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Financing Choices and Corporate Governance along a Firm's Life Cycle

Julia Hirsch
Iberoamerican University Mexico City

Uwe Walz
University Frankfurt and CFS

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Financial Markets Group, London School of Economics and Political Science, LSE, UK
Dipartimento di Scienze Economiche e Finanziarie Prato, Università di Torino, TORINO, Italy
Centre for Financial Studies, CFS, Germany
Haute Etudes Commerciales, HEC, France
Baltic International Center for Economic Policy Studies, BICEPS, Latvia
Amsterdam University, UVA, Netherlands
Neaman Institute for Advanced Studies in Science and Technology at Technion, TECHNION, Israel
Indian School of Business, ISB, India
Tilburg University, UTIL.CER, Netherlands
University of Southern Switzerland, USI, Switzerland
The Institute of Physics, IBP, Serbia

Financing Choices and Corporate Governance along a Firm's Life Cycle

Julia Hirsch and Uwe Walz[1]

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Abstract

We analyze in a two-period model whether and how financing decisions and choices of corporate governance structures in early phases of a firm's development affect their future financing and project choices. We show that high preferences for corporate control lead entrepreneurs to choose a low growth development path which mainly involves bank-financed low risk projects. Furthermore, the efficiency of active investors (venture capitalists) decisively governs firm dynamics. Mature VC markets allow firms to choose rather rapid development paths which eventually lead them to become large and to go public early in their life time. Finally, if there are many innovative projects available (e.g. due to new technological developments or to globalization), it becomes attractive for the entrepreneurs to seek the VC's support even if VC markets are less developed. This, in turn, induces growth in these markets. Thus, we are able to stress the interaction between the development of firms and the VC market, an interaction which can go in both directions.

JEL Classification: G24, G32, G34

Keywords: Firm dynamics, corporate governance, financing choices, venture capital

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Nontechnical Summary

The dynamics of young firms play a crucial role with respect to economic growth and development in a given economy. The entry of young firms and their further expansion are decisive not only for employment dynamics but also for the process of creative destruction underlying economic growth in developed economies. The entry and expansion process is very much affected by the access to adequate financing and the proper professionalization and corporate governance of the respective firms. Without these two ingredients the likelihood of success is very large making such ventures rather insignificant for the overall development of the economy. Despite the recognition of the importance of firm dynamics on the evolution of industries and economies, there exists a crucial gap in research, especially as concerns the analysis of the interrelation between financing and corporate governance choices over the life cycle of a firm.

In the aftermath of Modigliani/Miller 1958, a huge theoretical literature on the financing and corporate governance choices of mature firms has been developed. In addition, there exists a significant body of theoretical research on financing decisions and governance structures of young, start-up firms. But, there are very few analyses which link these two branches in order to investigate financing choices and corporate governance over time together.

There exist important empirically observed stylized facts about the dynamics of financing and corporate governance structures of firms. Especially striking are the insights about firms which are financed by active investors (i.e. venture capitalists). We know that they tend to grow faster with respect to real assets, sales and employment. They are more innovative on average, the average period of time until these firms go public is shorter and their likelihood of failure is lower. In addition, empirical studies suggest that there are significant differences across countries with respect to the development of young firms. Whereas we find in the US a significant number of big gorillas (i.e. start-up firms which grow and mature very fast), they are almost entirely absent in Europe.

In order to address these stylized facts, we construct a model which allows us to represent the dynamics of a firm's financing and governance structures and potential path dependencies. We ask to which extent the initial financing and governance mode of the start-up determines its future project and financing choices as well as the growth path of the firm. Do there exist any differences between active and passive investors as concerns the evolution of a young start-up firm (especially with respect to corporate governance and hence the likelihood of going public)? Which factors are the crucial determinants of the sequence of choices?

We investigate the financing choices and the associated corporate governance structures of a firm in two phases of its life cycle. In a first phase, the firm has to decide on its initial start-up structure by choosing a specific project and a specific type of investor for the financing of this project. In a later, more mature phase, the firm may choose a specific expansion strategy for its business and has to decide on the mode of financing of this expansion. We distinguish two types of investors: active investors providing capital and advice and passive investors providing only capital. It turns out that it is optimal for the passive investor (say a bank) to provide debt while the active investor (say a VC) optimally uses equity. The firm can choose among three projects which differ in their degree of innovativeness and riskiness. The payoffs of the two more innovative projects can be improved by the advice of the active investor. A successful innovative project in the first phase enables the firm to exercise a growth option and to invest in the most innovative project in the second phase. This project in the expansion phase can, however, only become a success with the help of an active investor and the thereby resulting governance and professionalization strategy of the firm. The notion of an embedded growth option which plays an important role if active investors are involved is supported by a number of observable features in VC financing. The most notable feature in this regard is one of the crucial characteristics of many VC investments: staging which is not only common in the US but also widespread in other countries. A further indication for the relevance of growth options can be seen in the distribution of VC financing across industries. For example, in the US 80 percent of all VC investments take place in what is typically termed growth industries (such as software, biotechnology, semiconductors etc.).

The main empirical implications of our model are the following. First, our model predicts a positive relationship between the maturity of the VC market and firm dynamics. With maturing VC markets (or other types of active investors), we should observe faster growing firms. Second, we should expect a strong impact of the initial owner's preference for corporate control on firm dynamics. The stronger the initial owner's private benefits for control the more reluctant he is to relinquish control to an active investor implying more debt-financing, fewer realization of growth options and a firm growth path with a significantly smaller slope. Third, our model predicts that economic shocks which make more innovative projects available will lead to more early and later stage investments by active investors leading to faster professionalization and potential growth of firms but also to an expansion of the market for active investors. Overall, we are thus stressing the interaction between firm development and financing, on the one hand, and the development of the market for active investors, on the other hand - an interaction which can go in both directions.

A. Introduction

The dynamics of young firms play a crucial role with respect to economic growth and development in a given economy. The entry of young firms and their further expansion are decisive not only for employment dynamics but also for the process of creative destruction underlying economic growth in developed economies. The entry and expansion process is very much affected by the access to adequate financing (see Aghion et al. 2007 and Bartelsmann et al. 2003) and the proper professionalization and corporate governance of the respective firms (cf. Hellmann/Puri 2002). Despite the recognition of the importance of firm dynamics on the evolution of industries and economies, there exists a crucial gap in research, especially as concerns the analysis of the interrelation between financing and corporate governance choices over the life cycle of a firm.

In the aftermath of Modigliani/Miller 1958, a huge theoretical literature on the financing and corporate governance choices of mature firms and corporations has been developed (see e.g. Tirole 2006 for an overview). In addition, there exists a significant body of theoretical research on financing decisions and governance structures of young, start-up firms. But, there are very few analyses which aim at linking these two branches of the mentioned literature (two notable exceptions are Fluck 2000 and Inderst/Mueller 2007) in order to investigate the relationship of financing choices and corporate governance not only at a given point in time but over time. The main objective of our analysis is to contribute to partially fill this gap.

There exist important empirically observed stylized facts about the dynamics of financing and corporate governance structures of firms. Especially striking are the insights about firms which are financed by active investors (i.e. venture capitalists). We know that they tend to grow faster with respect to real assets, sales and employment. They are more innovative on average, the average period of time until these firms go public is shorter and their likelihood of failure is lower (cf. Puri/Zarutskie 2008). In addition, empirical studies suggest that there are significant differences across countries with respect to the development of young firms. Whereas we find in the US a significant number of big gorillas (i.e. start-up firms which grow and mature very fast), they are almost entirely absent in Europe (cf. Inderst/Mueller 2007).

In order to address these stylized facts, we construct a model which allows us to represent the dynamics of a firm's financing and governance structures and potential path dependencies. We ask to which extent the initial financing and governance mode of the start-up determines its future project and financing choices as well as the growth path of the firm. Do there exist

any differences between active and passive investors as concerns the evolution of a young start-up firm (especially with respect to corporate governance and hence the likelihood of going public)? Which factors are the crucial determinants of the sequence of choices?

We construct a model which allows us to spell out the main economic mechanisms as clearly as possible. We investigate the financing choices and the associated corporate governance structures of a firm in two phases of its life cycle. In a first phase, the firm has to decide on its initial start-up structure by choosing a specific project and a specific type of investor for the financing of this project. In a later, more mature phase, the firm may choose a specific expansion strategy for its business and has to decide on the mode of financing of this expansion. We distinguish two types of investors: active investors providing capital and advice and passive investors providing only capital. It turns out that it is optimal for the passive investor (say a bank) to provide debt while the active investor (say a VC) optimally uses equity. The firm can choose among three projects which differ in their degree of innovativeness and riskiness. The payoffs of the two more innovative projects can be improved by the advice of the active investor. A successful innovative project in the first phase enables the firm to exercise a growth option and to invest in the most innovative project in the second phase. This project in the expansion phase can, however, only become a success with the help of an active investor and the thereby resulting governance and professionalization strategy of the firm. The notion of an embedded growth option which plays an important role if active investors are involved is supported by a number of observable features in VC financing. The most notable feature in this regard is one of the crucial characteristics of many VC investments: staging which is not only common in the US (see Sahlmann 1990) but also widespread in other countries. Staging which consists of either round financing or milestone financing allows to abandon a project or to learn about the potential future development of the firm (see Bergemann/Hege 1998). Especially the latter is consistent with our notion of a sequential structure of projects with a growth option in the second stage. Bienz/Hirsch 2008 show that especially milestone financing (with capital injections being contingent on milestones) can cope with the higher flexibility to react to growth options but overcome the associated hold-up problem of the VC.

While modeling staged financing as an alternative is beyond the scope of our paper we consider it nevertheless as a clear signal that growth options matter in VC financing. A further indication for the relevance of growth options can be seen in the distribution of VC financing across industries. For example, in the US 80 percent of all VC investments take place (see

NVCA 2006) in what is typically termed growth industries (such as software, biotechnology, semiconductors etc.).

The main empirical implications of our model are the following. First, our model predicts a positive relationship between the maturity of the VC market and firm dynamics. With maturing VC markets (or other types of active investors), we should observe faster growing firms. Second, we should expect a strong impact of the initial owner's preference for corporate control on firm dynamics. The stronger the initial owner's private benefits for control the more reluctant he is to relinquish control to an active investor implying more debt-financing, fewer realization of growth options and a firm growth path with a significantly smaller slope. Third, our model predicts that economic shocks which make more innovative projects available will lead to more early and later stage investments by active investors leading to faster professionalization and potential growth of firms but also to an expansion of the market for active investors. Overall, we are thus stressing the interaction between firm development and financing, on the one hand, and the development of the market for active investors, on the other hand - an interaction which can go in both directions.

Our analysis is related to three branches of the literature. First of all, our study is similar in a number of aspects to the papers focusing on venture capital financing. Especially, the results of the papers who have concentrated on the choice of venture capital funding vis-a-vis the funding from other financial intermediaries such as banks (cf. e.g. Landier 2004 and Ueda 2004), business angels (cf. Chemmanur/Chen 2003) or on the choice of different types of VCs (cf. Hirsch/Walz 2007) constitute an important basis for our analysis. Furthermore, we consider aspects of the papers which analyze the impact of venture capital financing on a firm's development through their impact on its professionalisation strategy (Hellmann/Puri 2002), its standing on the product market (Hellmann/Puri 2000) as well as its overall development (Puri/Zarutskie 2008). We distinguish ourselves from the mentioned literature by investigating interdependencies between financing mode and corporate governance over time rather than by focusing on financing choices and their impact on a firm at a specific moment. In addition, our paper is closely related to Inderst/Mueller 2007 who model the impact of VC financing in an asymmetric information framework and strategic interaction on the product market. They show that as past investments have an important impact on the future competitiveness of the firm, the decision for VC financing may represent an important strategic advantage. The focus of our paper differs from this paper as we model only very roughly the influence of VC financing on the project´s outcome but are rather interested in

the overall determinants of the financing sequences over time, especially potential changes from one investor type to another.

Second, our paper is closely related to the large capital structure literature. This literature has focused on static analyses and larger firms for a long time. However, in recent years, dynamic aspects gained importance (see, for example, Shyam-Sunder/Myers 1999). Thus, there also exist some first empirical studies which analyze the financing choice of firms at different points of their life cycle (see, for example, Rocha Teixeira/Coutinho dos Santos 2005) or which study the temporal relationship between the choice of different sources of financing (see, for example, Cantillo/Wright 2000). The two theoretical papers on optimal financing choices which are most close in spirit to our analysis are the papers of Berger/Udell 1998 and Fluck 2000. In their synopsis, Berger/Udell 1998 show which financing alternatives are available for young firms at different stages of their development. The different alternatives may be substitutes or complements. Therefore, this approach is an important starting point for our analysis as it allows for different potential sequences of financing over the life cycle of young firms as in our model. On the other hand, Fluck 2000 shows that future financing decisions are influenced by previous financing decisions and that the latter ones may differ from the previous ones. This is due to the dependence of control rights of subsequent investors (who can draw on the rights of the existing investors in order to get their debt claims) on the previous situation. In our model, these interdependencies are crucial, too.

Third, our analysis relates to a number of studies on family firms which analyze the interdependence of the specific characteristics of these firms with the capital markets. Anderson et al. 2002, for example, empirically analyze the impact of family ownership on the agency cost of debt, thereby stressing the effects of ownership on financing modes and costs. Bhattacharya/Ravikumar 2001 construct a dynamic model to analyze the impact of primary capital markets on the evolution of the family business. While sharing the dynamic aspect of firm development with our paper, they focus on the dynamic interaction within a family rather than with outside investors over time. Erhardt et al. 2006 analyze the evolution of ownership, control, and performance in German family-owned firms over the last century by employing a hand-collected matched sample of German stock companies founded before World War I and still in existence in 2003. We rely on their finding that families are slow to give up ownership, and that control of family businesses remains strong even after several generations.

The paper is organized as follows. In the next section, we provide the basic set-up and derive the equilibrium project, financing and corporate governance choices. Afterwards, we analyze the main aspects which drive the firm's decision at the different stages of its life cycle.

Therefore, in a first step, we assume that we are confronted with a relatively little developed VC market which is not able to offer financing at very early stages of a firm's development. In a second step, we discuss - with the aid of a numerical example - the consequences of the availability of early stage VC financing and the aspects which govern the project, financing and corporate governance choices in relatively more developed VC markets. The last section concludes.

B. The model

I. The basic set-up

We consider a young firm which can choose between different projects and financing modes at two subsequent stages in time. We will refer in the following to the initial owners of the firm as entrepreneurs. As the entrepreneur is wealth-constraint, he has to approach an outside investor in order to get the projects financed. The entrepreneur possesses at each stage initial wealth W which he uses to finance the firm. The initial investment amounts to I+W independently of the choice of the project. So, in order to facilitate notation we interpret I as the financing amount which must be financed by outside investors. Moreover, we assume that it always pays off for the entrepreneur to invest his initial wealth W.

We consider three alternative projects and rank them according to their risk-return profile. Project 1 is the riskiest project while project 3 is the safe project. Project 2 ranges in-between. At the first stage, the firm can choose among projects 2 and 3. In addition to different realized returns, this choice has an impact on the project choice at stage II. To be more precise, project 2 enables the firm to exercise the valuable growth option, i.e. to invest in the high risk-high return project 1, given that project 2 was successful. In case of failure, the firm can only realize project 3. On the contrary, having invested in project 3 at the first stage limits the firm's alternatives at the second stage to projects 2 and 3. In a nutshell, this implies that the basic choice at the first stage is between a risky first stage project (project 2) which opens up the potential of expanding the firm and a safe, but less dynamic development path (project 3).

The success probabilities p_i (i = 1, 2, 3) of the three alternative projects can be ranked as follows: $p_1 < p_2 < p_3 = 1$. In case of failure, all projects yield zero returns. This assumption which is mainly chosen for sake of simplicity could potentially give the investor the incentive to liquidate the firm in the case of failure (if he possesses a debt-like claim). However, since we limit our analysis to situations in which the expected returns of the second stage allow to

cover the costs of the investor in both stages (most notably we assume that $R_3 - 2I \geq 0$), it always pays for the investor to renegotiate his debt rather than to liquidate the firm.

The monetary returns of project 3 are independent of the mode of financing and denoted by R_3. On the contrary, the returns of the two risky projects depend on the investor's advice activities e_i (i denoting the stage at which the advice is granted). We distinguish between two types of investors: active investors which are able to provide advice to the firms at costs $\frac{1}{2}\gamma e_i^2$ (with $0 < \gamma < 1$) and other (passive) investors with prohibitively high costs for providing advice. We will refer to the first type of investors as VCs and to the second type as banks which may have a monitoring but no advice technology. We allow for perfect competition in the banking as well as in the VC industry. We consider this to be a reasonable approximation of the allocation of bargaining power in hot issue markets and in economies with rather little entrepreneurial activity.[2] Though, as time proceeds, the investors of the first stage may have gained important information about the firm creating a lock-in effect. We assume, however, that the entrepreneur is able to credibly communicate the firm's situation to outside investors thereby ensuring perfect competition for follow-on investments of the same investor at stage II as well.

Moreover, we assume that investors as well as entrepreneurs are risk-neutral.[3] The advice activities of the VCs increase the returns of the risky projects in case of success (project 2) or are even necessary in order to generate positive outcomes (project 1). To be more precise, project 2 yields a success return of $(1+ e_i)R_2$ and project 1 of e_iR_1.[4] We implicitly assume that the entrepreneur's incentive problem is solved as long as she gets a minimum share of the firm's equity.[5] In addition, we assume that in equilibrium the more innovative the project the higher the expected returns, i.e. $p_1 \min[1, e_i^*] R_1 > p_2R_2 > R_3$ with e_i^* denoting the profit-maximizing advice level. Making the involvement of the active VC investor necessary for the profitability of project 1 depicts the notion that these projects do not only require substantial technological ideas but also professional management expertise which can either be provided directly or indirectly by the VC (Hellmann/Puri 2002).

Besides monetary returns, entrepreneurs obtain private benefits from running the firm. The extent of these control benefits depends, however, on the firm's governance structure. If the firm is financed by passive investors, the entrepreneur's private benefits amount to U_B. On the contrary, the involvement of an active investor in the firm reduces the entrepreneur's private benefits by τ. This simple representation of control losses reflects the idea that active investors tend to restrict the discretionary powers of entrepreneurs even if the firm turns out to

be a success. In order to allow for a straightforward analysis, we abstract from the empirically observable positive relationship between the level of advice and the allocation of control rights towards the VC (see e.g. Bienz/Walz 2007). Rather we depict the control parameter in a simple shift parameter which is independent of the level of advice.[6] The level of τ varies across entrepreneurs depending on their valuation of the private benefits, i.e. family owners may attribute a major value to running the firm than, for example, professional managers. Hence, taking this loss of control benefits into account, the entrepreneurs are confronted with an obvious trade-off when deciding on the source of financing: active investors may provide return-enhancing advice while leading to losses in control benefits whereas passive investors only provide capital but leave the control benefits of the entrepreneurs in place.

In each of the two stages, we model the following sequence of moves. First, entrepreneurs decide on the project they want to invest in. Second, investors, who know the project choice, compete by offering different contracts to the entrepreneurs. After having signed one of the contracts, the entrepreneurs invest in the chosen project. Then the investors decide on the level of advice they are willing to provide. Finally, the project's cash-flows are realized. Figure 1 depicts the whole time line. Overall, we solve for the subgame perfect equilibrium. The rate of interest is normalized to zero.

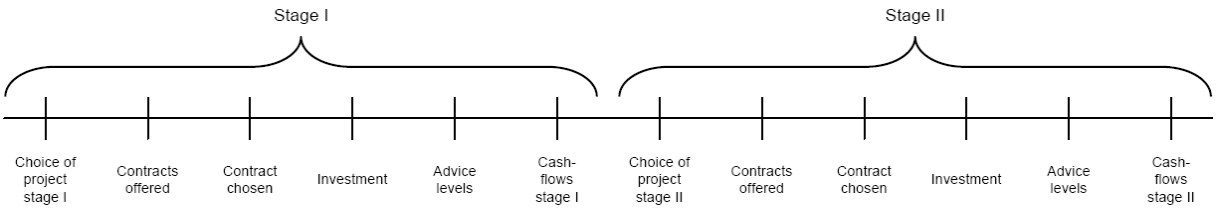

Figure 1: Time line of the model

Before we turn to the detailed analysis, it is helpful to stress that our chosen set-up implies that the choice of investors for projects 1 and 3 is straightforward. With project 3, there does not exist any comparative advantage of the active VC investor because advice is not productive. Given the loss of control associated with the VC's engagement in the firm, it is definitively better to finance project 3 with a bank rather than involving a VC investor. The reverse is true for project 1. There, funding with a bank would imply that the project would never realize any positive returns due to the bank´s prohibitively high costs of advice. Hence, the firm is only able to realize the investment if a VC is involved. This implies that we can restrict our analysis to cases in which project 3 is financed by a bank and project 1 by a VC. Only for project 2 both sources of financing are viable. Figure 2 provides an overview of the

sequence of project choices and the respective possible sources of financing. We will now turn to the analysis of the equilibrium choices at the second stage of our game.

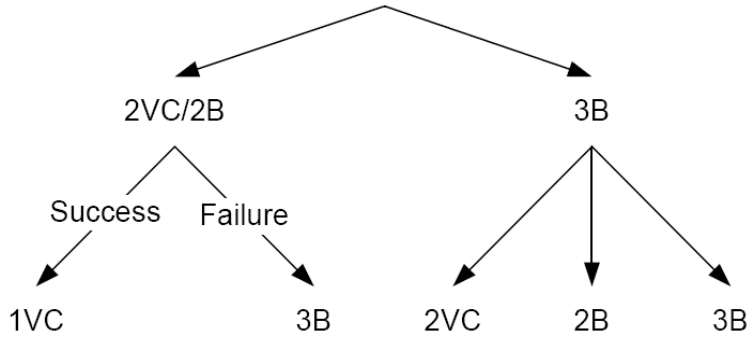

Figure 2: Sequence of project choices and the respective possible sources of financing

II. Project financing and corporate governance at stage II

We start by analyzing project financing and corporate governance at the second stage subsequent to the choice of project 3 at the first stage. Afterwards, we turn to the project and financing choices following project 2 at the first stage.

1. Decisions following project 3 at stage I

We have to distinguish three subcases at stage II following project 3 at stage I: a bank-financed project 3, a bank-financed project 2 and a VC-financed project 2 (see figure 2).

For a *bank-financed project 3*, the analysis is straightforward. As banks offer competing contracts, they will just break-even in equilibrium, i.e. they will only be compensated for the initial investment I. Thus the entrepreneur's monetary returns will amount to R_3 - I.[7] Taking non-monetary control benefits into account gives us the entrepreneur's total returns at the second stage:

(1) $$\Pi^{E,II}_{3B,3B} = U_B + R_3 - I.$$

Analogously, we can determine the entrepreneur's total returns with a *bank-financed project 2*:

(2) $$\Pi^{E,II}_{3B,2B} = U_B + p_2 R_2 - I.$$

For a *VC-financed project 2*, the analysis is slightly more complicated as we have to use backward induction. In addition, we know that it is optimal to employ a pure equity contract as mode of financing in order to address the moral hazard problem of the VC.[8] Expected profits of the VC financing this project are:

$$\Pi_{2B,2VC}^{VC,II} = \alpha_{II}^{2} p_2 (1 + e_{II}^{2}) R_2 - \frac{1}{2}\gamma (e_{II}^{2})^2 - I,$$

with α_{II}^{2} denoting the VC's equity share with a type 2 project. The variable e_{II}^{2} stands for the advice level chosen at stage II with project 2. This leads us to the optimal level of advice:

$$(e_{II}^{2*}) = \frac{\alpha_{II}^{2}}{\gamma} p_2 R_2.$$

Taking the zero-profit condition of the VC into account yields the following share of the VC of the firm's total equity:

$$(\alpha_{II}^{2*}) = \gamma \left(\sqrt{1 + \frac{2I}{\gamma}} - 1 \right) / p_2 R_2.$$

This implies for the total returns of the entrepreneur:

(3) $$\Pi_{2B,2VC}^{E,II} = U_B - \tau + p_2 R_2 \sqrt{1 + \frac{2I}{\gamma}} - 2I + \gamma \left(\sqrt{1 + \frac{2I}{\gamma}} - 1 \right).$$

2. Decisions following project 2 at stage I

In case the firm has opted for project 2 at stage I, the subsequent project and financing choices depend on the outcome of project 2 at the first stage. If project 2 turned out to be a success, the firm will continue with project 1. On the other hand, if project 2 turned out to be a failure, the firm will proceed with project 3 despite the potential debt-overhang from the previous period since $R_3 \geq 2I$. It is important, however, to take into account whether project 2 was financed by a VC or a bank at the first stage.

If *project 2 was bank- (and hence debt-) financed*, the total expected profit of the entrepreneur at the second stage after a failure of the first stage project 2 and therefore the choice of project 3 amounts to:

(4) $$\Pi_{2B,3B}^{E,II} = U_B + R_3 - 2I.$$

If project 2 was a success, the firms will opt for a VC-financed project 1 at stage II. Here, it is important to take into account that the entrepreneur still owns the entire firm at the beginning of the second stage as the firm was so far bank-financed. Therefore, the profit function of the VC at stage II is:

$$\Pi_{2B,1VC}^{VC,II} = \alpha_{II}^{1} e_{II}^{1} p_1 R_1 - \frac{1}{2}\gamma (e_{II}^{1})^2 - I,$$

with α_{II}^{1} denoting the VC's equity share with a type 1 project after a successful bank-financed project 2 and e_{II}^{1} the VC's advice level chosen in this case. Using the incentive constraint to

determine the optimal effort level and the binding participation constraint to determine the minimal fraction of the VC in the firm undertaking project 1 at stage II leads us to

$$(\alpha_{II}^{1*}) = \frac{\sqrt{2I\gamma}}{p_1 R_1},$$

and the optimal advice level chosen in this case is

$$(e_{II}^{1*}) = \sqrt{\frac{2I}{\gamma}}.$$

Plugging this result into the entrepreneurs profit function yields the following total returns for the entrepreneur:

$$\Pi_{2E,1VC}^{E,II} = U_E - \tau + p_1(a_{II}^{1*})\, R_1 - I - \frac{1}{2}\gamma\,(e_{II}^{1*})^2$$

$$= U_E - \tau + p_1 R_1 \sqrt{\frac{2I}{\gamma}} - 2I. \qquad (5)$$

If, in contrast, *project 2 was VC-financed*, the total expected profit of the entrepreneur at the second stage after a failure of the first stage project 2 and therefore the choice of project 3 amounts to:

$$\Pi_{2VC,3E}^{E,II} = U_E - \tau + (1 - \alpha_I)\,(R_3 - I), \qquad (6)$$

with α_I denoting the equity share of the VC stemming from the first stage.

If project 2 turns out to be a success, the derivation of the optimal incentives and the equilibrium contract of a VC-financed project 1 at the second stage becomes more complicated. One of the main reasons for this is the fact that the VC has an incentive to provide effort and advice due to the initial equity share from the first round of financing. As a consequence of the moral hazard problem, it is further optimal to finance the second stage with equity as well, leaving us with two sources for the incentives to provide effort and advice. For matters of concreteness, we assume that both stages are financed by the same VC investor[9]. In order to determine the total level of advice provided by the VC at the second stage, we have to consider the VC's profit function at the second stage:

$$\Pi_{2VC,1VC}^{VC,II} = \alpha p_1 e_{II} R_1 - \frac{1}{2}\gamma e_{II}^2 - I,$$

with e_{II} denoting once again the total advice level provided at the second stage and α representing the VC's total equity share after having provided financing at stage II. The VC's total equity share stems from the equity share of stage I (α_I) and stage II (α_{II}). Correspondingly, total advice consists of the sum of the advice levels resulting from the

incentives from the VC's equity shares of stage I (e_{II}^{I}) and stage II (e_{II}^{II}), respectively. Note that due to the sequence of moves, the VC will only be compensated for the investment costs and the incremental advice costs, i.e. $\frac{1}{2}\gamma\left[e_{II}^{2}-(e_{II}^{I})^{2}\right]$. Maximizing the VC's objective function gives us:

(7) $$e_{II}^{*}=\frac{\alpha_{II}}{\gamma}p_1R_1=e_{II}^{I}+e_{II}^{II}=\frac{\alpha_{I}}{\gamma}p_1R_1+\frac{\alpha_{II}}{\gamma}p_1R_1.$$

Plugging the optimal advice level e_{II}^{*} stemming from the investment at the second stage in the VC's profit function:

$$\Pi_{2VC,1VC}^{VC,II/II}=\alpha_{II}p_1e_{II}^{*}R_1-\frac{1}{2}\gamma((e_{II}^{*})^{2}-(e_{II}^{I})^{2})-I$$

gives us after some computations the equilibrium stage II equity share:

(8) $$\alpha_{II}=\frac{\sqrt{2I\gamma}}{p_1R_1}.$$

Note that the VC's profits resulting from the first period's equity share ($\Pi_{2VC,1VC}^{VC,II/I}$) amount to $\alpha_I e_{II}R_1-\frac{1}{2}\gamma(e_{II}^{I})^{2}$. They are taken into account later on and, together with $\Pi_{2VC,1VC'}^{VC,II/II}$ add up to $\Pi_{2VC,1VC'}^{VC,II}$.

Hence, we can state the entrepreneur's profit function from financing project 1 at stage II with a VC after a successful VC-financed project 2 at stage I:

(9) $$\Pi_{2VC,1VC}^{E,II}=$$

$$U_B-\tau+(1-\alpha_I-\alpha_{II})p_1\alpha_{II}^{*}R_1=U_B-\tau+\left(1-\alpha_1-\frac{\sqrt{2I\gamma}}{p_1R_1}\right)\left(\alpha_1+\frac{\sqrt{2I\gamma}}{p_1R_1}\right)\frac{(p_1R_1)^{2}}{\gamma}.$$

III. Project financing and corporate governance at stage I

We can now turn to stage I. We know that the entrepreneur can choose between project 3 financed by a bank or project 2 financed either by a bank or a VC.

As concerns project 3, the analysis is straightforward. The entrepreneur's payoffs resulting from a bank-financed project 3 at stage I always amount to U_B+R_3-I.

Hence, we can determine the entrepreneur's total profit resulting from both stages for the case that he chooses the less dynamic development path starting with project 3 at the first stage. With a bank-financed project 3 at the second stage, the entrepreneur just receives the same payoffs at stage I and at stage II (see equation (1)) and thus, total payoffs are given by:

(10) $$\Pi^{E}_{3B,3B} = 2(U_B + R_3 - I).$$

In case a bank-financed project 2 follows, the entrepreneur obtains (see equation (2))

(11) $$\Pi^{E}_{3B,2B} = 2U_B + R_3 + p_2 R_2 - 2I.$$

As concerns project 2 at the first stage, the analysis is more complicated. Especially, we have to distinguish between bank- and VC financing at the first stage.

With bank-financing of project 2 at the first stage, we know that in the case of failure, a bank-financed project 3 follows (see equation 4)) whereas in case of success, the firm will invest in a VC-financed project 1 (see equation 5)). We get the following total payoff function of the entrepreneur:

(12) $$\Pi^{E}_{2B,3B/1VC} = 2U_B - p_2\tau + p_2\left(R_2 - R_3 - I + p_1 R_1\sqrt{\frac{2I}{\gamma}}\right) + R_3 - 2I.$$

Finally, we turn to a VC-financed project 2 at stage I. Here, it is important to note that the VC of stage I not only participates in the costs and benefits of project 2 at stage I but also of the projects in which the firm invests at stage II. This is due to the fact that his equity share from stage I continues to exist at stage II. This equity share, in turn, gives rise to additional incentives to provide advice given project 1 is realized at stage II. These additional effort costs are due to the VC's initial share in the company and are therefore not compensated by the stage II contract. Hence, we can express the VC's objective function at the first stage as:

(13) $$\Pi^{VC,I}_{2VC,3B/1VC} = \alpha_I p_2(1+e_I)R_2 - \frac{1}{2}\gamma e_I^2 - I + p_2\left(\alpha_I p_1(e_{II}^I + e_{II}^H)R_1 - \frac{1}{2}\gamma(e_{II}^I)^2\right) + (1-p_2)\alpha_I(R_3 - I).$$

The first term denotes the direct expected net returns form project 2 at stage I, whereas the second (third) term represents the VC's net returns emerging from project 1 (3) at stage II. Taking first order derivatives with respect to e_I yields:

$$e_I^* = \frac{\alpha_I}{\gamma} p_2 R_2.$$

Plugging the optimal effort level into the VC's objective function yields after some calculations:

(14) $$\Pi^{VC,I}_{2VC} = (\alpha_I)^2\Gamma + \alpha_I\Omega - I,$$

with

(15) $$\Gamma = \frac{(p_2R_2)^2 + p_2(p_1R_1)^2}{2\gamma},$$

and

(16) $$\Omega = p_2 R_2 + p_2 p_1 R_1 \sqrt{\frac{2I}{\gamma}} + (1 - p_2)(R_3 - I).$$

Solving for a binding participation constraint of the VC gives us the following equilibrium equity share of the VC related to his first stage investment:

$$\alpha_I^* = \delta\left(\sqrt{1 + 2I/\delta\Omega} - 1\right),$$

with $\delta = \frac{\Omega}{2\Gamma}$ and hence, the following total payoff function of the entrepreneur:

(17) $$\Pi^B_{2VC,3B/1VC} = 2(U_B - \tau) + p_2(1 + \alpha_I^*)R_2(1 - \alpha_I^*) + (1 - p_2)(1 - \alpha_I^*)(R_3 - I)$$

$$+p_2(1 - \alpha_I^* - \alpha_{II}^*)\,\Pi^1_M = 2U_B - 2\tau + p_2 R_2 - \alpha_1 p_2 R_2 + 2\Gamma(\alpha_1 - \alpha_1^2) + (1 - p_2)(1 - \alpha_1)$$

$$(R_3 - I) + (1 - 2\alpha_1)p_2 p_1 R_1 \sqrt{\frac{2I}{\gamma}} - 2p_2 I \text{ with } \alpha_I = \delta\left[\sqrt{1 + \frac{2I}{\delta}} - 1\right].$$

C. The dynamics of project and financing choices

We are now able to analyze the entire sequence of decisions as well as the determinants governing the dynamic choices of projects, financing modes and corporate governance. The entrepreneur can potentially choose between five different sequences (see figure 2) which we denote by the succession of projects and investor types: 3B-3B; 3B-2B; 3B-2VC; 2B-3B/1VC; 2VC-3B/1VC whereby the first (second) term refers to the project and investor type chosen at the first (second) stage.

In order to be able to analyze the determinants governing the dynamics of project and financing choices, we have to compare the entrepreneur's total payoffs with the different options. In a first step, we can eliminate the sequence 3B-3B as we can show that on the basis of our assumption the sequence 3B-3B is strictly dominated by the 3B-2B sequence. 3B-3B<3B-2B (meaning that the 3B-2B sequence dominates the 3B-3B sequence) translates into:

$$2U_B + 2R_3 - 2I < 2U_B + R_3 + p_2 R_2 - 2I,$$

which holds true since $R_3 < p_2 R_2$. Since the non-monetary returns of the entrepreneur are the same, the project sequence leading to higher monetary returns turns out to be dominant[10]. Hence, we are left with four options. Pair wise comparisons lead to six different cut-off levels with respect to the entrepreneur's valuation of the loss of private benefits through the involvement of an active investor (τ). Table 1 shows the denomination of the different cut-off levels which indicate the maximum level of τ for which the stated inequality still holds. All

cut-off levels are derived in the appendix. We separate our analysis of the dynamics of financing and project choices into two parts. In a first step, we assume that - for institutional reasons - VC financing is not possible at the first stage. This means that we rule out the sequence 2VC-3B/1VC. In a second step, we introduce the possibility of early stage financing. Our procedure allows us to analyze two different institutional settings separately and deduce important insights for both young VC markets as well as matured VC industries.

Table 1: Cut-Off Levels

Comparison	3B-2B≤ 3B-2VC	2B-3B/1VC ≤3B-2VC	3B-2B≤ 2B-3B/1VC	3B-2VC≤ 2VC-3B/1VC	3B-2B≤ 2VC-3B/1VC	2B-3B/1VC≤ 2VC-3B/1VC
Cut-off levels:	B_1	B_2	B_3	B_4	B_5	B_6

I. The dynamics of project and financing choices without early stage financing

In the absence of proper early stage financing but with later stage private equity financing, the firms face three potential paths for their development: 3B-2B; 3B-2VC and 2B-3B/1VC. The relevant cut-offs are B_1, B_2, and B_3. In order to understand the firm's choices, we need to take a closer look at these cut-off levels. First, it turns out that B_1 is always positive (all calculations can be found in the appendix). Furthermore, we find that $B_3 > B_1 > B_2$ if advice is sufficiently productive (i.e. if γ is not too large) and if project 1 is sufficiently innovative (i.e. if R_1 is sufficiently large)[11]. We assume this to hold true for the moment. In a second step, we will discuss the reverse setting. For the mentioned scenario, the resulting project and financing choice sequences for the different valuation levels of the private benefits by the entrepreneur are depicted in figure 3.

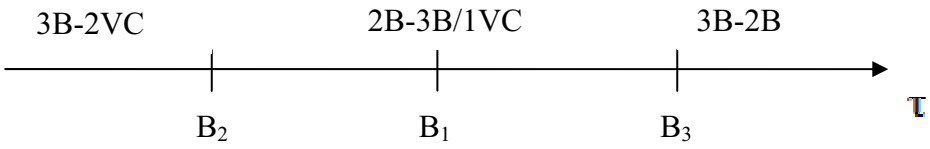

Figure 3: Project choices without early stage VC financing

The intuition behind this order of the financing and project choices is rather straightforward. Entrepreneurs with pronounced preferences for control (high τ) prefer the 3B-2B sequence, thereby trading off the possibility of potential high monetary returns (due to advice activities and/or the growth option) in favor of control benefits. This depicts e.g. the situation of families wanting to hold tight control over their firms. On the other extreme, entrepreneurs with low benefits of control who are more interested in monetary returns choose the 3B-2VC

sequence (given that B_2 is positive) or the 2B-3B/1VC sequence. The latter one represents the in-between solution since the loss of control is realized only in cases in which the first period project is a success, i.e. with a less-than-one probability. Taken together, these results also show that if the entrepreneur's preferences for control decrease (e.g. because firms are handed over to next generations which weigh monetary returns more strongly compared to control benefits) more active investors become involved in later stages.

Besides looking at the effects of a decrease in control benefits on the project choice, it is definitely interesting to look into other comparative static effects (see the appendix for the formal derivations). We find that an increasing γ (i.e. an reduced efficiency of the VC sector in less mature VC markets) leads to a shift of B_3 to the left. In addition, we can show that the difference between B_3 and B_2 shrinks while the effect on B_2 is indeterminate. This implies that VCs get - due to their reduced efficiency - a smaller market share either because they finance fewer projects 2 and/or projects 1 at the second stage. At the same time, the share of firms choosing the 2B-3B/1VC sequence decreases, making it less likely to observe firms on a high growth-high risk path which may become successful ventures having matured in a rather short period of time. In contrast, firms on a low growth-low risk path (choosing project 3 at stage I and project 2 at stage II) are more likely to emerge, implying that the overall economic dynamics are reduced and private equity markets loose importance. If γ increases even further our above condition is violated implying $B_2 > B_1 > B_3$. In this case of a sufficiently low productivity of the private equity investors, the intermediate project type in figure 3 vanishes, i.e. 2B-3B/1VC sequences are completely abandoned. Hence, we will not observe any very fast growing, risky firms anymore.

Considering the effect of larger expected payoffs of project 1 (i.e. increasing p_1R_1) which we interpret as a higher degree of innovativeness, we find that B_3 (B_2) shifts to the right (left). Hence, we should expect that firms in industries with a high degree of innovativeness and strong growth options choose more often the 2B-3B/1VC sequence. These firms will not only go for riskier projects at the second stage, but they will also start with riskier projects by choosing a bank-financed project 2 at the first stage. This means that our analysis predicts that economic shocks which open up the potential for more innovation (e.g. in the biotechnology or internet sector) lead to more involvement of active investors and therefore of equity-like financing as well as more firms on a high growth-high risk path and thus a more dynamic economic environment. In contrast, in an economy and/or in industries with a low degree of innovativeness (small p_1R_1), we find few high risk and fast growing firms. If the degree of

innovativeness is too low the possibility that such firms emerge even vanishes completely (i.e. our above condition is violated once again) leading to an elimination of the intermediate range (2B-3B/1VC) projects.

Finally, pronounced profitability of low risk projects (i.e. a large R_3) implies that firms will choose a development path which offers little growth potential. They are more likely to opt for project 3 in period 1 (B_3 shifts to the left and B_2 to the right) thereby foregoing the growth option in period 2. That is, our model predicts that firms facing rather profitable low risk investments (e.g. a solid and profitable traditional sector) will choose hands-off, passive investors in the first place and employ debt-like financing instruments. This reduces, in turn, their potential to expand in the future and to benefit from the comparative advantage of the active investors. That is, a pleasant outlook at the beginning hampers future upward potential.

II. The dynamics of project and financing choices with early stage financing

In an economy in which early stage VC financing is available (i.e. with more mature VC industries), the 2VC-3B/1VC sequence becomes feasible. It is rather straightforward that the choice of this sequence requires rather low valuation levels of control benefits since the entrepreneur foregoes the respective control benefits at both stages. This explains why this additional sequence 2VC-3B/1VC would rank lowest in figure 3, i.e. to the left of the 3B-2VC sequence.

In order to be able to analyze in detail the scenario of more mature VC markets, we have to consider three additional cut-off levels: B_4, B_5, and B_6 (see appendix for details). The actual ranking of the different financing and project choice sequences depends on the relative order of these cut-off levels with respect to B_3 and B_2. In general, we can say that the additional sequence becomes available for a low enough τ. Thereby, it either sums up to the existing options (in which case all four (or three) options would be chosen by entrepreneurs with different preferences for control depending on the initial situation) or replaces either only the 3B-2VC sequence or even both the 3B-2VC as well as the 2B-3B/1VC sequence (if existent). It turns out that the last case is only feasible under very specific assumptions. Thus, to avoid looking at this rather extreme case, we focus in the following on the two first cases and their comparative statics. Rather than going through the lengthy and complicated analytic analysis, we prefer to depict the comparative statics graphically with the aid of a numerical example. We will take a basic example and will then analyze the impact of the same three parameters as in the previous subsection, i.e. the efficiency of the VC industry (γ), the innovativeness and

the availability of growth options in the economy ($p_1 R_1$) and the profitability of the traditional sector (R_3).

In the appendix, we show that the patterns in the figures display the general structure. Table 2 outlines our benchmark case (deviations are explicitly noted).

Table 2: Numerical example

R_1	R_2	R_3	p_1	p_2	I
900 (600*)	100	40	0.1	0.5	20

*in order to represent the availability of more or less innovative projects 1.

We will start by analyzing the impact of γ on the project and financing choices. Looking at figure 4 which displays the variation in γ against the background of a pronounced degree of innovativeness of project 1 reveals that in developed VC markets, i.e. in markets with a low γ, the financing choice of the entrepreneur is primarily governed by his preference for private benefits of control.

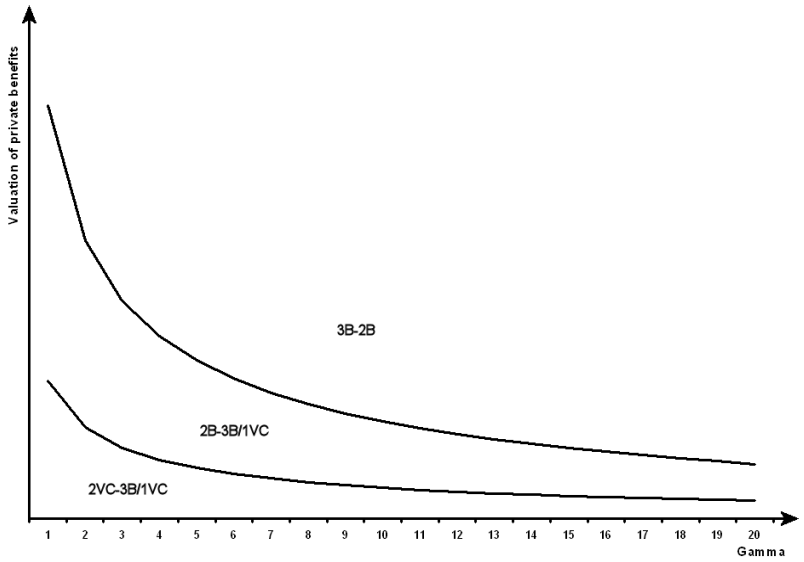

Figure 4: Financing choices with a variation in γ; $R_1 = 900$

If he attaches high importance to maintaining control, he will choose the sequence 3B-2B. The firm starts with a traditional secure project 3 and then continues by investing in the in-between project 2. Nevertheless, both projects will be debt-financed via banks in order to avoid relinquishing control to the investor. On the other hand, entrepreneurs with a low or intermediate valuation of private benefits prefer project 2 at the first stage thereby opening up the possibility for future growth via project 1. As entrepreneurs are less interested in private benefits, the growth option becomes relatively more valuable. For those entrepreneurs with the lowest valuation it even pays off to finance this project 2 with money from a VC as the

relatively low advice costs guarantee that the increase of the cash flows of project 2 (as well as of project 1) for the entrepreneur through the VC's involvement is higher than the loss in private benefits. Entrepreneurs with an in-between valuation of private benefits, on the contrary, will continue to finance the first stage project via a bank even though they choose project 2 as they still see the benefits in the growth project 1 but no longer in a VC-financed project 2.

In less developed VC markets (in which γ is larger), the area where the sequence 3B-2B is chosen enlarges whereas the parameter range in which the risky project is chosen at the first stage (i.e. the sequences 2VC-3B/1VC and 2B-3B/1VC) is selected shrinks (see figure 4). This phenomenon can be explained by the fact that as VC financing becomes more and more expensive and thus has a lower and lower impact, entrepreneurs have to value private benefits less and less in order to be willing to relinquish control to the VC. Broadly spoken, this also implies that the likelihood of big gorillas to emerge via VC involvement - one of our stylized facts - increases with the maturity of the VC market.

If we allow for a lower innovativeness of project 1 (i.e. choose a lower R_1) the picture changes only slightly (see figure 5). There are two qualitative differences.

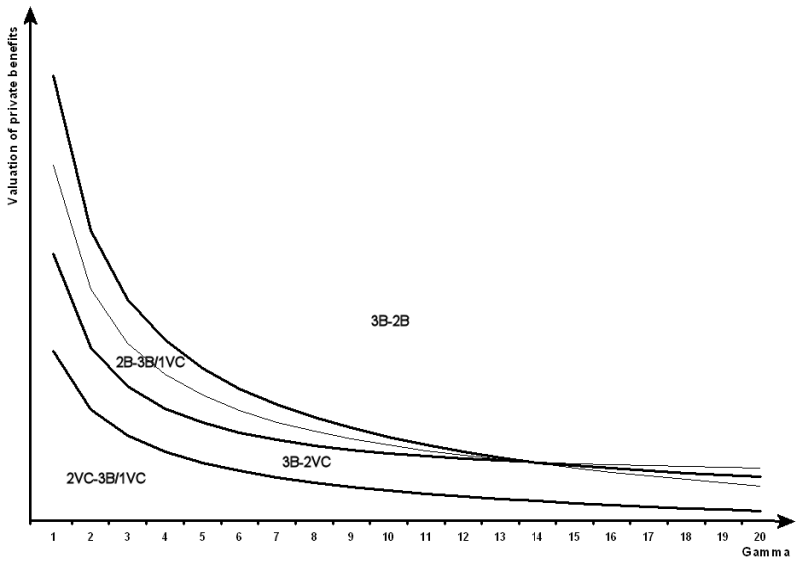

Figure 5: Financing choices with a variation in γ $R_1 = 600$

First of all, the sequence 3B-2VC is now potentially chosen. Second, the 2B-3B/1VC sequence vanishes completely if advice costs exceed a specific level. Both phenomena can be easily explained by the fact that loosing control benefits is the main cost of VC financing whereas the cash-flow enhancing advice is the main benefit. This result is further reinforced as with a little innovative project 1, the difference between project 1 and project 2 shrinks.

Therefore, the choice of project 2 at the first stage in order to have access to the growth option does not longer pay off, but entrepreneurs prefer the secure project at stage I which always gives the possibility to realize the VC-financed project 2 at stage II. Moreover, if control benefits become lower, it is in the interest of the entrepreneur to opt more often (in terms of probabilities) for VC involvement. That is, entrepreneurs move from no VC involvement to VC involvement in case of success at stage I, further to unconditional VC involvement at stage II and finally, to VC involvement at both stages (if possible). This implies that in economies or industries with a relative low degree of innovativeness, we will also see later stage VC involvement in firms with a rather flat growth path. Only for entrepreneurs with very little control benefits it pays off to demand VC financing in early stages of the development of a firm.

Secondly, it is also interesting to have a closer look on how the degree of innovativeness in an economy influences the financing choices in the presence of potential early stage VC financing. We will analyze this relation for developed VC markets. In less developed VC markets (i.e. in markets with a relatively high γ), the results do not change qualitatively.

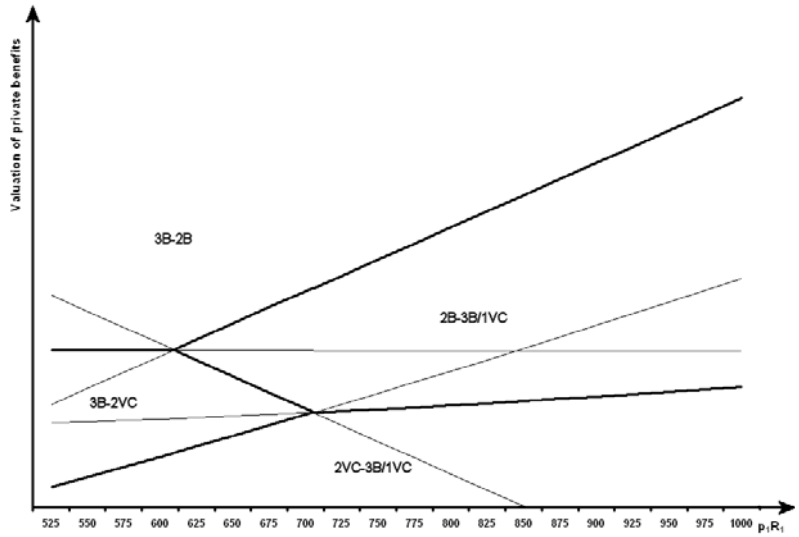

Figure 6: Financing choices with a variation in p_1R_1 $(\gamma = 5)$

In figure 6, we can observe the trade-off between the benefits of control and the degree of innovativeness which governs the choice between the safe project 3 and project 2 with the incorporated growth option. For high benefits of control, the entrepreneur gives up choosing the 3B-2B sequence to switch to a project sequence with the growth option (the 2B-3B/1VC) with an increase in the innovativeness of project 1. On the contrary, for lower control benefits the entrepreneur gives up the 3B-2VC sequence in case of an increasing R_1 in order to invest in project 2 at the first stage which enables the growth option. Depending on the valuation of

the private benefits, he either chooses a VC or a bank to finance this project 2 (i.e. the 2VC-3B/1VC sequence or the 2B-3B/1VC sequence respectively). This means that the more innovative the project 1, the more entrepreneurs - even those with a medium valuation of private benefits - are willing to undertake the risk of a project 2 investment as an early stage investment in order to realize this growth option. Only with relative low levels of innovativeness and/or pronounced benefits of control, the safe early stage investment project 3 is still chosen. Furthermore, we observe that the higher the expected cash-flows of project 1, the more probable is the choice of the VC at the first stage. The intuition for this is that the increased contribution of the VC(s) at the second stage is the more valuable the more innovative project 1 becomes. VC financing as from the first stage increases the advice level of the VC(s) at the second stage. This implies that entrepreneurs with a higher valuation of private benefits will also opt for the sequence 2VC-3B/1VC if project 1 is highly innovative even though they have to relinquish control in both stages. Overall we would expect to see VC financing involving active corporate governance especially in high-tech industries. Firms in these industries are also more likely to go public early since they are financed by VCs which aim to disinvest their shares stemming from both period investments. The active involvement of the VC makes it further more likely that these firms are also ready to go public early. Thus, economic shocks leading to the availability of more innovative projects imply an expansion of VC financing in early stages as well as later (expansion) stages.

Finally, it is also important to take a closer look at the impact of an improvement of the traditional project 3. We will again distinguish two scenarios. First of all, we will have a closer look on relatively developed VC markets (i.e. a low γ) and projects 1 with a relatively high degree of innovativeness. As can be seen in figure 7, there is a three part choice between 3B-2B, 2B-3B/1VC and 2VC-3B/1VC. The more profitable the safe project 3, the more entrepreneurs will choose this project at the first stage. The choice of early stage financing is, however, hardly affected by the profitability of project 3.

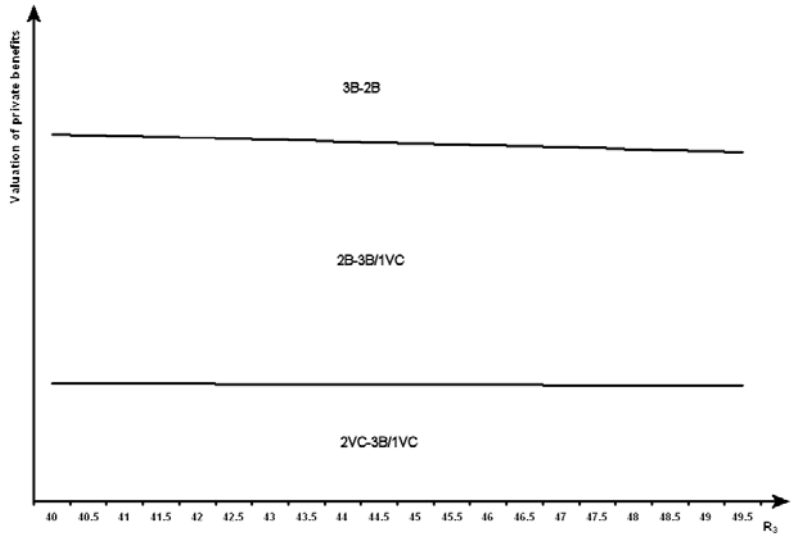

Figure 7: Financing choices with a variation in R_3 $(\gamma = 5,\ R_1 = 900)$

In relatively less developed VC markets (see figure 8), one important difference emerges: the sequence 2B-3B/1VC is substituted by the 3B-2VC sequence. This is due to the fact that project 1 is not sufficiently attractive for entrepreneurs with an intermediate valuation of private benefits due to the low degree of innovativeness of project 1. If the safe project 3 increases in profitability, entrepreneurs choose this project more often at the first stage. However, the 3B-2B sequence is not affected but the 3B-2VC sequence gains the respective loss of the 2VC-3B/1VC sequence. This stems from the fact that for entrepreneurs with an intermediate to high valuation of control benefits the decision to be taken is not about the sequence of projects but only about the investor at the second stage (VC or bank). Therefore, we observe no effect of a profitability increase in project 3 on the choice between these two alternatives. The mentioned gain of the 3B-2VC sequence with an increase in the payoff of project 3 at the expense of the 2VC-3B/1VC sequence, on the other hand, emerges from the fact that an increasing payoff of the third project makes it relatively more attractive to choose project 3 right away rather than only in the case of failure as in the 2VC-3B/1VC sequence. Hence, more profitable safe projects make early stage VC financing less likely.

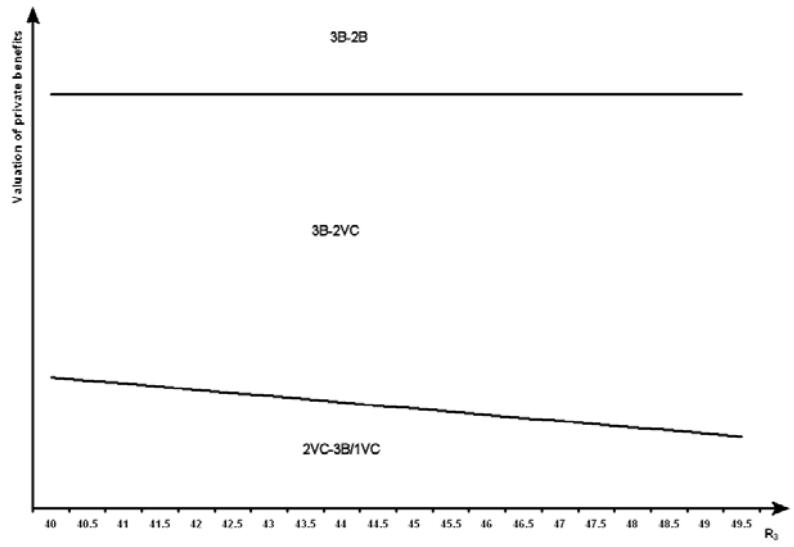

Figure 8: Financing choices with a variation in R_3 $(\gamma = 15;\ R_1 = 600)$

D. Conclusion

One of the main lessons learned from the discussion in the corporate finance literature in the aftermath of Modigliani/Miller 1958 is the way in which investment and financing decisions may interact and that corporate governance structures typically have a decisive impact on the performance as well as the development of a firm. The main aim of this paper was to go one step beyond by looking at the interaction over time of investment decisions, on the one hand, and financing and corporate governance decisions, on the other hand. Our simple two-period model - though abstracting from a number of important issues - still enabled us to come up with a number of empirical hypotheses. The main ones are:

1. Reductions in the valuation of private benefits of control (e.g. in the course of handing over firms to next generations) lead to the involvement of active investors in a larger number of cases especially in later stage but also in early stage investments. This, in turn, leads to steeper growth paths of firms.
2. Reversely, firms with owners with strong preferences for control (such as founder-owned firms) are restricted in their dynamics and are typically debt-financed.
3. We should expect from our analysis a positive relationship between the maturity of VC markets (especially in the early stage segment) and firm dynamics.
4. Economic shocks leading to the availability of more innovative projects lead to an expansion of equity financing and a larger share of VC-backed firms in early but also in later stage segments.

While testing these hypotheses is obviously beyond the scope of the paper, we nevertheless would like to discuss some broad observations supporting our hypothesis beyond the stylized facts discussed in the introduction. The first hypothesis can be related to the observation that in the course of handing over firms from the founder generation(s) to the further generations, active investors (PE investors) become involved in quite a number of cases. Whereas the founder generation, has typically high benefits of control this is less so with subsequent generations. Furthermore, we often observe that VC and PE-backed firms are managed by professional managers (see Hellmann /Puri 2002) which typically have rather low benefits of control. Relatedly, founders of VC-backed firms often have previous management experience (see, for example, Bienz/Hirsch 2008 who show that this is often the case in Germany) thereby lending clear support for our first two hypotheses. The findings of Kortum/Lerner 2000 can be seen as strong indirect indication for our third hypotheses: in a mature VC market like the US, VC-backed firms are significantly more innovative, thereby exhibiting stronger firm dynamics. The fourth hypothesis is supported by the steep increase in VC fundraising and the associated expansion of VC activity during the years of the internet boom. Last but not least, we would like to stress that the observed return profiles are in line with our arguments on the mapping of projects to active investors. Typically, we find rather high mean returns (gross of fees) which are however, widely distributed around the mean with quite fat tails at the bottom (see e.g. Cumming/Walz 2006).

In addition, we could have modified our set up so as to allow that the advice activities of the VCs enhance the success probabilities of the risky projects rather than only the project returns in case of success. If we suppress the thereby induced strategic interaction between the different stages but interpret our setting more widely in this direction, we get additional interesting insights. Most importantly, the increase in risk in the economy due to the shift to more riskier projects (i.e. to more firms which choose the expansion path at the first stage - project 2 and subsequently project 1 or 3 respectively), may be compensated by the fact that type 2 projects are more frequently VC-backed implying lower probabilities of failure (see Puri/Zarutskie 2008).

Obviously, our analysis is only a first step towards the understanding of the interaction of financing and investment choices as well as corporate governance structures over the life cycle of a firm. It would be definitely interesting to explore in more detail a more sophisticated contractual design between the active investor and the firm considering also the entrepreneur's moral hazard problem, but also to leave more room for the involvement of the bank. In addition, it would be interesting to allow for strategic behavior at the first stage and

thus more dependencies between both stages. Furthermore, it would be important to take lock-in effects of the entrepreneur as well as different competition structures of the financing markets into account. Finally, combining risk-aversion of the entrepreneur and an impact of VC advice on the success probabilities would add further interesting insights which would by and large draw the entrepreneur away from high-risk bank-financed projects. We consider these (and there are definitely many more others) as very interesting routes for the future exploration of the dynamics of a firm's development.

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Appendix

Derivation of cut-off levels

a) 3B-2B ≤ 3B-2B

$$2U_B + 2R_3 - 2I \leq 2U_B + R_3 + p_2R_2 - 2I$$

$$R_3 \leq p_2R_2$$

⇒ This is – due to our assumptions – always fulfilled.

b) 3B-2B ≤ 3B-2VC

$$2U_B + R_3 + p_2R_2 - 2I \leq 2U_B - \tau + R_3 - 3I + p_2R_2\sqrt{1+\frac{2I}{\gamma}} + \gamma\left[\sqrt{1+\frac{2I}{\gamma}} - 1\right]$$

$$\tau \leq [p_2R_2 + \gamma]\left[\sqrt{1+\frac{2I}{\gamma}} - 1\right] - I \equiv B_1$$

c) 2B-3B/1VC ≤ 3B-2VC

$$2U_B - p_2\tau + p_2\left[R_2 - R_3 - I + p_1R_1\sqrt{\frac{2I}{\gamma}}\right] + R_3 - 2I \leq$$

$$2U_B - \tau + R_3 - 3I + p_2R_2\sqrt{1+\frac{2I}{\gamma}} + \gamma\left[\sqrt{1+\frac{2I}{\gamma}} - 1\right]$$

$$\tau \leq \frac{1}{1-p_2}\left[(p_2R_2 + \gamma)\left(\sqrt{1+\frac{2I}{\gamma}} - 1\right) - p_2p_1R_1\sqrt{\frac{2I}{\gamma}} + p_2R_3 - (1-p_2)I\right] \equiv B_2$$

d) 3B-2B ≤ 2B-3B/1VC

$$2U_B + R_3 + p_2R_2 - 2I \leq 2U_B - p_2\tau + p_2R_2 - p_2R_3 - p_2I + p_2p_1R_1\sqrt{\frac{2I}{\gamma}} + R_3 - 2I$$

$$\tau \le p_1 R_1 \sqrt{\frac{2I}{\gamma}} - R_3 - I \equiv B_3$$

e) 3B-2VC ≤ 2VC-3B/1VC

$$2U_B - \tau + R_3 - 3I + p_2 R_2 \sqrt{1 + \frac{2I}{\gamma}} + \gamma \left[\sqrt{1 + \frac{2I}{\gamma}} - 1 \right]$$

$$\le 2U_B - 2\tau + p_2 R_2 - \alpha_1 p_2 R_2 + 2\Gamma(\alpha_1 - \alpha_1^2) + (1 - p_2)$$

$$(1 - \alpha_1)(R_3 - I) + (1 - 2\alpha_1) p_2 p_1 R_1 \sqrt{\frac{2I}{\gamma}} - 2p_2 I$$

$$\tau \le 2\Gamma(\alpha_1 - \alpha_1^2) - 2\alpha_1 p_2 p_1 R_1 \sqrt{2I/\gamma} - \alpha_1 p_2 R_2 + I$$

$$-\alpha_1 (1 - p_2)(R_3 - I) - (1 - p_2) B_2 \equiv B_4$$

f) 3B-2B ≤ 2VC-3B/1VC

$$2U_B + R_3 + p_2 R_2 - 2I \le 2\Gamma(\alpha_1 - \alpha_1^2) + 2U_B - 2\tau + p_2 R_2 - \alpha_1 p_2 R_2$$

$$+(1 - p_2)(1 - \alpha_1)(R_3 - I) + (1 - 2\alpha_1) p_2 p_1 R_1 \sqrt{\frac{2I}{\gamma}} - 2p_2 I$$

$$\tau \le \frac{1}{2} \left[2\Gamma(\alpha_1 - \alpha_1^2) - \alpha_1 p_2 R_2 + (1 - 2\alpha_1) p_2 p_1 R_1 \sqrt{\frac{2I}{\gamma}} + (1 - p_2) I - p_2 R_3 \right.$$

$$\left. - \alpha_1 (1 - p_2)(R_3 - I) \right] \equiv B_5$$

g) 2B-3B/1VC ≤ 2VC-3B/1VC

$$2U_B - p_2 \tau + p_2 R_2 - p_2 R_3 - p_2 I + p_2 p_1 R_1 \sqrt{\frac{2I}{\gamma}} + R_3 - 2I$$

$$\le 2U_B - 2\tau + p_2 R_2 - \alpha_1 p_2 R_2 + 2\Gamma(\alpha_1 - \alpha_1^2) + (1 - p_2)(1 - \alpha_1)$$

$$(R_3 - I) + (1 - 2\alpha_1) p_2 p_1 R_1 \sqrt{\frac{2I}{\gamma}} - 2p_2 I$$

$$\tau \le \frac{1}{2 - p_2} \left[2\Gamma(\alpha_1 - \alpha_1^2) - 2\alpha_1 p_2 p_1 R_1 \sqrt{\frac{2I}{\gamma}} - \alpha_1 p_2 R_2 + I - \alpha_1 (1 - p_2)(R_3 - I) \right]$$

$$\equiv B_6$$

Analysis of cut-off levels without early stage financing

a) Analysis of B_1

Claim: $B_1 > 0$.

Proof: $$B_1 = (p_2R_2 + \gamma)\left(\sqrt{1 + 2I/\gamma} - 1\right) - I \geq 0$$

After some calculations we find that this requires:

$$\frac{2}{\gamma} \geq \frac{2}{p_2R_2+\gamma} + \frac{I}{(p_2R_2+\gamma)^2} \quad \text{or}$$

$$\gamma \geq -\frac{2p_2^2R_2^2}{2p_2R_2-I} < 0 \quad \text{since } p_2R_2 > I.$$

Comparative statics:

$$\frac{\partial B_1}{\partial R_2} = 0$$

$$\frac{\partial B_1}{\partial p_2R_2} = 0$$

$$\frac{\partial B_1}{\partial \gamma} = \frac{1}{\sqrt{1+2I/\gamma}}\left(1 - \sqrt{1 + 2I/\gamma} - \frac{I}{\gamma}\left(\frac{p_2R_2}{\gamma} - 1\right)\right) < 0$$

since $p_2R_2 > \gamma$.

b) Analysis of B_3

Claim: sgn $(B_3 - B_1) = sgn\left(\sqrt{2I/\gamma}\left[p_1R_1 - (p_2R_2 + \gamma)\sqrt{1 + \gamma/2I}\right] - [R_3 - p_2R_2 - \gamma]\right)$.

Proof: $B_3 > B_1$ if:

$$p_1R_1\sqrt{2I/\gamma} - R_3 - I > (p_2R_2 + \gamma)\left(\sqrt{1 + 2I/\gamma} - 1\right) - I$$

Rewriting this expression gives us, thus proving our claim:

$$\sqrt{2I/\gamma}\left[p_1R_1 - (p_2R_2 + \gamma)\sqrt{1 + \gamma/2I}\right] > R_3 - p_2R_2 - \gamma$$

Comparative statics:

$$\frac{\partial B_3}{\partial R_3} = -1 < 0$$

$$\frac{\partial B_3}{\partial p_1R_1} = \sqrt{2I/\gamma} > 0$$

$$\frac{\partial B_3}{\partial \gamma} = -p_1R_1\frac{I}{\gamma^2\sqrt{2I/\gamma}} < 0$$

$$\frac{\partial(B_3 - B_1)}{\partial \gamma} = -p_1R_1\frac{I}{\gamma^2\sqrt{2I/\gamma}} - \sqrt{1 + 2I/\gamma} + 1 + (p_2R_2 + \gamma)\frac{I}{\gamma^2\sqrt{1 + 2I/\gamma}}$$

$$< -p_1 R_1 \frac{I}{\gamma^2\sqrt{1+2I/\gamma}} - \sqrt{1+2I/\gamma} + 1 + (p_2 R_2 + \gamma)\frac{I}{\gamma^2\sqrt{1+2I/\gamma}}$$

$$= \frac{I}{\gamma^2\sqrt{1+2I/\gamma}}\left[I(p_2 R_2 - p_1 R_1) - \gamma^2(1 + I/\gamma - \sqrt{1+2I/\gamma})\right] < 0$$

since $p_2 R_2 < p_1 R_1$ and $1 + I/\gamma > \sqrt{1+2I/\gamma}$

c) **Analysis of B_2**

Claim: $sgn(B_1 - B_2) = sgn(B_3 - B_1)$.

Proof:

We know that $(1-p_2)B_2 = B_1 - p_2 B_3$ and hence $B_2 = \frac{1}{1-p_2}(B_1 - p_2 B_3)$. Rewriting B_1-B_2 using this expression gives us:

$$B_1 - B_2 = \frac{p_2}{1-p_2}(B_3 - B_1)$$

thereby proving our claim.

Comparative statics:

$$\frac{\partial B_2}{\partial R_2} = \frac{p_2}{(1-p_2)} > 0$$

$$\frac{\partial B_2}{\partial p_2 R_2} = \frac{p_2}{(1-p_2)}\sqrt{2I/\gamma} > 0$$

$$\frac{\partial B_2}{\partial \gamma} = \frac{1}{1-p_2}\left|\frac{\partial B_4}{\partial \gamma} - p_2\frac{\partial B_3}{\partial \gamma}\right| \gtrless 0$$ depending on the size of γ.

However, we find that

$$\frac{\partial(B_3 - B_2)}{\partial \gamma} = \frac{\partial(B_3 - B_2)/(1-p_2)}{\partial \gamma} < 0$$ (see above).

Analysis of cut-off levels with early stage financing

If VC financing is possible at the first stage, we have to take into account three additional cut-off levels: B_4, B_5, and B_6. In order to be able to deduce the financing preferences depending on the level of τ, it is important to be able to rank the different cut-off levels.

We know that:

$$B_4 = (2-p_2)B_6 - (1-p_2)B_2$$

$$B_5 = 0.5[(2-p_2)B_6 + p_2 B_3]$$

This implies that $B_4 > B_6$ if $B_2 < B_6$ and $B_5 > B_6$ if $B_3 > B_6$. Moreover, we know that $B_5 > B_3$ if $B_6 > B_3$ and $B_4 < B_2$ if $B_6 < B_2$.

Moreover, it is important to be able to compare the cut-off levels B_5 and B_4.

In order for $B_5 > B_1$, $0.5[(2-p_2)B_6 + p_2B_3] > B_1$

or rearranging

$$B_6 > \frac{2(1-p_2)}{2-p_2}B_2 - \frac{p_2}{2-p_2}B_3.$$

In order for $B_4 > B_1$, $(2-p_2)B_6 - (1-p_2)B_2 > B_1$

or rearranging

$$B_6 > \frac{p_2}{2-p_2}B_3 + \frac{2(1-p_2)}{2-p_2}B_2.$$

In order for $B_4 > B_5$, $(2-p_2)B_6 - (1-p_2)B_2 > 0.5[(2-p_2)B_6 + p_2B_3]$

or rearranging

$$B_6 > \frac{2(1-p_2)}{2-p_2}B_2 - \frac{p_2}{2-p_2}B_3.$$

Thus, if $B_5 > B_1$ then also $B_4 > B_5$ and consequently $B_4 > B_1$.

Against this background, we can distinguish different cases with respect to the relative level of B_6 and the order of B_3 and B_2. First, if $B_3 > B_2$, we have to distinguish three different cases with respect to the relative level of B_6.

Case 1: $B_6 < B_2$

This implies that $B_6 < B_3$ as $B_3 > B_2$ (see above). In addition, we know that $B_4 < B_6$ and $B_5 > B_6$ as well as $B_5 < B_3$ and $B_4 < B_2$. Thus, we can state: $B_3 > B_2 > B_6 > B_4$ and $B_6 < B_5 < B_3$. Hence, one new area comes into play to the left (2VC-3B/1VC) without substituting any of the other projects (see figure 3).

Case 2: $B_2 < B_6 < B_3$

This implies $B_4 > B_6$ and $B_5 > B_6$ as well as $B_5 < B_3$ and $B_4 > B_2$. Thus, $B_3 > B_5 > B_6$,

$B_4 > B_6$ and $B_3 > B_6 > B_2$ implying that the second case differs from the first one only by the fact that 2VC-3B/1VC squeezes out the 3B-2VC sequence.

Case 3: $B_6 > B_3$

This implies that $B_6 > B_2$. In addition, we know that $B_4 > B_6$ and $B_5 < B_6$ as well as $B_5 > B_3$ and $B_4 > B_2$. Thus, $B_4 > B_6 > B_5 > B_3 > B_2$ implying that in this case 2VC-3B/1VC squeezes out the 3B-2VC as well as the 2B-3B/1VC sequence.

The last case is very specific and thus does not appear in our numerical example.

Second, if $B_3 < B_2$, we must distinguish the following cases with respect to the relative level of B_6.

Case 1: $B_6 > B_2$

This implies that $B_6 > B_3$ and consequently, $B_4 > B_6$, $B_5 > B_3$ and $B_5 < B_6$. Thus, we can state: $B_4 > B_6 > B_2 > B_1 > B_3$ and $B_6 > B_5 > B_3$. Thus, in this case, we continue observing only two areas as in the basic case where $B_2 > B_1$ with the difference that the 3B-2VC sequence is now substituted by the 2VC-3B/1VC sequence.

Case 2: $B_2 > B_6 > B_1$

This implies $B_6 > B_3$ and consequently, $B_4 < B_6$, $B_5 > B_3$ and $B_5 < B_6$. Thus, we can state: $B_2 > B_6 > B_1 > B_3$ and $B_6 > B_5 > B_3$ and $B_6 > B_4$. Though we have to consider to subcases depending on the relative order of B_4 and B_5. If $B_5 > B_4$, then we get an additional area at the left with the sequence 2VC-3B/1VC with respect to the basic case where $B_2 > B_1$. If $B_5 < B_4$, then the sequence 3B-2VC is substituted by the sequence 2VC-3B/1VC.

Case 3: $B_1 > B_6 > B_3$

This implies that $B_2 > B_1 > B_6$ and consequently, $B_4 < B_6$, $B_5 > B_3$ and $B_5 < B_6$. Thus, we can state: $B_2 > B_1 > B_6 > B_5 > B_3$ and $B_5 > B_4$ as $B_1 > B_5$. In this case, we again get an additional area at the left with the sequence 2VC-3B/1VC with respect to the basic case where $B_2 > B_1$.

Case 4: $B_6 < B_3$

This implies $B_6 < B_2$ and consequently, $B_4 < B_6$, $B_5 < B_3$ and $B_5 > B_6$. Thus, we can state: $B_2 > B_1 > B_3 > B_5 > B_6 > B_4$. In this case, we again get an additional area at the left with the sequence 2VC-3B/1VC with respect to the basic case where $B_2 > B_1$.

Thus, as we can see, the four cases reduce indeed to only two cases:

If $B_6 > B_2$ or if $B_2 > B_6 > B_1$ and $B_5 > B_1$, the sequence 3B-2VC is substituted by the sequence 2VC-3B/1VC. In all other cases, we get an additional area at the left with the sequence 2VC-3B/1VC with respect to the basic case where $B_2 > B_1$. In fact, the last case is the only case which appears in our numerical example.

Endnotes:

[1] We thank Patrick Herbst for the very constructive and helpful comments on an earlier version of the paper.

[2] Moreover, we think that even if investors had a specific level of bargaining power, this would not change our results fundamentally. This is due to the fact that a general shift of the bargaining power to the banks, for example, would only imply a level change of the entrepreneur´s profits but no change in the relative ordering. In addition, if only VCs had some bargaining power due to their specific human capital but not banks, the entrepreneur would loose a part of the profits of projects 2 and 1 respectively. However, ensuring that the gain through the VC's advice is sufficiently high would guarantee that no change occurs in the relative ordering either.

[3] Allowing for risk aversion of the entrepreneur would complicate the analysis considerably. Nevertheless, we expect that there would not be any qualitatively different results. The introduction of a risk averse entrepreneur would only change the relative valuations of the projects: project 3 would gain and projects 1 and 2 would loose. But as the financing choice does not have any influence on the probabilities of the projects, this would only imply that the differences between the projects would increase or shrink depending on the project pair. But this is just equivalent to our analysis in section 3.

[4] We have chosen the most tractable way to express this idea. Alternatively, we could have assumed that the advice activities of the VCs enhance the success probabilities. This turns out to complicate the analysis significantly because it introduces the possibility of strategic behavior at the first stage.

[5] An extension to a double moral hazard problem is straightforward (see, for example, Schmidt 2003 or Casamatta 2003). However, we want to limit our analysis to the most basic case and exclude detailed contracts design issues. Therefore, we normalize returns in case of failure to zero as this allows us to restrict to linear contracts.

[6] Loosing more control benefits would increase the costs of advice and thus decrease the optimal advice levels chosen. Consequently, VC financing would become relatively less attractive but the qualitative results of section 3 should still hold.

[7] Given our set-up, we cannot distinguish explicitly between a debt and an equity contract. However, for interpretation issues, we will assume that banks always offer debt contracts while VCs offer pure equity contracts. The idea behind this interpretation is the following. As banks do not offer advice, they do not need any specific incentives. Furthermore, equity contracts reduce the entrepreneur's private benefits. Thus, debt contracts are optimal with banks.

[8] This is due to the fact that we exclude upfront payments from the VC to the entrepreneur. Consequently, the VC will always choose suboptimal effort levels as he will never be full residual claimant. Therefore, in order to achieve the maximum possible advice level, it is optimal to give him a pure equity contract.

[9] This would be the case, for example, if there are potential informational asymmetries between inside and outside investors regarding the quality of the venture. Our results would remain unchanged, however, if financing is undertaken by two different VCs as long as advice costs are convex in the total advice level of the syndicate and the second VC covers the additional effort costs of the syndicate.

[10] This facilitates our analysis significantly. Allowing for the reverse order would not change, however, the qualitative nature of our subsequent analysis at all.

[11] More precisely, this requires $\sqrt{2I/\gamma}\left[p_1 R_1 - (p_2 R_2 + \gamma)\sqrt{1 + \gamma/2I}\right] > R_2 - p_2 R_2 - \gamma$.