New}^I - I_E = 65.08 - 35.08 = 30$.

Since the new bondholders get a market value which is the same as their actual dollar contribution, the value of the old debt increases by 135.18 in State 1:

New debt: $I_D = 64.92$,
Change in old debt: $Z_t = D_{Old}^I - D = 907.03 - 771.85 = 135.18$.

The investment incentive to old shareholders are preserved in State 2 as well. With 64.92% debt financing at $I_D = 64.92$, the values of the firm and the equity in State 2 at $t = 2$ will be:

State	Firm Value	Equity
21	$V_{21}^I = 1273.25$,	$E_{21}^I = \text{Max}(1273.25 - 1000 - 64.92 \times 1.05^2, 0) = 201.68$,
22	$V_{22}^I = 565.89$,	$E_{22}^I = \text{Max}(775.41 - 1000 - 64.92 \times 1.05^2, 0) = 0$,

And the values of the firm and the equity in State 2 at $t = 1$ will be:

$V_1^I = (1273.25 \times 0.46 + 565.89 \times 0.54)/1.05 = 848.83$,
$E_1^I = (201.68 \times 0.46 + 0 \times 0.54)/1.05 = 88.36$.

Thus, the values of the firm and the equity in State 2 at $t = 0$ will be:

$V^I = 848.83/1.05 = 808.41$.
$V_E^I = 88.36/1.05 = 84.15$.

Finally, the values to both old and new shareholders in State 2 are $E_{Old}^I = 76.24$ and $E_{New}^I = 7.91$ as shown in Panel B of Figure 4:

$$E_{Old}^I = V_E^I \times (E + B)/(E + B + I)$$
$$= 84.15 \times (328.15 + 10)/(328.15 + 10 + 35.08) = 76.24,$$
$$E_{New}^I = V_E^I \times (I)/(E + B + I)$$
$$= 84.15 \times (35.08)/(328.15 + 10 + 35.08) = 7.91.$$

Since the total debt is 724.27, the value of old debt becomes 659.35:

$V_D^I + V_{ND} = V^I - V_E^I = 808.41 - 84.15 = 724.27$,
$D_{Old}^I = 724.27 - 64.92 = 659.35$.

The value E_{Old} of the old equity increases by 34.52 and the value of new equity decreases by 27.17 when shares are issued in State 2:

Change in E: $V_E^I - E - I_E = 84.15 - 41.72 - 35.08 = 7.35$,
Change in old equity: $E_{Old}^I - E_{Old} = 76.24 - 41.72 = 34.52$,
Change in new equity: $E_{New}^I - I_E = 7.91 - 35.08 = -27.17$.

Since the new bondholders get a market value which is the same as their actual dollar contribution, the value of the old debt decreases by 112.50 in State 2:

New debt; $I_D = 64.92$,
Change in old debt: $Z_t = D_{Old}^I - D = 659.35 - 771.85 = -112.50$.

The payoffs to shareholders with investment can be compared to those without investment.

State	Issue and invest	No investment
1	$E_{Old}^I = 664.40$	$E_1/(1 + r_f) = 664.40$
2	$E_{Old}^I = 76.24$	$E_2/(1 + r_f) = 41.72$.

Since the value of the old equity remains constant when shares are issued in State 1 and is higher than when shares are issued in State 2, the optimal strategy is to issue and invest regardless of which state occurs.

To see the case that the old shareholders receive the full value of the growth opportunity in State 1, we set $\alpha = 0$ and have a target debt ratio $1 - \alpha = 1$. With 100% debt financing at $I_D = 100$ the value of the old equity increases by $B = 30$ when shares are issued in State 1:

State	Firm Value	Equity
11	$V_{11}^I = 2679.75$,	$E_{11}^I = \text{Max}(2679.75 - 1000 - 100 \times 1.05^2, 0) = 1569.50$,
12	$V_{12}^I = 1191$,	$E_{12}^I = \text{Max}(1191 - 1000 - 100 \times 1.05^2, 0) = 80.75$.

And the values of the firm and the equity in State 1 at $t = 1$ will be:

$V_1^I = (2679.75 \times 0.46 + 1191 \times 0.54)/1.05 = 1786.50$,
$E_1^I = (1569.50 \times 0.46 + 80.75 \times 0.54)/1.05 = 729.12$.

Thus, the values of the firm and the equity in State 1 at $t = 0$ will be:

$V^I = 1786.50/1.05 = 1701.43$,
$V_E^I = 729.12/1.05 = 694.40$.

Finally, the value of the old equity in State 1 is $E^I_{Old} = 694.40$ as shown in Panel C of Figure 4:

$V^I_E = E^I_{Old} = 729.12/1.05 = 694.40,$
$E^I_{New} = 0.$

Since the total debt is 1007.03, the value of old debt becomes 907.03:
$V^I_D + V_{ND} = V^I - V^I_E = 1701.43 - 694.40 = 1007.03,$
$D^I_{Old} = 1007.03 - 100 = 907.03.$

The value E_{Old} of the old equity increases by 30 and the value of old debt increases by 135.18 when shares are issued in State 1:

Change in E = Change in old equity: $V^I_E - E - I_E = 694.40 - 664.40 - 0 = 30,$
New debt; $I_D = 100,$
Change in old debt: $Z_t = D^I_{Old} - D = 907.03 - 771.85 = 135.18.$

With 100% debt financing at $I_D = 100$ the value of the old equity increases by 26.29 when shares are issued in State 2. The values of the firm and the equity in State 2 at $t = 2$ will be:

State	Firm Value	Equity
21	$V^I_{21} = 1273.25,$	$E^I_{21} = \text{Max}(1273.25 - 1000 - 100 \times 1.05^2, 0) = 163,$
22	$V^I_{22} = 565.89,$	$E^I_{22} = \text{Max}(565.89 - 1000 - 100 \times 1.05^2, 0) = 0,$

And the values of the firm and the equity in State 2 at $t = 1$ will be:

$V^I_1 = (1273.25 \times 0.46 + 565.89 \times 0.54)/1.05 = 848.83,$
$E^I_1 = (163 \times 0.46 + 0 \times 0.54)/1.05 = 71.41.$

Thus, the values of the firm and the equity in State 2 at $t = 0$ will be:

$V^I = 848.83/1.05 = 808.41,$
$V^I_E = 71.41/1.05 = 68.01.$

Finally, the payoff to old shareholders is $E^I_{Old} = 68.01$ as shown in Panel D of Figure 4:

$V^I_E = E^I_{Old} = 71.41/1.05 = 68.01,$
$E^I_{New} = 0.$

Since the total debt is 740.40, the value of old debt becomes 640.40:

$V_D^I + V_{ND} = V^I - V_E^I = 808.41 - 68.01 = 740.40,$
$D_{Old}^I = 740.40 - 100 = 640.40.$

The value E_{Old} of the old equity increases by 26.29 and the value of old debt decreases by 131.45 when shares are issued in State 2:

Change in E = Change in old equity: $V_E^I - E - I_E = 68.01 - 41.72 - 0 = 26.29,$
Change in new equity: $E_{New}^I - I_E = 0 - 0 = 0.$
New debt; $I_D = 100,$
Change in old debt: $Z_t = D_{Old}^I - D = 640.40 - 771.85 = -131.45.$

The payoffs to shareholders with the investment can be compared to those without investment.

State	Issue and invest	No investment
1	$E_{Old}^I = 694.40$	$E_1/(1 + r_f) = 664.40$
2	$E_{Old}^I = 68.01$	$E_2/(1 + r_f) = 41.72.$

Since the value of old equity becomes higher when shares are issued in either state, the optimal strategy is to issue and invest regardless of which state occurs.

Hence, if the investment I is partially financed with debt between 64.92% and 100%, both old shareholders do not lose value and the firm will not pass up the positive NPV project regardless of which state occurs.

5.3 Uncertainty in Asymmetric Information

Investors might be uncertain about asymmetric information in a firm and only have some probabilities between zero and one on asymmetric information, while the firm still faces the underinvestment problem with risky debt. Target debt ratios could resolve the underinvestment problem resulting from uncertain asymmetric information.

Recall that the underinvestment caused by risky debt in Myers (1977) is resolved when the firm in the example sets target debt ratios between 4% and 69.84%, and that the underinvestment caused by asymmetric information in Myers-Majluf is resolved when the firm sets target debt ratios between 64.92% and 100%. Thus, if the firm sets target debt ratios between 64.92% and 69.84%, the underinvestment problem caused by both risky debt and uncertain asymmetric information can be simultaneously resolved. The narrow range (64.92%, 69.84%) of target debt ratios might be considered as unique to this example. However, the example illustrates the potential of target debt ratios to reduce the underinvestment problem resulting from risky debt and asymmetric information.

6. Are Target Debt Ratios Effective?

It appears that target debt ratios will not be completely effective in aligning incentives for value maximizing investment decisions because they can only be effective if they are accompanied by the *absence* of a covenant which forces new debt to be of a lower priority. Thus, the presence of the target ratio does some aligning of incentives but it is imperfect at best. That is, it is unlikely that it can completely eliminate the tendency of risky debt and/or asymmetric information to cause the firm to pass up positive NPV projects. We have seen from the examples that setting the target debt ratio depends on the profitability of the positive NPV project. This suggests that target debt ratios would need to change frequently as firms encountered growth opportunities of various levels of profitability to align the incentives properly.

We note also that the target debt ratio is used in a limited sense. It applies to financing new projects. Thus a firm may have, say, 30% of its existing capital structure financed by debt when it seeks to finance a new project. But 30% is not necessarily the target debt ratio it should be attempting to use with the new project. That ratio depends on the characteristics of the new project as well as the existing capital structure.

One way to get around the restrictive covenant is to issue new debt with shelf registration. Traditionally-issued debt tends to face the restrictive covenant potentially inserted by existing bondholders. Firms that shelf-register a specific amount of debt are subsequently allowed, but are not required, to issue debt within two years of registration. Thus, when a firm issues risky debt, it could also register additional debt to be issued within two years. By issuing shelf-registered debt, a firm could maintain the same priority in new debt as in old debt. While Moerhle et. al. (2004) identify the higher risk in shelf-registrations of debt than in traditionally-issued debt, the shelf-registered debt does not appear to cost a firm more than does the traditionally-issued debt. Skaradzinski et. al. (2006) examine 612 new industrial issues during 1995-1998 and find that the yield of debt issue is not significantly related to whether the debt was traditionally- or shelf-registered. Although there are several issues in shelf registration of debt including increased efficiency and increased risk and the motivation of their study is not directly related to target debt ratios, the shelf-registered debt could increase the potential benefits of target debt ratios in reducing the underinvestment problem.

However, even shelf registration of debt is not sufficient enough to implement the target debt ratios for investment incentives because it has a two-year limit to shelf-registered issues and requires new debt to be issued within the shelf-registered amount of debt.

7. Conclusion

Myers (1977) shows that risky debt outstanding in a firm can discourage new investment because of potential wealth transfer from shareholders to old bondholders. He also indicates without details that the target debt ratios can increase the incentives to

invest by adding new debt and offsetting the wealth transfer as a result. On the other hand, Myers and Majluf (1984) present the underinvestment problem related to asymmetric information. When managers have information on growth opportunities that investors do not have, they could pass up profitable investment projects to protect the interest of existing shareholders against new shareholders financing the investment. We extend the investment incentive problem by including both new and old debt and new and old equity.

We provide the details (that have heretofore not been provided) of how target debt ratios can eliminate or reduce the disincentive to invest. This is accomplished by offsetting effects of issuing new equity and new debt. The newly issued debt induces the wealth transfer from old bondholders to shareholders and offsets the wealth transfer from shareholders to old bondholders associated with the new equity issue. Target debt ratios also play a role to offset the wealth transfer from existing shareholders to new shareholders in the existence of asymmetric information. The opposite transfer depends on the relative power of target debt ratios for investment incentives and the priority of new debt. The relative effects of these "canceling" transfers of wealth depends on the relationship of assets in place to growth options as well as the NPVs that exist in the firms opportunity set.

Numerical examples in binomial settings illustrates that a firm with risky debt outstanding does not pass by profitable investments when it appropriately sets a target debt ratio in the Myers (1977) context. The same example is extended to incorporate the underinvestment problem with asymmetric information as in Myers-Majluf. That is, target debt ratios can be chosen to solve the underinvestment problem resulting from both sources: risky debt and asymmetric information. However, the appropriate target debt ratio is likely to be constantly changing with the emerging profitability of new growth opportunities and the existing capital structure of the firm.

Although adopting the target debt ratio will contribute to the investment incentives, the adoption is still incomplete at best even with new debt issued by shelf registration. It is unlikely that the target debt ratios can completely remove the agency cost of risky debt and/or asymmetric information when firms have to pass up positive NPV projects.

References

Asquith, P. and D. W. Mullins, 1986, Equity Issues and Offering Dilution, *Journal of Financial Economics 15:1-2,* 61-89.

Ang, J. S., 1976, The Intertemporal Behavior of Corporate Debt Policy, *Journal of Financial and Quantitative Analysis*, 555-566.

Dann, L. Y., 1981, Common Stock Repurchase: An Analysis of Returns to Bondholders and Stockholders, *Journal of Financial Economics 9,* 113-183.

Diamond, D. W., 1989, Reputation Acquisition in Debt Markets, *Journal of Political Economy 97-3*, 828-862.

Eckbo, E., 1986, The Valuation Effects of Corporate Debt Offerings, *Journal of Financial Economics 15:1-2*, 119-152.

Harris, M. and A. Raviv, 1991, The Theory of Capital Structure, *Journal of Finance 46-1*, 297-355.

Hirschleifer, D. and A. V. Thakor 1992, Managerial Conservatism, Project Choice, and Debt, *Review of Financial Studies 5-3*, 437-470.

Hovakimian, A. and G. Li, 2008, Do Firms Have Unique Target Debt Ratios to which They Adjust?, *Working Paper*, Bruch College, available at http://ssrn.com/abstract=1138316.

Jensen, M.C. and W. H. Meckling, 1976, Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure, *Journal of Financial Economics 3*, 305-360.

Jong A. and P. Verwijmeren, 2007, To Have a Target Debt Ratio or Not: What Difference does it Make?, Working Paper, RSM Erasmus Univesity, Rotterdam, the Netherlands, available at http://ssrn.com/abstract=1023581.

Kim, Y. C. and R. M. Stulz ,1988, The Eurobond Market and Corporate Financial Policy: A Test of the Clientele Hypothesis, *Journal of Financial Economics 22-2*, 189-205.

Masulis, R. W., 1980, Stock Repurchase by Tender Offer: An Analysis of the Causes of Common Stock Price Changes, *Journal of Finance 35-2*, 305-319.

Masulis R. W. and A. N. Korwar, 1986, Seasoned Equity Offering: An Empirical Investigation, *Journal of Financial Economics 15:1-2*, 91-118.

Mikkelson, W. H. and M. M. Partch, 1986, Valuation Effects of Security Offerings and the Issuance Process, *Journal of Financial Economics 15:1-2*, 31-60.

Millon-Cornet, M. H. and N. G. Travlos, 1989, Information Effects Associated with Debt-

for-Equity and Equity-for-Debt Exchange Offers, *Journal of Finance 44-2*, 451-468.

Moehrle, S., J. A. Reynolds-Moehrle, and P. S. Stuerke, 2004, Self-Registered Securities: Is It Time to Re-evaluate the Process?, Research in Accounting Regulation 17, 3-24.

Myers, S. C., 1977, Determinants of Corporate Borrowing, *Journal of Financial Economics 5*, 147-775.

Myers, S. C., 1984, Capital Structure Puzzle, *Journal of Finance 39-3*, 575-592.

Myers, S. C., 1993, Still Searching for Optimal Capital Structure, *Journal of Applied Corporate Finance 1:6*, 4-14.

Myers, S. C., 2001, Capital Structure, *Journal of Economic Perspectives 15-2*, 81-102.

Myers, S. C., 2003, Financing of Corporations, *Handbook of the Economics of Finance, Volume 1A-Chapter 4*, 215-254.

Myers, S. C. and N. S. Majluf, 1984, Corporate Financing and Investment Decisions when Firms Have Information That Investors Do not Have, *Journal of Financial Economics 13*, 187-221.

Ross, S., 1973, The Economic Theory of Agency: The Principal's Problems, *American Economic Review 62-2*, 134-139.

Schipper K. and A. Smith, 1986, A Comparison of Equity Carve-outs and Seasoned Equity Offerings: Share Price Effects and Corporate Restructuring, *Journal of Financial Economics 15:1-2*, 153-186.

Scott, D. F. and D. J. Johnson, 1982, Financing Policies and Practices in Large Corporations, *Financial Management 11-2*, 51-59.

Skaradzinski, D., A. Graham, and P. Stuerke, 2006, The Effects of Shelf Registration on Cost of Debt, *Journal of American Academy of Business 8-1*, 40-47.

Smith, C. W., Jr. and J. Warner, 1979, On Financial Contracting: An Analysis of Bond Covenants, *Journal of Financial Economics 7-2*, 117-161.

Smith, C. W., Jr. and R. L. Watts, 1982, Incentive and Tax Effect on Executive Compensation Plans, *Australian Journal of Management 7*, 139-157.

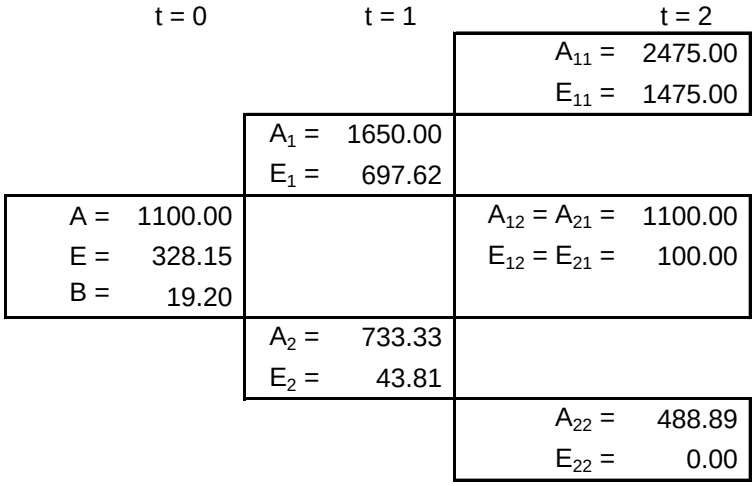
Spence, M. and R. Zechhauser, 1971, Insurance, Information and Individual Action, *American Economic Review 61-2*, 380-387.

Stulz, R. M., 1990, Managerial Discretion and Optimal Financing Policies, *Journal of Financial Economics 26-1*, 3-26.

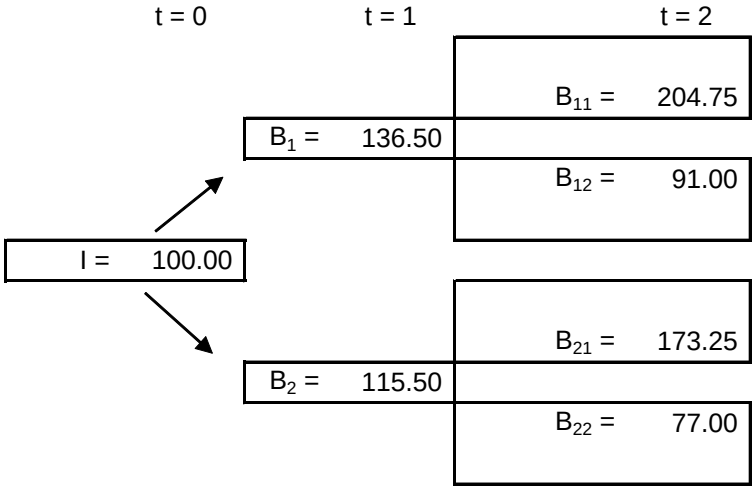
Titman, S. and R. Wessels, 1988, The Determinants of Capital Structure Choice, *Journal of Finance 43-1*, 1-19.

Vermaelen, T., 1981, Common Stock Repurchases and Market Signaling: An Empirical Study, *Journal of Financial Economics 9*, 139-183.

Panel A: The value of the assets-in-place A and of the equity E



Panel B: The value of the Investment opportunity B
with the required investment $I = 100$



B = B(PV) − I = 119.20 − 100 = 19.20

Figure 1: The value of assets-in-place, equity, and growth opportunity.

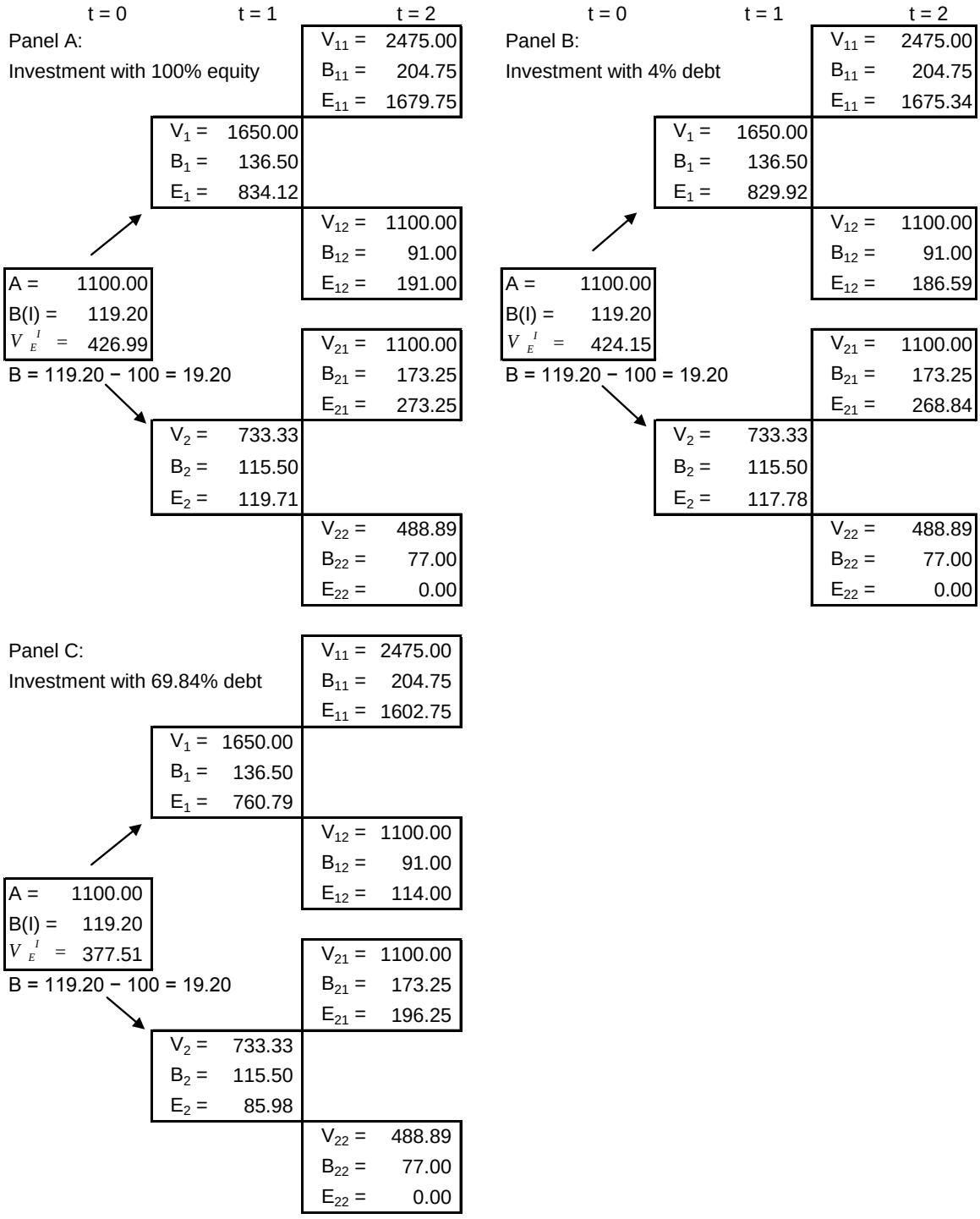


Figure 2: The value of the firm and the equity with risky debt outstanding.

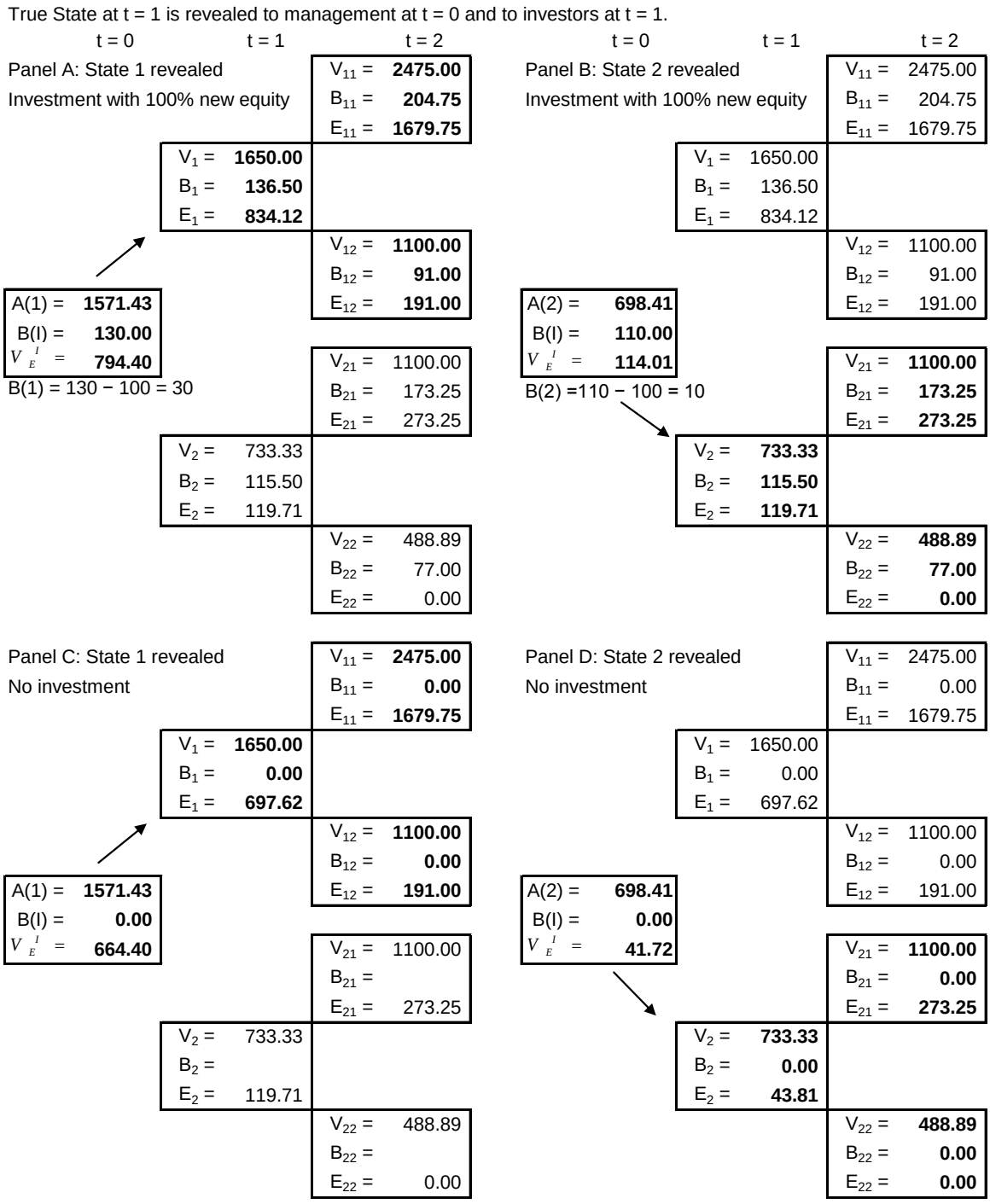


Figure 3: The value of the firm and the equity with risky debt outstanding and asymmetric information.

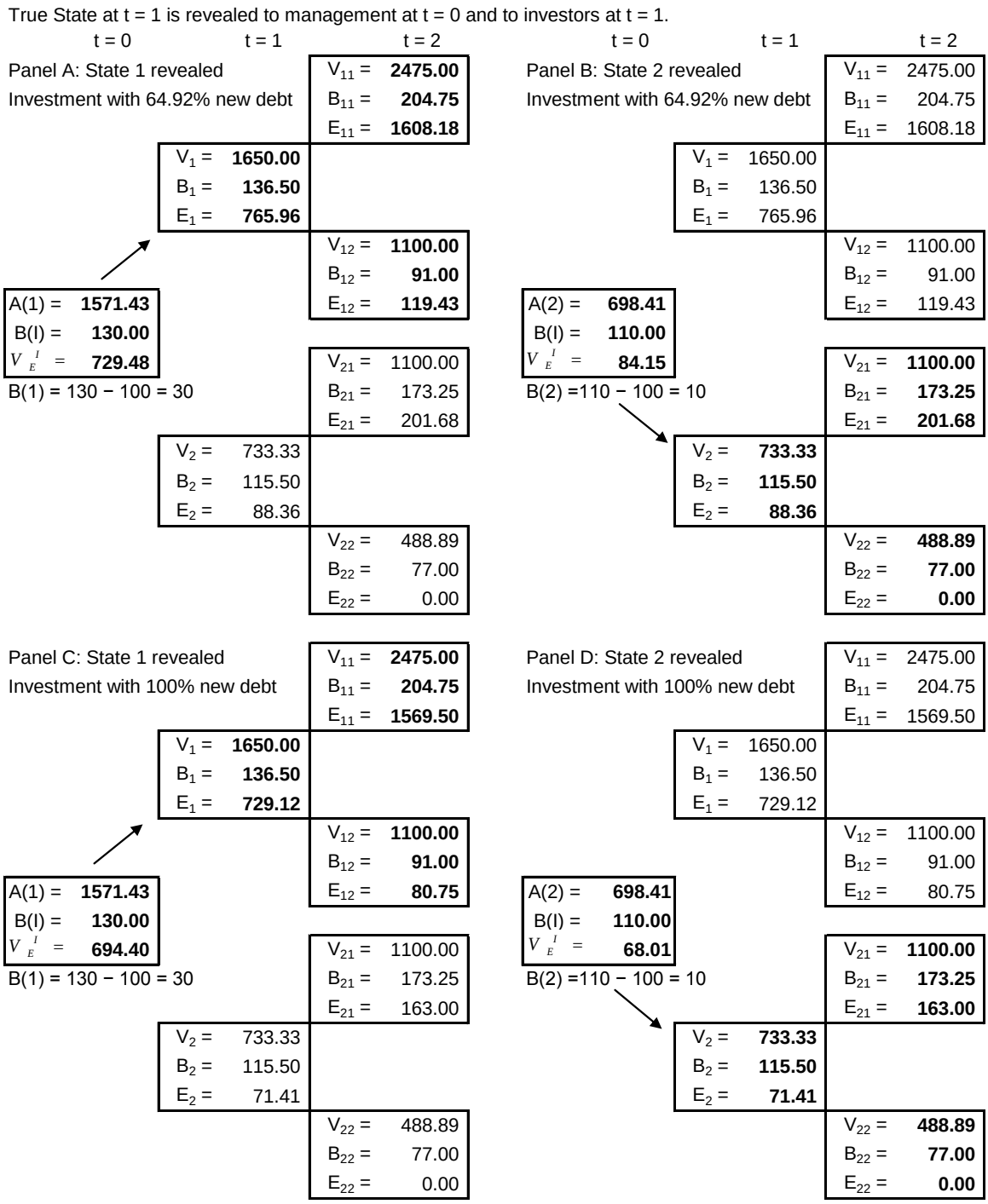


Figure 4: The value of the firm and the equity with risky debt outstanding and asymmetric information with different target debt ratios.