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Convertible securities and optimal exit decisions in venture capital finance ☆

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Abstract

We study the interaction between exit decisions and contract design in venture capital finance. One of the main characteristics of venture capital funds is that they need to divest their holdings in the portfolio firms after a limited period of time. However, venture capitalists and entrepreneurs often have diverging interests with respect to different exit solutions (e.g., IPOs or trade sales). We show that with convertible securities, the ex-ante agreed optimal exit policy can be implemented. Thereby, we give an explanation for the widespread use of convertible securities in venture capital finance. © 2001 Elsevier Science B.V. All rights reserved.

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1. Introduction

Entrepreneurs with innovative ideas of potentially high economic value, often find it difficult to meet their financing needs through traditional channels such as personal savings and bank loans. These difficulties are due to several critical factors: uncertainty, asymmetric information, the nature of firm assets, and the

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conditions in the relevant financial and product markets, for example. Nonetheless, private equity investors have tried to develop adequate responses to these challenges, namely, in the institutional form of specialized financial intermediaries such as venture capital organizations (VC) (e.g., Sahlman, 1990).

Venture capitalists differ from other intermediaries in a number of ways. For example, they play a more active governance role by employing an array of instruments such as capital staging (e.g., Gompers, 1995), direct monitoring (e.g., Lerner, 1995), and explicit control covenants (e.g., Gompers, 1997; Cornelius, 1997) in the form of founder replacements (e.g., Chan et al., 1990; Hellmann, 1998), to mention just a few. Another main characteristic of venture capital finance is the limited investment period. In fact, most venture capital funds are closed-end. This is often interpreted as an instrument, used by the limited partners of the venture capital fund, to control the manager of the venture capital organisation, in order to ensure the distribution of their investment returns. However, even if funds are not formally closed-end, the investors also preserve the right not to invest in any future fund managed by the same VC, if funds are not liquidated.

Given the constraints on its investment period, the VC wants to or has to terminate the financial relationship with the firm after a more or less given period of time. However, if there exists no verifiable information about firm value at the moment the VC wants to divest, major control problems and thus possible inefficiencies can arise. Examples are the timing of an initial public offering (IPO) —the so-called *grandstanding* phenomenon (e.g., Gompers, 1996)—or the possibility of asset stripping if the firm is sold to a private investor (e.g., Berglöf, 1994).

There are a number of ways to terminate the financial relationship. Besides liquidation, share repurchases by the founder (buy-back) and selling shares to institutional investors (secondary purchase), trade sales (TS), i.e. selling the firm as a whole to another company, and IPOs are the most valuable ones. In an IPO, at least some part of the firm is sold to a disperse spectrum of shareholders, none of them having a majority stake in the firm. The last two exit modes accounted, on average, for about two-thirds of the overall exit-volume in the European Union over the last decade (e.g., BVK, 1998).

Motivated by this empirical observation, we focus on the problem of how to select efficiently between an IPO or a TS and the consequences for the design of the financial contract between the founder (in the following, we call him interchangeably entrepreneur or owner–manager (OM)) and the VC. We discuss potential ways of resolving problems associated with the exit decision by using a well-specified contract design. We argue that the interests of the OM and VC diverge not only with regard to the distribution of the monetary surplus. More importantly, they also diverge with respect to the choice of the exit mode because of the nonmonetary benefits associated with different exit modes. In addition, the problem of observation and verification of major variables such as the value of the

firm makes it impossible to contract directly upon the choice of the exit mode. We show that it is possible to avoid efficiency losses stemming from unresolved conflict of interests, with the help of one of the major empirically observed instruments of corporate control in venture capital finance, namely, convertible securities (CS) (e.g., Sahlman, 1990). Convertibles can be used to assure an efficient exit choice. In order to see what a contractually efficient solution looks like, we divide the analysis in two parts.

First, we identify the set of efficient contracts in a market equilibrium, i.e. the set of efficient allocations of control rights and the division of the surplus. This includes the description of the ex-ante efficient solution, the characterization of all admissible contracts and the derivation of the necessary conditions for efficient contracts. This serves to pin down the boundaries of the set of efficient contracts. Second, we show that it is possible to implement the ex-ante efficient solution with the help of incentive-compatible financing contracts in the form of CS. By concentrating the search for an efficient contract on the empirically most relevant financing instruments, one can see why simple contracts, using debt and equity or a combination of both, fail to achieve efficiency. Additionally, in the context of CS, we are able to present an argument for both the separation and the combination of control and payoff rights. Thereby, the results of our paper are consistent with a recent empirical observation by Trester (1998), who shows that the ability to convert preference shares into ordinary shares does not always result in a transfer of control.

Previous rationalizations of CS in the context of venture capital can be categorized into two sets of papers. One part of the theoretical literature views convertibles as an instrument of incentive-compatible financing by emphasizing the role of entrepreneurial incentives during the life of the project. In contrast to our model, these papers study how the choice of financing instruments can ameliorate the incentive distortions originating in the reliance on external funding. Gompers (1993) argues that convertible debt induces exactly the right incentives for the entrepreneur to invest in projects with different risks and helps to separate out entrepreneurs with low ability. Cornelli and Oved (1997) show that convertible debt reduces the incentive of the entrepreneur to invest in (inefficient) short-term signal manipulation ("window dressing") when capital contributions are staged. Hansen (1991) and Bergemann and Hege (1998) model a stopping game between an entrepreneur and a VC under moral hazard. They derive the optimal sharing contract which explains the use of CS. By incorporating an advisory role of the VC, Repullo and Suarez (1998) as well as Casamatta (1999) extend the analysis of convertibles to the case in which the incentive problem is double-sided.

The use of CS can also be of economic value if the VC is making a specific major decision, over which he has control, rather than contributing managerial effort to the project. This is shown in the second set of papers which view convertibles as a way to allocate control rights efficiently. As is the case in our model, potential inefficiencies stem from conflicts of interest between en-

trepreneurs and VCs. They are due to information problems and nontransferable private benefits of control affecting critical decisions in the life of the project. This is the case in the liquidation decision in Marx (1998), or the sale of the firm to a private investor in Berglöf (1994). Our model fits into this second set of papers. But rather than concentrating on the most efficient way to terminate the economic life of the firm, we focus on the efficient allocation of future control over a young and possibly further-expanding firm.

Most closely related to our approach is Black and Gilson (1998), who, without the use of a formal model, stress the importance of the opportunity to enter into an implicit contract over control, which gives a successful entrepreneur the option to reacquire control from the VC via an IPO as the means by which the VC exits from a portfolio investment. They argue that this implicit contract will be self-enforcing as long as a reputable investment banker will underwrite a firm commitment offering. However, as Michaely and Womack (1999) show, recommendations by underwriter analysts are significantly biased, suggesting a potential conflict of interest inherent in the different functions that investment bankers perform. We therefore believe that the supposed superiority of the implicit contract over an explicit contract specifying at least some (contingent) shift of control is not as clear-cut as claimed.

In line with the above mentioned papers, our paper also aims to extend the basic idea of Aghion and Bolton (1992) to venture capital finance by stressing the importance of the (possibly contingent) allocation of control rights. But rather than conditioning control rights on the realization of a verifiable state of the world, we ask as to what extent it is necessary and possible to separate control rights from the allocation of payoff rights, so that the contracting parties behave in an ex-ante efficient manner.

The paper is organized as follows. In Section 2, we outline the main assumptions of the model as well as the timing of the game. In Section 3, we look at the first-best solution to the exit problem and characterize the set of efficient contracts. In Section 4, we ask if it is possible to implement the first-best solution with the use of standard financing instruments. Thereby, we analyze the characteristics of convertible securities that lead to an efficient outcome and we show their superiority over other financing instruments. Section 5 concludes.

2. Basic model

We look at a simple one-stage investment project.[1] In order to realize a promising idea, an entrepreneur has to invest a certain amount. After the imple-

[1] It is usually the case that venture capitalists invest in multiple stages in order to mitigate various agency problems during project implementation (e.g., Gompers, 1995). Since there are already several theoretical papers that examine stage financing, we abstract from problems of this kind and concentrate on agency problems stemming from nonmonetary benefits of control both during and after project implementation.

mentation stage, this investment results in a present value of future cash flows w^r (the gross firm value), which is stochastic and continuously distributed on the interval $[\underline{w}; \overline{w}]$ with density $f(w)$, with $\underline{w}$ and $\overline{w}$ representing the minimum and the maximum firm values, respectively. The corresponding cumulative distribution function $F(w)$ is assumed to be entirely independent of the effort and type of the entrepreneur and VC involved. That is, we abstract from incentive problems as well as from issues of adverse selection and focus on our main theme: how to organize separation of control and ownership between the entrepreneur and the external investor. Since the entrepreneur lacks any resources of his own, he has to rely on external funds.[2] A potential source of external funds is the venture capital industry, which is organized competitively. Venture capitalists are, however, committed to restrict their investment in young firms to a limited period of time. This restriction follows from the need to refinance investments from closed-end investment funds. In addition to this legal constraint, venture capital funds have strong incentives to exit from their investments well before the end of the partnership (e.g., Black and Gilson, 1998). Besides the aim to free capital for other investments, a fund's performance record is the principal tool to attract investors to future funds (e.g., Gompers and Lerner, 1999b).[3]

At the end of the first period, the VC and the OM can observe the realization of the discounted value of the stochastic project return, subsequently denoted by w^r. As in Admati and Pfleiderer (1994), the firm value cannot, however, be verified by outsiders. This reflects the idea that the VC is familiar with the profitability of the firm because of the typical engagement of the VC in management issues. Due to the special features of the investment project, which involves substantial investment into nontangible assets, this information cannot, however, be passed on to courts in a credible manner.

There are two potential exit channels.[4] On the one hand, there exists the possibility to sell the firm to an outside firm or conglomerate, a trade sale (TS). This outside firm takes over all assets as well as the control over the firm. Even if the previous OM holds a managerial function in the acquired firm, he no longer controls "his" firm to the same extent as before. On the other hand, at least some part of the firm could be sold to disperse shareholders via an IPO. In this case, the

[2] Since there are neither adverse selection nor moral hazard problems, our results would remain completely unchanged if the entrepreneur possessed positive but insufficient initial wealth. In this case, the investment amount can be regarded as the additional investment the entrepreneur has to obtain from the venture capitalist.

[3] In contrast to the positive effects of the closed-end feature, there is also evidence of some inefficiencies created by this requirement. Examples are the "grandstanding" phenomenon (e.g., Gompers, 1996) or negative share price reactions as a result of venture capital distributions (e.g., Gompers and Lerner, 1998).

[4] For the sake of simplicity, we limit our analysis to the two exit modes which are the most valuable ones. Though taking into account a larger number of exit channels would not change our basic line of argument, this would complicate the analysis considerably.

OM typically stays after the IPO as central executive officer on the firm's board. The corresponding exit proceeds are observable and verifiable.

We assume that in both cases, the observed firm value must not be distorted unsystematically for different w^r's. For simplicity, we say that buyers pay the true price of the firm. In the case of an IPO, market participants notice that overstating the firm's value implies an underperformance of the respective share in the future, leading to pronounced reputation losses for the VC. In the case of a TS, the buyer is familiar with the business and is able to acquire the necessary information in sales negotiations.

Whereas the gross value of the firm, w^r, is independent of the choice of the exit channels, this is not true with respect to the aggregate monetary payoff. If the firm is sold in the capital market (IPO), emission costs (E) are incurred. These are evident, for example, in the form of underpricing effects (e.g., Rock, 1986) or bonding and certification costs caused by the use of an underwriter (e.g., Booth and Smith, 1986). Additionally, in the case of a first registration, the company has to incur expenses originating from liquidity and publicity regulations in the stock exchange market. In contrast, in the case of a TS, the outside conglomerate experiences synergy effects between the acquired firm and its established business (e.g., Bygrave and Timmons, 1992). It suffices to assume that there are at least two potential buyers bidding for the firm, so that the firm extracts the highest potential premium (P) the conglomerate is willing to pay, after subtracting potential auditing costs which must not be too high.

Hence, we could define a general value-at-exit function $v(w^r, P, E \mid \text{IPO, TS})$ by mapping the gross value of the firm (w^r) and potential exit costs (E) or premiums (P) into such a value function. For our analysis, it suffices to assume that this value-at-exit function is continuous and monotone, with the derivatives $\partial v/\partial w^r > 0$, $\partial v/\partial P > 0$ and $\partial v/\partial E < 0$. In order to facilitate the analysis and allow for an explicit solution, we use the specific case that the respective arguments enter linearly and additively into this value-at-exit function. Hence, the value-at-exit function can be expressed by $w^r - E$ for an IPO and by $w^r + P$ for a TS, with $P, E > 0$ and constant for all w^r. We now describe the entrepreneur's and the VC's preferences.

2.1. Entrepreneur

For the sake of simplicity, both agents are assumed to be risk-neutral. Their preferences are additively separable and linear in income. The main feature of the entrepreneur's preferences is that he realizes nonmonetary benefits if he is in control over the firm's management. This assumption, which is well-founded in the empirical small-business literature (e.g., Westhead and Wright, 1998), simply reflects the notion that one of the main reasons for the entrepreneur to set up a business is his desire for independence. Then, the OM realizes control benefits *during* the project if, for example, he holds a majority of voting shares. We

subsequently refer to these control benefits during the implementation period of the project as CB_I ($CB_I > 0$). With regard to the allocation of control *after* exit, we argue that normally, the OM's independence is assured in the case of an IPO, where the firm remains an independent unity. With a TS, in contrast, the entrepreneur is likely to lose control as the firm is sold as a whole. Even if the founder continues to run the firm as a division manager of the larger firm, he is not solely in control of all decisions concerning "his" firm. Hence, we normalize the OM's utility benefits arising from control to zero in the case of a TS, and assume them to be strictly positive in the case of an IPO.

In the subsequent analysis, the control benefits after exit ($CB_e > 0$) are assumed to be smaller than the sum of the premium paid by the outside conglomerate (P) in the case of a TS and the emissions costs (E) incurred with an IPO:[5]

$$CB_e < P + E. \tag{1}$$

In order to illustrate the preference structure of the OM with regard to the exit channel, let us denote the entrepreneur's share in the exit proceeds by his equity holdings (α). This allows us to write his utility function at the point of time the exit decision has to be made as:[6]

$$U^{OM}_{equity} = \begin{cases} U^{OM}_{IPO,\alpha} = \alpha(w^r - E) + CB_e \\ U^{OM}_{TS,\alpha} = \alpha(w^r + P) \end{cases}. \tag{2}$$

Hence, we find the following exit preferences for the OM:

$$IPO \succeq (\prec) TS \quad \text{for} \quad CB_e \geq (<)\, \alpha(P + E). \tag{3}$$

For all possible firm values, the OM has a strict preference either for an IPO or a TS.

2.2. Venture capitalist

The VC does not only engage in one project, but invests repeatedly. In the course of his repeated engagement in project finance, the VC accumulates a "reputation capital stock" (e.g., Black and Gilson, 1998). The idea that the VC's reputation becomes important at the exit stage is consistent with the empirical work by Megginson and Weiss (1991) and Gompers (1996). From a theoretical point of view, there are two possible explanations for a reputation function that depends on the firm value at the exit stage.

[5] It turns out that this assumption is necessary for our problem. Without this assumption, an IPO would always be optimal for $w^r > 0$. In this case, the basic economic problem stressed in our paper vanishes.

[6] Note that at this time, control benefits during the implementation stage have already been realized.

First, the VC selects the project and typically engages in value enhancing management assistance of the consulting type.[7] As Gompers and Lerner (1999a) have shown, there is evidence in favour of the hypothesis that the VC, like other outsiders, learns of his own ability only once he observes firm value. Hence, the larger the realized firm value, the better the signal for own quality to the VC and the higher the reputation gain as a reflection of the revised estimate of the VC's quality. Second, because of informational asymmetries, the ability of the VC to exit may be significantly affected if investors are uninformed (relative to the VC) with regard to the firm value. In response, VCs might try to acquire reputation for presenting only high-quality ventures in IPOs (e.g., Amit et al., 1998).

The notion that the relative increase in reputation resulting from a single project also depends on the exit mode can be justified by the following reasoning. Since in the case of an IPO, the true value of the firm is easier and more precisely to observe by the interested public, we argue that the average revised estimate of the VC's quality is higher with an IPO than with a TS.[8] This seems reasonable, because the less publicity in the case of a TS, there is a smaller number of investors to revise their beliefs about the VC's quality upwards, compared to the case of an IPO. Hence, the VC's relative reputation gain is more pronounced with an IPO than with a TS. As with the other arguments of the value-at-exit function, we choose to model the reputation gain linearly in the realized firm value. The marginal reputation gain is larger with an IPO than with a TS. In order to save notation, we normalize, without loss of generality, the reputation gain with a TS to zero and denote the relative reputation gain with an IPO (relative to a TS) by $R_{\mathrm{IPO}} = r_{\mathrm{IPO}} w^r$. Hence, we can write the utility function of the VC as:

$$U^{\mathrm{VC}}_{\mathrm{equity}} = \begin{cases} U^{\mathrm{VC}}_{\mathrm{IPO},\alpha} = (1-\alpha)(w^r - E) + r_{\mathrm{IPO}} w^r \\ U^{\mathrm{VC}}_{\mathrm{TS},\alpha} = (1-\alpha)(w^r + P) \end{cases}. \tag{4}$$

Therefore, for $U^{\mathrm{VC}}_{\mathrm{IPO},\alpha}(w^{\mathrm{VC}}) = U^{\mathrm{VC}}_{\mathrm{TS},\alpha}(w^{\mathrm{VC}})$, we find $w^{\mathrm{VC}} = (1-\alpha)(P+E)/r_{\mathrm{IPO}}$.

For small realized firm values, $w^r < w^{\mathrm{VC}}$, the VC prefers the TS to the IPO, whereas the opposite is true for large realized firm values, $w^r > w^{\mathrm{VC}} \Leftrightarrow \mathrm{IPO} \succ \mathrm{TS}$. This just reflects the notion that with larger firm values, the differences in reputation effects become more pronounced. For $w^r > w^{\mathrm{VC}}$, this gain in reputation overcompensates the lower net revenues from an IPO (from the VC's perspective: $(1-\alpha)(P+E)$).

[7] For the empirical discussion about the project selection versus "value added" hypothesis, see, e.g., Brander et al. (1999).

[8] There are with no doubt several prominent examples of firms for which an acquisition at a high price created a tremendous reputation. But it seems quite obvious that in these cases, the reputation gain associated with an IPO would not have been less, but even larger.

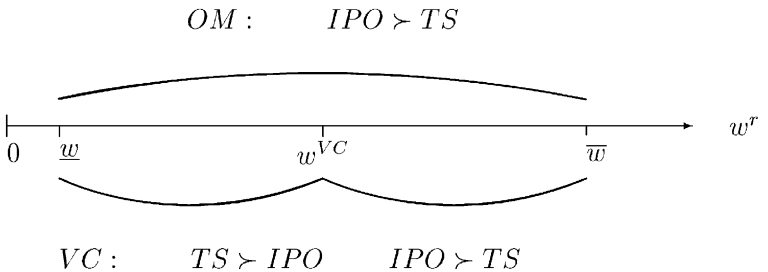

Fig. 1. Possible ex-post conflict of interests with equity contract and $\alpha_e \leq CB_e/(P+E)$.

Comparing the VC's and the entrepreneur's interests regarding the exit modes, it now becomes obvious that a potential ex-post (i.e. when it comes to deciding on the exit channel) conflict of interests exists. As can be seen form Fig. 1, for small equity shares of the OM and for large realized values of the firm, both parties prefer an IPO. But for relatively low realizations of firm values, the VC would choose a TS, whereas the entrepreneur is still in favour of an IPO. The reason for this conflict of interest between the OM and the VC is that the nonmonetary benefits accrue to them asymmetrically.

That is, ex-ante we have two noncoinciding areas of conflicting interests: (i) the distribution of the resulting net surplus and (ii) the choice of the exit mode. Whereas the first conflict is always prevalent and independent of the realization of w^r, the second conflict does not necessarily arise for all w^r. The fact that there are two potential conflicts of interest between the OM and VC will require (as we will show at least in some cases) a separation of the sharing rule for the surplus from the investment, and a rule governing the distribution of control rights over the exit mode.

2.3. Timing of the game

We model the idea that a novice founder approaches the competitively organized venture capital industry for financial resources. We look at the interaction between a single VC and the entrepreneur. Competition between at least two equally reputable VCs pushes the VC down to his reservation utility, U_r^{VC}, consisting of the cost of capital plus, eventually, a fee for his management assistance. Technically speaking, this implies that the participation constraint of the VC binds with equality and thus the entire surplus accrues to the OM.

There are three stages of the game. In the first stage, the OM offers a contract to the VC, which specifies the VC's payoff structure as well as the right to choose the exit channel. In the second stage, the VC rejects or accepts the offer. In the latter case, both parties invest and nature decides upon the realized firm value. The VC and the OM observe w^r and decide in the third stage on the exit mode, given the rule of decision rights specified ex-ante. This eventually includes the execution

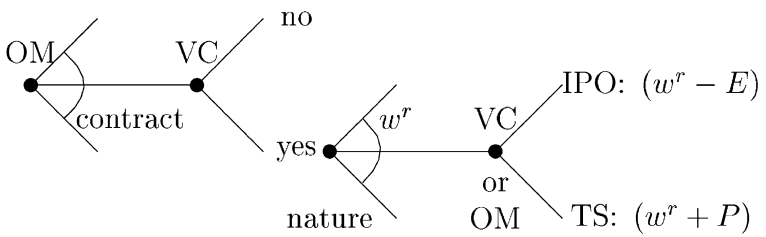

Fig. 2. Time structure.

of a conversion option so that the decision right could switch from one party to the other. The described time structure is summarized in Fig. 2.

3. Optimal exit decisions and financing instruments

Now, we turn to possible solutions for our main problem: the potential conflict of interests with respect to the exit mode and the possession of control rights. The other conflict, namely, the division of the exit proceeds, is only a distributional one which has, in contrast to the exit mode problem, no efficiency effect.

In order to analyze the control rights and exit problem in more detail and to discuss potential solutions, we first deduce the first-best solution as a reference case. Then, we derive the conditions for an efficient contract in market equilibrium. Against this background, we analyze some of the standard financing arrangements. We show that standard debt and/or equity contracts are no suitable solutions to our problem. We therefore turn to more sophisticated financing instruments such as convertible securities.

3.1. First-best solution

The first-best solution characterizes the point of reference with perfect information. In this case, it is feasible to write state-contingent contracts which define the mode of exit as depending on the value of the firm. One major element of the first-best contract is the necessity of making exit decisions in an efficient manner. Hence, the correct choice of exit mode for different w^r's is the solution to the following problem:

$$\text{Maximize } U^{\text{s}} = U^{\text{VC}} + U^{\text{OM}} \text{ through the choice of the exit mode.}$$

The sum of utility U^{s} for the two exit channels can be written as:

$$\text{Exit via IPO} \quad U^{\text{s}}_{\text{IPO}} := U^{\text{VC}}_{\text{IPO}} + U^{\text{OM}}_{\text{IPO}} = w^r - E + \text{CB}_{\text{e}} + r_{\text{IPO}} w^r \tag{5}$$

$$\text{Exit via TS} \quad U^{\text{s}}_{\text{TS}} := U^{\text{VC}}_{\text{TS}} + U^{\text{OM}}_{\text{TS}} = w^r + P. \tag{6}$$

Comparing these two utility functions reveals that for low firm values, a TS is preferable to an IPO and with large firm values, the reverse is true. This simply reflects the fact that with low firm values, the premium paid in the case of a TS overcompensates the positive net aspects of an IPO. With large firm values, the positive aspects of an IPO (control benefits minus emission costs and higher reputation effects) loom larger than those of the TS.

By using Eqs. (5) and (6), we find for the critical firm value ($U^{s}_{IPO}(w^{*}) = U^{s}_{TS}(w^{*})$):

$$w^{*} = \frac{P + E - CB_{e}}{r_{IPO}}. \tag{7}$$

The other main element of the first-best contract is the necessity of giving the OM control during the implementation, in order to maximize the overall utility benefits from the project. We can summarize this finding in:

Proposition 1. *The exit rule is ex-ante Pareto optimal if it leads to an IPO for* $w^{r} \geq w^{*}$ *and to a TS for* $w^{r} < w^{*}$. *Overall efficiency requires the allocation of control during the project to the OM.*

3.2. The set of efficient contracts in market equilibrium

The crucial question to be dealt with in what follows, is whether it is possible to replicate this first-best solution if the value of the firm is not verifiable in the third stage of the game. An obvious way out, namely, the possibility of state verification by one of the two agents, is not feasible since this entails verification costs leading to an outcome worse than the one described above. Another solution consists of renegotiation. As Aghion et al. (1994) have shown, renegotiations will always lead to efficient outcomes if the contractual status quo is properly chosen and all bargaining power is given to one of the parties when renegotiating. However, we argue that as state verification, renegotiation is also costly and thereby inferior to a self-enforcing efficient contract.

The set of feasible contracts is quite large. We only require that contracts lead to an unequivocal distribution of control rights and to a clear-cut distribution of payoffs among the two parties. The set of Pareto efficient contracts, however, is potentially much smaller and can be characterized by two conditions. The first condition specifies an efficient allocation of control during the project:

Condition 1. During the implementation stage, control rights have to be with the OM.

Otherwise, the OM's control benefits, CB_{I}, are simply foregone. The second condition determines an efficient exit choice by the controlling party.

Condition 2. For an efficient exit mode, control rights should be allocated so that:

(i) for $w^r < w^*$, there should be no control rights with the OM (VC) if $U_{TS}^{OM} < U_{IPO}^{OM}$ ($U_{TS}^{VC} < U_{IPO}^{VC}$);
(ii) for $w^r \geq w^*$, there should be no control rights with the OM (VC) if $U_{TS}^{OM} > U_{IPO}^{OM}$ ($U_{TS}^{VC} > U_{IPO}^{VC}$).

There always exists a distribution of control rights contingent on w^r which fulfills this condition. By the definition of Pareto efficiency, it can never happen that both parties prefer the inefficient exit mode. For instance, for any $w^r < w^*$, it cannot be true that the OM and the VC prefer the IPO to the TS because in this case, an IPO would be Pareto preferred to a TS, thereby contradicting Proposition 1. At least one party is always willing to exercise the efficient exit mode. At the same time, however, the above condition does not necessarily give us a unique distribution of control rights. It is perfectly feasible that both parties are willing to choose the efficient exit channel for some range of w^r. In this case, one can grant either of the two parties the control rights on the basis of the efficient contract.

With the two conditions characterizing the efficient contract, it becomes most obvious that only the distribution of control rights constitutes an allocation problem but not the division of the surplus of the project. Hence we can state:

Proposition 2. Conditions 1 and 2 *are necessary and sufficient for contracts in the efficient set.*

As we assume competition between VCs, an efficient contract in market equilibrium is characterized by:

Condition 3. In market equilibrium, the participation constraint of the VC always has to be met with equality.

Hence, an efficient contract in market equilibrium has to fulfill conditions 1, 2 and 3.

4. Financing instruments and the efficient contract

Using the characteristics of the efficient contract, we now ask whether and how it is possible to translate them into a financing arrangement, resulting in a market equilibrium.

4.1. Standard debt and equity contracts

Let us start with a conventional *debt contract*. The main feature of a standard debt contract is the state–contingent shift of control. The contract efficiently leaves control during the project (condition 1), and thus also the choice of the exit mode to the OM if he can repay the ex-ante agreed debt value D. If he fails to repay control shifts to the VC. But in this case, the exit has already taken place and there is nothing left for the VC to decide upon. So it remains to be shown that with a debt contract, the OM will not act in an ex-ante Pareto efficient way. If we assume that the OM is able to repay the contracted debt, his utility function is:

$$U_{\text{debt}}^{\text{OM}} = \begin{cases} U_{\text{IPO},D}^{\text{OM}} = w^r - E + \text{CB}_\text{e} - D \\ U_{\text{TS},D}^{\text{OM}} = w^r + P - D \end{cases}. \tag{8}$$

Comparing the utility levels for the two exit modes, it becomes apparent that the OM will always opt for the TS (according to Eq. (1), $P + E > \text{CB}_\text{e}$). Hence, the debt contract does not meet condition 2 of the efficient contract: it does not lead to a switch in exit modes.

The same is true for conventional *equity finance*: it does not achieve Pareto efficiency. With conventional equity finance, the VC receives an ex-ante agreed share $(1 - \alpha)$ of the realized firm value as he holds the equivalent percentage of the firm's common stocks. Depending on the value of α, the VC or the OM holds the majority and thus the decision right over the exit. Therefore, independently of the realized firm value, it is either the VC or the OM who is in control, both during the project and when the exit decision is made.

From our discussion in the preceding section (see Eq. (3)), we know that if, according to condition 1, the OM is in control ($\alpha > 0.5$), he has a strict preference for either an IPO or a TS for all possible realisations of firm values. Hence, this will never lead to a switch in the exit mode, violating condition 2.

The last candidate of standard financing contracts we consider is a *debt–equity mix*. With a combination of debt and equity (common stock), control is held by the party owning more than 50% of ordinary shares. Thus, we have to find a combination of $\alpha_{D/e} > 0.5$ (condition 1) and D, so that the participation constraint for the VC strictly binds (condition 3). But even if this is possible, one can easily verify that the first-best exit mode will not be implemented. In order to see this, one can follow the same line of argument as in the pure equity case.

The OM's utility function, in the case of a debt–equity mix, is:

$$U_{\text{debt/equity}}^{\text{OM}} = \begin{cases} U_{\text{IPO},D/e}^{\text{OM}} = \alpha_{D/e}(w^r - E - D) + \text{CB}_\text{e} \\ U_{\text{TS},D/e}^{\text{OM}} = \alpha_{D/e}(w^r + P - D) \end{cases}. \tag{9}$$

If we compare these two utility levels, we obtain the same prediction as in Eq. (3), which states that the OM has a strict preference for one exit channel

depending on the level of his equity share. Hence, if the OM is in control, the first-best exit choice will not be realized, violating condition 2. Combining these findings, we can state:

Proposition 3. *It is not feasible to implement the first-best solution by using conventional debt and / or equity finance.*

The underlying reason why standard debt and equity contracts fail to achieve efficiency is that we aim, at the same time, at three objectives (i.e. conditions to fulfill): (i) to give the OM control during the implementation period, (ii) to achieve an efficient choice of exit mode, and (iii) to meet the participation constraint of the VC with equality. Neither standard debt, nor equity contracts, nor a combination of both are as flexible as to meet all three requirements simultaneously.

At this point of our analysis, it becomes obvious that our assumption $CB_I > 0$, leading to condition 1, is crucial for our problem. Namely, if the OM would not value control during the project, we could give the VC unconditional control by setting $\alpha_{D/e} = \alpha^+ = CB_e/(P+E)$ so that $w^{VC} = w^*$. This gives the VC the first-best incentives, satisfying condition 2, because his utility function is:

$$U^{VC}_{\text{debt/equity}} = \begin{cases} U^{VC}_{IPO,D/e} = D + (1-\alpha_{D/e})(w^r - E - D) + r_{IPO} w^r \\ U^{VC}_{TS,D/e} = D + (1-\alpha_{D/e})(w^r + P - D) \end{cases}. \quad (10)$$

Hence, given that $CB_I = 0$, an efficient debt–equity contract is feasible (condition 3) if, first, with $\alpha_{D/e} = \alpha^+ = CB_e/(P+E)$ and $D = 0$, the expected utility of the VC does not exceed U_r^{VC}. Second and more importantly, α^+ has to be lower than 50% if the VC holds ordinary shares. But since α^+ is determined by the parameter values of CB_e, P and E, it is also possible that $\alpha^+ > 0.5$. In this case, the OM should hold nonvoting shares or the VC should hold preference shares with superior voting rights. Hence, we see, even if $CB_I = 0$, a debt–equity mix may require a deviation from the one-share one-vote rule.

In contrast, allowing for $CB_I > 0$ has two crucial advantages. On the one hand, this corresponds well with the abovementioned studies favouring nonmonetary control benefits. On the other hand, it allows us to provide a rational for the observation by Trester (1998). In venture capital deals using preferred equity, the mean percentage of the use of convertible preferred is 88.8%. We show in the following that contracts on the basis of convertible securities can be designed, such that all our three conditions for an efficient equilibrium contract can be met.

4.2. Convertible securities

Two of the most common instruments in venture capital finance are convertible debt and convertible preferred equity (e.g., Sahlman, 1990). The main difference

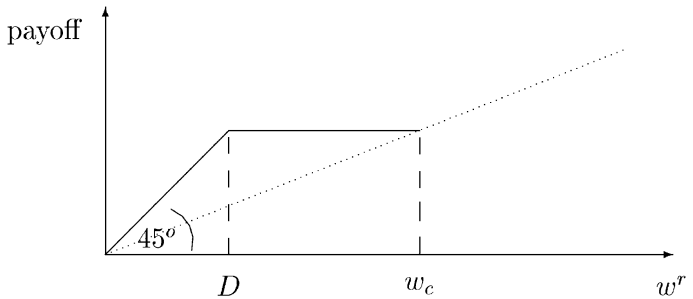

Fig. 3. VC's payoff with convertible preferred equity.

between the two instruments concerns the rights in the case of a default. Whereas the preference shareholders do not have any particular rights in this case, debt holders can force the firm into liquidation or, in our context, they are able to take over the exit decision. Since the agency problem associated with the two exit channels, liquidation and trade sale, is already treated by Berglöf (1994), we concentrate our analysis on the so-called success stories and exclude henceforth the possibility that the OM cannot repay his debt (we assume that $\underline{w} - E > U_r^{\mathrm{VC}}$).[9]

Convertible debt and convertible preferred equity are very similar with respect to the resulting payoff structure. With convertible debt as well as with convertible preferred equity, the VC has a fixed claim (the debt component or accumulated dividends) on the monetary payoff and a call option on a proportional share according to his equity holdings. As can be seen in Fig. 3, with convertible preferred shares, the VC receives the entire firm value (represented by the 45° line) as long as his payoff claim is not fully satisfied. If $w^r \geq D$, he receives a fixed amount of accumulated dividend payments (the flat line) until he decides to convert the preferred shares into ordinary shares, which is usually achieved by the so-called conversion rate. The slope of the dotted line represents the payoff share of the VC after conversion. The VC's conversion point is denoted by w_c and depends on the relation between the a-priori contracted share in the firm value and the debt claim.

The reason why we will find convertible securities useful, lies in the analogy between the actual control allocation *before* and *after* the conversion and the required control allocation *during* and *at* the exit decision. Before conversion and hence during implementation, the OM has unconditional control as the VC holds either a debt claim or nonvoting preference shares. After conversion and hence at the point of time the exit decision is made, it is either the VC or the OM who is in

[9] With our competitive venture capital industry the participation constraint of the VC has to bind. Hence, the debt level can never exceed U_r^{VC}, implying that the above assumption guarantees that all debt can be repaid.

control, depending on the allocation of voting rights. Therefore, with the use of convertible securities, it is already ensured that condition 1 will always be satisfied. It remains to be shown that we can also ensure an efficient choice of exit modes in a market equilibrium.

4.2.1. Convertible securities and the efficient choice between exit modes

The basic problem facing us here is that there exists no variable which is verifiable and upon which conversion can be made contingent.[10] Hence, an efficient setup requires that conversion must be incentive-compatible, i.e. it has to be in the interest of the VC to convert his debt into equity so that the first-best exit solution actually takes place. It turns out that such an incentive-compatible contract is possible with convertible debt and convertible preferred shares, respectively. We distinguish between conversion with and without a switch in control, henceforth referred to as the nonvoting and the voting case. Thereby, we emphasize the fact that a shift in control is not always necessary to achieve the first-best solution. Instead, what is much more needed is a switch in the payoff structure of the agent deciding on the exit mode (obviously, this can also involve a switch in control). In a recent study by Trester (1998), it is shown that the mean percentage of deals where the ability to convert into voting shares results in a transfer of control is only 28%. We want to include this fact into our framework by arguing, first, that it is feasible to achieve the first-best solution with conversion into nonvoting equity (and without a switch in control) for some cases. Second, we show that in other cases, a switch to voting equity (i.e. a switch in control) is required to implement an efficient solution. With convertible debt, the VC's utility function consists of two parts as given below.

First, if conversion has not taken place yet (nc), we get:

$$U_{\mathrm{nc}}^{\mathrm{VC}} = \begin{cases} U_{\mathrm{IPO},D}^{\mathrm{VC}} = D + r_{\mathrm{IPO}} w^r \\ U_{\mathrm{TS},D}^{\mathrm{VC}} = D \end{cases}. \tag{11}$$

Second, after conversion (c), we find:

$$U_{\mathrm{c}}^{\mathrm{VC}} = \begin{cases} U_{\mathrm{IPO},\alpha_{\mathrm{c}}}^{\mathrm{VC}} = (1-\alpha_{\mathrm{c}})(w^r - E) + r_{\mathrm{IPO}} w^r \\ U_{\mathrm{TS},\alpha_{\mathrm{c}}}^{\mathrm{VC}} = (1-\alpha_{\mathrm{c}})(w^r + P) \end{cases}, \tag{12}$$

where α_{c} denotes the ex-ante agreed share of the OM in the exit proceeds after conversion. The utility function of the OM is given by Eqs. (8) and (2).

[10] While one can often observe automatic conversion provisions from preference to ordinary shares for the realization of an IPO, in our model, this is not considered as a mechanism to implement the first-best exit rule. Instead, we believe that such a conversion provision is mainly due to legal registration requirements rather than its use as an instrument to influence incentives.

In the *nonvoting case*, control remains with the OM. Hence, either $\alpha_c > 0.5$ or the VC converts his debt holdings into nonvoting shares. To achieve the first-best solution, it is necessary that at w^*, the OM changes his mind and chooses an IPO (TS) for $w^r \geq (<) w^*$. This can be achieved if the VC converts at w^* so that the payoff structure of the OM changes.

Our discussion about the behaviour of the OM therefore implies that the first requirement is met if, after conversion to nonvoting equity (see Eq. (3)), the following holds:

$$\alpha_c \leq \frac{CB_e}{P+E}. \tag{13}$$

The VC will convert at w^* (anticipating the OM's behaviour), if the debt level and the VC's share in exit proceeds after conversion are arranged, so that the VC is just indifferent at w^* between the debt arrangement (leading to a TS) and the equity arrangement (leading to an IPO). More formally:

$$U^{VC}_{TS,D}(w^*) = U^{VC}_{IPO,\alpha_c}(w^*). \tag{14}$$

Note that it is optimal for the VC to convert at w^*, since for all $w^r < (>) w^*$, $U^{VC}_{TS,D} > (<) U^{VC}_{IPO,\alpha_c}$.

The contract we look at is, however, only an equilibrium if, in addition to the conditions expressed in Eqs. (13) and (14), the participation constraint holds with equality.

We can express the participation constraint in the case just discussed as:

$$U^{VC}_r = \int_{\underline{w}}^{w^*} (D) f(w) \mathrm{d}w + \int_{w^*}^{\overline{w}} \left[(1-\alpha_c)(w-E) + r_{IPO} w\right] f(w) \mathrm{d}w, \tag{15}$$

where the first (second) term on the RHS represents the payoff if a TS (IPO) is realized before (after) conversion. We see that for a rather low reservation utility of the VC, either the VC's share $(1-\alpha_c)$ or his debt component has to be reduced. But from condition (13), we know that there is a lower bound to which the VC's share can decrease, i.e. $(1-\alpha_c^+)$ with $\alpha_c^+ = CB_e/(P+E)$.

Using α_c^+ and Eq. (14), we can compute a floor for the debt level ($\overline{D}$), which must be exceeded in order to simultaneously achieve an efficient conversion and exit decision. We can rewrite Eq. (14) to:

$$\overline{D} = (1-\alpha_c^+)(w^* - E) + r_{IPO} w^*. \tag{16}$$

Plugging both α_c^+ and w^* into Eq. (16) yields the lower bound of feasible debt level in the nonvoting case:

$$\overline{D} = \left(\frac{P+E-CB_e}{P+E}\right)\left(\frac{P+E-CB_e}{r_{IPO}} + P\right). \tag{17}$$

Hence, with conversion to nonvoting equity, the agreed debt level has to exceed $\overline{D}$. However, if U_r^{VC} is quite low, a potential problem arises. Given that α_c^+ is rather low (see Eq. (13)), so that the VC's minimal share is already quite high, the debt level has to be drastically reduced in order to satisfy the participation constraint. This in turn is only possible to a certain extent, since the debt level cannot be lower than $\overline{D}$. If, however, the combination of $(1-\alpha_c^+)$ and $\overline{D}$ leads to a payoff for the VC in excess of his reservation utility, a contract with conversion to nonvoting equity does not represent an equilibrium. As we will show below, there exists another contract with conversion into voting equity, which pulls the expected utility of the VC down to his reservation utility.

In the *voting case*, the switch in the chosen exit mode results from a switch in control (and therefore of the deciding party). After conversion, the VC decides on the exit mode; hence, either $\alpha_c < 0.5$ or the VC converts into voting shares so that he holds the majority of voting rights. In order to achieve the first-best solution with convertible debt when conversion to voting equity takes place, it needs to be ensured that for $w^r < w^*$, a TS is chosen, and for $w^r \geq w^*$, an IPO is selected. Our previous discussion revealed that the OM always prefers the TS to the IPO with a debt contract. Hence, the contract has to be set up so that the VC has an incentive to convert for $w^r \leq w^*$. A second condition is that the VC chooses the optimal exit mode (if he is in charge), or to be more precise, that the VC chooses the IPO (TS) for $w^r \geq (<) w^*$. Both conditions must be fulfilled simultaneously. We can express these conditions formally as:

$$U_{\mathrm{TS},D}^{\mathrm{VC}}(w^*) \leq U_{\mathrm{TS},\alpha_c}^{\mathrm{VC}}(w^*) \tag{18}$$

$$w^* = w^{\mathrm{VC}} \qquad \text{or} \qquad \alpha_c = \alpha_c^+ = \frac{\mathrm{CB_e}}{P+E}. \tag{19}$$

In addition, the participation constraint of the VC, Eq. (15), has to bind in equilibrium. Fig. 4 illustrates the idea behind the optimal contract with convertible debt in the voting case.

In bad states of nature, i.e. low w^r, the VC prefers to hold his debt claim and the OM chooses a TS. For $w^r \geq w_c$, the VC converts his debt claim into voting common stocks because in the case of a TS, his utility with an equity stake exceeds his utility with a debt claim. By converting into voting equity, he takes over control and realizes a TS. For $w^r \geq w^*$, the preference of the VC switches from a TS to an IPO and, henceforth, the Pareto optimal exit policy is pursued for all possible realizations of w^r. Combining Eq. (18) with Eq. (19) enables us to derive an upper bound for the feasible debt level in the present case. Expressing Eq. (18) as:

$$D \leq (1-\alpha_c^+)(w^* + P), \tag{20}$$

and inserting α_c^+ as well as w^* gives us:

$$D \leq \overline{D} = \left(\frac{P+E-\mathrm{CB_e}}{P+E}\right)\left(\frac{P+E-\mathrm{CB_e}}{r_{\mathrm{IPO}}} + P\right). \tag{21}$$

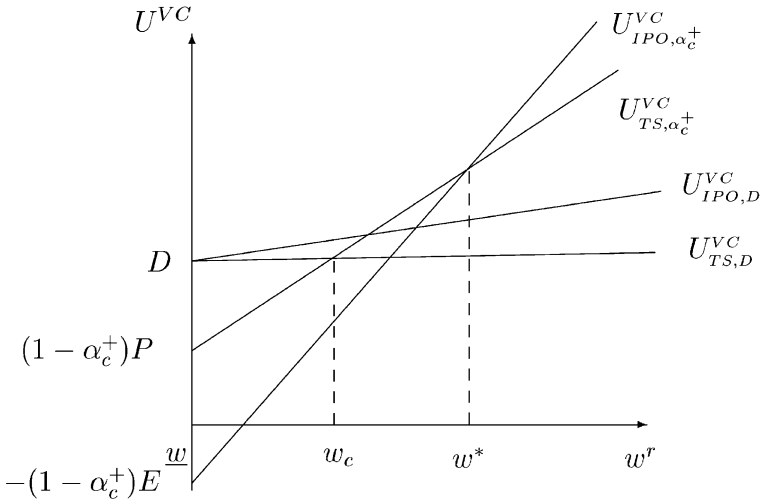

Fig. 4. VC's utility in the voting case.

That is, the *upper* bound in the voting case is just equal to the debt-level-floor of the nonvoting case. This implies that one of the two instruments always leads to an optimal solution. If the participation constraint of the VC is violated in the case of nonvoting equity, it is always feasible to convert to voting equity and to achieve the first-best outcome. Comparing Eq. (17) with Eq. (21) reveals that the range over which the two instruments are used efficiently does not overlap. An increase in r_{IPO} shifts $\overline{D}$ to the left, increasing the likelihood of the nonvoting case. Fig. 5 illustrates our findings.

We can summarize our findings in:

Proposition 4. *It is always feasible to achieve the first-best solution by using convertible debt. Depending on the parameter constellations, the participation constraint of the VC requires conversion into nonvoting or into voting shares. The larger the reputation effect (i.e. the larger r_{IPO}), the more likely is the use of nonvoting equity.*

Combining Proposition 4 and the fact that convertible securities leave control during project implementation with the OM, shows the superiority of convertible

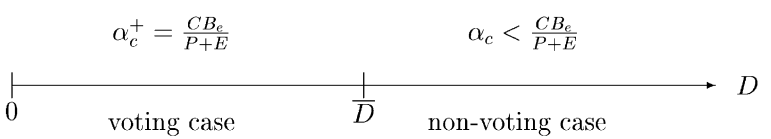

Fig. 5. Conversion into voting vs. conversion into nonvoting equity.

securities over the other discussed financing instruments. Thus, despite the fact that there are two alternative financing instruments allowing for an efficient exit solution (condition 2) and market equilibrium (condition 3), convertible securities are always preferred to a debt–equity mix, since by the former the OM has control during the project (condition 1).

5. Conclusion

In this paper, we have provided an explanation for the widespread use of convertible securities in venture capital finance. One of the main characteristics of venture capital funds is that they invest in particular projects only for a limited period of time. Therefore, exit becomes a crucial decision for the venture capitalists. It has been shown that parameter values and realizations of firm value exist, such that there is a conflict of interests ex-post with respect to the exit mode. If this problem cannot be solved by using ex-ante contractual provisions, the agreement between the OM and the VC may be suboptimal as renegotiation is likely to be costly, and an implicit contract over control could be difficult to enforce.

One result of our analysis is that conventional debt and/or equity instruments are not flexible enough to achieve overall efficiency. However, with the use of CS, it is possible to leave the OM with control during the project so that convertibles prove to be superior to a debt–equity mix from this point of view. This corresponds very well to the empirical fact that preference shares are almost always complemented with a conversion option in venture capital finance. Further, it has been shown that convertibles provide for the switch in payoff structures which, in some cases, is already sufficient for achieving an efficient solution with respect to the exit mode. In other words, there are situations where the use of a conversion option does not lead to a shift in control from the OM to the VC, which is also well in line with empirical observations. Two empirical hypotheses emerge from our analysis. First, our model implies that CS are most widely used if the OM has strong control benefits. An indication of this can be seen in the fact whether he is active in management. Second, from our model, we would expect that CS are more likely to be based on nonvoting equity when the reputation affect is pronounced (i.e. in the case of young and unproved VCs).

Though we find our results convincing, there are at least two qualifications to be made. First, without a calibration of our model, which is beyond the scope of this paper, we cannot definitely claim that our results are in line with the stylized fact observed by Trester (1998), pointing to the relative frequency of the voting and the nonvoting case. Second, while we have restricted our search for efficient contracts to the empirically most relevant financing instruments, namely, all those containing elements of debt and equity, there might exist optimal contracts that are nonlinear and thus not in the class considered here. Nevertheless, we think that

one of the main reasons why we rarely observe nonlinear contracts is that, financing instruments containing standardized elements, such as debt and equity, help to economize on transaction costs and are, as has been shown, flexible enough to achieve efficiency.

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