Managerial Compensation and Capital Structure under Asymmetric Information

Kostas Koufopoulos[∗]

University of Warwick

Warwick Business School
Coventry, CV4 7AL
United Kingdom
Kostas.Koufopoulos@wbs.ac.uk.

This version: January 2009

Abstract

We consider firm financing when the firm quality is private information of the manager and, given its inherent quality, the project viability depends on the manager exerting unobservable effort. We show that capital structure matters even though managerial contracts are optimally designed. The interaction between managerial compensation and leverage does not allow good firms to issue more debt to avoid selling underpricing equity. Because debt is senior to (the performance-related part of) managerial compensation, a high leverage prevents the implementation of the optimal managerial contract and so it destroys effort incentives. Therefore, we provide an explanation of why good firms appear to use debt conservatively and issue both debt and underpriced equity (even if the bankruptcy and agency costs of debt are zero). We also show that the optimal financial contract can be implemented by a combination of debt and equity. The predictions of our model are consistent with some puzzling empirical findings.

Key Words: Asymmetric Information, Capital Structure, Managerial Compensation

JEL classification: D82, G32

1. Introduction

Following the famous irrelevance proposition of Modigliani and Miller (1958), a vast literature has developed trying to explain the financial choices of firms when they seek outside funds. This research effort has given rise to two main theories of capital structure: the trade-off theory and the pecking-order theory. The trade-off theory argues that the firms determine their optimal capital structure by balancing the benefits and the costs of debt at the margin.[1] According to the pecking-order theory (Myers (1984), Myers and Majluf (1984)), because managers are better informed about the firm quality than outside financiers, if good firms issue risky securities to raise funds these securities will be underpriced. The extent of the mispricing depends on the informational sensitivity of the claim issued. Debt is the least information-sensitive security and so it minimizes the mispricing. That is, firms should issue debt first and then equity as a last resort.[2]

However, these two theories of capital structure have difficulties in explaining some well-documented financing patterns. One of the main predictions of the trade-off model, the positive relation between leverage and profitability, is at odds with the empirical evidence. Several empirical studies have reported a negative relationship (e.g., Titman and Wessels (1988), Rajan and Zingales (1995) and Fama and French (2002)).

Concerning the pecking-order theory, equity issue announcements are associated with stock price drops (e.g. Asquith and Mullins (1986), Jung et al. (1996) and Masulis and Korwar (1986)), whereas debt issue announcements have no significant effect on the stock price (e.g. Jung et al. (1996) and Mikkelson and Partch (1986)). That is, debt is a more favourable signal than equity. Nevertheless, equity dominates debt as a source of external financing. Fama and French (2005) find that during the period 1983-2002 small firms (which probably face the most severe asymmetric information problems) raised more funds through equity issues than debt issues even though they appeared to have unexploited debt capacity.[3] Frank and Goyal (2003) report that net equity issues follow the financing deficit more closely than debt issues. Finally, in Jung et al (1996), a significant fraction of typical debt-issuing firms (firms with low leverage and high tax payments) issue equity. These empirical findings contradict the predictions of the pecking order theory even after taking into account the various costs associated with debt issues.

Fama and French (2005) also report that during the period 1973-2002 the number of highly profitable firms declines, and the number of unprofitable or low-profitability firms increases. At the same time, the proportion of funds raised through equity issues, as opposed to debt issues, increases.

On theoretical grounds, these theories of capital structure have been criticized because they take managerial objectives as given and ignore the effects of the interaction between managerial compensation and capital structure on the managers' choices. For example, Dybvig and Zender (1991) consider the model in Myers and Majluf (1984) and show that if managerial contracts are optimally chosen the capital structure becomes irrelevant.

---

[1] The costs of debt include potential financial distress/bankruptcy costs and costs due to agency problems between debtholders and shareholders (e.g. risk shifting (Jensen and Meckling (1976)) and debt overhang problems (Myers (1977)). The benefits of debt include the tax shield created by the tax deductibility of interest payments (see, MacKie-Mason (1990) and Graham (2000)) and the reduction of "empire building" problems (Jensen, (1986)).

[2] See Harris and Raviv (1991) for a survey of this literature.

[3] See also Helwege and Liang (1996).

In this paper, we construct a simple asymmetric information model that sheds some light on the above issues. We abstract from taxes, financial distress, bankruptcy and other agency costs. We consider firms (projects) that seek outside financing under adverse selection and (effort) moral hazard. More specifically, these firms are run by managers who can improve their firm's profitability by exerting costly and unobservable effort. There are also two types of projects, good (G) and bad (B), which differ with respect to their inherent quality. The project's quality can be observed only the entrepreneur and the manager. Given identical effort levels, good projects generate higher profits than the bad ones (in the sense of first-order stochastic dominance). Also, regardless of the project's type, if the manager exerts effort the net present value (NPV) of his project exceeds the cost of effort whereas if he shirks the project has negative NPV. That is, exerting effort is socially efficient regardless of the project's inherent quality.

As a benchmark, we first consider the case where moral hazard is not binding (pure adverse selection). In this case, the role of securities is to convey socially costless information about the type of the project. Equity issued by the G-type is more valuable whereas debt issued by both types is equally valuable.[4] So, if the G-type issues some equity the B-type will mimic him and so in the resulting pooling equilibrium the G-type will subsidize the B-type through the mispricing of equity. However, in any pooling equilibrium where some mispriced equity is issued, the G-type has an incentive to deviate by issuing more debt (the relatively less valuable for him security). By doing so, he can credibly signal his type, reduce the mispricing and increase his expected return. As a result, no pooling equilibrium where some equity is issued can sustain. That is, the G-type issues just debt to avoid selling an underpriced security (equity). Therefore, only the B-type may use equity to raise funds and so the market reacts negatively to the announcement of an equity issue. This prediction is consistent with the pecking order theory.

The introduction of moral hazard into an adverse selection framework has significant effects both on the combinations of the securities issued in equilibrium and their pricing. The distinguishing feature of this paper is the existence of pooling equilibria involving cross-subsidization across types and the issue of both debt and equity. These pooling equilibria reflect a trade-off between information revelation and effort incentives. The securities issued by both types of firms are priced as a pool. Although, because of perfect competition, debt and equity are fairly priced collectively, at individual level equity is mispriced. In fact, it is precisely this mispricing that provides the manager of a bad firm with the subsidy necessary to induce him to choose the socially efficient high-effort level.[5]

As we have seen, under pure adverse selection, good firms would have issued just debt to eliminate this mispricing. However, in the presence of moral hazard, the elimination of the subsidy destroys the bad firms managers' effort incentives. The managers of bad firms shirk and the aggregate expected return falls. As a result, the financiers, in order for

---

[4] The market value of debt depends only on the success probability (which, given the effort level, is equal for both types of projects) whereas the value of equity depends on both the success probability and the return in case of success which greater for the good project.

[5] If funds are offered at fair terms, the managers of good projects exert effort whereas those of bad projects shirk. Hence, the bad project's NPV is negative and so, if its type is revealed, no rational financier offers funds to it. Therefore, in order to receive financing, the manager of a bad project will always mimic the manager of a good one.

them to break even, ask for a higher interest rate on debt. This additional cost of debt exceeds the underpricing of equity. That is, since they cannot reveal their type, good firms accept to issue just enough equity to induce the managers of bad firms to exert effort because the resulting increase in their net expected return (due to the lower interest rate on debt) more than offsets the cost of the subsidy (the adverse selection cost of issuing equity). Notice that as the proportion of bad firms increases, the fraction of equity needed to provide their managers with the subsidy necessary to induce them to work also increases (the debt-equity ratio falls).

Our results have several interesting implications. First, they show that capital structure matters even if managerial contracts are optimally chosen. Second, they provide an explanation of why good firms issue both debt and underpriced equity even though the bankruptcy and other agency costs associated with debt are zero. The issue of equity, through its mispricing, provides the managers of bad firms with the incentives to work whereas debt is used to reduce the subsidy to the minimum required. What is more, because it relaxes the moral hazard constraint, the cross-subsidization occurring in this pooling equilibrium is socially beneficial. It results in the conversion of negative into positive NPV projects leading to an improvement in the aggregate expected returns and social welfare.

They have also some interesting empirical implications: i) The higher the proportion of low-profitability (B-type) firms, the higher the fraction of funds raised through equity. This prediction is consistent with the findings in Fama and French (2005).[6] ii) Because the good firms' equity is more valuable, once the firms' quality becomes known, good firms have lower debt-equity ratios. This negative relation between leverage and profitability has been documented by several empirical studies (e.g., Titman and Wessels (1988), Rajan and Zingales (1995) and Fama and French (2002)).

2. Related Literature

This paper is related to three strands in the literature: agency models, pure adverse selection models and models combining adverse selection and moral hazard.

In the celebrated Jensen and Meckling (1976) paper firms issue both debt and equity to minimize the sum of agency costs of these two securities.[7] The agency cost of equity arises from the conflict of interest between management and outside shareholders. The agency cost of debt stems from the conflict of interest between existing shareholders (managers) and would-be debtholders. The issue of debt induces the managers to undertake riskier projects that reduce the value of debt and transfer wealth from debtholders to shareholders (asset substitution problem).[8]

---

[6] Fama and French (2005) report that during the period 1973-2002 the proportion of high-profitability firms declines while the fraction of funds raised through equity increases.

[7] More recently, Biais and Casamatta (1999) consider a model similar to Jensen and Meckling but they completely endogenize the contractual form. Nevertheless, they show that if the risk-shifting problem is more severe, a debt-equity combination (or convertible debt) can implement the optimal contract whereas if the effort problem is more severe stock options are also needed.

[8] Notice that in our model there is no conflict of interests between shareholders and debtholders (no asset substitution problem) which, given the agency cost of equity, is the driving force of the coexistence of debt and equity in Jensen and Meckling.

Jensen (1986) argues that managers have an incentive to invest to grow firms more than optimal (by undertaking even negative NPV projects) since this increases the resources under their control. Debt is a commitment to pay out cash (interest payments) whereas dividend payments are not compulsory. Thus, an increase in the amount of debt reduces the amount of free cash flow (cash flow in excess of that required to fund all positive NPV projects) available for managers to engage in value-reducing activities (empire building). Jung et al. (1996) use an argument along these lines to explain why some typical debt-issuing firms (firms with low leverage and high tax payments) issue equity although the announcement of a new equity issue leads to a fall in the stock price. The managers of these firms are willing to issue (even underpriced) equity to avoid the disciplinary effects of debt.

Pure adverse selection models emphasize the signalling role of the financing decisions of the firm.[9] For example, if firms have debt and equity outstanding and debt and equity repurchases are allowed, there potentially exist fully separating equilibria under a wide range of distributional assumptions. Brennan and Kraus (1987) allow only for debt repurchases and consider two cases: first-order stochastic dominance and mean-preserving spreads. They show that fully revealing equilibria can be obtained by issuing equity and repurchasing debt in the first case and by issuing convertible debt in the second. Constantinides and Grundy (1989) allow only equity repurchases and prove that, under first-order stochastic dominance, the issue of convertible debt coupled with equity repurchases leads to full information revelation. However, it should be noted that, in the absence of bankruptcy or financial distress costs, these pure adverse selection models cannot explain why good firms issue equity even if it is underpriced.

This paper is most directly linked to models involving both adverse selection and (effort) moral hazard. Darrough and Stoughton (1986) provide such a model where entrepreneurs are risk averse and can issue combinations of debt and equity. However, they only consider separating equilibria where the securities issued are fairly priced. As a result, neither cross-subsidization across types occurs nor the issue of equity when it implies adverse selection costs can be explained.

Notice that if the projects' inherent quality were observable, bad projects would not receive financing and so both investment and social welfare would be lower. These results contrast with those of pure adverse-selection models. In Myers and Majluf (1984) adverse selection leads firms to forego positive NPV projects whereas in de Meza and Webb (1987) it encourages firms to undertake negative NPV projects. Hence, in either case social welfare is lower than under full information about types. The key to this difference is that in the presence of (effort) moral hazard the cross-subsidization taking place in the pooling equilibrium relaxes this additional constraint and so it can be beneficial. In contrast, in these two pure adverse selection models there is no channel through which the cross-subsidy can have positive effects but it may have negative ones.

This paper is organized as follows. Next section describes the basic framework and develops the analytical tools. Section 4 provides some general results about the existence

---

[9] The pure adverse selection part of this paper belongs to a class of models that seek methods of financing that lead to nondissipative equilibria (Bhattacharya (1980)). Other examples include Heinkel (1982), Brennan and Kraus (1987), and Constantinides and Grundy (1989). Early examples of signalling models in the corporate finance literature are: Leland and Pyle (1977), Ross (1977), Bhattacharya (1979).

and the type of the equilibria where funds are offered. Section 5 analyzes the roles of debt and equity under pure adverse selection and adverse selection cum moral hazard. In Section 6, we show that, in the adverse selection cum moral hazard case, a debt-equity combination can implement the optimal financial contract as a competitive equilibrium. Some brief concluding remarks are provided in Section 7.

3. The Model

We consider a simple model of financing involving both adverse selection and effort moral hazard. There are four dates, 0, 1, 2 and 3, and one homogeneous (perishable) good which can be used either for consumption or investment purposes. There are also three groups of agents: entrepreneurs, managers and financiers. All agents are risk neutral and consume only at date 3.

Each entrepreneur has an indivisible project but no initial wealth. All projects require the same fixed initial investment I, at date 1. Since the entrepreneurs have no initial wealth, this amount I needs to be raised from the market. The projects are run by managers whose actions cannot be observed either by the entrepreneurs or the financiers. All managers have identical managerial skills and there are at least as many managers as projects. If a manager is not hired by an entrepreneur, his utility is zero.

Each financier has a very large amount of initial wealth and can lend at zero interest rate. For simplicity, we assume that there are just two financiers involved in Bertrand competition. Also, there are no taxes, no bankruptcy or financial distress costs.

At date 1, investment takes place and the managers decide whether they will exert effort or not. At date 2, the project quality becomes public information. Returns are realized at date 3 and are observable and verifiable. There are two states of nature: Success, Failure. If a project succeeds it yields X_i. In case of failure, all projects yield 0 regardless of the project's type. There are two types of projects, G (good) and B (bad), with respective proportions in the population λ and $1-\lambda$, $0 < \lambda < 1$.

The success probability of a project, denoted by π_j^i, depends on the effort level that the manager chooses privately. There are two effort levels: Low (shirking), High (working). If a manager exerts effort, he incurs a utility cost of C and the project's success probability is π_H^i. If he shirks, his utility cost is 0 but the project's success probability is π_L^i, where $\pi_H^i > \pi_L^i$. Given identical effort levels, the success probability is the same for both types of projects but in case of success the good project's return is higher: $X_G > X_B$ and $\pi_j^G = \pi_j^B = \pi_j$, $j = H, L$. (Our results also hold true if $\pi_j^G \geq \pi_j^B$).

If the high effort level is chosen, the net present value (NPV) of both types of projects exceeds the cost of effort. In contrast, if shirking is chosen, neither project is economically viable (both types of projects have strictly negative NPV). That is,

Assumption 1: $\pi_H X_i - I > C > 0 > \pi_L X_i - I$, $\quad i = G, B$

Assumption 1 also implies $(\pi_H - \pi_L)X_i > C$, ($i = G, B$). That is, the choice of the high effort level by the manager leads to an increase in the net social surplus regardless of the project's type and so is socially efficient.

Managerial Contracts

At date 0, the entrepreneur hires a manager to run his project. The managerial contract, $M = (W_S, W_F)$, specifies the manager's compensation, W, in each state of nature. The terms of the contract become public information. After the manager has signed his contract with the entrepreneur, he learns the type of the project. By Assumption 1, if the manager shirks the project has negative NPV. Thus, any rational financier will fund a project only if he knows that the managerial contract provides the manager with the incentive to exert effort. As a result, the managerial contract will be designed so as to induce the manager to work and its terms will become known to the financiers. The managerial contract will induce effort if:

$$\pi_H W_S + (1 - \pi_H)W_F - C \geq \pi_L W_S + (1 - \pi_L)W_F$$

$$\text{or} \quad (\pi_H - \pi_L)(W_S - W_F) \geq C \tag{1}$$

The left-hand side of (1) is the increase in the manager's net expected return from exerting effort and the right-hand is the cost of effort. Given limited liability and the fact that the manager's outside option is zero, the entrepreneur will offer to the manager a contract that minimizes the wage bill given that it induces the manager to work. That is, the optimal managerial contract is:

$$M^* = (W_F^*, W_S^*) = (0, W) \quad \text{where} \quad W = \frac{C}{\pi_H - \pi_L} = c \tag{2}$$

Notice that, due to the unobservability of his actions, the manager extracts an informational rent of $\pi_H W - C = \pi_L C / (\pi_H - \pi_L) > 0$.

Financial Contracts

At date 1, the manager seeks the funds required for the investment, I. For expositional purposes (and without loss of generality), we restrict the financing instruments available to managers to debt and equity. Debt claims are zero-coupon bonds that are senior both to managerial compensation and equity.

A financial contract $A = (\alpha, D)$ provides the manager with the required amount of funds, I, in return for a combination of debt of face value D and a proportion of equity of the project α, $0 \leq \alpha \leq 1$, $D \geq 0$. The manager chooses the contract that maximizes the entrepreneur's expected utility (return).

Therefore, given risk neutrality and limited liability, the manager seeks to maximize:

$$U_i(X_i, \alpha_i, D_i, W) = \pi_j^i Max\big[(1-\alpha_i)(X_i - D_i - W), 0\big],^{10} \quad i = G, B \quad j = H, L \quad (3)$$

where U_i is the expected utility of an entrepreneur of type i given that the contract $A_i = (\alpha_i, D_i)$ is chosen.

At date 1, when the financial contract is signed, the managers know the type of the project they run but the financiers cannot observe either the type of each project or verify the actions (choice of effort level) of the managers applying for funds. The financiers do, however, know the proportion of each type in the population of projects, the terms of the managerial contract and the nature of the investment and moral hazard technology. The financiers also wish to maximize their expected profit. The expected profit, P_F, of an financier offering a contract (α, D), given limited liability, is given by:

$$P_F = \pi_j^i \big\{ Max\big[\alpha(X_i - D - W), 0\big] + Min(X_i, D) \big\} - I, \quad i = G, B \quad j = H, L \quad (4)$$

3.1 Effort Incentive Constraints

Because debt is senior to managerial compensation, the structure of the financial contract will also affect the effort incentives of a manager running a project of type i faces. A given contract (α, D) will induce the high effort level if

$$\Delta_i = X_i - D - W \geq 0 \qquad i = G, B \quad (5)$$

Let ICF_i be the locus of combinations (α, D) such that $\Delta_i = 0$. This locus divides the (α, D) space into two regions: On and to the left of the ICF_i locus the managers running a project of type i exert effort (this is the set of effort incentive compatible contracts, IC_i) whereas to the right of it they do not. Because, in case of success, the return of the good project exceeds that of the bad one ($X_G > X_B$), the face value of debt consistent with a manager running a bad project exerting effort is lower. That is, the set of effort incentive compatible contracts corresponding to G-type projects is strictly greater than that of the B-type ($IC_B \subset IC_G$).

3.2 Indifference Curves

The family of indifference curves of type i can be derived from Eq. (3). It should be noted that the shape of the indifference curves is independent of the probability of success.[11] As a result, no indifference curve of type i crosses ICF_i and therefore the indifference curves do not exhibit kinks in the (α, D) space. For each type, one of the indifference curves coincides with the corresponding ICF.

---

[10] Whenever the Max or Min operators are irrelevant they will be suppresed.

[11] This is due to fact that in the event of failure the return is zero.

Lemma 1. Let U_i denote the family of indifference curves of type i, and u_i denote a member of this family. In the (α, D) space, for $0 \leq \alpha < 1$ and $0 \leq D < X_i - W$

a) u_i are downward sloping and concave.

b) At any (α, D) pair, u_G is flatter than u_B and so the indifference curves of G- and B-type cross only once.

Proof: See the Appendix.

That is, the marginal rate of substitution of debt for equity of the G-type is greater than that of the B-type. Intuitively, equity is more valuable for the G-type whereas debt is equally valuable for both types.[12] As a result, the G-type is willing to accept a greater increase in D in exchange for a given reduction in α than the B-type. Technically, the single-crossing condition is satisfied. Also, the closer to the origin an indifference curve, the higher the expected utility.

3.3 Zero-profit Lines

The expected profit of a financier offering a contract (α, D) is given by Eq. (4). It is clear that the expected profit depends crucially on the effort level chosen (through the success probability of the project). Thus, if a zero-profit line crosses the corresponding effort incentive frontier ICF, it will exhibit a discontinuity because the success probability changes discontinuously when the entrepreneurs change their effort level. However, given limited liability and the assumption that both types of projects have negative NPV when the low effort level is chosen ($\pi_L X_i - I < 0$), the zero-profit lines corresponding to shirking ($\pi = \pi_L$) do not exist. Any contract (α, D) financing a project whose manager is shirking is loss-making and no rational financier will offer it. Therefore, zero-profit lines can exist only if the high effort level is chosen (at least by the managers running one of the two types of projects).

More specifically, the zero-profit line corresponding to the i-type (ZP_i) exists only if the i-type chooses the high effort level (his effort incentive constraint is satisfied) when he receives funds at fair terms.[13] In other words, the existence of a zero-profit line (ZP_i) requires that it belong to the corresponding set of effort incentive compatible contracts (IC_i). Given the investment and moral hazard technology, if both types receive funds at fair terms three different cases may arise: i) the effort incentive constraint is not binding for either type, ii) it is not binding for the G-type but is violated for the B-type, and iii) it is violated for both types. Conditional on the choice of the high effort level there exist three zero-profit lines: that corresponding to the G-type (ZP_G), to the B-type (ZP_B), and

---

[12] The market value of debt depends only on the success probability (which is equal for both types of firms) whereas the value of equity also depends on the return in case of success which greater for the G-type.

[13] By assumption 1, both types of projects have strictly positive NPV when the high effort level is chosen and negative NPV when the managers opt for shirking.

the pooling zero-profit line (PZP_H).[14] Lemma 2 summarizes the key properties of the zero-profit lines and their relationship with the corresponding indifference curves. Subsequently, Lemma 3 provides the conditions for the existence of the individual zero-profit lines ZP_G and ZP_B.

Lemma 2. In the (α, D) space,

a) All ZP_i, PZP_H are downward sloping and strictly concave.

b) ZP_G and ZP_B intersect at $\alpha = 0$. For $\alpha > 0$, ZP_G lies entirely below ZP_B.

c) u_i and ZP_i never cross each other, $i = G, B$.

Proof: See the Appendix.

Intuitively, in Part (b), since both have the same success probability, given its face value, the debt issued by both types is equally valuable. Thus, if both issue only debt, zero profit for financiers requires the issue of the same level of debt. However, if equity is also issued, since the G-type equity is more valuable, a financier who just breaks even would ask for a lower proportion of equity if he offered funds to the G-type than to the B-type (given the face value of debt). That is, ZP_G lies below ZP_B at any strictly positive level of equity issued.

Also, since all three, zero-profit lines and indifference curves corresponding to type i have the same slope, they never cross. One of the indifference curves coincides with the corresponding zero-profit line. However, the location of the zero-profit line relative to the corresponding effort incentive frontier is the key determinant for the existence of the former.

Lemma 3. Suppose both types obtain funds at fair terms, then

a) If $\pi_H X_i - I \geq \pi_H c$, $i = G, B$, then both ZP_G and ZP_B exist.

b) If $\pi_H X_G - I \geq \pi_H c$, $\pi_H X_B - I < \pi_H c$, then only ZP_G exists.

c) If $\pi_H X_i - I < \pi_H c$, $i = G, B$, then neither ZP_G nor ZP_B exists.

Case (a) corresponds to pure adverse selection. Although, moral hazard is present, because for both types the NPV ($\pi_H X_i - I$) exceeds the expected wage ($\pi_H W = \pi_H c$), it has no bite. If either type of project obtains funds at fair terms, its manager exerts effort and so the corresponding zero-profit line exists. In Case (b), financing at fair terms implies that the effort incentive constraints of managers running good projects are satisfied but those of managers running bad projects are violated (ZP_G belongs to IC_G but ZP_B lies outside IC_B). As a result, managers with good projects exert effort and so ZP_G exists whereas those with bad projects opt for shirking and ZP_B does not exist. In

---

[14] There can also exist another pooling zero-profit line corresponding to the case in which one type opts for the high effort level and the other shirks (PZP_L).
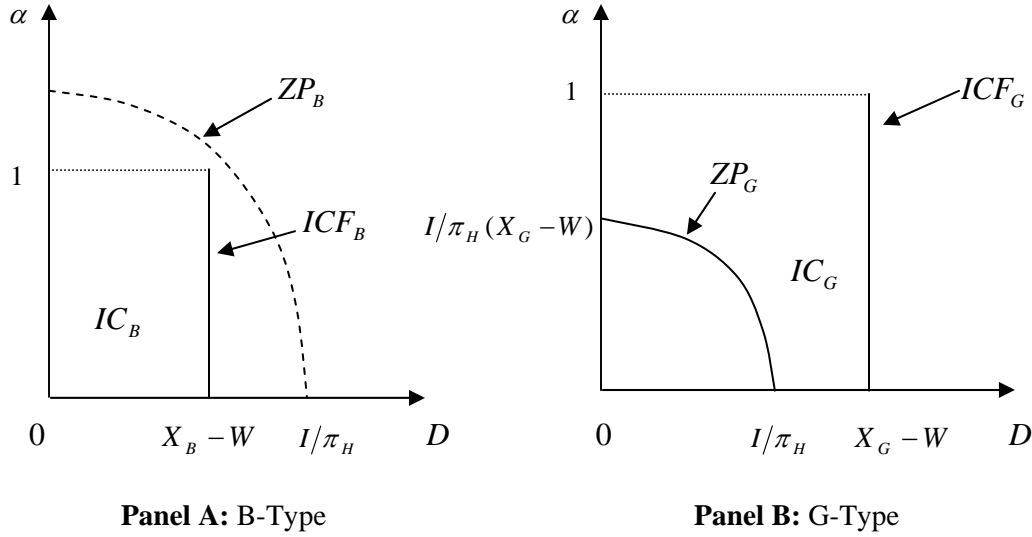
Figure 1. Effort incentive constraints and zero-profit lines.

Case (c), the NPV of the project falls short of the expected wage for both types. Thus, the managers of both types of projects opt for shirking and so no zero-profit line exists. Figure 1 provides an illustration for Case (b).

3.4 Equilibrium

It is well-known that, in most cases, the equilibrium outcome in competitive markets with asymmetric information depends crucially on the game-theoretic specification of the strategic interaction between the informed and uninformed agents. Yet, no agreement has been reached on which game structure is the most appropriate. Here, I assume that the financiers and the managers play the following three-stage screening game:

Stage 1: The two financiers simultaneously offer contracts (α, D). Each financier may offer any finite number of contracts.

Stage 2: After observing the contracts offered by his rival, each financier decides which of the offers he made at Stage 1 will be withdrawn.

Stage 3: Given the contracts available after the withdrawals at Stage 2, the managers choose (at most) one contract from one financier. If a manager's most preferred contract is offered by both financiers, the manager chooses each financier's offer with probability $1/2$. In the light of the contract chosen, the manager decides whether to work or shirk.

This game structure rationalizes a Wilson equilibrium (1977) as a subgame perfect Nash equilibrium (SPNE). Unlike the two-stage screening game, it allows for the existence of a (interior) Nash pooling equilibrium when this pooling equilibrium Pareto-dominates any other equilibrium.

11

We only consider pure-strategy subgame perfect Nash equilibria. A pair of contracts (A_G, A_B) is an equilibrium if the following conditions are satisfied (in a pooling equilibrium $A_G = A_B = A$):[15]

- No contract in the equilibrium pair implies negative (expected) profits for the financier. In other words, the financiers' participation or IR constraints are satisfied:

$$\pi_j^i \left\{ Max\left[\alpha(X_i - D - W), 0\right] + Min(X_i, D)\right\} \geq I, \quad i = G, B \quad j = H, L \qquad (6)$$

- Profit maximization: No other set of contracts, if offered alongside the equilibrium pair at Stage 1, would increase a financier's expected profit.

4. Types of Equilibria and Provision of Funds: General Results

Because of Bertrand competition, any equilibrium involves zero expected profits for the financiers. This implies that any equilibrium contract must lie on one of the zero-profit lines. This, in turn, implies the following result:

Lemma 4. A separating equilibrium can exist only if both ZP_G and ZP_B exist. If either ZP_B or ZP_G or both do not exist, then no separating equilibrium exists.

Proof: First, given limited liability, if funds are offered (whatever the terms they are offered at) all managers, regardless of the quality of the project they run, will always accept them and undertake their project. Thus, there cannot exist a separating equilibrium where only one type of project is undertaken. Suppose now there is a separating equilibrium in which the manager of a good project chooses contract (α_G, D_G) and that of a bad project chooses contract (α_B, D_B). The contract chosen by the manager of a good project must lie on the G-zero-profit line (ZP_G) and that chosen by the manager of a bad project on the B-zero-profit line (ZP_B). Therefore, a separating equilibrium can exist only if both zero-profit lines exist. If one (or both) of the zero-profit lines does not exist, a separating equilibrium cannot exist. **Q.E.D.**

Lemma 4 implies that in cases where one (or both) of the zero-profit lines does not exist, if there exists an equilibrium, it must be pooling. Proposition 1 summarizes these results.

Proposition 1. A separating equilibrium can exist only if $\pi_H X_i - I \geq \pi_H c$, $i = G, B$. If $\pi_H X_i - I < \pi_H c$, for either $i = B$, or $i = G, B$, then the resulting equilibria must be pooling.

The next general result concerns the conditions under which funds are provided.

Proposition 2.
a) If $\pi_H X_i - I \geq \pi_H c$, $i = G, B$, then both types of projects receive financing.
b) If $\pi_H X_G - I \geq \pi_H c$, $\pi_H X_i - I < \pi_H c$, then funds are offered to both types only if (a part of) either PZP_H or PZP_L exists.
c) If $\pi_H X_i - I < \pi_H c$, $i = G, B$, there exists a unique pooling equilibrium where no project is funded.

Proof: In any equilibrium, funds are offered only along the zero-profit lines. Thus, in any equilibrium, the financiers will offer funds only if (a part of) a zero-profit line exists.
a) By Lemma 4, both ZP_G and ZP_B exist. As a result, PZP_H also exists. Hence, regardless of the type of the equilibrium (separating or pooling) funds are offered.
b) By Lemma 4, in this case, only pooling equilibria can exist. However, the existence of pooling equilibria where funds are offered requires that (a part of) a pooling zero-profit line exists. Thus, (a part of) either PZP_H or PZP_L must exist.[16]
c) By Lemma 4, neither ZP_G nor ZP_B exists. As a result, by Lemma 5, no separating equilibrium exists. Moreover, since neither ZP_G nor ZP_B exists, no pooling zero-profit line exists. If a financier offers funds to any firm, he will make losses. Therefore, no rational financier will do so (the financiers' participation constraints are violated). *Q.E.D.*

5. Types of Equilibria and Methods of Financing: Specific Results

Now that we have developed the analytical apparatus, we can go on to prove our main results. Subsection 5.1 examines the pure adverse selection case. In subsection 5.2 we consider the case where adverse selection and moral hazard interact.

5.1 The Pure Adverse Selection Case

It would be useful, as a benchmark, to first consider the pure adverse selection case (Case (a) of Lemma 3). In this case, as we have seen, no effort incentive constraint is binding if funds are offered at fair terms and so both zero-profit lines ZP_G and ZP_B exist. This, in

---

[16] (A part of) PZP_H exists if it belongs to the intersection of IC_B and IC_G. Contracts offered along it are effort incentive compatible for the managers of both types of projects. Thus, all managers choose the high effort level and so it actually exists. If PZP_H does not belong to the intersection of IC_B and IC_G, it does not exist. In such a case, the managers of (at least) one of the two types of projects shirks contradicting the condition on which PZP_H is drawn. (A part of) PZP_L exists if the following two conditions are satisfied: i) (A part of) it belongs to either IC_G and ii) $\lambda \pi_C X_G + (1 - \lambda) \pi_0 X_B \geq I$.

turn, implies that the pooling zero-profit line PZP_H also exists. Therefore, both separating and pooling equilibria can exist. More specifically,

Proposition 3. If $\pi_H X_i - I \geq \pi_H c$, $i = G, B$, there exists a pooling equilibrium where both types issue only debt as well as a continuum of separating equilibria where the G-type issues only debt whereas the B-type issues a combination of debt and equity. In any equilibrium, the securities issued are fairly priced (See Figure 2).

Under pure adverse selection, debt and equity are only used to convey information about the type of the project. Because equity issued by a good firm is more valuable whereas debt issued by both types is equally valuable, if a good firm issues some equity the bad firm will mimic and so in the resulting pooling equilibrium the good firm will subsidize the bad one through the mispricing of equity. Hence, in any pooling equilibrium where some equity is issued, the manager of a good firm has an incentive to deviate by issuing more debt. By doing so, it can credibly signal his firm's type, reduce the cross-subsidization and increase the firm's shareholders (entrepreneur's) expected return. As a result, no pooling equilibrium where some equity is issued can sustain. That is, good firms issue just debt to avoid selling an underpriced security (equity). Given that, bad firms are indifferent between issuing just debt and any fairly priced combination of debt and equity. Therefore, the issue of equity signals a firm with a low quality project and so the market reacts negatively to its announcement. This prediction is consistent with the pecking order theory.
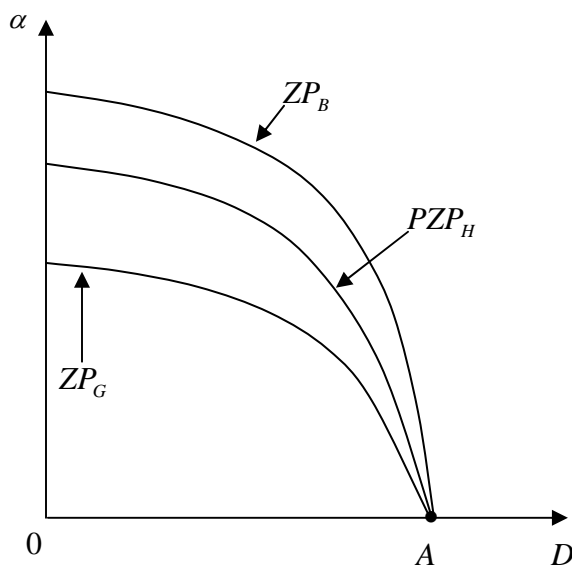

Figure 2. Equilibria under pure adverse selection.

5.2 The Adverse Selection cum Moral Hazard Case

In this subsection, we examine the case where the B-type NPV falls short of the expected wage (Case (b) of Lemma 3). That is, if the manager of a bad project is offered funds at fair terms, his effort incentive constraint is violated and so the corresponding zero-profit line does not exist. Thus, only pooling equilibria can exist. Because the choice of the high effort level is socially efficient, here we focus on pooling equilibria where both types exert effort. These equilibria involve cross-subsidization across types and Pareto-dominate any other equilibrium. Through the mispricing of equity at individual level, the B-type receives the subsidy necessary to induce him to work.

Proposition 4. Suppose that $\pi_H X_G - I > \pi_H c$, $\pi_H X_B - I < \pi_H c$. Then if $\lambda \geq \bar{\lambda}$ there exists a unique pooling equilibrium where the managers of both types of projects exert effort and obtain funds by issuing a combination of debt and equity (See Figure 3).

where $\bar{\lambda} \equiv \dfrac{I - \pi_H (X_B - c)}{\pi_H (X_G - X_B)}$

$I - \pi_H (X_B - c)$: Minimum expected subsidy required to induce the B-type to work.

The equilibrium contract, $A = (\alpha^*, D^*)$, lies at the intersection of ICF_B and PZP_H with:

$$\alpha^* = \frac{I - \pi_H (X_B - c)}{\lambda \pi_H (X_G - X_B)} \tag{7}$$

$$D^* = X_B - c \tag{8}$$

Proof: We test whether the contract at A is an equilibrium by considering deviations. Offers below ZP_G are clearly loss-making. Any offer in the area between u_G^A (the G-type indifference curve through the equilibrium contract) and ZP_G to the left of ICF_B is going to be taken by both types and so is unprofitable. Thus, we only need to consider the following two deviations: i) Suppose that a financier deviates by offering a contract, say A', in the area between u_G^A and ZP_G to the right of ICF_B. The deviant contract, contract A', will attract only the G-type. This, in turn, implies that contract A is taken only by the B-type and so it becomes loss-making. As a result, at Stage 2, contract A will be withdrawn. Therefore, at Stage 3, the B-type will also choose A', and hence A' becomes also loss-making (since to the right of ICF_B, PZP_H does not exist, and PZP_L lies to the right of u_G^A). Therefore, there is no profitable deviation to the right of A. ii) Consider now a financier who deviates by offering a contract, say A'', in the area between ICF_B and u_G^A to the left of (above) A. Given contract A, contract A'' will attract only the B-type and so is loss-making. Therefore, the pooling equilibrium at A is the unique equilibrium where funds are provided. **Q.E.D.**
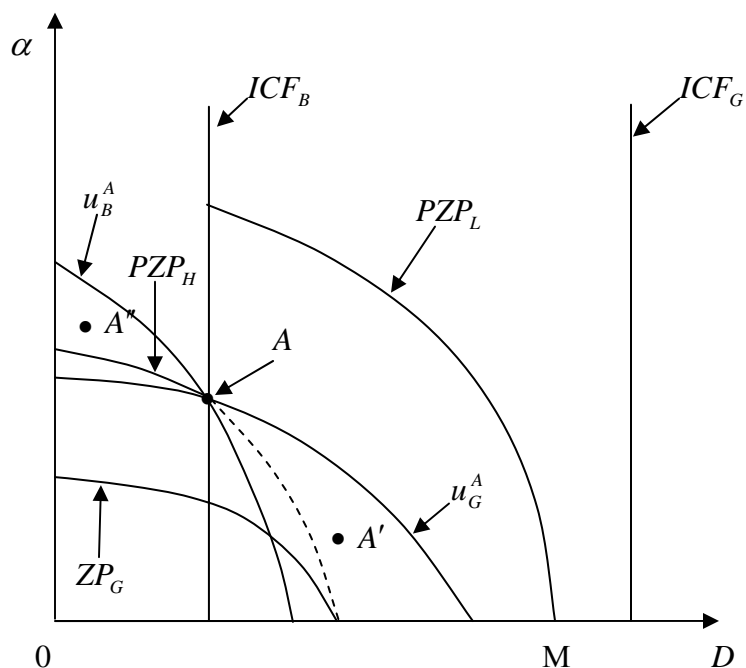
Figure 3. Pooling equilibrium where both debt and (mispriced) equity are issued.

The pooling equilibrium at *A* reflects a trade-off between information revelation and effort incentives. The securities issued by the G- and B-type are priced as a pool. Although, because of perfect competition, debt and equity are fairly priced collectively, at individual level equity issued by the G-type is underpriced and that issued by the B-type overpriced. Not surprisingly, it is precisely this mispricing that provides the managers of bad projects with the subsidy necessary to induce them to exert effort. At first sight, a financier has an incentive to deviate by offering a contract involving more debt and less equity than the equilibrium contract to profitably attract the G-type.

However, his attempt will be fruitless. If the G-type chooses the deviant contract, the equilibrium contract becomes loss-making for the financiers and so it will be withdrawn at Stage 2. As a result, at Stage 3, the B-type will always mimic the G-type preventing him from revealing his type and obtaining funds in better terms. What is more, the deviant contract gives the B-type less subsidy and so destroys his effort incentives. The B-type shirks and the collective expected return falls significantly. A financier who offers a contract involving less equity than the equilibrium contract can break even only if he asks for a considerably greater face value of debt (higher interest rate on debt). But neither type prefers such a deviant contract to the equilibrium contract. Hence, no financier has an incentive to offer a contract involving less equity than the equilibrium contract and so the G-type stays in equilibrium and provides the B-type with just enough subsidy in order to induce him to work.

Loosely speaking, the G-type accepts to issue some equity and induce the B-type to exert effort because the increase in his net expected return (due to the lower interest rate

he pays on debt) more than offsets the cost of the incremental subsidy (the adverse selection cost of issuing equity). That is, the G-type is better off in the pooling equilibrium of Proposition 4 where both debt and equity are issued and both types exert effort than in a pooling equilibrium where only debt is issued and so the B-type shirks (point M in Figure 3).[17]

Moreover, the role of debt and equity as communication devices implies that no financier can make a profit by offering a contract involving more equity (subsidy) and less debt than the equilibrium contract. Given the equilibrium contract, the deviant contract will be taken only by the B-type and so is loss-making.

That is, the existence of the socially efficient pooling equilibrium relies on two factors: i) the endogenous (discrete)[18] choice of the effort level and ii) the three-stage game structure that allows for an (interior) pooling subgame perfect Nash equilibrium even if cross-subsidization across types takes place and the single-crossing condition is met.[19]

If it exists, the pooling equilibrium of Proposition 4 has several interesting implications: First, it shows that capital structure is relevant even though managerial contracts are optimally designed. Second, it provides an explanation of why good firms issue both debt and underpriced equity even though the bankruptcy and other agency costs associated with debt are zero. Third, in contrast with the pure adverse selection case, the cross-subsidization is socially beneficial. It converts a negative into a positive NPV project and improves social welfare. Finally, it has implications for empirical testing.

5.2.1. Implications for the Issue of Securities

To fix ideas, let us compare the adverse selection cum moral hazard case with the pure adverse selection and pure moral hazard cases. Under pure adverse selection, the securities issued are only used to convey socially costless information about the type of the project. Therefore, firms issue combinations of debt and equity only if both securities are fairly priced not only collectively but also individually. Pooling equilibria involving cross-subsidization can exist only if the less valuable for the subsidizer security (debt) is issued (corner solution). In this case, there is no channel through which the cross-subsidy can have positive effects for the subsidizer. As a result, the subsidizer maximizes his return by minimizing the subsidy he provides the other type.

---

[17] Notice that in the pooling equilibrium of Proposition 4 an entrepreneur owning a good project is worse off compared to the case where types are observable and his project is funded at fair terms. However, social welfare exceeds that under full information about types (see also the discussion in Subsection 5.2.2).

[18] We conjecture that, under certain restrictions on the probability and cost functions, this pooling equilibrium exists even if the effort level is a continuous variable.

[19] In a two-stage signalling game, such a pooling equilibrium cannot exist. Behaving myopically, the managers of good projects would try to reveal the type of their project by issuing more debt and less equity. However, the managers of bad projects would always mimic and, more importantly, their effort incentives would be destroyed. Therefore, there would exist either pooling equilibria where only debt is issued (corner solution) and the managers of good projects work whereas those of bad projects shirk or pooling equilibria where the managers of both types of projects shirk and so no funds are provided. In either case, the resulting pooling equilibria are Pareto-inferior to that of Proposition 4.

In contrast, in the presence of effort moral hazard, if the subsidizer cannot reveal his type, it may be in his interest to incur the adverse selection cost of issuing some of the more valuable for him security. By doing so, he provides the manager of the bad project with the subsidy necessary to induce him to work and so the collective expected return rises. If the resulting increase in his expected return exceeds this adverse selection cost, the subsidizer's welfare improves. For example, in Proposition 4 the benefit (due to the lower interest rate his firm pays on debt) for the entrepreneur with a good project from his firm issuing some equity and inducing the manager of a bad project to exert effort exceeds the underpricing of his equity (the adverse selection cost associated with the equity issue).[20]

In the pure moral hazard case, the financiers observe the type of each individual project. As a result, each type of project is offered contracts along the corresponding zero-profit line, provided it exists. In the context of our simple model, the mode of financing is irrelevant.[21] All combinations of debt and equity along the existing zero-profit line are offered and are equally preferred by the corresponding type.

5.2.2. Implications for Investment and Social Welfare

Under the conditions in Proposition 4, if types were observable only good projects would receive financing. If the manager of a bad project receives funds at fair terms he shirks and so his project NPV is negative. Moreover, financiers have no incentive to transfer resources from good to bad projects to induce the managers of the latter to exert effort. Thus, no rational financier would be willing to provide the manager of a bad project with the funds required for the investment and so no bad project would be undertaken. That is, under full information about the inherent quality of projects a potentially positive NPV investment opportunity is forgone. Furthermore, because when the manager of a bad project works his project NPV exceeds the cost of effort, the social welfare also worsens.

These results are in sharp contrast with the pure adverse selection case. In Myers and Majluf (1984) adverse selection leads firms to forego positive NPV projects whereas in de Meza and Webb (1987) it encourages firms to undertake negative NPV projects. Hence, in either case social welfare is lower than under full information about types. The key to this difference is that in the presence of (effort) moral hazard the cross-subsidization taking place in a pooling equilibrium relaxes this additional constraint and so it can be beneficial. In contrast, given risk neutrality, under pure adverse selection there is no channel through which the cross-subsidy can have positive effects but it may have negative consequences.

---

[20] Notice that, although the pooling equilibrium of Proposition 4 involves cross-subsidization across types of entrepreneurs, it does not involve cross-subsidization across debt and equity. Once the equilibrium is determined, the value of these two contracts can be calculated independently and so debt and equity could be traded separately in a secondary market. In fact, the same equilibrium obtains even if instead of one financier offering both debt and equity, the financiers specialize in one of the two contracts and debt and equity markets are perfectly competitive (see Appendix for a proof).

[21] This result is due to the assumption that in case of failure the project yields zero regardless of its type. If instead we assume that in case of failure the return is strictly positive then debt becomes the optimal contract (Innes (1990)). All the main results go through under the latter assumption. However, the zero-return assumption simplifies considerably the analysis without losing any insight.

5.2.3. Empirical Implications

This pooling equilibrium also has implications for empirical testing: i) From Eq. (7) it is clear that the higher the proportion of low-profitability firms (the lower λ), the higher (lower) the fraction of funds raised through equity (debt). Intuitively, as the proportion of good projects falls, the fraction of equity needed to provide the managers of bad projects with the subsidy necessary to induce them to work increases. This prediction is consistent with the findings in Fama and French (2005). ii) At date 1, all firms issue the same fraction of equity and debt with identical face value. However, at date 2, when the quality of projects becomes publicly known, because debt issued by both types of firm is equally valuable while the equity issued by good firms is more valuable, good firms have lower debt-equity ratios. This negative relation between leverage and profitability has been documented by several empirical studies (e.g., Titman and Wessels (1988), Rajan and Zingales (1995) and Fama and French (2002)).

6. Optimal Financial Contracts under Adverse Selection and Moral Hazard

If the inherent quality of projects and the actions of managers were observable (and verifiable), the managers of both types of projects would exert effort if they were offered funds at fair terms. As a result, the net social surplus (social welfare) would be maximized (first best). However, if the choice of the effort level is not observable and th managers of bad projects shirk if they receive funds at fair terms, the implementation of the socially efficient outcome requires cross-subsidization across types. In this section, we address the following question: Can competitive financial markets implement the socially efficient outcome under the same conditions as a benevolent central authority (social planner) who aims at maximizing social welfare?

Competitive financiers have no incentive to transfer resources from good projects to bad ones to induce the managers of the latter to exert effort. Therefore, if the quality of projects is observable or can be credibly revealed, they offer funds only to good projects and so competitive markets cannot maximize social welfare. In a competitive environment, the implementation of the socially efficient outcome can be achieved only in a pooling equilibrium where the required cross-subsidization takes place through the mispricing of the more valuable security issued by the good projects (equity). We begin by characterizing the social planner's solution (the optimal contract) under adverse selection and effort moral hazard.

6.1. The Social Planner's Solution: The Optimal Contract

The social planner's objective is to induce the managers of both types of projects to exert effort whenever feasible. Hence, the social planner will offer the managers of bad projects the required subsidy even if he can distinguish the two types, provided the effort incentive constraint of managers of good projects is not violated. Since the returns of the two types of projects in case of success are different, observable and verifiable, the social planner can ex post distinguish them and promise to offer them funds at fair terms. Moreover, he can commit to making direct lump-sum transfers, τ, from good projects to bad ones so that the effort incentive constraint of the managers of bad projects and the

social planner feasibility constraint are just binding, and the effort incentive constraint of the managers of good projects is not violated. Mathematically,

$$(X_B - I/\pi_H - \tau_B) = c \tag{9}$$

$$(X_G - I/\pi_H - \tau_G) \geq c \tag{10}$$

$$\lambda \pi_H \tau_G + (1-\lambda)\pi_H \tau_B = 0 \tag{11}$$

Solving (9) and (10) for τ_B and τ_G respectively and substituting into (11), we obtain:

$$\lambda \geq \frac{I - \pi_H(X_B - c)}{\pi_H(X_G - X_B)} \equiv \lambda^{SP} = \bar{\lambda} \tag{12}$$

Where λ^{SP} is the minimum proportion of good projects consistent with the managers of both types of projects exerting effort. In fact, it is the only restriction on the parameter values the social planner faces in his attempt to implement the socially efficient outcome. That is, the optimal contract involves the resolution of the adverse selection problem and lump-sum transfers.

6.2. Implementing the Optimal Contract with Debt and Equity

Now that we have characterized the optimal contract, we examine its implementation as a competitive equilibrium using financial instruments observed in the real world. By Proposition 4, we know that, for any $\lambda \geq \bar{\lambda} = \lambda^{SP}$ there exists a pooling equilibrium where the managers of both types of projects exert effort and receive funds by issuing a debt-equity combination. That is, the only restriction on parameter values required for the existence of the socially efficient pooling equilibrium is that the social planner also faces. Therefore, a debt-equity combination can implement the optimal contract as a competitive equilibrium. This result relies on the fact that the socially efficient pooling equilibrium Pareto-dominates any other equilibrium even if both effort incentive constraints are just binding. In other words, the benefit for the owner of a good project from inducing the manager of a bad project to exert effort through the mispricing of equity more than offsets the incremental subsidy (relative to the all-debt equilibrium where the bad project manager shirks) even if the total subsidy is so high that the effort incentive constraint of the good project manager is just binding.[22]

7. Conclusion

In this paper, we consider project financing under adverse selection and (effort) moral hazard. Several interesting results are obtained. First, we showed that capital structure

---

[22] See also the Proof of Proposition 4 in the Appendix.

matters even though managerial contracts are optimally designed. Second, we provided an explanation of why good firms issue underpriced equity even though the bankruptcy and other agency costs associated with debt are zero. This mispricing provides the managers of bad firms with the subsidy necessary to induce them to exert effort. The resulting increase in the aggregate expected return leads to a fall in the interest rate on debt (gain) which is greater than the underpricing of equity. That is, good firms accept to incur the adverse selection cost of issuing equity because this cost is more than offset by the benefit from relaxing the moral hazard constraint. Third, we showed that, in the presence of moral hazard, this mispricing may result in the conversion of a negative into a positive NPV project and an improvement in the aggregate expected returns and social welfare.

Finally, our results have also some implications for empirical testing: i) The higher the proportion of low-profitability (bad) firms, the higher the fraction of funds raised through equity. This prediction is consistent with the findings in Fama and French (2005). ii) In our pooling equilibrium all firms issue the same fraction of equity and debt with identical face value. However, because debt issued by both types of firm is equally valuable while the equity issued by good firms is more valuable, when the quality of projects becomes publicly known good firms have lower debt-equity ratios. This negative relation between leverage and profitability has been documented by several empirical studies (e.g., Titman and Wessels (1988), Rajan and Zingales (1995) and Fama and French (2002)).

References

Asquith, P., Mullins, D., 1986. Equity issues and offering dilution. Journal of Financial Economics 15, 61-89.

Bhattacharya, S., 1979. Imperfect information, dividend policy, and the bird in the hand fallacy. Bell Journal of Economics 10, 259-270.

Bhattacharya, S., 1980, Nondissipative signalling structures and dividend policy, Quarterly Journal of Economics 95, 1-24.

Biais, B., Casamatta, C., 1999. Optimal leverage and aggregate investment. Journal of Finance 54, 1291-1323.

Brennan, M., Kraus, A., 1987. Efficient financing under asymmetric information. Journal of Finance 42, 1225-1244.

Constantinides, G., Grundy, B., 1989. Optimal investment with stock repurchase and financing as signals. Review of Financial Studies 2, 445-465.

Darrough, M., Stoughton, N., 1986. Moral hazard and adverse selection: The question of financial structure. Journal of Finance 41, 501-513.

De Meza, D., Webb, D., 1987. Too much investment: A problem of asymmetric information. Quarterly Journal of Economics 102, 281-292.

Dybvig, P., Zender, J., 1991. Capital structure and dividend irrelevance with asymmetric information. Review of Financial Studies 4, 201-219.

Fama, E., French, K., 2002. Testing trade-off and pecking order predictions about dividends and debt. Review of Financial Studies, 15, 1-33.

Fama, E., French, K., 2005. Financing decisions: Who issues stock? Journal of Financial Economics, 76, 549-582.

Frank, M, Goyal, V., 2003. Testing the pecking order theory of capital structure. Journal of Financial Economics 67, 217-248.

Graham, J., 2000. How big are the tax benefits of debt? Journal of Finance 55, 1901-1941.

Harris, M., Raviv, A.,1991, The theory of capital structure. Journal of Finance 46, 297-355.

Heinkel, R., 1982. A theory of capital structure relevance under imperfect information. Journal of Finance 37, 1141-1150.

Helwege, J., Liang, N., 1996. Is there a pecking order? Evidence from a panel of IPO firms. Journal of Financial Economics 40, 429-458.

Innes, R., 1990. Limited liability and incentive contracting with ex ante action choices. Journal of Economic Theory 52, 45-67.

Jensen, M., 1986. Agency cost of free cash flow, corporate finance and takeovers. American Economic Review 76, 323-329.

Jensen, M., Meckling, W., 1976. Theory of the firm: Managerial behavior, agency costs, and capital structure. Journal of Financial Economics 3, 305-360.

Jung, K., Kim, Y., Stulz, R., 1996. Timing, investment opportunities, managerial discretion, and the security issue decision. Journal of Financial Economics 42, 159-185.

Leland, H., Pyle, D., 1977. Informational asymmetries, financial structure and financial intermediation. Journal of Finance 32, 371-387.

MacKie-Mason, J., 1990. Do taxes affect corporate financing decisions? Journal of Finance 45, 1471-1493.

Masulis, R., Korwar, A., 1986. Seasoned equity offerings: An empirical investigation. Journal of Financial Economics 15, 91-118.

Mikkelson, W., Partch, M., 1986. Valuation effects of security offerings and the issuance process. Journal of Financial Economics 15, 31-60.

Miller, M., Modigliani, F., 1958. The cost of capital, corporation finance, and the theory of investment. American Economic Review 48, 261-297.

Myers, S., 1977. Determinants of corporate borrowing. Journal of Financial Economics 5, 147-175.

Myers, S., 1984, The capital structure puzzle. Journal of Finance 39, 575-592.

Myers, S., Majluf, N., 1984. Corporate financing and investment decisions when firms have information investors do not have. Journal of Financial Economics 13, 187-221.

Rajan, R., Zingales, L., 1995. What do we know about capital structure? Some evidence from international data. Journal of Finance 50, 1421-1460.

Ross, S., 1977. The determination of financial structure: The Incentive signalling approach. Bell Journal of Economics 8, 23-40.

Titman, S., Wessels, R., 1988. The determinants of capital structure choice. Journal of Finance 43, 1-19.

Wilson, C., 1977. A model of insurance markets with incomplete information. Journal of Economic Theory 16, 167-207.

Appendix

Proof of Lemma 1: a) For any $0 \leq \alpha < 1$, $0 \leq D < X_i - W$, Eq. (3) becomes:

$$U_i = \pi_j^i (1-\alpha)(X_i - D - W), \qquad i = G, B \qquad \text{(A1)}$$

Differentiating (A1), we obtain:

$$\left(\frac{d\alpha}{dD} \right)_{u_i = \bar{u}} = -\frac{1-\alpha}{X_i - D - W} < 0$$

$u_i = u$ implicitly defines α as a function of D and so:

$$\left(\frac{d^2\alpha}{dD^2} \right)_{u_i = \bar{u}} = -\frac{2(1-\alpha)}{(X_i - D - W)^2} < 0$$

Hence, the indifference curves of both the G- and the B-type are downward sloping and concave.

b) Since $X_G > X_B$, at any (α, D) pair, u_G is flatter than u_B and hence they cross only once. ***Q.E.D.***

Proof of Lemma 2: a) The equations for ZP_i and PZP_H are respectively:

$$\pi_H \left[\alpha(X_i - D - W) + D \right] = I, \qquad i = G, B \qquad \text{(A2)}$$

$$\lambda \pi_H \left[\alpha(X_G - D - W) + D \right] + (1-\lambda)\pi_H \left[\alpha(X_B - D - W) + D \right] = I \qquad \text{(A3)}$$

Differentiating (A2) and (A3) we obtain the slopes of ZP_i and PZP_H respectively.

$$\left(\frac{d\alpha}{dD} \right)_{ZP_i} = -\frac{1-\alpha}{X_i - D - W} < 0$$

$$\left(\frac{d\alpha}{dD} \right)_{PZP_H} = -\frac{(1-\alpha)}{\lambda(X_G - D - W) + (1-\lambda)(X_B - D - W)} < 0$$

b) Using (A2), (A3) and solving for α and D, we obtain the values of α and D where ZP_G and ZP_B intersect in the (α, D) space.

$$\hat{\alpha} = 0, \qquad \hat{D} = I/\pi_H \qquad \text{(A4)}$$

Also, ZP_G is flatter than ZP_B. Hence, for $\alpha > 0$ ZP_G lies below ZP_B in the (α, D) space.

Since $X_G > X_B$ and $0 < \lambda < 1$, it is obvious that at any given (α, D) pair,

$$\left| \left(\frac{d\alpha}{dD} \right)_{ZP_B} \right| > \left| \left(\frac{d\alpha}{dD} \right)_{PZP_H} \right| > \left| \left(\frac{d\alpha}{dD} \right)_{ZP_G} \right|$$

c) By Lemmas 1, 2, and 3

$$\left(\frac{d\alpha}{dD} \right)_{ICF_i} = \left(\frac{d\alpha}{dD} \right)_{u_i = \bar{u}} = \left(\frac{d\alpha}{dD} \right)_{ZP_i} = -\frac{1-\alpha}{X_i - D - W} < 0, \qquad i = G, B \qquad \text{(A6)}$$

Hence, u_i, ZP_i ($i = G, B$) never intersect. **Q.E.D.**

Proof of Proposition 4: The pooling equilibria described in this proposition exist if the G-type indifference curve through the equilibrium contract A, u_G^A, does not intersect PZP_L (see Figure 3). Since $X_G > X_B$ and $0 \le \lambda \le 1$, at any given (α, D) pair, u_G^A is flatter than PZP_L. Therefore, it suffices to show that for all $\lambda \ge \bar{\lambda}$ the intersection point of u_G^A with the horizontal axis lies to the left of that of PZP_L. The intersection point of PZP_L with the horizontal axis is given by:

$$D = \frac{I}{\lambda \pi_H + (1-\lambda)\pi_L} \qquad \text{(A7)}$$

Moreover, the expected utility of the G-type in equilibrium is given by:

$$U_G^* = (1 - \alpha^*)\pi_H (X_G - D^* - c) \qquad \text{(A8)}$$

At $\alpha = 0$, the G-type's expected utility is:

$$(U_G)_{\alpha=0} = \pi_H (X_G - D) - \pi_H c \qquad \text{(A9)}$$

Setting $U_G^* = (U_G)_{\alpha=0}$ and using the expressions for α^* and D^*, we obtain:

$$D = \frac{I - (1-\lambda)\pi_H (X_B - c)}{\lambda \pi_H} \qquad \text{(A10)}$$

Hence, this condition is satisfied if:

$$\frac{I}{\lambda\pi_H + (1-\lambda)\pi_L} \geq \frac{I - (1-\lambda)\pi_H(X_B - c)}{\lambda\pi_H} \qquad (A11)$$

Let $\quad f(\lambda) = \dfrac{I - (1-\lambda)\pi_H(X_B - c)}{\lambda\pi_H} \quad$ and $\quad g(\lambda) = \dfrac{I}{\lambda\pi_H + (1-\lambda)\pi_L}$

then $\quad f'(\lambda) = -\dfrac{1}{\lambda^2\pi_H}[I - \pi_H(X_B - c)] < 0, \quad f''(\lambda) = \dfrac{2}{\lambda^3\pi_H}[I - \pi_H(X_B - c)] > 0$

Since, by assumption, $I - \pi_H(X_B - c) > 0$.

Also, $\quad g'(\lambda) = -\dfrac{(\pi_H - \pi_L)I}{[\lambda\pi_H + (1-\lambda)\pi_L]^2} < 0, \quad g''(\lambda) = \dfrac{(\pi_H - \pi_L)^2 I}{[\lambda\pi_H + (1-\lambda)\pi_L]^3} > 0$

Since $\pi_H > \pi_L$, both $f(\lambda)$ and $g(\lambda)$ are strictly decreasing and strictly convex.

Furthrermore, $f(\lambda) \leq g(\lambda) \implies \lambda \leq 1 \quad$ and $\quad \lambda \geq \dfrac{I - \pi_H(X_B - c)}{(\pi_H - \pi_L)\dfrac{\pi_H}{\pi_L}(X_B - c)} \equiv \tilde{\lambda}$

Since i) $0 < \lambda < 1$, ii) both $f(\lambda)$ and $g(\lambda)$ are continuous, strictly decreasing and strictly convex, iii) $f(\lambda) \leq g(\lambda)$ for $\lambda \geq \tilde{\lambda}$ and $f(\lambda) > g(\lambda)$ for $\lambda < \tilde{\lambda}$, then $f(\lambda) \leq g(\lambda)$ for all $\lambda \in [\tilde{\lambda}, 1]$. Therefore, u_G^A does not cut PZP_L for any $\lambda \in [\bar{\lambda}, 1]$ if and only if:

$$\bar{\lambda} \geq \tilde{\lambda} \qquad \Leftrightarrow \qquad \pi_H X_B - \pi_L X_G \geq C \qquad (A12)$$

By Assumption 1, this condition is always satisfied. ***Q.E.D.***

Separate Debt and Equity Markets

The analysis in the text assumed that the required amount of funds I is provided by the same financier who purchases both debt and equity. In this appendix, we show that all the results go through even if the buyer of debt and the buyer of equity are different (debt and equity markets are separate). It suffices to show that the zero-profit lines of an equity-buyer, a debt-buyer and a financier purchasing both debt and equity coincide. The following assumptions are made:

i) The project is indivisible.

ii) Firms cannot lend and the consumption good is perishable.

iii) Debt and equity markets are perfectly competitive.

The first assumption implies that firms borrow at least I. The second implies that no firm will borrow more than I. Therefore, they borrow just I. Given these three assumptions, we have:

$$I_D + I_E = I \qquad (A13)$$

$$P_{DF} = \left[\lambda \pi_j + (1-\lambda)\pi_k \right] D - I_D = 0, \quad j = H, L, \quad k = H, L, \qquad (A14)$$

$$P_{EF} = \alpha \left[\lambda \pi_j (X_G - D) + (1-\lambda)\pi_k (X_B - D) \right] - I_E = 0 \qquad (A15)$$

$$P_F = \lambda \left[\alpha \pi_j (X_G - D) + \pi_j D \right] + (1-\lambda)\left[\alpha \pi_k (X_B - D) + \pi_k D \right] - I = 0 \qquad (A16)$$

where I_D: Amount the firm borrows from the debt-financier

I_E: Amount the firm borrows from the equity-financier

P_{DF}: Expected profit of the debt-financier

P_{EF}: Expected profit of the equity-financier

P_F: Expected profit of a financier purchasing both debt and equity

Using (A13), (A14), (A15) and (A16) we obtain:

$$\lambda \left[\alpha \pi_j (X_G - D) + \pi_j D \right] + (1-\lambda)\left[\alpha \pi_k (X_B - D) + \pi_k D \right] - I$$

$$= P_{EF} = P_{DF} = P_F = 0 \qquad (A17)$$

That is, the zero-profit lines of an equity-financier, a debt-financier and a financier purchasing both debt and equity coincide. Therefore, the pooling equilibrium of Proposition 4 obtains regardless of whether the same investor purchases both debt and equity and provides the required amount I or the debt-financier and the equity-financier are different (bond and equity markets are separate).