International Research Journal of Finance and Economics
ISSN 1450-2887 Issue 24 (2009)

http://www.eurojournals.com/finance.htm

A Note on the Role of Exit Horizon in the Selection of Projects in Venture Capital Finance

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Abstract

We build a model to highlight the role of preferences of the external investor over the project's exit horizon in venture capital finance. We show that if the external investor prefers short investment periods, then the set of eligible projects is restricted and the venture capitalist cuts off the riskier and hence more innovative projects. Our model provides a theoretical framework that supports the argument that low participation of pension funds in early stage highly innovative investments is attributed to the short exit horizon of pension fund managers. Furthermore, from the policy point of view, our model suggests that if state-owned funds extend their investment horizon, more innovative projects will be financed through venture capital finance.

Keywords: Venture capital, exit horizon, project selection, pension funds.
JEL Classification Codes: G24, G23

1. Introduction

Venture capitalists are financial intermediaries that collect funds from external investors and invest them in equity of young firms. Start-up firms who desire to implement innovative projects bear high levels of uncertainty because the value of their projects cannot be assessed by the stock market unless similar projects exist. Consequently, young innovative firms find it difficult to raise financing through standard bank credit channels and rely heavily on external investors.

From the society's point of view, the role of the venture capitalist (VC) as an intermediary between the external investor (EI) and the investee firm is essential for technological advancement. In the literature of venture capital finance, the VC - investee relation has been extensively examined and the primary focus has been on the various information asymmetry problems that occur (Marx, 1998; Casamatta, 2002; Schmidt, 2002; Cornelli and Yosha, 2003; Repullo and Suarez, 2004; Kanniainen and Keuscnnigg 2003, 2004). Specifically, the main concern of these papers is the study of the optimal contractual structure under double sided moral hazard. By the latter, we mean that not only the

[*] This research project is co-financed by the E.U.-European Social Fund (75%) and the Greek Ministry of Development-GSRT (25%)

principal VC but also the agent entrepreneur has to induce some kind of effort which affects the project's probability of success.

Despite the plethora of studies on the VC - investee relation, the literature on EI-VC interaction seems to be rather poor. To the best of our knowledge only Dessi (2005) examines the possibility of collusion between the venture capitalist and the entrepreneur at the expense of the external investors. There is also a strand of literature that focuses on the exit strategy or instrument (IPO or merger) rather than the exit horizon, see for instance Bascha and Walz (2001), Arikan (2003).

This paper studies the role of the external investor's preference over the project's exit horizon on the types of projects that the venture capitalist will select for funding. By exit horizon we mean the time of liquidation or sale of the project. Our approach differs in perspective from the ones who focus on asymmetry of information and design of optimal contracts. We claim that the external investor's time impatience, which is equivalent to a short exit horizon, is leading to the financing of safe projects, leaving out riskier but possibly more innovative ones. Consequently, the technological advancement potential of the economy is constrained.

In particular, the model consists of an external investor characterized by risk aversion and an exogenous favorite exit horizon. The external investor is supplying funds to a risk neutral venture capitalist who chooses from an endogenously determined range of projects. Each project requires an effort level from the venture capitalist which is costly and non-contractible. The optimal project decision of the venture capitalist depends on her own effort level and the characteristics of the external investor. We show that financing from an external investor whose exit horizon preference is sufficiently short, restricts the projects that a venture capitalist is willing to undertake, making riskier projects infeasible. We interpret risky projects as innovative or "early stage" investments and safer projects as buyouts or less innovative. From the policy point of view our model suggests that if technological advancement is a social priority, then state-owned funds characterized by a longer exit horizon, like pension funds for instance, should invest more in venture capital.

Having established the relation between exit horizon and the range of eligible projects, our paper sheds some light on the participation of pension funds in innovative projects. It is a popular belief that pension funds are typical investors with long term investment horizon, Mayer *et al.* (2005). This is due to their modest liquidity requirements, long term liabilities and their somehow deterministic expenses. Despite the importance of pension funds on strengthening the venture capital supply (see for example Jeng and Wells, 2000), the participation of pension funds in the financing of highly innovative and early stage investments is found to be limited. Mayer *et al.* (2005) analyze data of Germany, Israel, Japan and UK and show that pension fund participation has no statistically significant effect on early stage investments. In the same direction, Da Rin *et al.* (2006) find no evidence of pension funds' significance on innovative and early stage VC investments.

The Myner (2001) report on U.K. pension funds provides a possible explanation on the insignificance of pension fund participation in early stage and innovative projects which is consistent with the result of our model. In particular, although pension funds are traditionally characterized by a long term investment horizon, according to Myner (2001), U.K. pension fund managers are short-termists in the sense that they are mostly concerned with the short term performance of their investees. Our model provides the theoretical background that supports this view. According to it, the impatience of pension fund managers (EIs) is responsible for the low participation of pension funds in early stage, high risk investments because they restrict the set of eligible projects that are chosen by the venture capitalist, cutting off the more innovative ones.

The organization of the paper is the following: In section 2, we present the model and describe the characteristics of the projects, the external investor and the venture capitalist. In section 3, we derive the range of optimal projects and we show that it reduces when the favorite liquidation horizon of the external investor gets shorter. In section 4, we conclude.

2. The Model

We construct the simplest possible model consisting of a representative external investor, a venture capitalist and a set of start-up firms which are identified by their investment projects.

2.1. The Investment Projects

There exists a continuum $[\underline{\theta},\bar{\theta}] \subset \Re_+$ of investment projects. An investment project $\theta \in [\underline{\theta},\bar{\theta}]$ is characterized by its net return $R(\theta)$ and its risk $V(\theta)$. The net return can be viewed as the proceeds from an Initial Public Offering (IPO) and is distributed according to an increasing and continuous probability distribution F with density *f* and support $[0,\infty]$. The net expect return of project θ is

$$ER(\theta) = \int_0^{\infty} Rf(R;\theta)dR \tag{1}$$

In order to make projects comparable, we will assume that they all have the same positive net expect return but different risk, so that for every $\theta_2 \geq \theta_1$, $ER(\theta_2) = ER(\theta_1)$ and $V(\theta_2) \geq V(\theta_1)$ or

$$\int_0^{\infty} Rf(R;\theta_2)dR = \int_0^{\infty} Rf(R;\theta_1)dR\,, \tag{2}$$

$$\int_0^{x} F(R;\theta_2)dR \geq \int_0^{x} F(R;\theta_1)dR, \quad \forall x \geq 0\,, \tag{3}$$

that is, all distributions have the same mean but $F(R;\theta_2)$ is a mean preserving increase in spread of $F(R;\theta_1)$ and thus represents greater risk, i.e. θ_2 is riskier than θ_1 and every risk averse agent would prefer $F(R;\theta_1)$ to $F(R;\theta_2)$.

We will also assume that each project can be liquidated at any date $t \in [\underline{t},\bar{t}]$, where $[\underline{t},\bar{t}] \subset \Re_+$ is the interval of all possible exit dates. The expected date of exit depends on the level of effort $e \in [\underline{e},\bar{e}]$, put on the project by the venture capitalist. Effort is costly. We denote the corresponding cost with $c(e):[\underline{e},\bar{e}] \to \Re_+$ such that $c'(e) > 0, c''(e) > 0$. The exit date is distributed according to a continuous and increasing function $G(t;\ e)$ such that for any $e_1 < e_2$, $G(t;e_2) \geq G(t;e_1)$ (first order stochastic dominance) which implies that

$$\forall t > \underline{t}, \quad \int_t^{\bar{t}} tg(t;e_1)dt \geq \int_t^{\bar{t}} tg(t;e_2)dt \tag{4}$$

i.e. greater effort results in earlier expected date of liquidation. We also assume that for each effort level *e* there corresponds a unique expected exit date $t = \int_{\underline{t}}^{\bar{t}} tg(t;e)dt$.

To summarize, since all projects have the same net expect return, they are distinguished by their risk level, which is exogenously given and their liquidation or exit date, which will be endogenously determined in our model as an outcome of the interaction of the venture capitalist and the external investor.

2.2. The External Investor

The external investor is characterized by risk aversion and a favorite or individually optimal exit horizon $t^{EI} \in [\underline{t},\bar{t}]$. Let y^{EI} be the difference between the expected exit date of the project and EI's favorite one:

$$y^{EI} = \int_{\underline{t}}^{\bar{t}} tg(t;e)dt - t^{EI} \tag{5}$$

The external investor bears a positive delay cost in terms of expected utility and is given by the function $C^{EI}(y):[\underline{e},\bar{e}] \to \Re$, such that $C_e'(y) < 0, C_e''(y) > 0$ when $y > 0$. When the expected exit date

of the project is posterior to her favorite one, $t > t^{EI}$, there is positive delay cost $C^{EI}(y) > 0$, otherwise, when $t \le t^{EI}$, the delay cost is zero, i.e $C^{EI}(y) = 0$

Let $EU^{EI}[R(\theta)]$ be the EI's expected utility level corresponding to the return of project θ. Due to risk aversion if θ_2 is riskier than θ_1 or $\theta_2 > \theta_1$ then $EU^{EI}[R(\theta_2)] < EU^{EI}[R(\theta_1)]$. The role of the EI in our model is limited in deciding whether to finance a specific project or not. In her decision the EI takes into account the risk and the individual delay cost corresponding to the expected exit date of the project. An external investor finances a project if and only if

$$EU^{EI}[R(\theta)] - C^{EI}(y^{EI}(e)) \ge \overline{U}^{EI} \tag{6}$$

where $\overline{U}^{EI}$ is the utility level which she can guarantee for herself by investing in some other project. It can be seen as an investment with less return and risk compared to the investment on venture capital (outside option).

2.3 The Venture Capitalist

We will assume, as it is standard in the literature, that the capitalist is risk neutral. Given that all projects have the same expected return and the fact that due to risk neutrality the venture capitalist disregards any variability in returns, her preferences can be summarized by her favorite exit horizon $t^{VC} \in [\underline{t}, \bar{t}]$. Recall that to each expected exit date there corresponds a unique effort level, so in the absence of effort cost and external funding the venture capitalist would ideally choose an arbitrary project $\theta \in [\underline{\theta}, \overline{\theta}]$ and a level of effort e that would liquidate the project at an expected exit date $t \le t^{VC}$, that is an e such that $\int_{\underline{t}}^{\bar{t}} tg(t;e)dt \le t^{VC}$. However, the venture capitalist is constrained in her decision by the fact that she must convince the external investor to fund the project (the so-called participation constraint) and the fact the her effort is costly. Let y^{VC} be the difference between the expected exit date of the project and venture capitalist's favorite one, defined analogously to (5), $y^{VC} = \int_{\underline{t}}^{\bar{t}} tg(t;e)dt - t^{VC}$. The venture capitalist bears a positive delay cost in terms of expected utility and is given by the function $C^{VC}(y) : [\underline{e}, \bar{e}] \to \Re$, which satisfies the same properties as $C^{EI}(y)$ but the two cost functions need not be identical.

3. The Choice of Project

The venture capitalist faces the following maximization problem:

$$\min_{e,\theta} c(e) + C^{VC}(y^{VC}(e)) \tag{7}$$

$$s.t. \quad EU^{EI}[R(\theta)] - C^{EI}(y^{EI}(e)) \ge \overline{U}^{EI}$$

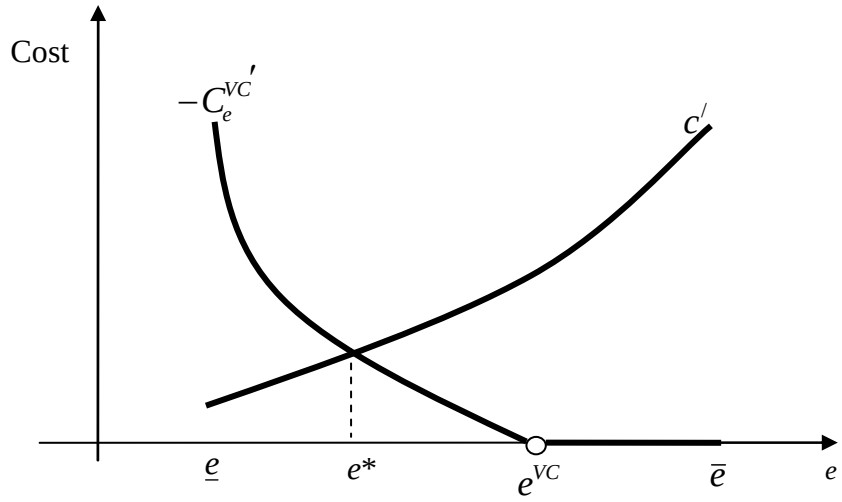
She must choose an effort level and a project so as to minimize her effort and delay cost and satisfy the participation constraint that guarantees a utility level $\overline{U}$ to the external investor. Increasing effort generates two effects for the venture capitalist. On the one hand, it increases the effort cost but on the other hand it decreases the delay cost since the project's expected exit horizon comes closer to her favorite one. Hence, the optimal level of effort *e** for the VC is such that

$$c'(e^*) = -C_e^{VC\prime}\left(\int_{\underline{t}}^{\bar{t}} tg(t;e^*)dt - t^{VC}\right) \tag{8}$$

which means that the marginal cost of effort must be equal to the marginal benefit of the reduction of the delay cost. Since the marginal cost of effort is always positive, *e** cannot belong to the interval $(e^{VC}, \bar{e}]$ where there is no delay cost. Notice that $C_e^{VC\prime}$ is zero in the interval $(e^{VC}, \bar{e}]$, where $\int_{\underline{t}}^{\bar{t}} tg(t;e^{VC})dt = t^{VC}$, negative in $[\underline{e}, e^{VC})$, and undefined for $e = e^{VC}$. Since $c'(e)$ is always positive, the

two marginal cost functions in (8) can intersect only in the $[\underline{e}, e^{VC})$. To summarize, the venture capitalist will never choose an effort level, say e', that induces an expected date posterior to her favorite one, $t(e') > t(e^{VC})$, so in fact it is always optimal for her to bear a positive delay cost. The VC will choose an optimal level of effort e^* which belongs to the interval $[\underline{e}, e^{VC})$, as figure 1 shows. Given e^*, the corresponding expected exit date of the project is $t(e^*) \in (t^{VC}, \bar{t}]$.

Figure 1: Optimal Effort Level



Once the optimal effort level e^* is chosen, the external investor's delay cost $C^{EI}(y^{EI}(e^*))$ is determined. The optimal choice of project θ by the VC must satisfy the participation constraint

$$EU^{EI}[R(\theta)] \geq \overline{U}^{EI} + C^{EI}(y^{EI}(e^*)). \quad (9)$$

in other words the venture capitalist will suggest a project that guarantees the external investor an expected utility level that equal to the level corresponding to her outside option and her delay cost.

Our fundamental question is whether a change in the liquidation horizon or exit date of the external investor will affect the risk of the project chosen by the venture capitalist. Our result is the following:

Proposition *If the external investor is risk averse and the venture capitalist is risk neutral, then the shorter the investment horizon of the external investor, the fewer and less risky projects will be selected as eligible for funding by the venture capitalist.*

Proof: The proof is in the appendix. We present a sketch of the proof here. Suppose that the liquidation horizon of the external investor becomes shorter. Then according to our assumptions on the delay cost functions, the external investor's delay cost C^{EI} will increase. The venture capitalist who is constrained by (9) has two options in order to cover the increased delay cost of the external investor: either to increase her effort e so that the expected exit date decreases or choose a project with less risk so that the expected utility of the external investor increases. However, as (8) shows, changing the effort level is not efficient for the venture capitalist. By increasing her effort, the venture capitalist will induce a deviation from e^* that would result in a suboptimal new effort level where effort cost is higher for the venture capitalist and delay cost is lower for both. On the other hand by choosing a less risky project given the optimal effort level, she increases the expected utility of the external investor, without affecting her own delay cost. Put differently, it is always dominant for the risk neutral venture capitalist to choose more risk, than costly effort. Consequently a decrease in the external investor's liquidation horizon will cause the venture capitalist to choose a less risky project instead of a higher effort level that would have shortened the expected exit date. So safer projects will continue to be eligible for selection, nevertheless a range of riskier but more effort intensive ones will be excluded.

4. Conclusion

We have built a model to highlight the role of the preferences of the external investor over the exit horizon in venture capital finance. We have shown that external investor's short term time preference or impatience can restrict the set of eligible projects by cutting off riskier ones. By interpreting riskier investments as early stage (seed) or highly innovative ones, we provide the theoretical background to explain the empirical evidence on low participation of pension funds in early stage investments given that pension fund managers have a short exit horizon. Furthermore, from the policy point of view, our model suggests that if state-owned funds extended their investment horizon, we would expect more innovative projects to be financed through venture capital.

Appendix

Proof of Proposition

The Lagrangean of the venture capitalist's minimization problem (8) writes:

$$L(e,\theta,\lambda) = c(e) + C^{VC}(y^{VC}(e)) + \lambda\left(EU^{EI}[R(\theta)] - C^{EI}(y^{EI}(e)) - \overline{U}\right) \tag{10}$$

Given that $e > 0$, $\theta > 0$, the first order conditions for maximum are:

$$\frac{\partial L}{\partial e} = 0 \Rightarrow \frac{\partial c(e)}{\partial e} + \frac{\partial C^{VC}(e)}{\partial e} - \lambda \frac{\partial C^{EI}(e)}{\partial e} = 0, \tag{11}$$

$$\frac{\partial L}{\partial \theta} = 0 \Rightarrow \lambda \frac{\partial EU^{EI}[R(\theta)]}{\partial \theta} = 0, \tag{12}$$

$$\frac{\partial L}{\partial \lambda} \geq 0 \text{ and } \lambda \frac{\partial L}{\partial \lambda} = 0 \Rightarrow EU^{EI}[R(\theta)] - C^{EI}(y^{EI}(e)) - \overline{U} \geq 0 \tag{13}$$

$$\text{and } \lambda\left(EU^{EI}[R(\theta)] - C^{EI}(y^{EI}(e)) - \overline{U}\right) = 0$$

Due to risk aversion $\partial EU^{EI}[R(\theta)]/\partial\theta < 0$ so from relation (12) we have $\lambda = 0$ and the complementary slackness condition reduces to

$$EU^{EI}[R(\theta)] \geq \overline{U} + C^{EI}(y^{EI}(e)). \tag{14}$$

The The optimal level of effort e^* is given in (8) which is derived from (11). The optimal choice of project θ^* is given by (9) which is derived from (14) for $e = e^*$. Let θ' be such that

$$EU^{EI}[R(\theta')] = \overline{U} + C^{EI}(y^{EI}(e^*)),$$

then any $\theta \in [\underline{\theta}, \theta']$ is optimal since it satisfies (14). Now suppose that the favorite investment horizon t^N of the external investor were shorter, $t^N < t^{EI}$. We must show that the project which corresponds to the shorter horizon t^N will be less risky than the one that corresponds to t^{EI}. If $t^N < t^{EI}$, then from (5) we have that $y^N > y^{EI}$, where $y^{EI} = \int_{\underline{t}}^{\bar{t}} tg(t;e)dt - t^{EI}$. Since $C^{EI}(y)$ is increasing, the external investor bears a higher delay cost, $C^{EI}(y^N) > C^{EI}(y^{EI})$. For (14) to hold the venture capitalist must choose a project θ such that $EU^{EI}[R(\theta)] \geq \overline{U} + C^{EI}(y^N(e^*))$.

Let θ^N be such that $EU^{EI}[R(\theta^N)] = \overline{U} + C^{EI}(y^N(e^*))$. Then any $\theta \in [\underline{\theta}, \theta^N]$ is optimal since it satisfies (14). Since $C^{EI}(y^N) > C^{EI}(y^{EI})$ it follows that $EU^{EI}[R(\theta^N)] > EU^{EI}[R(\theta')]$ which implies that $\theta^N < \theta'$ due to risk aversion. Consequently $[\underline{\theta}, \theta^N] \subset [\underline{\theta}, \theta']$, or the range $(\theta^N, \theta']$ of optimal projects has been cut off because the investment horizon of the external investor became shorter.

So we have shown that if the range of optimal projects that correspond to t^{EI} is $[\underline{\theta}, \theta']$, then for a shorter investment horizon $t^N : t^N < t^{EI}$, the optimal range of projects reduces to $[\underline{\theta}, \theta^N] \subset [\underline{\theta}, \theta']$. which represents safer projects.■

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