Moral Hazard by Inside Investors in the Context of Venture Financing

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Abstract:

We look at moral hazard by an insider investor in the context of venture financing The inside investor has experienced the entrepreneur's quality in a previous stage. An outside investor cannot assess the quality. Thus, generally, an outside investor offers financial terms reflecting the average entrepreneurial quality. If the entrepreneur is a good one the inside investor may have an incentive to appropriate rents due to his information monopoly by demanding a higher share on the venture's return before financing the next stage. If it is more costly for the entrepreneur to switch to an outside investor, she sticks to the inside investor, though. However, she may not choose the efficient level of effort or specific investments, rather she underinvests.

This problem of expropriation depends on the information structure and may be mitigated when the parties ex ante fix the financial terms of future capital infusions conditionally on the performance of previous stages. These provisions are quite common. So far, the literature considered them as a device to mitigate moral hazard by entrepreneurs. But they can also mitigate the inside investor's incentive to negotiate opportunistically.

The syndication of venture capital investments may mitigate the moral hazard problem, too, since co-investors are likely to be better informed than outside investors. Debt financing or mixed financing may be more favorable than equity financing since legal boundaries on interest rates limit the extent to which an inside investor could hold up an entrepreneur.

JEL-Classification: G 24

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1. Introduction

In general, innovations are financed in stages. This is a salient feature of venture financing.¹ There are two benefits of staging both due to the "option of waiting". First, it is possible to stop the venture without losing too much money when it turns out that external factors become unfavorable, e.g. market demand does not increase as expected or competitors emerge suddenly. The option to stop is valuable then to both the investor and the entrepreneur. Second, the staging of capital allows to mitigate opportunistic behavior by the entrepreneur.² Since the entrepreneur usually hardly provides funds by her own she may be interested in continuation although the termination of the venture would be efficient, for instance when she receives a private benefit from running the venture.³ The option to wait is valuable to the investor.

The staging of capital, however, may also induce opportunistic behaviour by the *investor*. When entrepreneur and investor negotiate the terms of the financial contract before a new stage is financed the investor may appropriate rents knowing the entrepreneur will lose when she would terminate the relationship and choose another, new investor. There are several reasons why the entrepreneur may lose and why this hold-up problem may occur:

- (1) The entrepreneur may (partly) lose the expected benefits of specific investments, *e.g.* the human capital she contributed.⁴
- (2) If the entrepreneur failed to file for patent protection or if patent protection is not yet available since the invention does not entirely meet the legal requirements of patent law, the entrepreneur has to take into account that the investor may "steal" the idea and use it for his own purposes or for other ventures.
- (3) Transaction costs may occur when the entrepreneur looks for a new investor, for instance searching costs and costs to overcome informational asymmetries.

When there is a good entrepreneur, the investor may take advantage and may demand a too large share on the venture's future return before financing the next stage. If it is more costly to acquire alternative funds, the entrepreneur may have to

¹ See Sahlman (1990), pp. 560f., Gompers/Lerner (1999), pp. 139-169.

² See Gompers/Lerner (1999), pp. 140-145, Neher (1999), pp. 269f., Schmidt, K. (2000), p. 9.

³ See the empirical study of *Arnold* (1989), pp. 224-279 for different sources of non-monetary benefits of German entrepreneurs (of small and medium sized enterprises).

⁴ The entrepreneur may also lose some private, non-monetary benefits when she switches to another investor.

accept the investor's offer, though. In this article, we especially focus on (3). If the new investor cannot distinguish between good and bad entrepreneurs,⁵ he at least will demand a share reflecting the average entrepreneur's quality. The problem becomes more severe when (a) an inside (old) investor makes his offer after the outside investor does, for instance due to a so-called *right of first refusal*⁶ and (b) when the new outside investor considers the termination of the first financial relationship as a signal for bad quality. Thus, the old investor may appropriate some rents due to his information monopoly. He just requires a slightly smaller share than the new investor. As a consequence, the entrepreneur sticks to the old investor, however, she may reduce her level of specific investments even if it would be not efficient to do so (*underinvestment*).

This problem of expropriation depends on the information structure on the venture capital market and may be mitigated when the parties ex ante agree that the financial terms of future stages should depend on the performance in previous stages. These provisions are quite common. So far, the literature has considered them as a device to mitigate moral hazard by *entrepreneurs*. But they may also mitigate the *investor*'s incentive to negotiate opportunistically.

The syndication of venture capital investments may mitigate moral hazard by an inside investor, since co-investors are likely to be better informed than outside investors. Debt financing or mixed financing may be more favorable than equity financing since legal boundaries on interest rates limit the extent to which an inside investor could hold up an entrepreneur. From a normative point of view, there should be a law against the "right of first refusal" which gives the inside investor the option to contract upon the terms an outside investor offers and thus, often ensures that the inside investor moves after the outside investor.

There is a large body of literature on incentive problems due to specific investments.⁷ However, there is only a piecemeal literature addressing the question how venture financing may be affected when the entrepreneur faces potential losses expressed by (2) to (3). With respect to position (1) there are the contributions by *Hart/Moore* (1994) and by *Neher* (1999).⁸ They analyze the opportunistic behavior of a wealth-constrained entrepreneur. Without her human capital the venture yields no return. Since the investor provides all the funds the entrepreneur may renegotiate the

⁵ The model also works for good and bad projects.

⁶ The right of first refusal is quite common, see *Walker* (1999).

⁷ See, for instance, Williamson (1983), Hart (1995).

⁸ For position (3) (loss of non-monetary utility benefits) see *Aghion/Bolton* (1992).

contract threatening to withdraw her human capital. Note that this is a kind of entrepreneur's moral hazard which is commonly analyzed in the literature. Aghion/Tirole (1994) ask whether a "research unit" (i.e., the entrepreneur) or the investor should own the property right on the invention, when both parties make specific investments simultaneously and the property right is not divisible. They conclude that the party who invests more should own the property right. However, they do not consider the special incentive problems which may occur due to stage financing and they solely focus on position (1). The same is true for Hansmann/Kraakman (1992) and Schmidt (2000), who analyze the question how to allocate cash flow rights when the parties invest in a sequence, but not simultaneously: first the entrepreneur invests, then the investor. The contributions by Fischer (1990) and Rajan (1992) are most closely related to this paper. They show that a *housebank* intentionally may accept losses in the first period to attract new debtors. The losses are compensated by profits in the second period. Since the housebank has close ties to the firm and thus, an informational advantage she can raise the interest rate to a certain extent in the second period. Fischer and Rajan do not look at equity financing and venture financing, though. Further, they rather allow for a framework where housebank and outside bank bid simultaneously whereas we look at a more plausible case where the inside investor has the "right of first refusal" and thus, bids after the outside (new) investor has bidden.

In what follows, we first present a model in section 2 showing how the old inside investor may behave opportunistically and renegotiate the contract when he can assess the entrepreneur's quality more precisely than a new investor. The assumptions are set out in sec. 2.1, the analysis in sec. 2.2. Section 3 provides a discussion, especially on the information structure and on some devices in order to mitigate this specific incentive problem, for instance on syndicated financing and financial support by state authorities. Section 4 offers a conclusion.

2. A model of investor's moral hazard due to informational advantage

2.1 Description of the model

In order to analyze the moral hazard problem we shall assume (M1) to (M5).

(M1) (Set of investment opportunities) Entrepreneur E is wealth-constrained and has the opportunity to undertake a venture in t=0. There are two stages. In t=0 and t=1, the same fixed investment I (I > 0) is required. Returns occur in t=2 and t=3, respectively. For simplicity, in t=2 and t=3, there are only two possible outcomes: success and failure. In case of success, return amounts to X (X > I > 0), in case of failure there is zero return. There is no correlation between the returns in t=2 and t=3.

The success probability p depends on both the entrepreneurial quality (good or bad) and the level of the entrepreneur's specific investments (e):

$$\begin{array}{ll} (1) & p = p(T) + p(e) & \text{mit } T = \{G,S\} \text{ und } e = \{e_L,e_H\}; \\ & p(T=G) = p_G; \ p(T=S) = p_S; \ 0 < p_S < p_G < 1; \\ & p(e = e_L) = 0; \ p(e = e_H) = p_H > 0; \\ & 0 < p_H < p_G + p_H \leq 1; \ 0 < p_H < p_S + p_H < 1. \end{array}$$

Obviously, the expected net return is higher with a "good" type.⁹ The portion of "good" (bad) entrepreneurs in the whole population amounts to λ (1– λ) with 0 < λ < 1. Even with a "bad" type it is favorable to undertake the venture, i.e. it holds (R is the expected gross project return):

 $(2.1) \qquad \qquad R_G = p_G \cdot X; \ R_S = p_S \cdot X \\ mit \qquad R_G > R_S > I > 0.$

Success probability will also increase if the entrepreneur chooses a high level of specific investments ($e_H = 0$). In contrast, there is no effect on success probability with a low level ($e_L = 0$). Specific investments are efficient, i.e.:¹⁰

(2.2)
$$e_{\rm H} < \phi(e_{\rm H}) X.$$

The parties cannot contract upon specific investments. This assumption seems to be plausible, if it is not possible (or prohibitively costly) to precisely describe the entrepreneurial effort ex ante, especially, when effort is comprised of several dimensions and actions, e.g. management and technical issues. Furthermore, effort is not contractible if a court cannot verify the effort level.

The returns in t=2 and t=3 depend on the same factors (entrepreneurial quality and entrepreneur's specific investments).

(M2) (Set of financing opportunities) The entrepreneur has no funds, however, the old investor Old and the new investor New have sufficient funds to provide the

⁹ According to assumption (M5), the market rate for risk-free investments is 0%.

¹⁰ Thus, we assume that non-monetary utilities can be measured in monetary units which is common in microeconomics theory. See for the restrictive requirements to do so *Keeney/Raiffa* (1976).

investment I in t=0 and/or t=1. For simplicity, we consider only equity financing:¹¹ an investor receives a share s ($0 < s \le 1$) on the future returns of the relevant investment, the entrepreneur the share 1–s. Since there are two investments, two financial transactions are required.

- In t=0, only investor Old or only investor N provides the investment. The same holds for t=1. In t=0, Old and New face Bertrand-competition, i.e. they calculate the required share under a zero-profit-constraint. Since neither Old nor New can assess the entrepreneur's quality in t=0,¹² they demand a share assuming the "average" entrepreneurial quality.
- In t=1, the inside investor Old, who financed the first stage, experienced the entrepreneur's quality. The non-informed investor New could also finance the second stage, however, he still cannot assess the entrepreneurial quality. The old investor has a "right of first refusal", i.e. he has an option to finance upon the terms offered by the non-informed new investor.

In t=3, the venture is liquidated (e.g., by an initial public offering).

(M3) (*Information structure*)¹³ Neither investor can correctly assess the entrepreneur's type in t=0. The new investor cannot even observe the type in t=1, but the (inside) old investor can. While the old investor experienced the first stage he can precisely assess the entrepreneur's quality. This information is mainly "soft in nature",¹⁴ i.e. the entrepreneur cannot credibly convey it to outside investors.¹⁵

Because the old investor makes the final offer, the new investor cannot derive informations from negotiations between entrepreneur and old investor. Even if the entrepreneur receives a bid from the old-investor first, the new investor may not derive the entrepreneurial quality from that, since it is worth to finance the venture even with a bad type.

No investor can control the level of specific investments. The old investor may observe the effort level chosen in the first period, but external players, e.g. a court, cannot. Since the return in t=2 is either X or zero, it is not possible to derive the chosen effort level from the payoff level. Apart from that, information is distributed symmetrically and all players have the same payoff functions in mind, i.e. there are homogeneous beliefs.¹⁶

¹¹ The qualitative results do not change assuming debt financing or a mix of debt and equity financing (hybrid financing).

¹² We assume that a good entrepreneur cannot signal her entrepreneurial quality, e.g. by contributing own funds since she is wealth-constrained.

¹³ Section 3.1 provides a discussion on the information structure.

¹⁴ *Rajan* (1992), p. 1371.

¹⁵ Moreover, the entrepreneur lacks funds in order to credibly signal his quality. The venture's returns occur in t=2 at the earliest, i.e. he cannot even invest the returns from the venture.

¹⁶ The assumption that beliefs are homogeneous when there is symmetric information is quite common in microeconomics. However, this assumption is critical when a court is likely to have a different view on the venture's pay-off functions. See on the issue of heterogeneous beliefs in the context of venture financing *Bigus* (2002a).

(M4) (*Contracts*) For sake of simplicity, we allow for equity financing only.¹⁷ It is not possible to contract neither upon the entrepreneurial quality nor on the effort level, since verification by a court is not possible or prohibitively costly.

(M5) (*Participation constraints*) An investor only agrees on a contract when he at least receives a zero profit in the considered period. The entrepreneur will only accept a financial contract if she gains (i.e. she receives a positive expected utility). The rate of return for risk-free investments is 0%. Entrepreneur E and the investors New and Old are all risk neutral. Each player is interested in maximizing (expected) individual wealth in t=3.¹⁸

The entrepreneur exerts - irrespective of his type - a high effort, only if her share on future cash flows is sufficiently large, i.e. if the investor's share s is small enough:

(3.1)
$$(1-s)p_{\rm H}X \ge e$$
 or $s \le 1 - \frac{e}{p_{\rm H}X}$.

In order to yield a zero profit at least, the minimum share an investor demands for a good type and a bad type equals to:

$$\begin{array}{ll} (3.2) \quad I \leq s(p_G + p_H)X & \mbox{ and } \quad I \leq s(p_B + p_H)X & \mbox{,respectively or} \\ s \geq \frac{I}{(p_G + p_H)X} & \mbox{ and } \quad s \geq \frac{I}{(p_B + p_H)X}. \end{array}$$

If the investor demands a larger share than in (3.1), the entrepreneur will not exert high effort. In what follows we assume that this holds for the bad type:

(4.1)
$$\frac{I}{(p_B + p_H)X} > 1 - \frac{e}{p_H X}$$
 or $p_B < \frac{p_H I}{p_H X - e} - p_H$.

If success probability is low enough, there will be no quota where both the entrepreneur's incentive constraint in (3.1) and the investor's participation constraint in (3.2) is met simultaneously. Vice versa, if success probability p is sufficiently large, both constraints can be met. To make things more interesting, we shall allow for a sufficiently large p regarding the good type:

 $^{^{17}}$ The qualitative results are quite the same when we allow for debt financing or mixed financing, see *Bigus* (2002), pp. 248-254. However, legal boundaries on interest rates limit the extent to which the inside investor may

¹⁸ Investors, for instance venture capitalists, may have a well diversified portfolio of investments. Thus, one may justify the assumption of risk neutrality. The entrepreneur usually is not able to diversify, however, they may not be risk averse in general, since often they quit a quite safe job in order to start their own business, see *Black/Gilson* (1998). The qualitative results do not change significantly assuming risk aversion.

(4.2)
$$\frac{I}{(p_G + p_H)X} < 1 - \frac{e}{p_H X}$$
 or $p_G > \frac{p_H I}{p_H X - e} - p_H$.

Thus, we look at a case where it may be worth for the good type to exert a high effort level, but not for the bad entrepreneur. To sum up, the sequence of the game may be described as follows:

1st period: An entrepreneur E needs funds for her venture consisting of a project in the first and a project in the second stage. The entrepreneurial quality of the entrepreneur is randomly chosen.

The investors Old and New offer financial contracts for the investment I in the first stage. Since the investment volume is fixed and we look at equity financing, the offer refers to the required share. There is Bertrand-competition among Old and New.

The entrepreneur accepts the more favorable offer (in case the investors demand the same share, she chooses the offer of Old).

The entrepreneur chooses the level of specific investments.

The project of the first stage is undertaken.

 2^{nd} period: After financing the first period, the investor Old can correctly assess the entrepreneurial quality of A.

Investor Old has an option to finance upon the terms investor New offers to the entrepreneur ("right of first refusal"). Again, the offer refers to the required share.

Again, the entrepreneur accepts the more favorable offer.

The entrepreneur chooses the level of specific investments.

The project of the second stage is undertaken.

- 3^{rd} period: In case of success, the outcome of the investment in t=0 is X, in case of failure, it is 0.
- 4^{th} period: In case of success, the outcome of the investment in t=1 is X, in case of failure, it is 0.

Graph 1 shows the structure of the model.

Graph 1: model structure

0		1			2	3 t
stage 1:	entrepreneur	stage 2:	rightof	entrepreneur	return of	return of
equity fin., investor Old	E chooses effort level e	2nd investment; offerby	first refusal; offer by	E chooses effort level e	project in stage 1;	project in stage 2;
invests I		investor New	investor Old		depends on e	depends on e

Section 2.2. shows how the old inside investor may appropriate some rents due to his informational advantage and how this may weaken the good entrepreneur incentives to exert high effort.

2.2 Analysis: moral hazard when the old investor has inside information on the entrepreneurial quality

This section shows first the first-best solution assuming that both investors share the same information (section 2.2.1). In section 2.2.2 we assume that the old investor behaves opportunistically. We obtain the equilibrium by backwards induction first analyzing with the player's actions in the second period. The subscripts "E", "O", and "N" denote the entrepreneur, the old (inside) investor and the new, non-informed investor; "s" denotes the investor's share on future cash flows.

2.2.1 First-best-Solution

Since both investors are non-informed in the first period, they demand a share orientated to the "average" entrepreneurial quality:

(5)
$$s := \frac{I}{[\lambda(p_G + p_H) + (1 - \lambda)(p_B + p_H)]X}$$

The entrepreneur will exert high effort, if the individual marginal benefits are sufficiently large and the investor's share is small enough, i.e. if

$$(3.1) \quad s \le 1 - \frac{e}{p_H X}$$

holds. In what follows we regard the case where the entrepreneur will choose a high effort if an investor orientates his claim to the average entrepreneur:

(6)
$$\frac{I}{\left[\lambda(p_{\rm G}+p_{\rm H})+(1-\lambda)(p_{\rm B}+p_{\rm H})\right]X} \le 1-\frac{e}{p_{\rm H}X}.$$

Other things being equal, condition (6) is the more likely to hold,

- the lower is the investment I,
- the larger is the portion of good entrepreneurs in the whole population (λ) ,
- and for a given output $p_H X$ the lower is the entrepreneurial effort (e).

Regarding the first best situation both investors can precisely assess the entrepreneurial quality in the second period. They offer favorable terms for the good type and rather bad terms for the bad type. Due to the assumptions in (4.1) and (4.2) only the good type is interested in high effort. Thus, we can derive the following proposition.

Proposition 1:

In the first-best-situation both investors are non-informed. They demand the following share for the *first* period

(7.1)
$$s_1^* := \frac{I}{[\lambda(p_G + p_H) + (1 - \lambda)(p_B + p_H)]X}$$

Thus, both bad and good entrepreneurs have an incentive to exert high effort in the first stage: $e_1^G = e_1^B = e > 0$. In the *second* period both investors may precisely assess the entrepreneurial quality, since the inside investor has no informational advantage by definition. The investors demand the following share for the *second* period:

(7.2)
$$s_2^{*;G} = \frac{I}{(p_G + p_H)X}$$
 and $s_2^{*;B} = \frac{I}{p_B X}$, respectively,

with $e_2^G = e > 0$ and $e_2^B = 0$, respectively.

Only the good entrepreneur exerts high effort.

The new investor do not finance in neither period. Since both investors demand the same terms in each period, the old investor finances both stages due to the right of first refusal. Thus, old inside investor, new outside investor, good and bad entrepreneur yield the following individual surplus in the first best situation:

(8.1)
$$Y_{Old} = -I + s_1^* [\lambda(p_G + p_H) + (1 - \lambda)(p_B + p_H)] X$$

$$-I + \lambda \cdot s_{2}^{*;G} \cdot (p_{G} + p_{H})X + (1 - \lambda) \cdot s_{2}^{*;B} \cdot p_{B}X$$

= 0 + 0 = 0,
(8.2) $Y_{New} = 0$,
(8.3.1) $Y_{E;G} = (1 - s_{1}^{*})(p_{G} + p_{H})X - e + [(p_{G} + p_{H})X - I - e] > 0.$
(8.3.2) $Y_{E;B} = (1 - s_{1}^{*})(p_{B} + p_{H})X - e + [p_{B}X - I] > 0.$

In order to find out social surplus we shall consider that the portion of good entrepreneurs in the population amounts to λ (0 < λ < 1).

(8.4)
$$Y_{Old} + Y_{New} + Y_E = 0 + 0 + [\lambda p_G + (1 - \lambda)p_B]X + p_H X - e - I$$

+ $[\lambda p_G + (1 - \lambda)p_B]X + \lambda (p_H X - e) - I > 0.$

Because of Bertrand-competition, both investors receive a zero profit. In case of information asymmetry there is zero profit in each period. The entrepreneurs entirely keep the social surplus. The term in squared brackets in (8.3.1) and (8.3.2) reflects the social surplus in the second period. Even the bad entrepreneur makes a profit, but she does not exert high effort due to assumption (4.1).

2.2.2 Moral hazard by the old (inside) investor

We now assume that the inside investor takes advantage of his superior knowledge. Because of backward induction we start with period 2.

2.2.2.1 Individual rationales in period 2

Since the old investor has accompanied the venture in the first period he can precisely assess the entrepreneurial quality at the beginning of the second period. The new investor is still non-informed and makes the first bid.

If the *new investor* demands s_1^* , i.e. a share orientated to the "average" type, he will only attract bad entrepreneurs and thus, will lose money. The argument goes as follows: when there is a good type, the old investor will make the same bid as the new investor does and – due to the right of first refusal – will finance the project in the second period. When it turns out that the entrepreneur is a bad one, the old investor is not willing to accept terms orientated to an average type. This rationale holds for bids s_2 with $s_2^{*;G} \le s_2 < s_2^{*;B}$. For $s_2 < s_2^{*;G}$ the new investor would finance even the good types, however, it is not worth it since he then loses money even with the good types. In order to lose no money, the new investor demands $s_2 = s_2^{*;B} = \frac{I}{p_B X}$ in the second period, i.e. he orientates his bid *solely on the bad type*.

Because of the right of first refusal, the *old investor* finances both types and demands a share of $s_2^{*;B}$, irrespective of the entrepreneur's type. Due to assumption (4.1), the bad type is not willing to exert high effort then. With a good type, a high effort level may still improve both the entrepreneur's and the old investor's individual surplus (see (4.2)). The good type is willing to exert high effort, if the old investor's share is sufficiently small:¹⁹

(9)
$$s_2^{*;B} \le 1 - \frac{e}{p_H X}$$
.

However, (9) does not hold due to the assumption in (4.1):

(10)
$$s_2^{*;B} = \frac{I}{p_B X} > \frac{I}{(p_B + p_H)X} > 1 - \frac{e}{p_H X}.$$

The good entrepreneur exerts low effort with $s_2 = s_2^{*;B}$. The old investor will anticipate the good entrepreneur's rationale. Since the old investor may benefit from a high effort level, he will not demand $s_2^{*;B}$ in any case. Rather, the old investor compares his individual surplus for the opportunistic bid $s_2 = s_2^{*;B} = \frac{I}{p_B X}$ with the surplus for the lower bid $s_2 = s_2' = 1 - \frac{e}{p_H X}$ which is incentive compatible:

(11.1)
$$Y_{Old;2}(s_2 = s'_2) = -I + s'_2(p_G + p_H)X = -I + \left(1 - \frac{e}{p_H X}\right)(p_G + p_H)X$$

(11.2)
$$Y_{Old;2}(s_2 = s_2^{*;B}) = -I + s_2^{*;B} p_G X = -I + \frac{I}{p_B X} p_G X$$

The old investor demands the lower share, if he is better off then, i.e. if holds:

(12)
$$Y_{Old;2}(s_2 = s'_2) > Y_{Old;2}(s_2 = s'^{*;B}_2)$$
 or - rearranging -

¹⁹ (3.1) provides a similar condition.

$$s'_{2} = 1 - \frac{e}{p_{H}X} > \frac{p_{G}}{p_{B}} \cdot \frac{I}{(p_{G} + p_{H})X}$$

Due to assumption (4.2) $1 - \frac{e}{p_H X} > \frac{I}{(p_G + p_H)X}$ holds, but also $p_G > p_B$ is valid.

Thus, condition (12) does not necessarily hold. Only if p_G is sufficiently small and/or p_B is big enough, condition (12) holds:

(13)
$$p_G < \frac{p_B p_H (p_H X - e)}{p_H I - p_B (p_H X - e)}$$
 or $p_B > \frac{p_G p_H I}{(p_H X - e)(p_G + p_H)}$

The intuition behind this result is that the old investor is only willing to demand a lower, but incentive compatible share s'_2 , if the rent due to the information monopoly is not too large and thus, too attractive to him. This rent is determined by the proportion of p_G and p_B , i.e. the success probabilities with a good and bad entrepreneur, respectively. The more p_G and p_B diverge – and thus, the more bad and good quality differ – the larger is the rent due the information monopoly and the more likely the old investor stick to the larger share $s_2^{*;B}$.

In what follows, we regard the more interesting case that the information rent is too large such that condition (12) does not hold. Then, the old investor bids $s_2^{*;B}$ and the good entrepreneur does not exert high effort – as (10) indicates – although it would be efficient to do so. Regarding a *good* entrepreneur, individual surpluses in period 2 amount to:

- (14.1) $Y_{Old;2}^{G} = -I + s_{2}^{*;B} \cdot p_{G}X = -I + \frac{I}{p_{B}X}p_{G}X = \frac{p_{G} p_{B}}{p_{B}}I > 0,$
- (14.2) $Y_{\text{New};2}^{\text{G}} = 0,$ (14.3) $Y_{\text{E};2}^{\text{G}} = \frac{(p_{\text{B}}X - I)p_{\text{G}}X}{p_{\text{B}}X} > 0,$

(14.4)
$$Y_{Old;2}^{G} + Y_{New;2}^{G} + Y_{E}^{G} = p_{G}X - I > 0.$$

Regarding a bad entrepreneur, individual surpluses in period 2 equal to:

- (15.1) $Y_{Old;2}^{B} = -I + s_{2}^{*;B} \cdot p_{B}X = -I + \frac{1}{p_{B}X}p_{B}X = 0,$
- (15.2) $Y_{\text{New};2}^{\text{B}} = 0$,
- $(15.3) \quad Y^B_{E;2} = \frac{(p_B X I)p_B X}{p_B X} = p_B X I > 0.$
- (15.4) $Y_{Old;2}^B + Y_{New;2}^B + Y_{E;2}^B = p_B X I > 0.$

Finally, let us consider that the portion of good entrepreneurs in the population amounts to λ . Thus, aggregating (14.1) to (15.4), we obtain for period 2:²⁰

$$\begin{array}{ll} (16.1) \quad Y_{Old;2} = \lambda \frac{p_G - p_B}{p_B} I + (1 - \lambda) \cdot 0 = \lambda \frac{p_G - p_B}{p_B} I > 0. \\ (16.2) \quad Y_{New;2} = 0, \\ (16.3) \quad Y_{E;2} &= \lambda \frac{(p_B X - I) p_G}{p_B} + (1 - \lambda) \cdot (p_B X - I) > 0. \\ (16.4) \quad Y_{Old;2} + Y_{New;2} + Y_{E;2} = \lambda \cdot (p_G X - I) + (1 - \lambda) \cdot (p_B X - I) > 0. \end{array}$$

The rationales in period 2 may affect the terms of contracting in the first period as the following section shows.

2.2.2.2 Rationales in period 1

Both investors anticipate in t = 0 that the one who finances the first period will receive an information rent in the second period due to the informational advantage. In period 1 both investors are non-informed. With Bertrand competition the investor's individual surplus will be zero over two periods, i.e. both investors are willing to accept losses in the first stage while expecting the information rent in the second stage. Thus, both investors are also willing to accept a share in the first period which is even below the one reflected by (7.1). Therefore, bad and good entrepreneurs exert high effort in the first period. The investor's bid for the first period (s₁), which leads to a zero profit over both periods can be derived as follows:

(17)
$$0 := -\mathbf{I} + \lambda \cdot s_1(p_G + p_H) \cdot \mathbf{X} + (1 - \lambda) \cdot b_1(p_B + p_H) \cdot \mathbf{X} + \left[\lambda \frac{p_G - p_B}{p_B}\mathbf{I}\right]$$

The term in the squared brackets denotes the information rent in the second period (see (16.1)), the remaining term in (17) shows the loss in the first period which the investors are willing to accept when there is Bertrand competition. We can solve (17) for the required share in period 1, s_1 :

(18)
$$s_1 := \frac{I - \frac{\lambda(p_G - p_B)}{p_B}I}{[\lambda(p_G + p_H) + (1 - \lambda)(p_B + p_H)]X} < s_1^*$$

²⁰ Term (16.3) shows the "average" entrepreneur's individual surplus as (19.3) and (20.3) do, too.

Compared with (7.1), this first period bid is below the one in the first best. Thereby, we can justify the implicit assumption that both good and bad entrepreneurs would exert high effort in the first stage. The individual surpluses in period 1 amount to (the old investor is supposed to finance the first stage) :

(19.1)
$$Y_{Old;1} = -\lambda \frac{p_G - p_B}{p_B}I < 0,$$

(19.2)
$$Y_{\text{New};1} = 0$$
,

$$(19.3) \quad \mathbf{Y}_{E;1} \quad = \ \lambda \frac{\mathbf{p}_{G} - \mathbf{p}_{B}}{\mathbf{p}_{B}}\mathbf{I} \ + \lambda \cdot \mathbf{p}_{G}\mathbf{X} \ + (1 - \lambda) \cdot \mathbf{p}_{B}\mathbf{X} + \mathbf{p}_{H}\mathbf{X} - \mathbf{e} - \mathbf{I} > \mathbf{0}.$$

(19.4)
$$Y_{Old;1} + Y_{New;1} + Y_{E;1} = \lambda \cdot p_G X + (1 - \lambda) \cdot p_B X + p_H X - e - I > 0$$

2.3 Social surplus with and without inside investor's moral hazard

In what follows we show the individual surpluses over both periods assuming opportunistic behavior by the old inside investor (see (16.1) - (16.4) and (19.1) - (19.4)):

$$\begin{array}{lll} (20.1) & Y_{Old} &= Y_{Old;1} + Y_{Old;2} = 0 \\ (20.2) & Y_{New} &= 0, \\ (20.3) & Y_E &= \lambda \frac{(p_B X - I) p_G}{p_B} + (1 - \lambda) \cdot (p_B X - I) \\ &\quad + \lambda \frac{p_G - p_B}{p_B} I + \lambda \cdot p_G X + (1 - \lambda) \cdot p_B X + p_H X - e - I > 0, \\ (20.4) & Y_{Old} + Y_{New} + Y_E = Y_E = [\lambda p_G + (1 - \lambda) p_B] X + p_H X - e - I \\ &\quad + [\lambda p_G + (1 - \lambda) p_B] X - I > 0. \end{array}$$

Now, let us compare social surplus in the world with moral hazard with social surplus in the first best world:

(8.4)
$$Y_{Old} + Y_{New} + Y_E = Y_E = [\lambda p_G + (1 - \lambda)p_B]X + p_H X - e - I + [\lambda p_G + (1 - \lambda)p_B]X + \lambda(p_H X - e) - I > 0.$$

Proposition 2:

Comparing (8.4) with (20.4), we observe that the welfare loss in the second period due to inside investor's moral hazard amounts to $\lambda(p_HX-e)$. Since the old investor is better informed and moreover, has the right of first refusal, he can demand a quite

large share in the second period and can appropriate an information rent. Because of the less favorable financial terms, a "good" entrepreneur may not be willing to exert high effort even if it would be efficient to do so. Thus, a special form of underinvestment occurs which is due to an information monopoly of an inside investor, *although* we assumed that the entrepreneur takes all the social surplus (Bertrand competition).

3 Discussion

We address three issues: (1) Are the results still robust in the case of debt or hybrid financing ? (2) How does the negotiation problem depend on the information structure ? (3) How can the negotiation problem be mitigated ?

Ad (1): The old, inside investor's incentive to negotiate better terms in the second period is due to the informational advantage but not to the type of financing. Thus, debt financing or mixed financing would not significantly change the qualitative results of the analysis. There is, however, an important difference between equity and debt financing. Form a legal point of view, there is an upper bound on the interest rate creditors can demand thereby limiting the extent to which an inside investor could hold up an entrepreneur. According to the jurisdiction to § 138 of the German civil code ("usurious interest") interest rates exceeding a certain threshold are supposed to violate the law.²¹ At first glance, this provision may be considered to be inefficient since it restricts bargaining and the set of possible negotiation outcomes. In our model, however, it limits the investor's discretion to behave opportunistically and thus, may induce the entrepreneur to invest efficiently. Note that there are similar legal provisions in other jurisdictions, too, e.g. in many US-states.²²

Ad (2): In the model we assumed an information structure implying the biggest informational advantage possible. The old investor can *precisely* assess the entrepreneur's quality whereas the new investor has no information at all and therefore assumes an average quality. It is, however, more plausible that the old investor has at least a little piece of information.

First, one could imagine that the new investor receives some information on the fact that entrepreneur and old investor are negotiating in t=1. In our simple model the old

²¹ See *Palandt* (1999), pp. 120-122. A contractual interest rate which is either more than double the "market rate" or exceeds the market rate by 12 percentage points at least is supposed to be immoral und thus illegal.

²² See *Stehle* (1984).

investor is willing to finance a second stage even with a bad entrepreneur. If it is not worth to continue the venture of a bad type, the fact that a new investor is negotiating with an entrepreneur may be a signal to the new investor and information may be revealed. Note that the new investor has to make the first offer then.

However, even in this case moral hazard by the inside investor may occur if the new investor cannot precisely find out the true reason for a break off. Since a break off is commonly interpreted as signal for a "bad" venture,²³ the old investor may still demand a high share $s_2^{*;B}$ even with a good entrepreneur. If the old investor can credibly commit not to renegotiate the take-it-or-leave-it-offer $s_2^{*;B}$, – may be because he has the reputation not to renegotiate – the entrepreneur has to accept it. Otherwise, the relationship is finished and a new investor may interpret it as a signal for bad quality thereby adjusting (and reducing) the a-posteriori-belief λ' ($\lambda > \lambda' \ge 0$) that he has met a good type.

Informational asymmetries may be reduced in the case of *co-venturing* or syndicated venturing where several investors contribute funds. Usually, there is one lead investor who contributes more funds and monitors the entrepreneur and there are less-informed co-investors who contribute less money. In Germany, co-venturing is quite important. In 1996 to 2000, the portion of co-venturing investments to total investments amounts to approximately 35% on average, in France it is even about 40%.²⁴ Co-investors may have better information than outside investors and could sanction opportunistic behavior by the lead investor more easily. Apparently, this argument does not hold when lead investor and co-investors cooperate, e.g. when they form a kind of cartel and cooperate.²⁵ Thus, syndicated venturing may mitigate the negotiation problem and may induce the entrepreneur to invest efficiently. To my knowledge, this function of syndicated venturing has not been mentioned yet.²⁶

The new investor could also try to gather information on the entrepreneur's quality. Of course he will do so, when marginal expected benefits will exceed marginal costs. Marginal expected benefits do not only depend on the new investor's share on the cooperative surplus but also on the probability that he and the entrepreneur will write a contract. This probability is usually reduced by a provision which is quite common

²³ See Sahlman (1990), p. 510.

²⁴ See EVCA (2000), p. 38f. and the yearbooks of the German Venture Capital Association (*BVK*).

²⁵ Microeconomic theory shows that the stability of a cartel decreases with the number of its members.

²⁶ See for other explanations *Aghion/Tirole* (1994), and *Lerner* (1994). *Lerner* argues, that better decisions are possible when there is a cumulative expertise of several investors. Another reason may be risk diversification. A risk-averse venture capital firm tends to share the risk of large investments with co-investors.

in venture financing, the "right of first refusal^{"27}: when the entrepreneur presents an offer of a new investor, the old investor has the right to bind the entrepreneur offering him at least the same terms. The right of first refusal reduces the probability that the new investor will attract the entrepreneur.²⁸ Thus, this right also weakens the incentive to gather information.

Informational asymmetries may be reduced when the entrepreneur reliably signals her quality. A good entrepreneur is more willing to invest own funds. Often, however, entrepreneurs are wealth-constrained and can hardly provide a considerable amount of money which may serve as a signaling device.

Ad (3) Finally, this special moral hazard problem may be mitigated by *contractual provisions* binding the investor. For instance, in venture financing it is quite common to agree ex ante that the investor's residual cash-flow-rights depend on the venture's revenue or on non-monetary "milestones" in the previous stage.²⁹ In the literature, this contractual provision is considered to mitigate moral hazard by the entrepreneur and to make the entrepreneur put much effort into the venture.³⁰ In this model, however, moral hazard by the investor may be mitigated by this provision; they make opportunistic negotiation more difficult.³¹

In the context of venture financing there are several forms of *state subsidies* – in Germany, but also in the U.S.³² In the literature, state subsidies are justified by potential positive external effects due to innovative industries.³³ They may also be beneficial when the entrepreneur cannot sufficiently protect the property rights on her idea or when the risk-averse entrepreneur does not want to bear the personal risk of a venture's failure although it would be efficient to undertake the venture.³⁴ From our perspective, there may be some additional benefits to the financial support of state authorities. First, the entrepreneur tends to suffer the less from investor's moral

²⁷ See *Walker* (1999).

²⁸ See for this argument Argument *Walker* (1999), pp. 13-26.

²⁹ See *Kaplan/Strömberg* (2000), pp. 14, 19f., table 2 (p. 51), table 5 (p. 59).

³⁰ See Sahlman (1990), Black/Gilson (1998).

³¹ The venture's return realised in the previous stage may not sufficiently signal the entrepreneur's quality although it may be a good proxy. Thus, with this provision there may occur two types of inefficient decisions: an inefficient venture (with a bad entrepreneur who had luck) may be continued, an efficient one not (a good entrepreneur who was not lucky).

³² Financial support by state authorities is manifold: there are loans with low interest rates, state guarantees or even non-repayable subsidies. See for an international overview *Lessat et al.* (1999), pp. 190-199, see for the U.S. *Lerner* (1999).

³³ See *Lerner* (1999); pp. 290f.

³⁴ See Schäfer/Ott (2000), pp. 581-583.

hazard the smaller the investor's financial contribution is. Second, a state-run venture capital firms which co-invests when there is a lead (privately organized) investor, often has control and information rights. This restricts the lead investor behaving opportunistically. Note, however, that state subsidies may also induce some special incentive problems (e.g. collusion):³⁵ for instance, entrepreneur and private venture capital firm may cooperate and undertake an inefficient venture if both of them would benefit from it.

4. Conclusion

Possibly, the staging of capital is the most salient feature of venture financing. This feature, however, may induce opportunistic behavior by the investor. He could demand a higher share on future cash flows threatening not to continue the venture. The entrepreneur may be forced to accept the investor's offer, when she is supposed to lose something by switching to another (new) investor. If there is asymmetric information and the new investor cannot distinguish between good and bad entrepreneurs the new investor at least will demand a share reflecting the average quality; he may even demand more when he considers the termination of the first financial relationship as a signal for bad quality.

The old investor is aware of the new investor's calculus and, thus, demands a higher share. He may appropriate some rents due to his information monopoly. Though, it may be more costly for the entrepreneur to switch to the new investor. As a consequence, she sticks to the old investor, however, since her share on future cash flows is diminished, she may reduce her level of effort or specific investments although a higher level would be efficient (*underinvestment*).

This problem of expropriation depends on the information structure on the venture capital market and may be mitigated when the parties ex ante fix the financial terms of future capital infusions conditionally on the performance of previous stages. These provisions are quite common. So far, the literature has considered them as a device to mitigate moral hazard by entrepreneurs. But they can also mitigate the investor's incentive to renegotiate opportunistically.

The syndication of venture capital investments may mitigate the moral hazard by an inside investor, since co-investors are likely to be better informed than outside investors. Debt financing or mixed financing may be more favorable than equity

³⁵ See Schäfer/Ott (2000), p. 587.

financing since legal boundaries on interest rates limit the extent to which an inside investor could hold up an entrepreneur. State subsidies may mitigate the moral hazard problem, too. First, the entrepreneur tends to suffer the less from investor's moral hazard the smaller the investor's financial contribution is. Second, a state-run venture capital firms which co-invests when there is a lead-investor, often has control and information rights. This restricts the lead investor behaving opportunistically.

The model may *explain* some features of venture financing. From a *normative* point of view, there should be a law against the "right of first refusal" which gives the inside investor the option to contract upon the terms an outside investor offers and thus, often ensures that the inside investor moves after the outside investor preserving a high level of superior information.

Appendix: List of Symbols

В	index for an entrepreneur with bad entrepreneurial quality		
e	entrepreneur's effort level: high level ($e_H > 0$), low level ($e_L = 0$)		
E	entrepreneur's name		
G	index for an entrepreneur with good entrepreneurial quality		
Ι	(fixed) investment volume		
New	name of a new, non-informed investor who has not financed the first stage		
Old	name of the old, inside investor who already financed the first stage		
р	(success) probability for a high return X; 1–p is the failure probability (zero return); p depends on both entrepreneur's quality and her effort level: $p = p(T) + p(e)$.		
R_G, R_B	expected return with good (bad) entrepreneurial quality (assuming a low (zero) level of specific investments; $e_L = 0$)		
s ₁	investor's share on future returns on the first period investment		
s'2	critical share level in period 2: if an investor requires more than s', the entrepreneur will choose a low, i.e. inefficient level of specific investments		
s ^{*;B} ₂	investor's share on the second period investment with a "bad" entrepreneur		
s ^{*;G} ₂	investor's share on the second period investment with a "good" entrepreneur		
Т	type of entrepreneurial quality, there are two types: t=g (good) and t=b (bad)		
Х	return of an investment in case of success		
Y_E , Y_{Old} , Y_{New}	expected utility of entrepreneur, old investor, new investor		
λ (λ')	portion of good entrepreneurs (portion of good entrepreneurs when the first financial relationship was terminated)		

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