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Optimal securities under adverse selection and moral hazard

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ABSTRACT

We consider project financing under adverse selection and moral hazard and derive several interesting results. First, we provide an explanation of why good firms issue both debt and underpriced equity (even if the bankruptcy and agency costs of debt are zero). Second, we show that, in the presence of moral hazard, adverse selection may induce the conversion of negative into positive NPV projects leading to an improvement in social welfare. Third, we provide a rationale for the use of warrants. We also show that a debt–warrant combination can implement the optimal contract. Our results have a number of testable implications.

1. Introduction

A large part of the securities issued by firms when they seek outside financing incorporate an option feature which provides the buyer with the right to buy the firm's shares at a prespecified price. In their attempt to raise funds at better terms, firms have used several option-like securities. However, two particular securities are the most widely used: convertible debt and debt–warrant combinations. In the case of convertible debt, if conversion takes place then the debtholder exchanges the face value of debt with a prespecified number of shares. In other words, the exercise price of the option coincides with the face value of debt. In debt–warrant combinations the exercise price of the option can be determined separately from the face of debt and in most cases it is different. That is, convertible debt is a special case of a debt–warrant combination that obtains when the exercise price of the warrant equals the face value of debt. Although debt–warrant combinations constitute a considerable fraction of these issues, the theoretical corporate finance literature has focused on convertible debt and paid little attention to debt–warrant combinations.[1] Existing models offer various explanations of why firms issue convertible debt but they do not justify the necessity for the use of warrants.[2]

In this paper, we construct a simple asymmetric information model that provides a rationale for the use of warrants. We abstract from taxes, financial distress, bankruptcy and other agency costs. We consider a model involving both adverse selection and (effort) moral hazard. There are two types of firms (projects): good (G), bad (B). 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 (first-

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[1] For example, De Roon and Veld (1998) report that about 30% of the convertible securities issued by Dutch companies from 1976 to 1996 were debt-warrant combinations.

[2] Green (1984), Constantinides and Grundy (1989), Stein (1992), Casamatta (2003), Cornelli and Yosha (2003) and Schmidt (2003) provide different rationales for the use of convertible debt.

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order stochastic dominance).[3] In the event of failure, regardless of its type, the project's return is zero. The entrepreneur can increase the success probability by exerting costly effort. Regardless of the project's type, if the entrepreneur 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 for both types. Both the project's type and the entrepreneur's action are private information of the entrepreneur.

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).

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 a pooling equilibrium involving cross-subsidization across types and the issue of both debt and equity (warrants). This pooling equilibrium 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 free entry of financiers, debt and equity (warrants) are fairly priced collectively, at individual level equity is mispriced. In fact, it is precisely this mispricing that provides the more prone to shirking type (B-type) with the subsidy necessary to induce him to choose the socially efficient high-effort level.[5]

Consider, for example, the case where the financial instruments available are debt and equity. In this case, in the pooling equilibrium the G-type subsidizes the B-type through the mispricing of equity. As we have seen, under pure adverse selection, the G-type would have issued just debt to eliminate this mispricing. However, in the presence of moral hazard, the elimination of the subsidy destroys the B-type's effort incentives. The B-type shirks and the aggregate expected return falls. As a result, the financiers, in order for 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 he cannot reveal his type, the G-type accepts to issue just enough equity to induce the B-type to exert effort because the resulting increase in his 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 the B-type increases, the fraction of equity needed to provide the B-type with the subsidy necessary to induce him to work also increases (the debt–equity ratio falls). The maximum subsidy is provided when only equity is issued. If the financial instruments available are debt and equity, for a sufficiently high proportion of the B-type, the pooling equilibrium where both types exert effort collapses although the G-type would have exerted effort even if a higher fraction of equity was issued (more subsidy was given to the B-type).

Warrants can help us restore the existence of the socially efficient pooling equilibrium. In absolute terms, the value of warrants issued by either type falls with the exercise price by the same amount. However, because in case of success the return of the G-type exceeds that of the B-type, the warrant value falls with the exercise price proportionately faster for the B-type. As a result, the B-type is willing to increase faster the fraction of equity offered to the financier than the G-type while still exerting effort. That is, the warrant payoff function can be steeper than the equity payoff function without violating the B-type effort incentive constraint. This implies that the difference between the total value of the warrants issued by the G- and B-type can exceed the corresponding difference of equity values consistent with both types working. Therefore, by choosing a sufficiently high exercise price, we can provide the B-type with the subsidy necessary to induce him to work when the proportion of the G-type is so low that the socially efficient pooling equilibrium breaks if a debt–equity combination is used.

That is, through the appropriate choice of their exercise price, warrants allow for the implementation of the socially efficient outcome even if this is not possible when we restrict ourselves to debt, equity and/or convertible debt.[6] This result

[3] This assumption is made for simplicity. All main results go through if instead we assume that, given identical effort levels, the success probability of good firms is greater (first-order stochastic dominance).

[4] The market value of debt depends only on the success probability whereas the value of equity depends on both the success probability and the return in case of success which greater for the G-type. Thus, our results go through even if, given the effort level, the success probability of the G-type is higher. The only difference is that in this more general case debt will also be mispriced but less than equity.

[5] If funds are offered at fair terms, the G-type exerts effort whereas the B-type shirks. Hence, the B-type's project NPV is negative and so, if his type is revealed, no rational financier offers funds to him. Therefore, in order to receive financing, the B-type will always mimic the G-type. Because, in case of success, the return of the good project exceeds that of the bad one, a given increase in the success probability leads to a greater increase in the net expected return of a good entrepreneur. As a result, good entrepreneurs may exert effort even if they subsidize the bad entrepreneurs.

[6] In our model, convertible debt does not improve on a debt-equity combination. If convertible debt is used, the exercise price of the option coincides with the face value of debt. This implies that if debt is converted into equity, the payment to the shareholders consists only of the project's return. As a result, the maximum proportion of equity offered to the financiers consistent with the B-type working is exactly the same as under a debt-equity combination. In contrast, if a debt-warrant combination is used, the total payment to the shareholders, if the option is exercised, consists of two components: (i) the project's return and (ii) the difference between the warrant exercise price and the face value of debt (which can be positive). Hence, the maximum proportion of equity issued consistent with the B-type working can be greater than under a debt-equity combination.